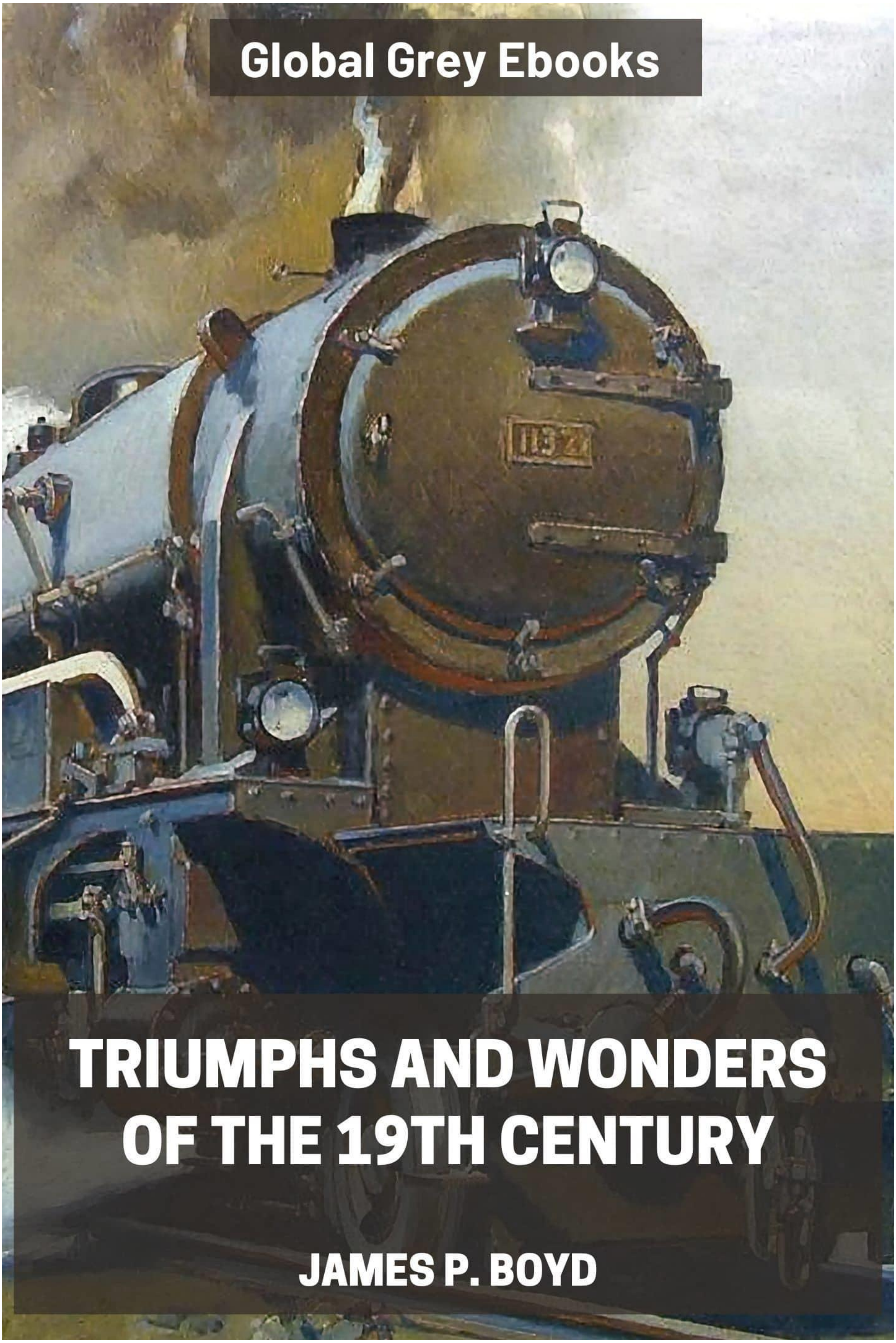

TRIUMPHS AND WONDERS OF THE 19TH CENTURY

JAMES P. BOYD

TRIUMPHS AND WONDERS OF THE 19TH CENTURY

JAMES P. BOYD

Triumphs and Wonders of the 19th Century by James P. Boyd.
First published in 1901.
This ebook edition was created and published by Global Grey on the 19th September 2023.
The artwork used for the cover is '*BBÖ Express Locomotive class 113*'
painted by Josef Danilowatz.
This book can be found on the site here:
globalgreyebooks.com/triumphs-and-wonders-of-the-nineteeth-century-ebook.html

Contents

Introductory

Measuring epochs, or eras, by spaces of a hundred years each, that which embraces the nineteenth century stands out in sublime and encouraging contrast with any that has preceded it. As the legatee of all prior centuries, it has enlarged and ennobled its bequest to an extent unparalleled in history; while it has at the same time, through a genius and energy peculiar to itself, created an original endowment for its own enjoyment and for the future richer by far than any heretofore recorded. Indeed, without permitting existing and pardonable pride to endanger rigid truth, it may be said that along many of the lines of invention and progress which have most intimately affected the life and civilization of the world, the nineteenth century has achieved triumphs and accomplished wonders equal, if not superior, to all other centuries combined.

Therefore, what more fitting time than at its close to pass in pleasing and instructive review the numerous material and intellectual achievements that have so distinguished it, and have contributed in so many and such marvelous ways to the great advance and genuine comfort of the human race! Or, what could prove a greater source of pride and profit than to compare its glorious works with those of the past, the better to understand and measure the actual steps and real extent of the progress of mankind! Or, what more delightful and inspiring than to realize that the sum of those wonderful activities, of which each reader is, or has been, a part, has gone to increase the grandeur of a world era whose rays will penetrate and brighten the coming centuries!

Amid so many and such strong reasons this volume finds excellent cause for its being. Its aims are to mirror a wonderful century from the vantage ground of its closing year; to faithfully trace the lines which mark its almost magical advance; to give it that high and true historic place whence its contrasts with the past can be best noted, and its light upon the future most directly thrown.

This task would be clearly beyond the power of a single mind. So rapid has progress been during some parts of the century, so amazing have been results along the lines of discovery and invention, so various have been the fields of action, that only those of special knowledge and training could be expected to do full justice to the many subjects to be treated.

Hence, the work has been planned so as to give it a value far beyond what could be imparted by a single mind. Each of the themes chosen to type the century's grand march has been treated by an author of special fitness, and high up in his or her profession or calling, with a view to securing for readers the best thoughts and facts relating to the remarkable events of an hundred years. In this respect the volume is unique and original. Its authorship is not of one mind, but of a corps of minds, whose union assures what the occasion demands.

The scope, character, and value of the volume further appear in its very large number and practical feature of subjects selected to show the active forces, the upward and onward movements, and the grand results that have operated within, and triumphantly crowned, an era without parallel. These subjects embrace the sciences of the century in their numerous divisions and conquests; its arts and literature; industrial, commercial, and financial progress; land and sea prowess; educational, social, moral, and religious growth; in fact, every field of enterprise and achievement within the space of time covered by the work.

A volume of such variety of subject and great extent affords fine opportunity for illustration. The publishers have taken full advantage of this, and have beautified it in a manner which commends itself to every eye and taste. Rarely has a volume been so highly and elegantly embellished. Each subject is illuminated so as to increase the pleasure of reading and make an impression which will prove lasting.

As to its aim and scope, its number of specially qualified authors, its vigor and variety of style and thought, its historic comprehensiveness and exactness, its great wealth of illustration, its superb mechanism, its various other striking features, the volume may readily rank as one of the century's triumphs, a wonder of industrious preparation, and acceptable to all. At any rate, no such volume has ever mirrored any previous century, and none will come to reflect the nineteenth century with truer line and color.

Not only is the work a rare and costly picture, filled in with inspiring details by master hands, but it is equally a monument, whose solid base, grand proportions, and elegant finish are in keeping with the spirit of the era it marks and the results it honors. Its every inscription is a glowing tribute to human achievement of whatever kind and wherever the field of action may lie, and therefore a happy means of conveying to twentieth century actors the story of a time whose glories they will find it hard to excel. May this picture and monument be viewed, studied, and admired by all, so that the momentous chapters which round the history of a closing century shall avail in shaping the beginnings of a succeeding one.

Wonders Of Electricity

By JAMES P. BOYD, A.M., L.B.

I. AT THE DAWN OF THE CENTURY.

When, in his “Midsummer Night’s Dream,” Shakespeare placed in the mouth of Puck, prince of fairies, the playful speech,—

“I’ll put a girdle round about the earth
In forty minutes,”

he had no thought that the undertaking of a boastful and prankish sprite could ever be outdone by human agency. Could the immortal bard have lived to witness the time when the girdling of the earth by means of the electric current became easier and swifter than elfin promise or possibility, he must have speedily remodeled his splendid comedy and denied to the world its delightful, fairy-like features.

An old and charming story runs, that Aladdin, son of a widow of Bagdad, became owner of a magic lamp, by means of whose remarkable powers he could bring to his instant aid the services of an all-helpful genie. When Aladdin wished for aid of any kind, he had but to rub the lamp. At once the genie appeared to gratify his desires. By means of the lamp Aladdin could hear the faintest whisper thousands of miles away. He could annihilate both time and space, and in a twinkling could transfer himself to the tops of the highest mountains. How the charm of this ancient story is lost in the presence of that marvelous realism which marks the achievements of modern electrical science!

The earliest known observations on that subtle mystery which pervades all nature, that silent energy whose phenomena and possibilities are limitless, and before which even the wisest must stand in awe, are attributed to Thales, a scholar of Miletus, in Greece, some 600 years B. C. On rubbing a piece of amber against his clothing, he observed that it gained the strange property of at first attracting and then repelling light objects brought near to it. His observations led to nothing practical, and no historic mention of electrical phenomena is found till the time of Theophrastus (B. C. 341), who wrote that amber, when rubbed, attracted “straws, small sticks, and even thin pieces of copper and iron.” Both Aristotle and Pliny speak of the electric eel as having power to benumb animals with which it comes in contact.

Thus far these simple phenomena only had been mentioned. There was no study of electric force, no recognition of it as such, or as we know it and turn it to practical account to-day. This seems quite strange when we consider the culture and power to investigate of the Egyptians, Phœnicians, Greeks, and Romans. True, a few fairy-like stories of how certain persons emitted sparks from their bodies, or were cured of diseases by shocks from electric eels, are found scattered through their literatures, but they failed to follow the way to electrical science pointed out to them by Thales. Even in the Middle Ages, when a few scientists and writers saw fit to speak of electrical phenomena as observed by the ancients, and even ventured to speculate upon them in their crude way, there were no practical additions made to the science, and the ground laid as fallow as it had done since the creation.

After a lapse of more than two thousand years from the experiment of Thales, Dr. Gilbert, physician to Queen Elizabeth (A. D. 1533–1603), took up the study of amber and various other substances which, when subjected to friction, acquired the property of first, attracting and then repelling light bodies brought near them. He published his observations in a little book called "De Magnete," in the year A. D. 1600, and thus became the first author of a work upon electricity. In this unique and initial work upon simple electrical effects, the author added greatly to the number of substances that could be electrified by friction, and succeeded in establishing the different degrees of force with which they could be made to attract or repel light bodies brought near them.

Fortunately for electrical science, and for that matter all sciences, about this time the influence of Lord Bacon's Inductive Philosophy began to be felt by investigators and scientific men. Before that, the causes of natural phenomena had not been backed up by repeated experiments amounting to practical proofs, but had been accounted for, if at all, by sheer guesses or whimsical reasons. Bacon's method introduced hard, cold, constant experiment as the only sure means of finding out exactly the causes of natural phenomena; and not only this, but the necessity of series upon series of experiments, each based upon the results of the former, and so continuing, link by link, till, from a comparison of the whole, some general principle or truth could be drawn that applied to all. This *inductive* method of scientific research gave great impetus to the study of every branch of science, and especially to the unfolding of infallible and practical laws governing the phenomena of nature.

For very many years electrical experiments followed the lines laid down by Dr. Gilbert; that is, the finding of substances that could be excited or electrified by friction. By and by such substances came to be called *electrics*, and it became a part of the crude electrical science of the time to compute the force with which these electrics, when excited, attracted or repelled other substances near them. Among the ablest of these investigators were Robert Boyle, author of "Experiments on the Origin of Electricity," Sir Isaac Newton, Otto von Guericke, and Francis Hawksbee, the last of whom communicated his experiments to the English Royal Society in 1705. Otto von Guericke used a hard roll of sulphur as an electric. He caused it to revolve rapidly while he rubbed or excited it with his hand. Newton and Hawksbee used a revolving glass globe in the same way, and thus became the parents of the modern and better equipped electrical machine used for school purposes.

The next step in electrical discovery, and one which marks an epoch in the history of the science, was made by Stephen Gray, of England, in 1729. To him is due the credit of finding out that electricity from an excited glass cylinder could be conducted away from it to objects at a remote distance. Though he used only a packthread as a conductor, he thus carried electricity to a distance of several hundred feet, and his novel discovery opened up what, for the time, was a brilliant series of experiments in England and throughout France and Germany. Out of these experiments came the knowledge that some substances were natural conductors of electricity, while others were non-conductors; and that the non-conductors were the very substances—glass, resin, sulphur, etc.—which were then in popular use as electrics. Here was laid the foundation of those after-discoveries which led to the selection of copper, iron, and other metals as the natural and therefore best conductors of electricity, and glass, etc., as the best insulators or non-conductors.

Up to this time an excited electric, such as a glass cylinder or wheel, had furnished the only source whence electricity had been drawn for purposes of experiment. But now another great step forward was taken by the momentous discovery that electricity, as furnished by the excited but quickly exhausted electric, could be bottled up, as it were, and so accumulated and preserved in large quantities, to be drawn upon when needed for experiment. It is not known who made this important discovery; but by common consent the storage apparatus, which was to play so conspicuous a part in after-investigations, was named the *Leyden Jar* or *Phial*, from the city of Leyden in Holland. It consisted of a simple glass jar lined inside and out with tinfoil to within an inch or two of the top, the tinfoil of the inside being connected by a conductor passing up through the stopper of the jar to a metallic knob on top. This jar could be charged or filled with electricity from a common electric, and it had the power of retaining the charge till the knob on top was touched by the knuckle, or some unelectrified substance, when a spark ensued, and the jar was said to be discharged. By conductors attached to the knob, guns were fired off at a distance by means of the spark, and it is said that Dr. Benjamin Franklin ignited a glass of brandy at the house of a friend by means of a wire attached to a Leyden jar and stretched the full width of the Schuylkill River at Philadelphia.

At this stage in the history of eighteenth century electricity there enters a character whose experiments in electricity, and whose writings upon the subject, not only brought him great renown at home and abroad, but perhaps did more to systematize the science and turn it to practical account than those of any contemporary. This was the celebrated Dr. Benjamin Franklin, of Philadelphia, Pa. He showed to the world that electricity was not created by friction upon an electric, but that it was merely gathered there, when friction was applied, from surrounding nature; and in proof of his theory he invaded the clouds with a kite during a thunder-storm, and brought down electricity therefrom by means of the kite-string as a conductor. The key he hung on the string became charged with the electric fluid, and on being touched by an unelectrified body, emitted sparks and produced all the effects commonly witnessed in the discharge of the Leyden jar.

Franklin further established the difference between positive and negative electricity, and showed that the spark phenomenon on the discharge of the Leyden jar was due to the fact that the inside tinfoil was positively electrified and the outside tinfoil negatively. When the inside tinfoil was suddenly drawn upon by a conductor, the spark was simply the result of an effort upon the part of the two kinds of electricity to maintain an equilibrium. By similar reasoning he accounted for the phenomenon of lightning in the clouds, and by easy steps invented the lightning-rod, as a means of breaking the force of the descending bolt, and carrying the dangerous fluid safely to the ground. Here we have not only a practical result growing out of electrical experiments, but we witness the dawn of an era when electricity was to be turned to profitable commercial account. The lightning-rod man has been abroad in the world ever since the days of Franklin.

Thus far, then, electrical science, if science it could yet be called, had gotten on at the dawn of the nineteenth century. No electricity was really known but that produced by friction upon glass, or some other convenient electric. Hence it was called *frictional* electricity by some, and *static* electricity by others, because it was regarded as electricity in a state of rest. Though a thing fitted for curious experiment, and a constant invitation to scientific research, it had no use whatever in the arts. An excited electric could furnish but a trivial and temporary supply of electricity. It exhausted itself in the exhibition of a single spark.

II. THE NEW NINETEENTH CENTURY ELECTRICITY.

By a happy accident in 1790, Galvani, of Bologna, Italy, while experimenting upon a frog, discovered that he could produce alternate motion between its nerves and muscles through the agency of a fluid generated by certain dissimilar metals when brought close together. Though this mysterious fluid came to be known as the galvanic fluid, and though galvanism was made to perpetuate his name, it was not until 1800 that Volta, another Italian, showed to the scientific world that really a new electricity had been found.

Volta constructed what became known as the galvanic pile, but more largely since as the voltaic pile, which he found would generate electricity strongly and continuously. He used in its construction the dissimilar metals silver and zinc, cut into disks, and piled alternately one upon the other, but separated by pieces of cloth moistened with salt water. This simple generator of electricity was the forerunner of the more powerful batteries of the present day, and which are still popularly known as voltaic cells or batteries.

But the importance of Volta's discovery did not lay more in the construction of his electrical generator than in the great scientific fact that chemistry now became linked indissolubly with electricity and electrical effects. The two novel and charming sciences, hitherto separate, were henceforth to coöperate in those majestic revelations and magnificent possibilities which so signally distinguish the nineteenth century. By means of greatly improved voltaic cells or batteries, that is, by jars containing acid in which were suspended dissimilar metals, electricity could be produced readily and in somewhat continuous current. By increasing the number of these cells or jars or batteries, and connecting them with conductors, the current could be made stronger and more effective. In contradistinction to the old frictional or static electricity, the new became known as chemical or current electricity.

As was to have been expected, Volta's invention and discovery excited the whole domain of electrical science to new investigation, and brought in their train a host of wonderful results, growing more and more practical each year, and pointing the way more and more clearly to the commercial value of electricity as a familiar, inexhaustible, and irresistible power. Thus, in 1801, Nicholson showed that an electric current from a voltaic pile would, when passed through salt water, decompose the water and resolve it into its two original gases, oxygen and hydrogen. In 1807, Sir Humphrey Davy, carrying electricity further into the domain of chemistry, showed, by means of the electric current, that various metallic substances embraced in the earth's crust, and before his time supposed to be elementary, were really dissoluble and easily resolved into their component parts, whether solids, or gases, or both. Two years later, in 1809, he made the equally momentous discovery of something which was to prove a veritable *sit lux*, "Let there be light," for the nineteenth century, and illuminate it beyond all others. Though it had been known almost from the date of the first voltaic pile that, when the ends of its two conducting wires were brought close together, a spark was seen to leap in a curved or arc line from one wire to the other, which phenomenon was known as the voltaic arc, it remained for Davy to exhibit this arc in all the beauty of a brilliant light by using two charcoal (carbon) sticks or electrodes, instead of the wires, at the point of close approach. Here was the first principle of the after-evolved arc light to be found by the end of the century in every large city, and to prove such a source of comfort and safety for their millions of inhabitants. This principle was simply that a stream of electricity pouring along a conducting wire will, when interrupted by a substance such as carbon (charcoal), which is a slow conductor, throw off a bright light at the point of interruption. The phenomenon has been very aptly likened to a running stream of water in whose bed a stone has been placed. The stone obstructs the flow of water. The water remonstrates by an angry ripple and excited roar. In Davy's experiment with the pieces of charcoal, both became intensely hot while the electricity was making its brilliant arc leap from one to the other, and would, of course, soon be consumed. He, therefore, in showing the principle of a permanent luminant, failed to demonstrate its practical possibilities. These last were not to be attained till the nineteenth century was well along, and only after very numerous and very baffling attempts.

Between 1810 and 1830, many important laws governing electrical phenomena were discovered, which tended greatly to render the science more exact, and to give it commercial direction. Oersted, of Denmark, discovered a means of measuring the strength and direction of an electric current. Ampère, of France, discovered the identity of electricity and what had before been called galvanism. Ritchie, of England, made the first machine by which a continuous motion was produced by means of the attractions and repulsions between fixed magnets and electro-magnets. This machine was an early suggestion of the dynamo and motor of the coming years of the century. It meant that electricity was a source of power, as well as of other phenomenal things.

In speaking of the electro-magnet in connection with Ritchie's machine, it is proper to say that the electro-magnet was probably discovered between 1825 and 1830, but precisely by whom is not known. It differs from the natural magnet, or the permanent steel horseshoe magnet, and consists simply of a round piece of soft iron, called a core, around which are wrapped several coils of fine wire. When an electric current is made to pass through this wrapping of wire, called the helix, the iron core becomes magnetized, and has all the power of a permanent magnet. But as soon as the electric current ceases, the magnetic power of the core is lost. Hence it is called an electro-magnet, or a temporary magnet, to distinguish it from a permanent magnet.

While the discovery of the electro-magnet was very important in the respect that it afforded great magnetic power by the use of a limited or economic galvanic force, or, in other words, by the use of smaller and fewer Voltaic batteries, it was not until Faraday began his splendid series of electrical discoveries, in 1831, that a new and exhaustless wellspring of electricity was found to lay at the door of science. Faraday's prime discovery was that of the induction of electric currents, or, in other words, of manufacturing electricity directly from magnetism. He began his experiments with what became known as an induction coil, which, though then crude in his hands, is the same in principle to-day. It consists of an iron core wrapped with two coils of insulated wire. One coil is of very lengthy, thin wire, and is called the secondary coil. The other is of short, thick wire, and is called the primary. When a magnetic current is passed through the primary coil, with frequent makes and breaks, it induces an alternating current of very high tension in the secondary coil, thus powerfully increasing its effects. In Faraday's further study of electric induction, he showed that when a conductor carrying a current was brought near to a second conductor it induced or set up a current in this second. So magnets were found to have a similar effect upon one another.

The secret of these phenomena was found to lie in the fact that a magnet, or a conductor carrying a current, was the centre of a field of force of very considerable extent. Such a field of force can be familiarly shown by placing a piece of glass or white paper sprinkled with fine iron filings upon the poles of a magnet. The filings will be drawn into concentric circles, whose extent measures the magnet's field of force. So also the extent of the field of force surrounding a conductor carrying a current may be familiarly shown. In these instances the filings brought within the fields of force are magnetized. So would any other conducting substance be, and would become capable of carrying away as an independent current that which had been induced in it. Here we have the essential principle of the modern dynamo-electric machine, commonly called simply dynamo. Faraday actually constructed a dynamo, which answered very well for his experiments, but failed in commercial results because the only source of energy he could draw upon in his time was that supplied by the rather costly voltaic cells.

During Faraday's time and subsequently, electricians in Europe and the United States were active in formulating further laws relative to the nature, strength, and control of electrical currents, and each year was one of preparation for the coming leap of electrical science into the vast realm of commercial convenience and profit.

III. THE TELEGRAPH.

From the date of the discovery that electricity could be conducted to a distance, dreams were indulged that it could be made a means of communicating intelligence. In the eighteenth century, many attempts were made to carry intelligent signals over electric wires. Some of these were quite ingenious, but in the end failures, because the old-fashioned frictional electricity was the only kind then known and employed. Even after the discovery of the voltaic cell or battery, which afforded an ample supply of chemical electricity to operate a telegraphic apparatus, the time was not ripe for successful telegraphy, for up till 1830 no battery had been produced that was sufficiently constant in its operation to supply the kind of current required. For feasible telegraphy, two important steps were yet necessary. One was the discovery of the electro-magnet, 1825–30. The other was the discovery of the Daniell's battery or cell, in 1836, by means of which a constant electric current could be sustained for a long time.

But even before these two indispensable requisites had been supplied by human genius, much had been done to develop the mechanical methods of conveying intelligence. In 1816, Ronalds, of England, constructed a telegraph by means of which he operated a system of pith-ball signals which could be understood. In 1820, Ampère suggested that the deflection of the magnetic needle by an electric current might be turned to account in imparting intelligence at a distance. In 1828, Dyar, of New York, perfected a telegraph by means of which he made tracings and spaces upon a piece of moving litmus paper, which tracings and spaces could be intelligently interpreted through a prearranged code. A little later, 1830, Baron Schilling constructed a telegraph which imparted motion to a set of needles at either end.

From this time up to 1837, which last year was a memorable one in the history of telegraphy, the genius of such distinguished men as Morse in America, Wheatstone and Cooke in England, and Steinhill in Munich, was brought to bear on the further evolution of the telegraph. While all these names have been associated with the invention of the first practical telegraph, it is impossible, with justice, to rob that of Morse of the distinguished honor. Morse conceived his invention on board the ship Surry, while on a voyage from Havre to New York, in October, 1832. It consisted, as conceived, of a single circuit of conductors fed by some generator of electricity. He devised a system of signs, which was afterwards improved into the Morse alphabet, consisting of dots or points, and spaces, to represent numerals. These were impressed upon a strip of ribbon or paper by a lever which held at one end a pen or pencil. The paper or ribbon was made to move along under the pencil or pen at a regular rate by means of clockwork. In accordance with these conceptions, Morse completed his instrument and publicly exhibited it in 1835. He gave it further publicity, in much improved form, in 1837. In this form it was entirely original in the important respects that the ribbon or paper was made to move by clockwork, while a pen or pencil gave the impressions, thus preserving a permanent record of the message conveyed.

Though under systems less original and effective than that of Morse, a first actual telegraph had been operated between Paddington and Drayton, England, a distance of 13 miles, in 1839, and one at Calcutta, India, for a distance of 21 miles, it was not until 1844 that the world's era of practical telegraphy actually set in under the Morse system, which speedily superseded all others. In that year, amid the jeers of congressmen and the adverse predictions of the press, Morse erected the first American telegraph line in America, between Baltimore and Washington, a distance of 40 miles, and, to the confusion of all detractors, sent the first message over it on May 27 of that year. From that date the fame of Morse was established at home, and soon became world-wide. His system of telegraphy, with slight modifications, became that of all civilized countries.

As was to be expected in a century so full of enterprise as the nineteenth, a science so attractive, so useful to civilization, so commercially valuable, so full of possibilities, as telegraphy, could not remain at rest. Everywhere it stimulated to improvement and new invention and discovery; and as the century progressed, it witnessed in steady succession the wonders of what became known as duplex telegraphy, that is, the sending of different messages over the same wire at the same time. Again, the century witnessed the invention of quadruplex telegraphy, that is, the sending of four separate messages over the same wire, two in one direction and two in another. This was followed by the invention of Gray's *harmonic system*, by means of which a number of messages greater than four are transmitted at the same time over the same wire; and this again by Delaney's *synchronous multiplex system*, by means of which as many as 72 separate messages have been sent over the same wire at the same time, either all in one direction, or some in one direction and the rest in an opposite.

For a time successful telegraphy was limited to overland spaces, the conductors or wires, consisting of iron or copper, being insulated where they passed the supporting poles. In the cities, supporting poles proved to be unsightly and dangerous, and they were succeeded by underground conduits carrying insulated wires. In 1839, we read of what may be reckoned the first successful experiment in telegraphing under water by means of an insulated wire, or cable, as a conductor. The experiment was tried at Calcutta, and under the river Hugli. In 1842, Morse experimented at New York with an under-water cable, and showed that a successful submarine telegraphy was practical. In 1848, a cable, insulated with gutta-percha, was laid under water between New York and Jersey City, and successfully operated. In 1851, a submarine cable was laid and successfully operated under the English Channel. An enterprising American, Cyrus W. Field, of New York, now took up the subject of submarine telegraphy, and suggested a cable under the ocean between Ireland and Newfoundland. One was laid in 1857, but it unfortunately parted at a distance of three hundred miles from land. A second was laid under Mr. Field's auspices in 1858, but the insulation proved faulty, and after working imperfectly for a month, it gave out entirely.

These disasters, though furnishing much valuable experience, checked the enterprise of submarine telegraphy for a number of years. Not until 1861, when a deep-sea cable was successfully laid and operated between Malta and Alexandria, and in 1864, when one was laid across the Persian Gulf, did enterprise gain sufficient courage to dare another attempt to cable the Atlantic. In 1865, that attempt was made. Again the cable broke, but this did not dissuade from another and successful attempt in 1866. This signal triumph was the forerunner of others, equally important to international commerce and the world's diplomacy. Countries far apart, and isolated by oceans, have, by means of deep-sea cables, been brought into intimate relation, and made sharers of one another's intelligence, enterprise, and civilizing instincts. What the overland telegraph has done toward bringing local states and communities into contact, the submarine cable has done for the remote nations.

In form, an ocean cable differs much from the simple wire which constitutes the conductor of an overland or even underground telegraph. It is made in many ways, but mostly with a central core of numerous copper wires, which are more flexible than a single wire. These are thickly covered with an insulating material, such as gutta-percha, after first being heavily wrapped in tarred canvas or like material. The central cores may be one, two, three, or even more in number. Where a cable is likely to be subjected to the abrasion of ship-bottoms, rocks, or anchors, it has an outer covering or guard composed of closely united steel wires. In submarine telegraphy, the instruments used in sending and receiving the message are very much more ingenious, delicate, and costly than in overland telegraphy.

Whereas at the beginning of the nineteenth century electric telegraphy was an unknown science, and even up to the middle of the century was of limited use and doubtful commercial value, nevertheless the end of the century witnesses in its growth and application one of its most stupendous marvels. From the few miles of overland wires in 1844, the total mileage of the century has expanded to approximately 5,000,000, and the submarine to 170,000. A single company (the Western Union) in the United States operates 800,000 miles of wire, conveying 60,000,000 messages per year, while throughout the world more than 200,000,000 messages per year serve the purposes of enlightened intercourse. The capital employed reaches many hundreds of millions of dollars.

The close of the nineteenth century opened possibilities in telegraphy that may be classed as startling in comparison with its previous attainments. It would seem that the intervention of the familiar conducting wire is not absolutely necessary to the transmission of intelligence. The old and well-established principle of induced currents has lately been turned to account in what is termed “telegraphy without wires.” As an instance, a telegraph wire, when placed close alongside of a railroad track, will take up and convey to and from the stations the induced pulsations of a magneto-telephone placed within a passing car, and connected to the metallic roof of the car. This system has been put to practical use on at least one railway, and pronounced feasible.

But a greater marvel than this springs from the discovery of Hertz, about 1890, that every electrical discharge is the centre of oscillations radiating indefinitely through space. The phenomenon is likened to the dropping of a stone in a placid lake. Concentric undulations of the water are set up,—little waves,—which gradually enlarge in diameter, and affect in greater or less degree the entire surface. Could an apparatus be invented to detect and direct the oscillations made in space by an electric generator,—to perceive, as it were, the ether undulations, just as the eye notes those on the lake’s surface?

In 1891, Professor Branley found that the electric vibrations in ether could be detected by means of fine metallic filings. No matter how good a conductor of electricity the metal in mass might be, when reduced to fine filings or powder it offered powerful resistance to a passing current; in other words, became a very poor conductor. An electric discharge or spark near the filings greatly decreased their resistance. If the filings were jarred, their original resistance was restored. Branley placed his filings in a tube, into either end of which wires were passed. These were connected with a galvanometer. Ordinarily, the resistance of the filings was such as to prevent a current passing through them, and the galvanometer remained unaffected. But when an electric spark was emitted near the tube, the resistance was so much decreased that the current passed readily through the filings, and was detected by the galvanometer. This is simply equivalent to saying that the discharge of the electric spark made the filings to cohere and become a better conductor than when lying loosely in the tube. Here, then, was opportunity for an instrument which had but to regulate the number of sparks and indicate the presence of the electric waves in order to produce dots and dashes similar to those used in the common telegraph. Such an instrument was brought nearest to perfection by Signor Marconi, a young Italian, in 1896. With it he succeeded in sending electric waves through ether or space, and without the use of wires, a distance of four miles, upon Salisbury Plain, England. Later, he transmitted messages by means of space (wireless) telegraphy across Bristol Channel, a distance of 8.7 miles, and subsequently across the English Channel, a distance of 18 miles. Mr. W. J. Clarke, of America, has improved upon Marconi’s methods of space telegraphy, and shown some remarkable results. Whether space telegraphy will eventually supersede that by wires is one of the problems that time only can solve. But such are the possibilities of electrical science that we may well be prepared for more wonderful revelations than any yet made.

IV. HELLO! HELLO!

Telegraph (Gr. *tele*, far, and *graphein*, to write) implies the production of writing at a distance by means of an electric current upon a conductor. Telephone (Gr. *tele*, far, and *phone*, sound) implies the production of sound at a distance by the same means, though the word telephone was in early use to describe the transmission of sound by means of a rod or tightly stretched string connecting two diaphragms of wood, membrane, or other substance. This last plan of transmitting sound came to be known as the string telephone, and it retained this name until the invention of the electric telephone.

Like the electric telegraph, the electric telephone was an evolution. The string telephone, in the hands of Wheatstone, showed, as early as 1819, that the vibrations of the air produced by a musical instrument were very minute, and could be transmitted hundreds of yards by means of a string armed with delicate diaphragms. But while the string telephone served to confirm the fact that sounds are vibrations of the atmosphere which affect the tympanum of the ear, it remained but a toy or experimental device till after electric telegraphy became an accepted science, that is, in the year 1837 and subsequently. One of the earliest steps toward the evolution of the electric telephone was taken by Mr. Page, of Salem, Mass., in 1837, who discovered that a magnetic bar could emit sounds when rapidly magnetized and demagnetized; and that those sounds corresponded with the number of currents which produced them. This led to the discovery, between 1847 and 1852, of several kinds of electric vibrators adapted to the production of musical sounds and their transmission to a distance. All this was wonderful and momentous, but a little while had still to elapse before one arose bold enough to admit the possibility of transmitting human speech by electricity. He came in 1854, in the person of Charles Bourseul, of Paris, who, though as if writing out a fanciful dream, said, “We know that sounds are produced by vibrations, and are adapted to the ear by the same vibrations which are reproduced by the intervening medium. But the intensity of the vibrations diminishes very rapidly with the distance, so that it is, even with the aid of speaking-tubes and trumpets, impossible to exceed somewhat narrow limits. Suppose that a man speaks near a movable disk, sufficiently flexible to lose none of the vibrations of the voice, that this disk alternately makes and breaks the current from a battery, you may have at a distance another disk, which will at the same time execute the same vibrations.”

Bourseul further showed that the sounds of the voice thus reproduced would have the same pitch, but admitted that, in the then present state of acoustic science, it could not be affirmed that the syllables uttered by the human voice could be so reproduced, since nothing was known of them, except that some were uttered by the teeth, others by the lips, and so on. The status of the telephone then, according to Bourseul, was that voice could be reproduced at a distance at the pitch of the speaker, but that something more was needed to transmit the delicate and varied intonations of human speech when it was broken into syllables and utterances. To transmit simply voice was one thing; to transmit the *timbre* or quality of speech was another.

Bourseul made plain the problem that was still before the investigator. And now comes one of the most remarkable episodes in the history of electricity,—a chapter of mingled shame and glory. In the village of Eberly’s Mills, Cumberland County, Pa., lived a genius by the name of Daniel Drawbaugh, who had made a study of telephony up to the very point Bourseul had left it. He had transmitted musical sound, sound of the voice, and other sounds in the same pitch. He had said that this was all that could be done till some means was discovered of holding up the constant onward flow of the electric current along a conducting wire by introducing into such flow a variable resistance such as would impart to simple pitch of voice the quality or *timbre* of human speech. Drawbaugh achieved this in his simple workshop as early as 1859–60, according to evidence furnished to the United States Supreme Court at the celebrated trial of the cases which robbed him of the right to his prior invention. He did it by introducing into the circuit a small quantity of powdered charcoal confined in a tumbler, through which the current was passing. The charcoal, being a poor conductor and in small grains, offered just that kind of variable resistance to the current necessary to reproduce the tones and syllables of speech. He transmitted speech between his shop and house, and proved the success he had met with before audiences in New York and Philadelphia. But he neglected to care for the commercial side of his discovery, though many of his patents antedated those which contributed to deprive him of deserved honor and profit.

In 1861, Reis, of Germany, came into notice as the inventor of a telephone which transmitted sound very clearly, but failed to reproduce syllabified speech. However, the principle and shape of his transmitter and receiver were accepted by those who followed him. Two men now came upon the scene who had reached the conclusion already arrived at by Drawbaugh, and who became rivals over his head for the honor and profit of an invention by means of which the quality of the voice in speaking could be transmitted. These two were Elisha Gray, of Chicago, and Alexander Graham Bell, of Boston. Their respective devices seem to have been akin, and to have been presented to the patent office almost simultaneously; so nearly so, at least, as to make them a part of that long, costly, and acrimonious legal contention over priority of invention which did not end till 1887.

Both Bell and Gray reached the conclusion that the transmission of articulate speech was impossible unless they could produce electrical undulations corresponding exactly with the vibrations of the air or sound waves. They brought this similarity about by introducing a variable resistance into the electric current by means of an interposing liquid, just as Drawbaugh had done years before with his tumbler of powdered charcoal. Bell exhibited his instrument with comparative success at the Centennial Exhibition in 1876 in Philadelphia; but much had yet to be done to perfect a telephone of real commercial value.

The years 1877–78 were years of great activity among electricians, whose prime object was to perfect a telephone transmitter and receiver, by means of whose mutual operations at opposite ends of a circuit all the modulations of speech could be preserved and passed. To this end Berliner introduced into a transmitter or sender the then well-known principle of the microphone (Gr. *mikros*, small, *phone*, sound), which magnified the faint sounds by the variation in electrical resistance, caused by variation of pressure at loose contact between two metal points or electrodes. Edison quickly followed with a similar transmitter or sender, in which one of the electrodes was of soft carbon, the other of metal. Then came (1878) Hughes and Blake with senders, in which both of the electrodes were of hard carbon. Subsequently came other and rapid modifications of the sender, both in the United States and Europe, till the form of telephone now in popular use was arrived at, and which, strange to say, is, in its method of securing the necessary variable resistance in the circuit, quite like that employed by Mr. Drawbaugh; to wit, the introduction of fine carbon granules into a small metal cup just behind the vibrating diaphragm or disk of the sender. The circuit goes into the diaphragm in front, passing through the carbon granules and out through the back of the instrument. The action of talking into the sender causes the granules to be agitated, thus opening and closing the circuit and producing the conditions necessary to the transmission of articulate speech. The diaphragm or disk is the very thin covering of the cup containing the granules. It is sometimes made of carbon, but generally of hard metal, as steel. On being struck by the sound waves of the voice, it vibrates to correspond. The same vibrations are reproduced in the receiver at the opposite end of the circuit, and thus one listens to the phenomenon of transmitted human speech. The current for telephonic purposes is furnished by one or more batteries or cells, whose effect is heightened by the presence of an induction coil. The tendency now is to make “bipolars”—two contacts at the diaphragm—in place of a single contact. This style is becoming more in vogue in order to meet the demands of long-distance work. To each telephone is attached a generator or device for ringing a little bell as a signal that some one wishes to communicate. To such perfection have telephones been brought that it is quite possible to converse intelligibly at the distance of a thousand miles, with a less satisfactory service at twice or thrice that distance. The possibilities of clear speech-transmission at indefinite distance are without measure. Like the telegraph, the telephone has opened an immense and profitable industry, involving hundreds of millions of dollars. At the end of the century it is, unfortunately, monopolistic; but the time is near when a reasonable charge for service will enable every business house to communicate with its customers, and when even the remote corners of counties will be brought into touch with their capitals and with one another. Along the lines of civilizing contact the telephone fairly divides the wonders of the century with the telegraph, while for intimate intellectual communication it is a triumph of genius without parallel. It is the dispenser of speech in city, town, and village; in factory and mine, in army and navy; throughout government departments; and in Budapest, Hungary, it is a purveyor of general news, like the newspaper, for the “Telephone Gazette” of that city has a list of regular subscribers, to whom it transmits, at private houses, clubs, cafes, restaurants, and public buildings, its editorials, telegrams, local news, and advertisements.

A very natural outgrowth of the telephone was that curious invention known as the phonograph (Gr. *phone*, sound, and *graphein*, to write). It is not only an instrument for writing or preserving sound, but for reproducing it. As a simple recorder of sound, it was an instrument dating as far back as 1807, when Dr. Young showed how a tuning-fork might be made to trace a record of its own vibrations. But Young’s thought had to go through more than half a century of slow evolution before the modern phonograph was reached; for in the phonautograph of Scott, the logographs of Barlow and Blake, and the various other attempts up to 1877 to make and preserve tracings of speech, there were no successful means of reproducing speech from those tracings hit upon.

In that year (1877), Edison, in striving to make a self-recording telephone by connecting with its diaphragm or disk a stylus or metal point which would record its vibrations upon a strip of tinfoil, accidentally reversed the motion of the tinfoil so that the tracings upon it affected the stylus or tracing-point in an opposite direction. To his surprise, he found that this reverse motion of the tinfoil, tickling, as it were, the stylus oppositely, reproduced the sounds which had at first agitated the diaphragm. It was but a step now to the production of his matured phonograph in 1878. He made a cylinder with a grooved surface, over which he spread tinfoil. A stylus or fine metal point was made to rest upon the tinfoil, so as to produce a tracing in it, following the grooves in the cylinder when the latter was made to revolve. This stylus was connected with the diaphragm of an ordinary telephone transmitter. When one spoke into the transmitter, that is, set the diaphragm to vibrating, the stylus impressed the vibratory motions of the diaphragm, or, in other words, the waves of the exciting sound, in light indentations upon the tinfoil. In order to reproduce the sounds thus registered in the tinfoil of the cylinder, it was made to revolve in an opposite direction under the point of the stylus, and as the stylus was now affected by precisely the same indentations it had first made in the tinfoil, it carried the identical vibrations it had recorded back to the diaphragm of the telephone, and thus reproduced in audible form the speech that had at first set the diaphragm to vibrating. The speech thus reproduced was that of the original speaker in pitch and quality. Ingenious and wonderful as Edison’s machine was, it was susceptible of improvement, and soon Bell and others came forward with a phonograph in which the recording cylinder was covered with a hardened wax. This was called the graphophone. Again, Berliner improved upon the phonograph by using for his tracing surface a horizontal disk of zinc covered with wax. By chemical treatment, the tracings made in the wax were etched into the zinc, and thus made permanent. Edison made further and ingenious improvements upon his phonograph by attaching hearing tubes for the ear to the sound receiver, and by the employment of an electric motor to revolve the wax cylinder. By the attachment of enlarged trumpets and other devices, every form of modern phonograph has been rendered capable of reproducing in great perfection the various sounds of speech, song, and instrument, and has become a most interesting source of entertainment.

V. DYNAMO AND MOTOR.

Dynamo is from the Greek *dunamis*, meaning power. Motor is from the Latin *motus*, or *moveo*, to move. Dynamo is the every-day term applied to the dynamo-electric machine. Motor is the every-day term applied to the electric motor. The dynamo and motor are quite alike in principle of construction, yet direct opposites in object and effect. Perhaps it might be well to designate both as dynamo-electric machines, and to say that, when such machine is used for the conversion of mechanical energy or power of any kind into electrical energy or power, it is a dynamo. When a reverse result is sought, that is, when electrical energy or power is to be converted into mechanical energy or power, the machine that is used is a motor. In practical use for most purposes they are brought into coöperation, the dynamo being at one end of an electric system, making and sending forth electricity, the motor being at the other end, taking up such electricity and running machinery with it. Both machines were epoch-making in the midst of a wondrous century, and both were results of those marvelous evolutions in electrical science which characterized the earlier years of the century.

We have seen how the simple glass cylinder or sulphur roll became, when rubbed, a generator of electricity. In a later chapter of electrical history, we saw a new and more powerful generator of electricity in the voltaic cell, by means of opposing metals acted upon chemically by acids. The greatest, grandest, most powerful, and most economic of all generators of electricity was yet to come in the shape of the dynamo. We see its beginnings in those investigations of Faraday which led to the discovery of the induction coil and the principles of magneto-electric induction. In 1831, he invented a simple yet, for that date, wonderful machine, which was none the less the first dynamo in principle, because he modestly called it “A New Electrical Machine.” He mounted a thin disk of copper, about twelve inches in diameter, upon a central axis, so that it would revolve between the opposite poles of a permanent magnet. As the disk revolved, its lower half cut the field of force of the magnet, and a current was induced which was carried away by means of two collecting brushes, fastened respectively to the axis and circumference of the disk. This was the first electric current ever produced by a permanent magnet. The Faraday machine and others that derived the mechanical energy which was converted into electric current from a permanent magnet were classed as magneto-generators. Soon the electro-magnet took the place of the permanent magnet, because it produced a much stronger field of force. But then the electro-magnet had to have a current to excite it. This current was supplied by a magneto-generator, placed somewhere on the dynamo. Now came the thought, suggested by Brett in 1848, that the induced currents of the dynamo could themselves be turned to account for increasing the strength of the electro-magnets used in inducing them. This was a most progressive step in the history of the dynamo. It led to rapid inventions, whose principle was based on the fact that every dynamo carried within the cores of its magnets enough of unused or residual magnetism to render the magnets self-exciting the moment the machine started. So the outside means of magnetizing the fields of force of the dynamo passed away.

The dynamo speedily grew in size and importance. The electro-magnets or fields of force were greatly increased in number, size, and power. There were great improvements in the construction and efficiency of the wire coils or armatures which cut the fields of force, and a corresponding increase in their number. Commutators and brushes underwent like improvement. So, at last, the well-nigh perfect and all-powerful dynamo of the end of the century was evolved, with a capacity for delivering, in the form of electricity, ninety per cent of the mechanical energy which set it in motion. In the application of steam to machinery, eighty per cent, and sometimes more, of the energy supplied by a ton of coal is lost.

With the perfection of the dynamo, its uses multiplied. It became a prime factor in electric lighting. Trolley systems sprang up in city, town, and village, taking the place of horse and traction cars. In certain places, as in the Baltimore tunnel, the dynamo superseded the engine for hauling freight and passenger cars. The mighty dynamos which convert the inexhaustible energy of Niagara Falls into electricity send it many miles away to Buffalo, to be applied to lighting and to every form of machinery. The end of the century sees a power plant in operation in New York city capable of furnishing one hundred thousand horse-power, or enough to supply the lighting, rapid transit, and thousand and one mechanical needs of the entire municipality. The essential parts of an ordinary dynamo are: (1.) The electro-magnets, which, however numerous, are arranged in circular form upon part of the framework of the machine. (2.) The iron coils or armatures, mounted in a circle upon a wheel. When the wheel revolves, the armatures pass close in front of the electro-magnets, cutting through their fields of force, and thereby inducing electric current. (3.) The commutator, which consists usually of a series of copper blocks arranged around the axle of the armatures, and insulated from the axle and from each other. The current passes from the armatures to the commutator. If the current be an alternating one, the commutator changes it into a continuous one, and the reverse may also be accomplished. (4.) The brushes, which are thin strips of copper or carbon, are brought to bear at proper points upon the commutator, making connection with each coil or sets of coils. They carry the corrected current to the outside line or lines. (5.) The outside line or lines, to carry the current away to the motor. (6.) The pulley for strap-belting, by means of which the water or steam power used is made to turn the dynamo machine.

But we must not forget the motor as a companion of the dynamo, as its indispensable brother, in turning to practical account the electricity sent to it. As we have seen, the motor is the reverse of the dynamo, at least in its effects. It is fed by the dynamo, and it imparts its power to the machinery which it is to set in motion. It is to the dynamo what the water-wheel is to the water. In one sense it is an even older invention than the dynamo, but its extended commercial application was not possible until the dynamo had reached certain stages of perfection. It is generally agreed that the first motor of importance was that constructed by Professor Jacobi, through the liberality of the Czar Nicholas, of Russia. Jacobi used two sets of electro-magnets, by means of whose mutual attraction and repulsion he rotated a wheel on a boat with a power equal to that of eight oarsmen. But as Jacobi’s electro-magnets required an electric current to magnetize them, and as there were then no means of producing such current except by the costly use of the voltaic battery, his invention was unripe as to time.

In 1850, Professor Page, of the Smithsonian Institution, constructed a motor which worked ingeniously, but was still open to the objection of cost in supplying the necessary electric current for the electro-magnets. Though various inventions came about having for their object a commercially successful motor, such a thing was impossible till Gramme produced his improved and effective dynamo in 1871. This dynamo was found to work equally well as a motor, and hence it became necessary for electricians to greatly enlarge their understanding of the nature of electro-magnetic induction. They soon discovered many curious things respecting the behavior of induced currents, with the result that rapid and simultaneous improvements were made in both dynamos and motors. One of the most curious of these discoveries was that a motor automatically regulates the amount of current that passes through its circuit in proportion to the work it is called upon to do; that is, if the work the machine has to do is decreased, the motor attains a higher speed, which higher speed induces a counter electro-motive force sufficient to check up the amount of current passing through the motor. So when the motor is required to do increased work, the machine slows up; but with this slowing up, the counter electro-motive force decreases, and consequently the current passing through the motor increases.

As with the dynamo, one of the marvels of the motor is its efficiency. In perfect machines, ninety to ninety-five per cent of the electrical energy supplied can be converted into mechanical energy. For this reason it has become a competitor with, and even successor of, steam in countless cases, and especially where water-power can be commanded. A prime motor, in the shape of a water-wheel, may be made to drive scores of secondary motors in places hundreds of miles away. The power developed by the waterfall at Lauffen, Germany, is transmitted one hundred miles to Frankfort, with a loss of only twenty-five per cent of the original horse-power.

In its adaptation for practical use, the motor, like the dynamo, assumes all sizes and embraces a host of ingenious devices, yet its power and usefulness always centre around, or are contained in, its two efficient parts, its armatures and fields of force. We have seen how in the dynamo the armatures became the source of induced currents by being made to cut the fields of force of electro-magnets. Now, a dynamo can be made to work in an opposite way; that is, by making the magnetic fields of force rotate in front of the coils or armatures. In the motor, the field of force is mostly established by the current directly from the dynamo. This current passes also through the armature, which begins to rotate, owing to the force of the field upon it. This rotation of the armature through the field of force produces in the armature conductors an electro-motive force, which is the measure of the power of the motor, be the same great or small.

VI. “AND THERE WAS LIGHT.”

Mention of the “candlestick of pure gold” (Ex. xxv. 31) may lead to the inference that the primitive artificial light was that of the candle. But “candlestick” in connection with the lighting of the temple is clearly a misnomer. The lamp was the original artificial light-giver, unless we choose to except the torch; and if less indispensable than in patriarchal times, it is still a favorite dispenser of nightly cheer. Prior to the middle of the eighteenth century, the lamp had practically no evolution. It was the same in principle at that date as when it illuminated the desert tabernacle. Even the splendid enameled glass or decorated Persian pottery lamps of Damascus and Cairo, and the magnificent brass or bronze lamps of Greece, Rome, and the European cathedrals, gave forth their dull, unsteady flame and noisome smoke by means of a crude wick lying in a saucer or similar receptacle of melted lard, tallow, oil, or some such combustible liquid. A prime improvement was made in lamp-lighting in 1783, by Leger, of Paris, who devised the flat, metallic burner, through which he passed a neatly prepared wick. A further improvement was made in 1784 by Argand, of Paris, who introduced a burner consisting of two circular tubes, between which passed a circular wick. The inner tube was perforated so as to admit of a draught of air to feed the flame on the inside of the wick. In order to similarly feed the flame on the outside of the wick, he invented the lamp chimney, which was at first a crude thing of metal. It, however, soon gave way to the glass chimney, which has up to the present taken on many improved forms, designed to secure more perfect combustion and a brighter, steadier glow.

Improvement in lamp-lighting during the nineteenth century has consisted of an indefinite number of inventions, all aiming at economy, brilliancy, steadiness, convenience, beauty, and so on. But in no respect has this improvement been more rapid and radical than in the adaptation of lamps to the various combustible fluids that have bid for favor. While the various oils, animal and vegetable, were almost solely in vogue as illuminants at the beginning of the century, they were largely superseded at a later period by the burning-fluid known as camphene. This was a purified oil of turpentine, which found great favor on account of its economy, convenience, cleanliness, and brilliancy of light. But it was very volatile, and its vapors formed with air a dangerously explosive mixture. Yet with all this it might have held its own for a long time, had not Gesner, in 1846, discovered that a superior mineral oil, which he called “kerosene,” could be readily and profitably distilled from the coal found on Prince Edward Island. This kerosene or hydrocarbon oil speedily displaced camphene as an illuminant. Its manufacture rapidly developed into an important industry in the United States, and large distilling establishments arose, both on the Atlantic coast, where foreign coal was used, and throughout the country, wherever cannel or other convertible coal was found. With the discovery of petroleum in paying quantities on Oil Creek, Pa., in 1859, there came about a great change in kerosene lamp-lighting. It was found, upon analysis, that crude petroleum contained about fifty-five per cent of kerosene, which constituted its most important product. The manufactories of kerosene from cannel or other coal, therefore, went out of existence, and new ones, larger in size and greater in number, sprung up for the manufacture of kerosene or, popularly speaking, coal oil, from petroleum. This illuminant came into almost universal favor for lamp use, owing to its cheapness and brilliancy. It is not free from danger when improperly distilled, but under the operation of stringent laws governing its preparation and testing, danger from its use has been reduced to a minimum. In rural districts, in smaller towns and villages, wherever economy and convenience are essentials, and when beauty in lamp effects is desirable, the kerosene illuminant has become indispensable.

The discovery of petroleum helped further to light the world and distinguish the century. It gave us gasolene, naphtha, gas oil, astral oil, and the very effective “mineral sperm,” which is almost universally used in lighthouses and as headlights for locomotives. With the addition of kerosene, a favorite light of the beginning of the century—the tallow dip of our grandmothers—began to fall into disuse. The homelike pictures of housewives at their annual candle-dippings, or in the manipulation of their moulds, became venerable antiques. Candle-light paled in the presence of the higher illuminants. Though still a convenient light under certain circumstances, it plays a gradually diminishing part amid its superiors.

One of the signal triumphs of the century has been the introduction of gas-lighting. Though illuminating gas made from coal was known as early as 1691, it did not come into use, except for experiments or in a very special way, until the beginning of the nineteenth century. In 1809, a few street lamps were lit with gas in London. An unsuccessful attempt was made to introduce gas into Baltimore in 1821. Between 1822 and 1827, the gas-light began to have a feeble foothold in Boston and New York. Other cities began to introduce it as an illuminant in streets and, eventually, in houses. But the process was very slow, owing to intense opposition on the part of both savants and common people, who saw in it a sure means of destruction by poison, explosion, or fire. It was not much before the middle of the century that prejudice against illuminating gas was sufficiently allayed to admit of its general use. But meanwhile many valuable experiments as to its production and adaptation were going on. The most productive source of illuminating gas was found to be bituminous coal. Though gas could be produced by distillation from other substances, such as shale, lignite, petroleum, water, turf, resins, oils, and fats, none could compete in quality, quantity, and economy with what is known as ordinary coal gas, at least, not until the time came, quite late in the century, when it was found that non-luminous gases, such as water gas, could be rendered luminous by impregnating them with hydrocarbon vapor. This became known commercially as water gas, and it is now largely used in place of coal gas, because it is cheaper and, for the most part, equally effective as a luminant.

Gas-lighting has, of course, its limitations. It is not adapted for use beyond the range of cities or towns whose populations are sufficient to warrant the large expenditures necessary for gas plants. It is a special rather than general light. Yet within its limited domain of use it has proved of wonderful utility,—a source of cheer for millions, a clean, safe, and economic light, a convenience far beyond the candle, the lamp, or any previous lighting appliance. In the street, it is a source of safety against thieves and way-layers. In the slums, it is both policeman and missionary, baffling the wrong-doer, exposing the secrecy that conduces to crime, laying bare the hotbeds of shame. It is as well a source of heat as light, and consequently convertible into power for light mechanical purposes. In the kitchen, it is more and more becoming a boon to the housewife, who by means of the gas range escapes, in cooking, much of the dust, smoke, worry, and even expense of the coal cook stove and range. In the parlor, library, or sick-room, it is a cheerful and effective substitute for the coal grate, and may be made to assume the cosy qualities and fantastic shapes of the old-fashioned wood fire. Coincident with the discovery of petroleum, its inseparable companion, natural gas, came into prominence as a source of both light and heat, or this became true, at least, after it was ascertained that natural gas regions existed which could be tapped by wells, and made to give forth their gaseous product independent of the oil that may have at one time existed near or in connection with it. This natural source of light and heat became as interesting to the geologist, explorer, and capitalist as the source of petroleum itself, and soon every likely section was prospected, with the hope of finding and tapping those mysterious caverns of earth in which the pent-up luminant abounded in paying quantities. It was found that workable natural gas regions were numerous in the United States, especially in proximity to petroleum or bituminous coal deposits, and little time was lost in their development. As if by magic, a new and profitable industry sprang into existence. The natural gas well became almost as common as the oil well, and at times far more awe-inspiring as it shot into space its volcanic blasts which, when ignited through carelessness, as sometimes happened, carried to the vicinage all the dangers and terrors of Vesuvius or Stromboli. Powerful as was the force with which natural gas sought its freedom, wonderful as was the phenomenon of its escape from the subterranean alembic in which it was distilled, human genius quickly harnessed it by appliances for conservation and carriage to places where it could be utilized. Sometimes great industries sprang up contiguous to the wells; at others, it was carried through pipes to cities many miles distant, where it became a light for street, home, and store, and a prodigious energy in factory, furnace, forge, and rolling-mill. In fact, no marvel of the century has been at once so weird and inscrutable in its origin as natural gas, or more potential as an agency within the areas to which its use is limited. The question is ever uppermost in connection with natural gas, will it last? The gas springs of the Caucasus Mountains have been burning for centuries. But that is where nature’s internal forces have their correlations and compensations. Where it is quite otherwise, that is, where the vents of natural gas reservoirs are abnormally numerous, or where those reservoirs are drained to the extreme for commercial purposes, not to say through sheer wastefulness, the geologist is ready to surmise that the natural gas supply cannot be a perpetual one.

But one of the most magnificent triumphs of the century in the matter of light came about through the agency of electricity. We have already seen the beginnings of electric lighting in the discovery of Sir Humphrey Davy, in 1809, that when the ends of two conducting wires, mounted with charcoal pieces, were brought close together, a brilliant light, in the shape of an arc or curve, leaped from one piece of charcoal to the other. Davy’s charcoal pieces or carbons were consumed by the fierce heat evolved; but the principle was established that an electric current, so interrupted, was a vivid light-producer, and might be made permanently so if a substance capable of resisting the heat could be substituted for his charcoal tips, and a generator of electricity of sufficient power and economy in use could be substituted for his voltaic batteries or cells.

Upon these two essentials hung the future of the electric light. The first essential, that of a substance at the ends of the wires or in the midst of the electric circuit which would resist the heat, was soon met by the use of specially prepared and hard graphite carbon tips, in the shape of candles. But the second essential, a generator of electricity cheaper and more powerful than the voltaic cell, was not met with till the dynamo machine reached an advanced stage of perfection; that is, about 1867.

The two grand essentials now being at command, invention of electric light appliances went on rapidly upon two lines, eventuating in two systems, which became known as arc lighting and incandescent lighting. By 1879–80, the arc light was sufficiently advanced to meet with favor as an illuminant for streets, railway stations, markets, and any large spaces, in which places it became a substitute for gas and other lights. The essential features of the arc light are: (1.) The dynamo machine, situated in some central place, for the generation of electricity. (2.) Conducting wires to carry the electricity throughout the areas or to the places to be lighted. (3.) The arc lamp, which may be suspended upon poles in the streets, or upon wires in stores and other covered places. Its mechanism consists of two pencils or candles of graphite carbon, very hard and incombustible, adjusted above and below each other so that their tips or ends are very close together, but not in contact. By means of a clockwork or simple gravity device these carbon tips are brought into contact at the moment the electric current is turned on, and then are slightly separated as soon as the current has heated them. The air between the heated tips, having also reached a high temperature, becomes a conductor, and the electricity leaps in the form of an arc or curve through it, rendering it brilliantly incandescent. Should the current be diminished in strength for any reason, the above-mentioned clockwork or gravity device brings the carbons a little closer together; and should the current be increased, the carbons are separated a little wider; thus the steadiness of the light is regulated. There are also various automatic devices for thus regulating the proximity of the carbons and maintaining the evenness of the glow. The power of an arc light is measured by candles. An ordinary arc light under two amperes of current gives a light equal to twenty-five candles, while under fifty amperes of current it gives a light equal to twenty thousand candles. In searchlights on board vessels, and where very large areas are to be lighted, both heavier currents and larger carbons are used than in the arc lamps for ordinary street purposes. No light surpasses the arc light in brilliancy, excepting the magnesium light. There are few cities in this country and Europe that do not employ the arc lamp as a means of street, station, and large-area lighting, owing to its superiority as an illuminant and the wonderful policing effect it has upon the slum sections.

The incandescent lamp, or electric lighting by incandescence, underwent a somewhat longer evolution at the hands of inventors than the arc lamp, owing to the difficulty of finding a substance suitable for the production of the necessary glow. The discovery of such substance may be accredited to Edison more fully than to any other. The incandescent or glow lamp is a glass bulb from which the air is exhausted. There passes into the bulb a filament of carbon, which, after a turn or two inside the bulb, passes out at the end through which it entered. When a current from a voltaic battery is sent through this carbon filament, it brings it, in the absence of oxygen within the bulb, to a high white heat without combustion. The portion of this high white heat which is radiated is the light-giving energy of the incandescent lamp. Metal filaments were at first tried in the bulb, but they quickly burned out. Carbon filaments were at length found to be the only ones capable of resisting the heat. They moreover had the advantage of cheapness, and of greater radiating energy than metals. Many substances, such as silk, cotton, hair, etc., were used in the preparation of the carbon filaments, but it was found that strips cut from the inside bark of the bamboo gave, when brought to a white heat by an electric current and then properly treated, the most tenacious and best conducting carbon filament.

The quality of light produced by an incandescent lamp is a gentler glow than that produced by the arc lamp, and in color more nearly resembles the light of gas or the oil lamp. The incandescent light speedily became for the home, hotel, hall, and limited covered area what the arc light became for the street and railway station, and, if anything, the former outstripped the latter in the extent and value of the industry it gave rise to.

In the arc lamp, the carbon pencils have to be renewed daily. In the incandescent lamp, the carbon filament, though very delicate, may last for quite a time, because incandescence takes place in the absence of oxygen. If the favor in which the electric light is held, and the great extent of its use, rested solely on the question of cheapness of production, such question would give rise to interesting debate. And, indeed, the debate would continue, if the question were the superior fitness of electric lighting for lighthouses and like service, where extreme brilliancy does not seem to penetrate a thick atmosphere as effectively as the more subdued glow of the oil lamp. But the debate ceases when the question is as to the beauty and efficiency of the electric light in the home, street, station, mine, on shipboard, and the thousand and one other places in which it has come to be deemed an essential equipment. In all such places the question of economy of production and use is subordinate to the higher question of utility and indispensability.

VII. ELECTRIC LOCOMOTION.

The dawn of the nineteenth century saw, as vehicles of locomotion, the saddled hackney, the clumsy wagon, the ostentatious stage-coach, the primitive dearborn, the lumbering carriage, the poetic “one-hoss shay.” The universal energy was the horse. A new energy came with the application of steam, and with it new vehicular locomotion,—easier, swifter, stronger, for the most part cheaper, rendering possible what was hitherto impossible as to time and distance.

This signal triumph of the century may not have been eclipsed by the introduction of subsequent locomotive changes, but it was to be supplemented by what, at the beginning, would have passed for the idle dream of a visionary. The horse-car came, had its brief day, and went out with all its inconveniences, cruelties, and horrors before, in part, the traction-car, and, in part, the rapidly revolutionizing energy of electricity.

The first conception of a railway to be operated by electricity dates from about 1835, when Thomas Davenport, of Brandon, Vt., contrived and moved a small car by means of a current from voltaic cells placed within it. In 1851, Professor Page, of the Smithsonian Institution, ran a car propelled by electricity upon the steam railway between Washington and Baltimore, but though he obtained a high rate of speed, the cost of supplying the current by means of batteries—the only means then known—prohibited the commercial use of his method.

With the invention of the dynamo as an economic and powerful generator of electricity, and also the invention of the motor as a means of turning electrical energy to mechanical account, the way was open, both in the United States and Europe, for more active investigation of the question of electric-car propulsion. Between 1872 and 1887, different inventors, at home and abroad, placed in operation several experimental electric railways. Few of them proved practical, though each furnished a fund of valuable experience. An underground electric street railway was operated in Denver as early as 1885; but the one upon the trolley plan, which proved sufficiently successful to warrant its being called the first operated in the United States, was built in Richmond, Va., in 1888. It gave such impetus to electric railway construction that, in five years' time, enormous capital was embarked, and the new means of propulsion was generally accepted as convenient, safe, and profitable.

The essential features of the electric railway are: (1.) The track of two rails, similar to the steam railway, (2.) The cars, lightly yet strongly built. (3.) The power-house, containing the dynamos which generate the electricity. (4.) The feed-wire, usually of stout copper, running the length of the tracks of the system, and supported on poles or laid in conduits. (5.) The trolley-wire over the centre of the track, supported by insulated cross-wires passing from poles on opposite sides of the tracks, and connected at proper intervals with the feed-wire. (6.) The trolley-pole of metal jointed to the top of the car, and fitted with a spring which presses the wheel on the end of the pole up against the trolley-wire with a force of about fifteen pounds, and which also serves to conduct the electricity down through the car to the motor. (7.) The motor, which is suspended from the car truck, and passes its power to the car axle by means of a spur gearing. The power requisite for an ordinary trolley-car is about fifteen horse-power. The speed of trolley-cars is regulated in cities to from five to seven miles per hour, but they may be run, under favorable conditions, at a speed equal to, or in excess of, that of the steam-car.

As a means of city transit, and of rapid, convenient, and economic intercourse between suburban localities and rural towns and villages, the electric traction system ranks as one of the greatest wonders of the century. The speed with which it found favor, the enormous capital it provoked to activity, the stimulus it gave to further study and invention, the surprising number of passengers carried, go to make one of the most interesting chapters in electric annals. The end of the century sees thousands of these electric roads in existence; a comparatively new industry involving over $100,000,000; a passenger traffic running into the billions of people; a prospect that the trolley will succeed the steam-car for all utilizable purposes within the gradually extending influence of cities and towns upon their rural surroundings.

In speaking of the passing of the horse-car and its substitution by the trolley, a distinguished writer has well said: "Humanity in an electric-car differs widely from that in the horse-car, propelled at the expense of animal life. It is more cheerful, more confident, more awake to the energy at command, more imbued with the subtlety and majesty of the propelling force. The motor confirms the ethical fact that each introduction of a higher material force into the daily uses of humanity lifts it to a broader, brighter plane, gives its capabilities freer and more wholesome play, and opens fresh vistas for all possibilities. We applaud Franklin for seizing the lightning in the heavens, dragging it down to earth, and subjugating it to man. Let this pass as part of the poetry of physics. But when ethics comes to poetize, let it be said that electricity as an applied force lifts man up toward heaven, quickens all his appreciations of divine energy, draws him irresistibly toward the centre and source of nature's forces. There is no dragging down and subjugation of a physical force. There is only a going out, or up, of genius to meet and to grasp it. Its universal application means the raising of mankind to its plane. If electricity be the principle of life, as some suppose, what wonder that we all feel better in an electric-car than any other? The motor becomes a sublime motive. God himself is tugging at the wheels, and we are riding with the Infinite."

Enthusiasts say the trolley is only the beginning of electric locomotion, and that there is already in rapid evolution an electric system which will supersede steam even for trunk-line purposes. In vision, it presumes a speed of one hundred and twenty-five miles an hour instead of forty; greater safety, cleanliness, and comfort; and what is most momentous and startling, an economy in construction and operation which will warrant the sacrifice of the billions of dollars now invested in steam-railway properties. The proposition is not to sacrifice the steam-railway track, but to add to it a third rail, which is to carry the electric current. Then, by means of feed-conduits alongside of the track, and specially constructed electric locomotives and cars, the system is supposed to reach the practical perfection claimed for it. Experiments with such an electrical system, made upon branch lines of some of our trunk-line railways, as the Pennsylvania, New York Central, and New Haven & Hartford, give much encouragement to the hypothesis that it may become the next great step in the evolution of electrical science.

Another means of electric propulsion was provided by the investigations of Planté, which resulted in his invention of the “accumulator” or “storage battery,” in 1859. His battery consists of plates of lead immersed in dilute sulphuric acid. By the passage of an electric current through the acid, it is electrolytically decomposed. By continuing the current for a time, first in one direction and then in another, the lead plates become changed, the one at the point where the current leaves the cell taking on a deposit of spongy lead, and the one at the point where the current enters the cell taking on a coating of oxide of lead. When in this condition, the battery is said to be stored, and is capable of sending out an electric current in any circuit with which it may be connected. After exhausting itself, it can be re-stored or re-charged in the same way as at first. Faure greatly improved on Planté’s storage battery in 1880, by spreading the oxide of lead over the plates, thus greatly reducing the time in forming the plates. Subsequently, further improvements were made, till batteries came into existence capable of supplying a current of many hundred amperes for several hours. One of the first practical uses to which the storage battery was put was in the propulsion of street-cars; but its weight proved a drawback. It was found better adapted for the running of boats on rivers, and, in the business of water-freightage for short distances, has in many instances become a rival of steam. It found one of its most interesting applications in helping to solve the problem of the *automobile*, or “horseless carriage,” either for pleasure purposes or for street traffic. In this problem it has, at the end of the century, an active rival in compressed air; but as the “horseless carriage” is rapidly coming into demand, means may soon be found to utilize the strong and persistent energy of the storage battery, without the drawback found in its great weight.

VIII. THE X RAY.

An astounding electrical revelation came during the last years of the century through the discovery of the X, or unknown, or Roentgen ray. A hint of this discovery was given by Faraday during his investigation of the effect of electric discharges within rarefied gases. He also invented the terms *anode* and *cathode*, both of which are in universal use in connection with instruments for producing the X rays; the anode being the positive pole or electrode of a galvanic battery, or, in general, the terminal of the conductor by which a current enters an electrolytic cell; and the cathode being the negative pole or electrode by which a current leaves said cell.

Geissler followed Faraday with an improved system of tubes for containing rarefied gases for experimentation. He partially exhausted his tubes of air, introduced into them permanent and sealed platinum electrodes, and produced those wonderful effects by the discharge obtained by connecting the electrodes with the terminals of an electric machine or induction coil, which from their novelty and beauty became known as Geissler effects, just as his tubes became known as Geissler tubes. In the attenuated atmosphere of the Geissler tube, the current does not pass directly from one platinum point or electrode to the other, but, instead, illuminates the entire atmospheric space. When other gases are introduced in rarefied form, they are similarly illuminated, but in colors corresponding to their composition. In his further experiments, Geissler noted that the gases in the tube behaved differently at the anode, or positive terminal, and the cathode, or negative terminal. A beautiful bluish light appeared at the cathode, while the anode assumed the same color as the illuminated space in the tube. It was also noted that after the electric discharge within the tube, there remained upon the inner surface of the glass a fluorescent or phosphorescent glow, which was attributed to the effect of the cathode.

This brought the study of the *cathode* rays into prominence, and through the investigations of Professor William Crookes, in 1879 and afterwards, a conclusion was reached that a “Fourth State of Matter” really existed. He perfected tubes of very high vacuum, by means of which he showed that molecules of gas projected from the cathode moved freely and with great velocity among one another, and so bombarded the inner walls of the tube as to render it fluorescent.

Subsequently, Hertz showed that the cathodic rays would penetrate thin sheets of metal placed within the tube or bulb; and soon after, Paul Lenard (1894) demonstrated that the cathodic ray could be investigated as well outside of the tube or bulb as within it. He set an aluminum plate in the glass wall of the bulb opposite the cathode. Though ordinary light could not penetrate the aluminum plate, it was readily pierced by the cathodic rays, to a distance of three inches beyond its outside surface. With these rays, thus freed from their inclosure, he produced the same fluorescent effects as had been noted within the bulb, and even secured some photographic effects. These cathodic rays produced no effect on the eye, which proved their dissimilarity to light. Lenard showed further that the cathodic rays outside of the tube could be deflected from their straight course by a magnet, that they might pass through substances opaque to light, and that in so passing they might cast a shadow of objects less opaque, which shadow could be photographed. Now Professor Roentgen came upon the scene. He had been conducting his experiments in Germany, along the same lines as Lenard, and had reached practically the same results as to the penetrative, fluorescent, and photographic effects of the cathodic rays. But he had gone still further, and, in 1896, fairly set the scientific world aflame with the announcement that all the effects produced by Lenard in the limited space of a few inches could also be produced at long distances from the tube, and with sufficient intensity to depict solid substances within or behind other substances sufficiently solid to be impermeable by light. Professor Roentgen claims that his X ray is different from the cathodic ray of Lenard and others, because it cannot be deflected by a magnet. This claim has given rise to much controversy respecting the real nature of the X ray, a controversy not likely to end soon, yet one full of inspiration to further investigation.

The essential features of the best approved apparatus designed to produce the X ray and to secure a photograph of an invisible object, are: (1.) A battery or light dynamo as a generator of the electric current, accompanied, of course, by the necessary induction coil, which should be so wound as to give a spark of at least two inches in length in the tube where a picture of a simple object, as a coin in a purse, is desired; a spark of four inches in length where pictures of the bones of the hands, feet, or arms are desired; and a spark of from eight to ten inches in length where inside views of the chest, thighs, or abdomen are desired. (2.) The second essential is the glass tube. The one in common use is the Crookes tube, usually pear-shaped, and resting upon a stand. Into it is inserted two aluminum electrodes or disks, the one through the smaller end of the tube being used as the cathode, and the one from below and near the large end being used as the anode. (3.) A fluoroscope with which to observe the conditions inside the tube necessary to the production of the X ray, to decide upon its proper intensity, and to establish the proper degree of fluorescence. The favorite fluoroscope for this purpose is the one invented by Edison. It is in the form of a stereopticon, in which is a dark chamber after the manner of a camera. In front are two openings, admitting of a view within of both eyes. At the opposite, and greatly enlarged, end is a screen which is rendered fluorescent by means of a new substance (tungstate of calcium) discovered by Mr. Edison after some eighteen hundred experiments. Such is the power of this fluoroscope that it may be used as an independent instrument in cases of minor surgery to locate bullets or other objects buried in the flesh, even before a photograph has been taken. (4.) The photographic plate, which is prepared with a sensitized film and mounted in a frame as in ordinary photography. Upon this film the object to be photographed is laid, say, for instance, the human hand, care being taken to have the film or plate at a proper distance from the Crookes tube. Current is now turned into the tube, the X ray is developed, the film is exposed to its effects, and the result is a negative showing the interior structure of the hand,—the bones or any foreign object therein. This negative is developed as in ordinary photography.

The discovery and application of the X ray has proved of immense value in medicine and surgery. By its means the physician is enabled to carry on far-reaching diagnoses, and to ascertain with certainty the whole internal structure of the human body. Fractures, dislocations, deformities, and diseases of the bones may be located and their character and treatment decided upon. In dentistry, the teeth may be photographed by means of the X ray, even before they come to the surface, and broken fangs and hidden fillings may be located. Foreign objects in the body, as bullets, needles, calculi in the bladder, etc., may be localized, and the surgery necessary for their safe removal greatly simplified. The beating of the heart, movement of the ribs in respiration, and outline of the liver may be exhibited to the eye. It has been boldly suggested that in the X ray will be found an agent capable of destroying the various bacilli which infest the human system, and become germs of such destructive diseases as cholera, yellow fever, typhoid fever, diphtheria, and consumption. Even if this be speculative as yet, there is still room for marvel at the actual results of the discovery of the X ray, and its future study opens a field full of the grandest possibilities.

IX. OTHER ELECTRICAL WONDERS.

The novel idea of keeping time by means of electricity originated quite early in the century, and culminated in two kinds of electric clocks, one moved directly by the electric current, the other moved by weights or springs, but regulated by electricity. The former have the advantage of running a very long time without attention, but as it is impossible to keep up an unvarying electric current, they are not so accurate as the latter in keeping time. Though the latter are popularly called electric clocks, they are really only clocks regulated by electricity, and in such regulation the electric current comes to be a most important agent, as is proved at all centres of astronomical and other observations, as at Greenwich and Washington. At such centres the astronomical time-keeper is set up so as to run as infallibly as possible. This central time-keeper, say at Washington, is electrically connected with other clocks, at observatories, signal-service stations, railway stations, clock-stores, city halls, etc., throughout the country. Should any of these clocks lose or gain the minutest fraction of time as compared with that of the central time-keeper, the electric current corrects such loss or gain, and so keeps all the clocks at a time uniform with one another and with the central one. Electrical devices are also often attached to individual clocks, as those upon city hall towers and in exposed places, for the purpose of meeting and correcting inequalities of time occasioned by weather exposure, expansion and contraction by heat and cold, etc.

The fatherhood of the very useful and elegant arts of electrotyping and electroplating is in dispute. Daniell, while perfecting his battery, noticed that a current of electricity would cause a deposit of copper. In 1831, Jacobi, of St. Petersburg, called attention to the fact that the copper deposited on his plates of copper by galvanic action could be removed in a perfect sheet, which presented in relief, and most accurately, every accidental indentation on the original plates. Following this up, he employed for his battery an engraved copper plate, caused the deposit to be formed upon it, removed the deposit, and found that the engraving was impressed on it in relief, and with sufficient firmness and sharpness to enable him to print from it. Jacobi called his discovery galvanoplasty in the publication of his observations in 1839. It was but a step from this discovery to the application of the electrotyping process to the art of printing. A mould of wax, plaster, or other suitable substance is made of an engraving or of a page of type. This mould is covered with powdered graphite (black lead) so as to make it a conductor of electricity. It is then inserted in a bath containing a solution of sulphate of copper. An electric current is passed through the bath, and the copper is deposited on the mould in sufficient quantity to give it a hard surface capable of offering greater resistance in printing than the types themselves, and also of producing a clearer impression. In electroplating, practically the same principle is employed. The bath is made to contain a solution of water, cyanide of potassium, and whatever metal—gold, silver, platinum, etc.—it is designed to precipitate on the article to be electroplated. The current is then passed through the bath, and the article—spoon, knife, fork, etc.—to be electroplated receives its coating of gold, silver, German silver, platinum, or whatever has been made the third agent in the bath.

The various modern submarine devices for the destruction of ships, known as torpedoes, submarine mines, etc., depend upon electricity for their efficiency. It is the lighting or firing agent, and is carried to the torpedo or mine by means of stout wires or cables from some safe shore-point of observation.

In railroading, electricity has become an indispensable agent for the operation of signal systems, opening and closing of switches, and limitation of safety sections. It moves the drill in the mine, sets off the blast, and supplies the light. It enables the dentist to manipulate his most delicate tools and do his cleanest and least painful work. In medicine it is a healing, soothing agent, boundless in variety of application and wondrous in results. It is a stimulus to the growth of certain plants, and has given rise to a new science called Electro-horticulture. It may be made a prolific source of heat for warming cars, and even for the welding of iron and steel. The electric fan cools our parlors and offices in summer, and the electric bell simplifies household service. In fact, it would appear that, in contrasting the electrical beginnings with the electrical endings of the nineteenth century, the space of a thousand rather than a hundred years had intervened, and that in measuring the agents which conduce to human comfort and convenience, electricity is easily the most potential.

X. ELECTRICAL LANGUAGE.

Out of the various discoveries and applications of electricity almost a new language has sprung. This is especially so of terms expressive of the measurements of electric energy, and of the laws governing the application of electric power. For a time, various nations measured and applied by means of terms chosen by themselves. This led to a jargon very confusing to writers and investigators. It became needful to have a language more in common, as in pharmacy, so that all nations could understand one another, could compute alike, and especially impart their meaning to those whose duty it became to apply discovered laws and actual calculations to practical electric operations. This was a difficult undertaking, owing to the tenacity with which nations clung to their own nomenclatures and terminologies. But the drift, though slow, finally ended at the Electrical Congress in Paris in 1881, in the adoption of a uniform system of measurements of electric force, and an agreement upon terms for laws and their application, which all could understand.

Three fundamental units of measurement were first agreed upon,—the *Centimetre* (.394 in.) as a unit of length; the *Gramme* (15.43 troy grains) as a unit of mass; the *Second* (1/60 of a minute) as a unit of time. These three units became, when referred to together by their initial letters, the basis of the C. G. S. system of units. Now by these units of measurement something must be measured, as, for instance, the electric force; and when so measured, an absolute unit of force must be the result.

Dyne:—This is but a contraction of *dynam*, force. It was adopted as the name of the "Absolute Unit of Force," or the C. G. S. unit of force, and is that force which, if it act for a second on one gramme of matter, gives to it a velocity of one centimetre per second.

Ampere:—Electrical force produces electrical current. Current must be measured and an absolute unit of current strength agreed upon. The "Absolute Unit of Current" was settled as one of such strength as that when one centimetre length of its circuit is bent into an arc of one centimetre radius, the current in it exerts a force of one dyne on a unit magnet-pole placed at the centre. But the absolute unit of current as thus obtained was decided to be ten times too great for practical purposes. So a practical unit of current was fixed upon, which is just one tenth part of the above absolute unit of current. This practical unit of current was called the ampere, in honor of the celebrated French electrician, Ampère. It may be ascertained in other ways, as when a current is of sufficient strength to deposit in a copper electrolytic cell 1.174 grammes (18.116 grains) of copper in an hour, such current is said to be of one ampere strength; or a current of one ampere strength is such a one as would be given by an electro-motive force of one volt through a wire offering one ohm of resistance.

Volt:—This was named from Volta, the celebrated Italian electrician, and was agreed upon as the unit of electro-motive force. It is that electro-motive force which would be generated by a conductor cutting across 100,000,000 C. G. S. lines in a field of force per second; or it is that electro-motive force which would carry one ampere of current against one ohm of resistance.

Ohm:—So called from Ohm, a German electrician. It is the unit of resistance offered by a conductor to the passage of an electrical current. As an absolute unit of resistance, it is equal to 1,000,000,000 C. G. S. units of resistance. As a practical unit, and as agreed upon at the International Congress of Electricians (Chicago, 1893), it represents the resistance offered to an electric current at the temperature of melting ice by a column of mercury 14.451 grammes in mass, of a constant cross-sectional area, and 106.3 centimetres in length. This is called the international ohm. The resistance offered by 400 feet of ordinary telegraph wire is about an ohm.

These three units—ampere, volt, and ohm—are the factors in Ohm's famous law that the current is directly proportional to the electro-motive force exerted in a circuit, and inversely proportional to the resistance of the circuit; that is,—

Current = Electro-motive force / Resistance

or,

Electro-motive force = Current × Resistance

or

Resistance = Electro-motive force / Current.

Erg:—From the Greek *ergon*, work, is the unit of work required to move a force of one dyne one centimetre. One foot-pound equals 13,560 ergs.

Calorie:—Latin *calor*, heat, is the unit of heat; being the amount of heat required to raise the temperature of one kilogram of water one degree centigrade.

Coulomb:—In honor of C. A. de Coulomb, of France. It is the practical unit of quantity in measuring electricity, and is the amount conveyed by one ampere in one second.

Farad:—From Faraday, the physicist. It is the unit of electric capacity, and is the capacity of a condenser that retains one coulomb of charge with one volt difference of potential.

Gauss:—From Carl F. Gauss (1785–1855). The C. G. S. unit of flux-density, or the unit by which the intensity of magnetic fields are measured. It equals one weber per normal square centimetre.

Gilbert:—The unit for measuring magneto-motive force, being produced by .7958 ampere-turn approximately.

Henry:—From Joseph Henry, of the Smithsonian Institution, Washington, D. C. The practical unit for measuring the induction in a circuit when the electro-motive force induced is one international volt, while the inducing current varies at the rate of one ampere per second.

Joule:—The C. G. S. unit of practical energy, being equivalent to the work done in keeping up for one second a current of one ampere against a resistance of one ohm. Named from J. P. Joule, of England.

Oersted:—From Oersted, the electrician. It is the practical unit for measuring electrical reluctance.

Watt:—The practical electrical unit of the rate of working in a circuit, when the electro-motive force is one volt, and the intensity of current is one ampere. It is equal to 107 ergs per second, or .00134 horse-power per second. Named from James Watt, of Scotland.

Weber:—The practical unit for measuring magnetic flux. Named from W. Weber, of Germany.

The Century's Naval Progress

By REAR ADMIRAL GEORGE WALLACE MELVILLE, U. S. N.

I. INFLUENCE OF SEA POWER.

The share of navies in the great movements which have moulded human destiny and shaped the world's progress, although long obscure and undervalued, has met in our time full recognition. Within a decade the influence of sea power upon history has become the frequent theme of historians and essayists who, in clear and striking form, have shown the cardinal importance, both in war and commerce, of the fleet—the nation's right arm on the sea. It is fitting, therefore, that in the retrospect of a hundred years navies should have their place; that, in looking backward with history's unclouded vision, we should mark, not only their growth and change, but, as well, their achievement in some of the most memorable conflicts of our race.

The century had but begun when, at Copenhagen, Nelson, with one titanic blow, shattered the naval strength of Denmark and the coalition of the Northern powers. His signal there, ever for "closer battle," told in few words the life story of the Great Admiral, and foreshadowed his end. Four years later, at Trafalgar, the desire of his eager heart was satisfied, when he met in frank fight the fleets of France and Spain. Amid the thundering cannonade of that last victory his life-tide ebbed, bearing with it the power of France upon the seas and the broken fortunes of Napoleon. In the war of 1812, our disasters upon the land met compensation in victory afloat. The United States was then among the feeblest of maritime powers; and yet Macdonough and Perry on the lakes and our few frigates on the ocean opposed, with success, the swarming squadrons of a nation whose naval glory, as Hallam says, can be traced onward "in a continuous track of light" from the days of the Commonwealth. The oppression of the Sultan was ended for a time when, in 1827, the Turkish and Egyptian fleets were annihilated, in sudden fury, by the allied squadrons in that brief engagement which Wellington termed the "untoward event" of Navarino.

A generation later, the command of the sea enabled England and France to despatch, in unarmed transports, 63,000 men and 128 guns to the Crimea, and to land them, without opposition, for the red carnage of the Alma, Balaklava, Inkerman, and Sebastopol. Following closely upon the disease and death, the fatuity and the glory, of the Crimea, came the great war of modern times, in which the gun afloat played such a gallant part, as the blockade, with its constricting coils, slowly starved and strangled the Confederacy to death, and Farragut, on inland waters, split it in twain. Passing over the sea-fights of Lissa,—in which imperial Venice was the stake,—of South America and the Yalu, we note, lastly, the swift and fateful actions off Santiago and in Manila Bay, which destroyed once again the sea power of Spain, won distant territory for the United States, and opened up for us a noble pathway of commercial expansion to the uttermost island of the broad Pacific and the vast Asian littoral beyond. Who will say, in the retrospect of the century, that the fleets of the world have not had their full share in the making of its history?

II. THE CENTURY'S GROWTH IN NAVAL STRENGTH.

The United States fleet, in the year 1800, comprised 35 vessels, 10 of which were frigates mounting 32 guns or more. In 1812, America entered the lists against a navy of a thousand sail, with a fleet of but 20 ships, the largest of which was a 44-gun frigate. The operations of the Civil War were begun with but 82 vessels, 48 of which were sailing craft. Before the close of that gigantic struggle there were added, by construction or purchase, 674 steamers. In 1898, during the war with Spain, there were borne on the Naval Register, as building or in service, 13 battleships and 176 other vessels, including torpedo craft, with 123 converted merchantmen. The total naval force during hostilities was 22,832 men and 2382 officers, excluding the Marine Corps.

At London, in 1653, there was printed “A List of the Commonwealth of England’s Navy at Sea, in their expedition in May, 1653, under the command of the Right Honorable Colonel Richard Deane and Colonel George Monk, Esquires, Generals, and Admirals.” This quaint record of that early time gives the force afloat as 105 ships, 3840 guns, and 16,269 men. In Britain’s strife for that ocean empire, which is world empire, that fleet had grown, by the year 1800, to 757 vessels, built or building, with an aggregate tonnage of 629,211, and carrying 26,552 guns, 3653 officers, and 110,000 men. The stately three-decker, with its snowy canvas and maze of rigging, has vanished with the past; but, despite time and change, that mighty fleet still dominates the seas. Its strength, on February 1, 1898, was 615 vessels—61 of which were battleships,—carrying a total force of 110,050 officers and men.

Colbert, when the Grand Monarch was at the zenith of his power, found France with a few old and rotten vessels, and left her with a noble fleet of 40 ships of the line and 60 frigates, which, under D’Estrée, Jean Bart, Tourville, and Duquesne, carried her flag to every sea. A state paper of the time gives the force at the beginning of this century as 61 ships of the line, 42 corvettes, and a numerous, although unimportant, flotilla of small craft. With Aboukir and Trafalgar, the maritime power of France wasted away; and, by the year 1839, there were afloat but three effective sail of the line. In 1840, however, the revival began, and during the modern era the French fleet has, at times, been a formidable rival of that of England. It comprised, in 1898, 446 vessels, including torpedo craft, 26 of the total being battleships. The force afloat numbered 70,925, of all ranks and ratings.

Germany’s navy is of modern creation. It began, a little less than half a century ago, with one sailing corvette and two gunboats; and, in 1898, comprised 13 battleships and 179 other vessels of all types, carrying 23,302 officers and men. The fleet of united Italy had its inception, also, within the age of steam. It was on March 17, 1860, that Italian national life began with the ascension of the throne by Victor Emmanuel. From the beginning, the kingdom has been lavish with its fleet, its expenditures within the first six years reaching $60,000,000. In 1898 there were in the Italian navy 265 vessels of all types, 17 of which were battleships. The force afloat was 24,200, of all ranks and ratings.

The Crimean war found Russia but little advanced, either on the Black Sea or the Baltic, in the substitution of steam for sail. Since that time, however, she has re-created her battle fleet, which is now especially strong in torpedo craft and cruisers of great steaming radius. Her navy, in 1898, comprised 20 battleships and 263 other vessels, with a force of 32,477 officers and men. Japan began her fleet in 1866 with the purchase of an armor-clad from the United States. In 1898, she had a total of 145 vessels, built and building—8 of which were battleships—carrying 23,000 men of all ranks and ratings.

Of minor navies little need be said. Austria had, in 1898, a fleet of 115 vessels of all types, including 13 battleships and 79 torpedo craft. Holland’s force was 185 vessels, 3 being battleships and 93 torpedo craft. The fleets of Turkey, Greece, Spain, and Portugal are “paper-navies” mainly. Norway and Sweden have a combined strength of 171 vessels of all types. Denmark, which began the century with overwhelming naval disaster at Copenhagen, has now a force of 3000 men borne on 50 vessels, half of which are torpedo craft. Argentina, Brazil, and Chili have afloat 102 torpedo vessels and 49 of other types. The vast growth in naval armaments during the century may be measured from the fact that the personnel of the leading navies of Europe, with those of Japan and the United States, comprised, in the year 1898, 368,028 officers and men, with a total force of 2749 vessels of all types, including torpedo craft.

III. THE BATTLESHIP,—PAST AND PRESENT.

In tracing the evolution of the modern man-of-war, it will be instructive to compare with her the type of the sailing age. There are two ships of the old time which hold chief places in the memory of the Anglo-Saxon race,—the Victory, Nelson's flagship at Trafalgar, and the Constitution, whose achievements under Hull, Bainbridge, and Stewart, rang around the world. There were, even before the days of steam, war-vessels twice as large and powerful as "Old Ironsides," but over no sea, in any age, has there sailed a ship with a more gallant record. Plate I shows her as she was in her prime—before the wind, with all sail set. On Plate II there is given a side view of her hull, which is of historic interest, in that it is reproduced from the original drawing made in October, 1796.

When her power and dimensions are compared with those of the Oregon, our sea-fighter of to-day, one sees what time has wrought. The frigate carried 456 men, the armor-clad, 500; and yet, with this approximately equal force, the Oregon has a displacement 6½ times that of her famed predecessor; and although the number of the guns—44—is the same in each, she discharges a broadside 8.3 times heavier and in energy overwhelmingly superior. The speed of the battleship is one half greater than that of the Constitution, and she carries armor varying from 18 inches to 4 inches thick, which the frigate wholly lacked. The longitudinal section of the Oregon indicates the immense advance in other directions. Her hull is, for safety, minutely subdivided, and is provided with engines for propulsion, steering, lighting, drainage, and ventilation, numbering in all 84, with miles of piping and hundreds of valves. The time-honored frigate was but a sail-propelled gun-platform, whose wants were as few as her construction was simple; the steel-clad battleship is a mass of mechanism, a floating machine-plant, which for full efficiency must be manned by a personnel not only brave and daring as of old, but expert in many arts and sciences, which in the age of sail were but rudimentary or unknown.

"*I have just read the project of Citizen Fulton, Engineer, which you have sent me much too late, since it is one which may change the face of the world.*"

So, in the beginning of the century, wrote the first Napoleon from his Imperial camp at Boulogne. Wrapped in his day-dream of a descent upon the Thames, he saw, with prophetic vision, in the plans of the American engineer, the future of navigation, and he strove to grasp—but too late—the opportunity which might have made his armada victorious over wind and tide.

His words, however, rang truer than he knew. On the sea, as on the land, the engineer has indeed "changed the face of the world;" and in no department of human progress has his influence been more radical or more far-reaching than in the mechanism, the scope, and the strategy of naval war. Fleets move now with a swiftness and surety unthought of in the days of sail. Over the same western ocean which Nelson, in his eager chase of Villeneuve, crossed at but four knots an hour, the United States cruiser Columbia swept, ninety years later, at a speed nearly four and three quarters times that of his lagging craft. When, in 1898, war came, the great battleship Oregon, although far to the northward on our western coast, was needed in the distant battle-line off the Cuban shore. In 79 days she steamed 14,500 miles, making a run which is without parallel or approach by any warship of any navy in the world's history. The magnificent manhood, the unconquerable pluck, the engineering skill, which brought her just in time off Santiago, won their reward when the Colon struck her flag. Speed has been a determining factor in many a naval action. It was that which gave the power to take and hold the old-time “weather-gauge.” None knew its value better than Nelson, the chief fighter of the age of sail. Once he said that there would be found, stamped upon his heart, “the want of frigates,” the swift and nimble “eyes of the fleet” in his day. If his career in warfare on the sea had been a century later, he would be found foremost among the advocates of high-speed battleships and quick-firing guns.

It is, however, not only in the speed of warships that steam and mechanism have revolutionized fleets. For example, the displacement of the battleship of to-day is fully three and one half times greater than that of her heaviest ancestor of the sailing age. With due limitation as to length of hull, it is evident that the wind would be, at best, a wholly inadequate and untrustworthy motor for this huge structure with its great weight of armor. It is true that, during the era of transition, sail and steam were both applied to iron-clads—this absurdity reaching its climax in the British Agincourt and her sisters, which were 400 feet long, 10,600 tons’ displacement, and were fitted with five masts. It is said that a merchant steamer narrowly escaped collision at night with one of these vessels, believing from her length and rigging that there were *two* ships ahead, between which she could pass. What these large displacements mean, in contrast with those of past days, will be, perhaps, best illustrated by the statement that the Italia of 13,600 tons—a ship with which, in her day, Italy challenged the criticism of the world—carries on her deck a weight, in armor and armament, of 2500 tons, or one fourth more than that of Nelson’s flagship Victory.

(Furnished by the Author.)

Length 174 ft. 10½ ins.
Beam 43 ft. 6 in.
Mean Draught 20 ft. 0 in.
Displacement 2200 tons.

William Doughty, Fecit. 1796, Oct.

Joshua Humphreys, of Philadelphia, Designer. Cloghorne and Hartley, of Boston, Builders. Launched Oct. 21, 1797.

Again, the largest naval gun in the year 1800 was one firing but a 42-pound shot, while in the United States navy we have now the 13-inch rifle of 60 tons, with a projectile of 1100 pounds, and Great Britain has afloat 1800-pounder breech-loaders which weigh 111 tons. Before monster ordnance such as this, the strength of man, unaided, is but crude and futile. He must call to his help—as he has done—steam as the source of power for the electric, hydraulic, or pneumatic engines, which load, elevate, and train the gun.

In summing up the service of steam, directly or indirectly, to the ship-of-war, it will be seen that the speed of the battleship has been increased by fully 50 per cent., and that of the cruiser has been doubled; that the displacement of the battleship is now three and one half times that of her sailing predecessor; and that, since the century’s birth, the gun has grown to such extent that the projectile for the Oregon’s main battery weighs 26 times that of the heaviest shot in the year 1800. This, however, is not all. Steam acts primarily, as well, to raise the anchor, to steer the ship, and to effect her lighting, heating, drainage, and ventilation. To the genius of James Watt there must be ascribed the possibility for the growth and change which have produced the modern man-of-war.

Closely allied with mechanism in this evolution, has been the transformation of the structural material of the hull, which has passed from the hands of the shipwright in wood to the engineer who works with steel. The reasons for this are not far to seek. They lie, firstly, in the greater strength of the metal construction to withstand the vibration of swift and heavy machinery, and the strains arising from the unequal distribution of massive weights in a hull which pitches or rolls with the waves. With wooden ships, the present proportions would have been unattainable. Again, there is a marked saving in the weight of the hull proper of the steel vessel, which is not only stronger but lighter. This weight in the days of timber averaged fully one half of the displacement; while in the Oregon, whose tonnage, at normal draught, is 10,288, the hull percentage is 44.06, leaving a gain over the wooden vessel of 611 tons to be applied to armor, armament, or equipment. Finally, the durability of the metal vessel, with adequate care, greatly exceeds that of the wooden war steamer, whose average life was but 13 years.

The creation of the steam machinery of navies has been the achievement of the engineers of practically but three great nations. The daring of France, the inventive genius of America, and the wide experience and sound judgment of Great Britain, have united in this work. Our country has led time and again in the march of improvement; although our progress has been fitful, since, more than a generation ago, we turned from the sea to the development of the internal resources of this continent. Limits of space permit but brief review of a history which has had its full share of triumphs, not only in battle, but over wave and wind.

A contemporary authority states that, when British Admiral Sir John Borlase Warren ascended the Potomac River, during the war of 1812, his expedition was reconnoitred by an American steamer. This appears to be the first record of the use of such craft for military purposes. In 1814 the United States built the first steam war-vessel in the world's history. She was called the Demologos, later the Fulton, and her completion marked truly, as her commissioners said, "an era in warfare and the arts." She was a double-ended, twin-hulled floating battery of 2475 tons, carrying twenty 32-pdr. guns, protected by 4 ft. 10 in. of solid timber. She was driven by a single central paddle-wheel; her speed was 5½ miles per hour; and she was both handy and seaworthy. France, in 1820, sent a commission to America to report upon steam vessels of war; and in 1830 the French had nine armed steamers afloat and nine building. In 1821, the Comet, a small side-wheeler, was commissioned as the first steam war-ship in the British navy, and in 1840, at the bombardment of Acre, steam vessels fought their first battle.

The growth of steam in navies had been retarded by its application solely to paddle craft, whose wheels and machinery were incapable of protection in action. During the years 1842–43, however, the United States built the sloop-of-war Princeton, of 954 tons. This vessel was the product of the genius of John Ericsson, the ablest marine engineer the world has ever seen. She was the first screw-propelled steam warship ever built, and, in other respects, foreshadowed the advances which were to come. Thus, her machinery was the first to be placed wholly below the water-line beyond the reach of hostile shot; her engine was the first to be coupled directly to the screw shaft, and blowers, for forced draft, were with her first used in naval practice. She was virtually the herald of the modern era.

The Princeton was followed closely by the Rattler, the first screw vessel of the British fleet, and in 1843–44 the French 44-gun frigate Pomone was fitted with propellers. In 1843, also, the English Penelope was the first man-of-war to be equipped with tubular boilers, and the year 1845 was notable for the building of the ill-fated Birkenhead, the first iron vessel of the British fleet. In 1850, when the French constructed the screw line-of-battle ship Napoleon, the English became alarmed, and began with vigor the renovation of their navy with regard to screw propulsion.

France, in 1854, laid the keels of four armored batteries, three of which, forming the first ironclad squadron in history, went into action a year later under the forts of Kinburn in the Crimea. They were of 1600 tons' displacement, carried 4⅓ inch armor and sixteen 68-pdr.

guns, and had a speed of four knots. In 1862, Ericsson launched the famous Monitor, the first sea-going ironclad with a revolving turret, and an "engineers' ship" from keel to turret top.

The Civil War found us with a sailing navy, and left us one of steam. Passing over its victories, in which steamers played always the chief part on sea and river, we come to that most notable triumph of Chief Engineer Isherwood, the cruiser Wampanoag of 4200 tons' displacement. This vessel, phenomenal in her day, steamed in February, 1868, from Barnegat to Savannah, over a stormy sea, in 38 hours. Her average was 16.6 knots for the run, and 17 knots during a period of six consecutive hours—a speed which for 11 years thereafter was unapproached by liner or by warship. In 1879, the British despatch vessel Mercury, of 3730 tons and 18.87 knots, wrested the palm from America; but, in 1893, it was won again for the United States by the triple-screw fliers Columbia and Minneapolis of 7475 tons, with speeds respectively of 22.8 and 23.073 knots. The laurels rest now with the Buenos Ayres, which, though built in England in 1895, flies the flag of Argentina. She has a tonnage of 4500 and a speed of 23.202 knots.

The British ironclad Pallas, completed in 1866, was remarkable for having the first successful naval engines on the compound principle, in which the steam is admitted at high pressure to a small cylinder, and passes thence to a larger one which it fills by its expansion. To Great Britain the world owes also the development of triple expansion, i. e., the use of steam successively in three cylinders. This system was inaugurated in naval engines by the British, in 1885–86, and is now universally employed. Prior to 1879, the boilers of all modern war-vessels had been those of the Scotch type, in which the flame passes through tubes fixed in a cylindrical shell containing water. In that year, however, France began a revolution in the steam generators of navies by equipping a dispatch-vessel with the Belleville tubulous boiler, in which the water to be evaporated is contained within tubes surrounded by flame confined in an outer casing. The water-tube principle, also, bids fair to become of universal application. It has had its most noteworthy naval installation in the British cruisers Powerful and Terrible, of 14,200 tons and 25,886 horse-power, completed in 1895.

The use of more than one screw for propulsion dates back to 1853. During our Civil War multiple screws figured, to a small extent, in the "tin clads" and larger monitors. The application of twin screws, in the modern era, begins with the British ironclad Penelope of 1868. France, in the years 1884–85, blazed the way for another naval advance of much importance in conducting a series of trials with the launch Carpe, equipped with triple screws. The system, however, although of much value, from engineering and tactical points of view, was not adopted in large, high-powered vessels until the advent of the French armored cruiser Dupuy de Lôme in 1890, and the protected cruisers Columbia and Minneapolis of the United States navy in 1893. It has now won full approval in the navies of continental Europe, and triple-screw ships, aggregating 500,000 tons, are built or building there.

The limits of space forbid more than a passing note of the triumphs of the engineer in torpedo craft, the light cavalry of the sea. With steamers of normal proportions, the speed and power depend largely upon, and increase with, the displacement. As has been stated, the maximum performance of large cruisers is now 23 knots on a tonnage of 4500. These particulars give a faint glimpse of the extraordinary problem which has confronted the torpedo-boat designer in driving hulls of, at present, about 150 tons at a speed which now approximates to 30 knots. With the brilliant record of success in this task, there will be linked always the names of Yarrow and Thornycroft in England, of Schichau in Germany, and of Normand in France. The achievement but recently of a British inventor, the Hon. Charles Algernon Parsons, in giving the Turbinia of 44.5 tons a speed of over 31 knots, has drawn the attention of engineers the world over to the possibilities of the steam turbine on the sea. This performance is phenomenal with such a displacement. The French Forban, of 130 tons, has made 31.2 knots, and a reported speed of 35 knots gives a Schichau boat her temporary laurels as the fastest craft afloat.

A brief glance at the improvements which have made possible these extreme speeds in cruisers and torpedo craft will be of interest. The progress which has been made has been, firstly, in the economy in the use of steam arising from higher pressures and multiple expansion; secondly, in the reduction of weight, per horse power, due to increase in strength of materials and in engine-speed with the employment of forced draft—which was reintroduced by France—and the water-tube boiler; and, finally, in the application of a more efficient propelling instrument. The advances of half a century in propelling machinery are shown, in some respects, by Plates III and IV, which contrast, on the same scale, the side-wheel machinery of the United States war-steamer Powhatan, of 1849, with the engines of the United States torpedo boat Ericsson of to-day. The data of the former vessel are: horse-power, 1172; steam pressure 15 lbs.; weight of machinery per horse-power 972 lbs.; while, for the Ericsson, the figures are: horse-power, 1800; steam pressure, 250 lbs.; weight of machinery per horse-power, 56 lbs. This comparison, however, must be qualified by the statement that the older engine was for a steamer of about 3760 tons, while the torpedo boat is but 120 tons in displacement. The contrast lies, therefore, only in the reduced weight of material per horse-power developed and in the increased steam pressure, which, however, are in themselves most striking.

V. THE GROWTH OF ORDNANCE.

At Trafalgar, the Victory drifted before the wind into action. In her slow advance, at a speed of one and one half knots through but 1200 yards, she was for half an hour under the prolonged fire of 200 guns, and yet she closed, practically unhurt, with her foes, and lived, not only to win the day, but to bring undying glory to the English flag. What a contrast the latest sea-fight of the century presents in the power of modern ordnance as compared with the puny guns of Nelson's time! Our battleship Oregon, at a range of nearly five miles, with one 1100-pound shell, drove the Colon, an armored cruiser, not only shoreward, but to surrender, stranding, and wreck.

The largest naval guns in the year 1800 were the long 32 and 42-pounders, smooth-bore muzzle-loaders, with a range of about 1200 yards. Carronades—short pieces with a heavy shot but limited range—found favor also, especially with British sailors, eager for that close-quarter fighting in which the "Smasher"—as General Melville called his carronade—would be most effective in shattering timbers and in sending clouds of splinters among the foe. The projectiles were spherical shot, canister, and grape, the diabolical shriek of the shell being yet unheard. Both gun and shot were of cast metal, and the mount was a wooden carriage on low trucks. The training, or horizontal angle of the gun, was effected by rope tackles, and the amount of elevation of its muzzle depended upon the position of a "quoin," or wooden wedge, thrust beneath the breech. The recoil was limited by rope "breeching," passing through the cascabel,—a knob behind the breech,—and secured to ring-bolts in the ship's side. The gun was harnessed, as a horse is, in the shafts.

Aiming was largely a perfunctory process, since the gun had no sights and the shot had excessive "windage," its calibre being from one fifth to one third inch less than the bore, making its outward passage a series of rebounds and its final direction a matter of chance. "Windage," however, was essential to facilitate muzzle-loading and to provide for the expanded diameter of red-hot shot. It is true that in 1801 a proposition to use sights was made to Lord Nelson. He, however, rejected it with the words:—

“I hope we shall be able, as usual, to get so close to our enemies that our shot cannot miss the object.”

His blind courage in this cost his countrymen dearly when, in 1812–14, their shot flew wild, while their ships were hulled and their gallant tars fell before the then sighted guns of the United States.

To ignite the charge the slow-match was still used, as is shown by the sharp words of a sailor of that time. Hailed in the darkness by a British ship and ordered to send a boat, his quick answer was:—

“This is the United States frigate Constitution, Edward Preble, commodore, commanding, and I’ll be d—d if I send a boat!”

Then to his men, silent and eager by the shrouded battle-lanterns:—

“Blow your matches, boys!”

A full crew for a 32-pounder consisted of 14 men. An old rule as to this was one man to every 500-lbs. weight of the gun, which would give the Oregon 1100 men to handle the four 13-inch rifles of her main battery, or more than twice her whole crew. Steam and mechanism have wrought a magic change in this.

The slow-match remained in use until well into the nineteenth century, although, until 1842, the flint lock was generally employed in the British navy, having replaced the priming horn and match in 1780. In 1807 there was discovered a composition which could be ignited by friction or concussion, and in 1839 the French had adopted the percussion lock, which exploded the cap and retracted, uncovering the vent before the backward rush of the gas could strike it. Later, a similar composition was used with “friction-primers,” or tubes filled with mealed powder and capped with composition, the tube forming a train leading to the charge, and the composition being fired by the friction of a rough wire drawn briskly through it. Percussion and friction have been in turn largely displaced by the electric primer, which consists essentially of a fine wire, or “bridge,” passing through a highly inflammable mixture. The bridge offers a resistance to the electric current, is heated thereby, ignites the composition, and fires the gun.

The older type of the cast-iron smooth-bore gun for solid shot reached its ultimate development in the 68-pounder, which endured until the advent of armor. In 1819 the system of firing shells loaded with gunpowder from smooth-bore guns was suggested by General Paixhans, of France. In 1824, it was introduced into the French navy, and about 1840 into that of the United States. At Sinope, in 1853, the terrible effect of shell fire upon wooden ships startled the world, when a Russian fleet destroyed absolutely 11 Turkish vessels, with their force of 4000 men. The Paixhans gun was modified and its form improved by Admiral Dahlgren, U. S. N., and in the late 50’s the armament—designed by him—of United States vessels was superior to that of any other in the world. The 9, 11, and 15-inch Dahlgrens formed the bulk of our guns afloat during the Civil War, the remainder being almost wholly rifles of the Parrott type.

The resistance which spherical projectiles met from the air, their deviation in flight, owing to the frequent lack of coincidence of the centres of gravity and form, their excessive “windage,” and their light weight relatively to calibre, led to the adoption of the rifled gun and the cylindrical projectile. The principle of the former—making the shot act as a screw-bolt and the bore as a screw-thread—is very old, there being at Woolwich a barrel of this type bearing date of 1547. The objects aimed at in rifling are to give a pointed cylindrical shot rotation on its axis that it may keep steady during flight, and secondly, to obtain increased weight in the projectile from its elongated form. As to the latter consideration, it may be noted that the old 32-pounder smooth-bore was of 6-inch calibre, while the United States 6-inch rifle of to-day throws a shot of 100 lbs. weight.

France, during the Crimean War, brought out the first heavy rifled gun. In 1860–61, Armstrong rifles were introduced in the British navy. The labors of Krupp met such success that at Paris, in 1867, he exhibited a rifle weighing 50 tons with a projectile of 1080 pounds. The Parrott rifle was brought out about 1856 in the United States, and was so developed that in 1862 it was the most powerful gun, for its weight and size, in existence. The adoption of rifling was the first great step on the road which engineering had laid toward the growth in power of modern ordnance.

Having thus secured a projectile of great weight and moderate calibre which would bore through the air a true path to the distant mark, there remained to seek but four chief elements in the magnificent advance made within a generation by the naval artillery of our day. These factors were: 1st. Increased strength in the material of the gun. 2d. A method of construction which would not only permit enormous pressures in the powder-chamber, but would make possible the continuous acceleration of the projectile during its passage through the bore. 3d. An explosive which would satisfy the objects of the method of construction; and, 4th. A system of loading which would enable guns of great length to be charged with ease. The mounting of ordnance of any weight, its control, and its rapid and facile handling were but minor matters of engineering.

In a paper such as this, of limited length and addressed to laymen, it is possible to give but a glance at the progress in the various elements of gun-construction which have been noted. Of material, little need be said. The rifle of Crimean days was a cast-iron piece; Parrott ordnance was of cast and wrought iron; and the first Armstrong gun was built of wrought iron and steel. Cast and compound materials, however, have vanished with the past. Steel—hardened and toughened to the last degree by every refinement of manufacture—forms the “reeking tube” for the “iron shard” of the century’s close.

The method of construction is the “built-up” process, shown by the partial section on Plate V., the barrel being reinforced by tubes which are shrunk on—like the tire of a wagon-wheel—so as to produce initial compression. The explosion in the powder chamber strains and expands temporarily the barrel, and the application of the shrinkage principle enables a portion of the strength of the tubes to be employed in preliminary internal pressure. The barrel thus supported can be strained by the charge, not only to its own limit of safety, but to an additional amount equal to this initial compression. The all-steel, built-up gun has a possible rival in wire-wound ordnance, a system which replaces the tubes, to a greater or less extent, by layers of wire, wound while in tension around the barrel.

Powder is the soul of the gun; it transforms the huge inert mass into a flaming engine of death. The great development of explosives began but a generation since. The researches of Robins and Rumford in the last century, and of Hutton in the dawn of this, formed the world’s knowledge of the gun’s internal ballistics until the year 1870. To the genius of Noble and Abel is due the stimulus to growth since then. The powders have kept pace with gun-construction in its advance. The increased strength of the chamber has been met by heavier and slow-burning charges—cocoa, brown prismatic, and the like—which have given not only greater initial velocity, but a continuous acceleration through bores whose maximum length has exceeded 47 feet. Indeed, to the production of this lingering combustion is due the great linear dimension and power of modern guns. Initial pressure had its limit; advance lay only in the subsequent acceleration given by late ignition of a portion of the charge.

Gunpowder, however, after a reign of more than five hundred years, has been dethroned. The “villainous saltpetre” of the monk, with its allies, charcoal and sulphur, yields now to nitro compounds, which produce not only far greater energy, but are as well smokeless. The sea-fights of our war with Spain saw the last contending fleets to be wrapped in a cloud, lingering and baffling, of their own making. Cordite, one of these compounds in use abroad, is prepared in long “cords” from di-nitro-cellulose and nitro-glycerine. The new smokeless “powder” of the United States navy is made from nitro-cellulose dissolved in ether alcohol. France was the first in employing explosives such as these, which, in their offensive and tactical advantages, form one of the signal triumphs of the century’s last years.

The long gun of modern days is of necessity breech-loading. The development of other elements gave, as a resultant, great length; and this, in turn, required a system of charging which would permit protection for the men while loading, and would obviate the intolerable inconvenience of ramming home powder and shot in a long muzzle-loader—an operation which was, in fact, impossible beyond a certain limit of length. The advocates of the older construction, especially in England, urged long and earnestly its simplicity and the superior strength of a solid breech; but the logic of events was against them, and the breech-loader won a complete triumph. It is worthy of note that it, like rifling and the principle of building up, was but a revival. From the warship Mary Rose, sunk in 1545 in action off Spithead, there were recovered in 1836 a number of guns, some of which are of wrought iron, built-up and breech-loading. There are in use two methods of closing the breech when the gun is loaded from the rear. In French, English, and American ordnance an axial screw-plug is inserted; in the Krupp system a cylindro-prismatic breech-block slides in a horizontal opening cut across the bore. The former, or interrupted screw mechanism, was first set forth in the United States’ patent of 1849 to Chambers.

In projectiles the tendency of the modern era has been towards simplification. Bar-shot, chain-shot, and grape have disappeared, while canister and solid shot are becoming obsolete. There remain shrapnel as the “man-killer” of this age, and explosive shell, differentiated into armor-piercing and that for attack on unarmored structures. Lieutenant Shrapnel, in 1796, invented the projectile which bears his name. In its modern form, it consists of a steel case containing lead or iron balls and a light bursting charge of powder, ignited by a time-fuse carried in the head. This projectile is most formidable against bodies of men, boats, and the embrasures of forts, since, when it is ruptured, the balls are dispersed, covering a wide area.

The use of explosive shell in high-angle discharge dates back to the fifteenth century. From Paixhans’ works, “La Nouvelle Arme,” published in 1821, came the stimulus to its development and to its deadly service, in our time, in horizontal fire. The “common shell” for the United States 13-inch rifle is made of forged steel, weighs 1100 pounds, and carries within it a bursting charge of 50 pounds of powder, ignited by a percussion fuse set in its base. It will penetrate 6 or 7 inches of armor and then explode within the ship. The United States “armor-piercing shell” is manufactured from crucible steel, alloyed with chromium; it is tempered to extreme hardness at the point, which carries a cap of soft metal. The function of the latter would appear to be that of a support to the shoulder of the projectile, or as a lubricant thereto, since, without the cap, the shell is broken or deformed in the attack on armor of surface hardened steel. To resist the crushing strain in its passage through massive plate, the walls of this shell must be so thick that no charge of gunpowder will burst it. Hence, as a rule, the shell is fired unloaded, although recently there have been adopted to some extent bursting charges of some high explosive, such as gun-cotton, joveite, or picric acid.

In closing this brief review of the progress of ordnance, but passing mention can be made of matters minor, but in themselves of much importance. Gun carriages, or mounts, are now intricate mechanisms, practically the whole service of large ordnance being performed by electric and hydraulic machinery. The rapid fire principle has been extended to pieces of 6-inch calibre, and bids fair to pass beyond that limit. Its success in increasing largely the number of shots within a given time lies in special breech-blocks, aiming devices, and prepared cartridges. Machine guns of rifle-calibre, partly or wholly automatic, have been so developed as to be capable of firing 1200 rounds per minute. The discharge of high explosives in large quantity was effected with success by the United States steamer Vesuvius off Santiago. The torpedo-gun afloat, however, would appear to be still in a tentative condition.

A brief lapse into technical terms may be permitted in summarizing the gun's growth in power. The term "muzzle energy" is used to describe the work which the projectile is capable of performing when it leaves the bore. It is expressed in foot-tons, i. e., the number of tons which the energy stored in the shot would lift to a height of one foot. The figures as to this for the 32-pounder of the century's beginning, for the United States 13-inch rifle and for the 111-ton English gun, are, respectively, 642, 33,627, and 54,690 foot-tons. Again, the round shot from the 32-pounder lost from the resistance of the air, in a range of 1200 yards, 76 per cent of its energy; while this loss, with the United States 13-inch, in a range of 1000 yards, is but 11 per cent. Finally, if the cast-iron shot of the 32-pounder were fired against armor-plate, it would lose, in breaking itself up, two thirds of its remaining energy, leaving at 1200 yards but 51 foot-tons for effective work; while with the modern armor-piercing shell the entire energy left at the end of the range is expended upon the armor-plate.

It will be seen then that the immeasurable superiority of modern guns is owing both to their great increase in energy and to their wiser disposition of that which has been attained. The gun has maintained fully during the century its primacy among naval weapons. It is true that, in theory and on paper, its supremacy has at times been questioned; but as to its two rivals, the ram would seem to be rather the weapon of accident than action, and the torpedo has yet to score in battle against ships in motion, while the precision, rapidity, and power of the gun grow more deadly with every passing year.

VI. THE DEVELOPMENT OF ARMOR.

Armor and the gun are natural and now hereditary foes. The function of the one is to resist, that of the other ever to attack. Since the beginning of the modern era in navies, there has been ceaseless strife for mastery between these two elements of warship design, the gun ever becoming more powerful, and the armor—at first through growing thickness and later through improved material—opposing a steadily more stubborn front. The official report of an English committee made in the year 1860 states that,—

"Vessels clothed in rolled-iron plates of four and a half inches' thickness are to all practicable purposes invulnerable against any projectile that can be brought to bear against them at any range."

The advance which forty years have seen may be shown by the single statement that the Krupp 15.7-inch gun develops sufficient energy to penetrate at the muzzle 47 inches of wrought iron. The battleship is at best but a series of compromises, each factor of the structure yielding or growing as the skill or whim of her designer may indicate. In the present stage of this unceasing change, the gun would appear to be the victor, and the power of this mighty 132-ton rifle seems scarcely needed on the sea. The distinguished chief of ordnance of the United States navy, in his annual report for 1898, says:—

"The development of the 12-inch gun has been so great and its power so much increased that the Bureau is of opinion that hereafter it will be the maximum calibre that it will be advisable to install on future battleships."

With armor, as with the torpedo, the talent of Europe reaped where the genius of America had sown. John Stevens of New Jersey was the first inventor of modern times to suggest the application of armor to a floating battery, his plans being submitted to the United States government during the war of 1812. They received, however, no serious consideration, and to France, forty-two years later, fell the honor of attaining the first practical results in the building of ironclads. Members of the Stevens family, however, continued the experiments of its founder, until by the year 1841 they had determined the thickness of iron necessary to stop spherical projectiles at point blank range, and the comparative resisting powers of iron and oak. These results led to an appropriation by Congress, in 1854, of $500,000 to begin work upon an ironclad,—the Stevens battery,—which vessel, however, never left the ways and was eventually broken up.

General Paixhans, who revolutionized naval artillery by the invention of the modern shell, prophesied, in an official letter to the French government in 1824, that the new projectile would force the creation of armored ships. In 1841 he recommended officially the clothing of vessels with iron armor, as a protection against his own missiles; and in 1853 his words of warning met complete and terrible fulfillment in the annihilation by shell guns of the Turkish fleet at Sinope. This action was the immediate cause of the introduction of armor in modern navies.

The British admiralty, in 1843, had duplicated the Stevens experiments, using a target of 14 plates of boiler iron riveted together, which gave a total thickness of 6 inches; and experiments on laminated plating had been also at this time carried on at Gavres, in France. In 1845 Dupuy de Lôme, the famous naval architect, submitted to the French government the first European design for an armored frigate. His plans were, however, rejected; and only with the outbreak of the Crimean War was the construction of armored vessels begun. On October 17, 1855, the three French batteries which were the first results of this new departure went into action off Kinburn, in the Crimea, silencing in four hours forts which had held at bay the combined fleets of England and France. Armor had won its first victory, and had shown most signally its position as one of the main factors in the warship design of the years which were to come.

These vessels, with three similar batteries constructed immediately thereafter by the British government, were clad with solid iron plates 4½ inches thick, backed by 27¾ inches of oak, comparative experiments at Vincennes, France, having shown the marked superiority of solid over laminated plating. They were, however, in but a most limited sense sea-going ships, their low speed and other inferior qualities being radical defects as to this. France led in a further advance, beginning in 1857 and completing in 1859 the transformation of the wooden line-of-battle ship Napoleon into the armored vessel of 5000 tons, which, as La Gloire, is famous as the first sea-going ironclad. She carried a strake of 4¾-inch plating at the water line, and 4½-inch plates in wake of the battery. England answered the challenge of her hereditary foe with the Warrior, an iron vessel of 9210 tons, completed in 1861. While her rival had a fully armored side, but 212 of the Warrior's 380 feet of length carried plating. Its thickness was 4½ inches.

At the outbreak of the Civil War in the United States, the government appointed a special naval committee to report upon types of ironclads. The conclusions of this board are of interest, in showing the state of armor development at that period. They required rolled armor of solid iron, whose minimum thickness was 4½ inches. Ericsson's Monitor, however, carried laminated plating from 3 to 5 inches thick on her low sides, and 11 layers, each one inch thick, on her turret. This construction, which the difficulties in the manufacture of solid plate necessitated, made the record of endurance of this type far from good. The defect lay mainly with fastening bolts, which broke frequently, thus loosening or detaching the side armor, and the heads or nuts of which, flying off with violence when the armor was struck by shot, became sometimes fatal missiles against those within the turrets. In contrast with this, the behavior of the New Ironsides, clothed with solid armor, was most excellent. She was a casemated ironclad frigate with unarmored ends, her plating was 4½ inches thick, and inclined throughout the citadel, at an angle of 30° from the perpendicular. For two years she was subjected to the most severe test that a war-vessel must meet, the tossing and straining of blockade duty and the fiery ordeal of close action with fortifications. In one engagement, she sustained alone a fight against the combined fire of the forts in Charleston harbor, and, although struck on her side-armor sixty times, came out of the struggle unhurt. The record of this ship is one which does honor to the flag.

The achievement of the Confederacy during this war, in the matter of armor, was remarkable. With iron worth almost its weight in gold, and with most limited facilities for manufacturing, they yet succeeded in constructing some of the most formidable ironclads of their day. The Merrimac, for instance—with 3-inch armor, in two layers of narrow bars, at an angle of 30° with the horizontal—sustained no material damage to her plating from the fire of the Monitor; although had the full charge of 30 lbs. of powder been used in the 11-inch smooth-bores of the latter, the story would have been different. Every fair blow would have smashed a hole completely through the armor, and driven a shower of splinters about the battery-deck. Again, the armor of the Atlanta and the Tennessee—both casemated ships, with the sides of the citadel inclined at a sharp angle to the horizontal—was sufficiently strong, with the former vessel, to withstand, at 500 yards, the 11-inch projectile fired with a 20-lbs. charge, and, with the latter, the same shot practically at the muzzle, although the 15-inch projectile broke through completely in both cases.

It is unnecessary to follow in detail, through its many tests in peace, the advance of iron armor. Its growth in strength, as the power of the gun developed, came almost solely from increase in thickness, the latter reaching its maximum with the British Inflexible, completed in 1876, which carries from 16 to 24 inches of iron on her belt and citadel. This plating, however, is divided and "sandwiched" with wood, there being, exterior to the skin, 6 inches of teak, then 12 inches iron, 11 inches teak, and an outer 12-inch plate. As armor, iron received its death-blow in the famous tests at Spezia, Italy, during the autumn of 1876, when the 100-ton gun, with a full charge, at a range of 100 yards, attacked solid and "sandwich" targets of iron and solid targets of steel—the single or aggregate thickness of metal in each case being 22 inches. These trials were undertaken through Italy's desire to build, in the Duilio and Dandolo, the most formidable vessels afloat. Steel won the day, and the roar of that mighty gun, thundering from the Spezia firing ground, sounded the knell of iron armor, deprived the as yet unlaunched Inflexible of her crown of invulnerability, and demanded, with success, a revolution in the armor manufacture of Europe.

As a compromise, compound armor, i.e., iron faced with steel, became popular for a time. As with steel, its beginnings were old, dating back at least to the year 1857. The first perfected compound plate, made by Cammel & Co., of England, was tested at Shoeburyness in 1877. It was composed of 5 inches of iron with a 4-inch face of steel; the iron being raised to a welding heat and the molten steel poured on its top. The great heat partially fused the contact face, the two metals were united, and the combination was assured by immediate rolling. Compound plates sprang in 1877 from obscurity to popularity; by 1879 iron armor had become obsolete with progressive naval powers, and, in 1880, both compound and steel plates had reached such development that they were close rivals, the leading competitors being Cammel in England and Schneider in France. Steel, however, slowly forged ahead during the next decade; and, at its close, compound armor was practically out of the race. In steel's victory, its alloy with nickel, in minute proportions, has materially aided; the combination imparting hardness without decreasing the toughness of the plate. This material gave superior results from the beginning. Its first plate, tested in 1889, was 9⅓ inches thick; it was pierced by a Holtzer shell, whose body did not pass wholly through and whose energy was 1.6 times that just necessary to perforate a wrought-iron plate of the same thickness. To the increased strength given by nickel there has been added a further gain through the application of face-hardening processes—such as that of the American, Harvey—which produce superficial carbonization, transforming the surface into a high grade of very hard steel, without the pronounced plane of demarcation between the two qualities of metal, as in the weld of the compound plate. A 10¼-inch nickel steel Harveyized plate, tested at the Indian Head Proving Grounds in 1892, showed a strength which previously had never been equaled in the history of armor, and established beyond question the value of the face-hardening process, which, by various methods, is applied to the nickel-steel plating of to-day. The distribution of armor in the development of battleship construction is shown by the shaded sections on Plates VI and VII, and its relative thicknesses, on various vessels during this progress, by Plate VIII.

VII. THE RAM AND THE TORPEDO.

For two thousand years the ram—the razor-edged "beak" of the swift galley—was the chief naval weapon. With the advent of sail-power and the employment of gunpowder, it vanished from the seas; but to reappear when the coming of steam gave again controllable propulsion. In 1859 there was built into the French frigate Magenta a sharp spur,—the first modern ram. British construction of the modern era, from the Warrior down, has also recognized this weapon, and it is to-day a factor, although a minor one, in the design of all vessels of high speed.

The ram has, however, but a scant record of service in action, while in accidental collision it has wrought more than once appalling disaster. The ironclad Merrimac rammed and sank in Hampton Roads, in March, 1862, the United States sailing sloop-of-war Cumberland, which, under the gallant Morris, went down with guns thundering and ensign flying. On July 20, 1866, during the action off the island of Lissa, in the Adriatic, the Austrian flagship Ferdinand Maximilian rammed the Italian armorclad Re d' Italia, which, with many of her 800 men, sank with a swiftness that chilled the blood of those who watched. Like this, in its sudden tragedy, was the destruction of the British battleship Victoria by her consort, the Camperdown, off Tripoli, Syria, in the summer sunlight of a June day in 1893. The ram of the latter vessel cut a deep and fatal gash in the Victoria, which within ten minutes turned bottom upward and went down, bow first, bearing with her 321 officers and men, whose unfaltering discipline gave a heroic splendor to their end. Despite these occasional instances of its deadly power, the ram holds a secondary place among naval weapons. To strike a modern vessel at high speed will require more than the skill of the swordsman.

The torpedo, like the ironclad, was an American invention, whose neglect by the United States government brought retribution when this deadly engine of war in 1861–65 destroyed not a few war-vessels flying our flag. Bushnell of Connecticut during the Revolution appears to have invented both the submarine boat and the marine torpedo, the latter being fired by clock-work. Fulton also met success in similar work during the period extending from 1801 to 1812. All of the elements of modern torpedo warfare, excepting the use of steam, compressed air, or electricity as a motive power, had been thus conceived by the early dawn of this century. The torpedoes of our day are practically of but two classes: the “mine,” or stationary (either “buoyant” or “ground,” as its position in the water determines), and the automobile, or “fish” torpedo. The former type is fired either by closing an electric circuit in a station on shore, or by the ship herself in contact, or in electric closure. During the Civil War nearly thirty vessels were sunk by mines, usually wooden barrels filled with gunpowder and fired by hauling lines or slow-burning fuses. It was a mine-field over which Farragut charged at Mobile Bay, when he uttered his famous oath and went “full speed ahead,” with the cases of the fortunately impotent torpedoes striking the Hartford’s bottom; it was a mine which, it is claimed, sunk the Maine; and it was a mine-field which kept Sampson’s battleships from entering the harbor of Santiago de Cuba. The stationary torpedo is now charged with gun cotton or other high explosive.

The origin of the most prominent of the automobile torpedoes is due to Captain Lupuis of the Austrian navy, and its development from 1864 onward to Whitehead, an Englishman. It is a cigar-shaped submarine vessel from 14 to 19 inches maximum diameter and from 14 to 19 feet long, which is blown from a torpedo-tube or gun within the ship by compressed air or an impulse charge of gunpowder. Twin-screw engines contained within its hull, and driven by compressed air stored in a reservoir therein, drive it at about thirty knots speed through an effective range of 600 yards. In its nose or “war-head” there is carried a large charge of gun cotton or other high explosive, which is fired by contact with the enemy’s hull. It is provided with both horizontal and vertical rudders, the depth of immersion being regulated by intricate machinery contained in the “balance-chamber.” The Whitehead has a somewhat formidable rival in the United States in the torpedo invented by Rear Admiral Howell, U. S. N. The automobile torpedo has never yet scored in battle against ships in motion. Its position in the naval warfare of the future is yet unfixed. The one certainty is, that its blow when struck home is almost surely fatal to ship and crew. The development of the submarine torpedo-boat, whose weapon is the Whitehead, has in recent years received much attention through the labors of the American Holland and others. France, in the Gustavus Zede, of 260 tons, has a diving boat of this character, for which much is claimed.

VIII. THE UNITED STATES FLEET.

Until the advent of the ironclad, the ships of the United States were equal, if not superior, in seaworthiness and fighting qualities to any in the world. The high standard set by the Constitution and her class of 1797 was maintained for sixty years; and, especially during the period from 1840 to 1860, the officers and men of the United States navy trod the decks of the finest ships afloat. They felt—as their successors feel—that, ton for ton and gun for gun, they had no foe to fear. The early steamers of the Powhatan class built in the late 40’s were a credit to the nation; the five screw frigates of the Merrimac type (1856–57) aroused the admiration and imitation of foreign experts, and the five corvettes which followed them in 1858–59–60, of which the noble Hartford was the chief, bore their full share in the war which was so soon to come. The gallant Kearsarge was the leader of a new class introduced in 1859.

During the Civil War two vessels, the Monitor and the New Ironsides, appeared which have left lasting traces on all battleship construction since their day. The great fleet of monitors, “tin-clads,” “90-day gunboats,” “double-enders,” and the like, which preceded and followed them during those dark years, served their country well. With the ending of that war, in the internal task of reconstruction and development, our maritime power was neglected and our fleet dwindled away. Its *renaissance* dates from the appointment of the first Naval Advisory Board in June, 1881. The growth since then has been so much a matter of national interest and pride that it needs no detailed recounting here; its results have been summarized previously herein.

The sea-going personnel of the United States navy includes the line, medical, pay, and marine officers, the chaplains and warrant officers—a total on March 1, 1899, of 1589, with an enlisted force of 17,196 blue-jackets and 3166 marines. The officers who serve on shore are the naval constructors, civil engineers, and the professors of mathematics, a total of 69.

Line officers are the commanders, navigators, gunners, and, by recent law, the engineers of our ships of war. Marine officers have charge of the policing of ships and shore-stations and of the guns of light calibre afloat. The duties of the remaining officers are indicated by their titles. The titles of line officers and their relative rank, as compared with that of officers of the army, are:—

NAVY/ARMY.

Admiral/General.

Rear-Admiral/Major or Brigadier-General.

Captain/Colonel.

Commander/Lieutenant-Colonel.

Lieutenant-Commander/Major.

Lieutenant/Captain.

Lieutenant Junior Grade/First Lieutenant.

Ensign/Second Lieutenant.

Line and marine officers and naval constructors are educated at the United States Naval Academy; all other officers are appointed from civil life. The Academy was founded in 1845 and is located at Annapolis, Md. The course comprises four years at the school and two years at sea on a naval vessel. The number of cadets at Annapolis is usually about 260.

It is by reason of wars that navies exist, and a few words as to our—now happily ended—conflict with Spain, may fitly close this review of naval progress. The military lessons of that struggle have been fully set forth by able writers. More important, by far, than these is its teaching as regard to our state and future as a nation. The world has learned that the people of these United States are stirred still by the same stern and dauntless spirit which, in Revolution and Civil War, has made and kept us a nation. Furthermore, with one swift stroke, the bounds which in theory and in territory circumscribed us have been swept away, and the United States have passed from a continental to a world power. This is not chance. It is but the leading onward to a destiny whose splendor we may not measure now, whose light and peace and prosperity shall traverse a hemisphere. The one note of sadness in it all is the memory of the gallant dead, of the heroes who fell that this might be. To them, in Cuba and the Philippines, Columbia—with a smile of pride and a sob of pain—drinks in the wine of tears to-day, as the smoke of battle fades.

Astronomy During The Century

By SELDEN J. COFFIN, A.M.,
Professor of Astronomy, Lafayette College, Easton, Pa.

ITS PROGRESS, ACHIEVEMENTS, AND NOTABLE RESULTS

Astronomy, the oldest of all the family of sciences, is not a whit behind its sister branches in activity of research and brilliance of discovery. The assiduity and zeal of its devotees are marvelous. The celestial field is so wide, the depths of space between the stars so vast, that no assurance can ever be given to an astronomer that a lifetime of faithful and intelligent research will be rewarded with even a single discovery of importance. In this respect it differs materially from other branches of science.

Nevertheless the patient labor of those who serve in its temple has rarely failed to receive an adequate reward. The discovery made in August, 1877, by Professor Asaph Hall, of Washington, that the planet Mars is attended by two satellites, is a convincing illustration of this peculiarity of the pursuit of astronomy as a study. An indefatigable watcher of the skies for many years, Professor Hall, looking at this planet at its opposition in 1877, when it was unusually near to the earth, was surprised to note two tiny points of light quite close to it; seeing them again the next evening, changed in their positions relative to Mars, it flashed upon him that the firm tradition that Mars had no moons was now disproved. His name will be forever associated with these two bodies, Deimos and Phobos, as their discoverer, although they are but wee orbs, only seven miles in diameter.

I. ASTRONOMY A CENTURY AGO.

The end of the eighteenth century found the Copernican theory of astronomy well established, the principles laid down by Kepler and Newton fully elaborated, and the application of the higher mathematics to the needs of astronomy complete. But there were, as yet, no large telescopes, and observatories were few. In Germany, a great disposition to make observations in this science and in meteorology was displayed in 1783 and for a few years following, and the records then made have proved of much value in confirming discoveries announced at later periods.

When Sir William Herschel, on March 13, 1781, pointed out a little star in the constellation of the Twins, and found that it had a perceptible disk and a slight motion, and was therefore not a star, but a newly found planet, to which the name Uranus was soon given, a careful inspection of the notebooks of previous observers showed that Uranus had been observed and recorded as a fixed star on twenty previous occasions in that century. One man had seen it twelve times, and made his record of it on a paper bag purchased at a perfumer's. Had he been a man of sufficient order and method to have penned what he saw on the regular records of his observatory, to him would have come the glory of the great discovery of that century.

II. HOW "BODE'S LAW" PROMOTED RESEARCH.

An erroneous guess, if it is a good guess, sometimes produces excellent results. In 1778, Bode, of Berlin, published a "law" that states the distances of the various planets from the sun. It is often expressed simply in this way: Set down 4, and add to it successively the numbers 3, 6, 12, 24, etc., and the sums obtained, viz., 4, 7, 10, 16, 28, etc., represent the relative distances of all the planets from the sun, viz., Mercury 4, Venus 7, Earth 10, Mars 16, [Asteroids 28], Jupiter 52, etc. In reference to all the planets then known to exist, the correspondence of the alleged law to the facts was remarkable. The one point in which the alleged system utterly failed was in requiring the existence of a planet to fill the gap between Mars and Jupiter. So boldly did Biela press his convictions of the correctness of this law upon the notice of his fellow-workers, that they resolved, in 1800, to divide the zodiac into twenty-four zones, to be apportioned among them, for the express purpose of searching for undiscovered planets. This well-organized effort was, erelong, rewarded by the surprising discovery of four new planets, the first one on the first night of the new century, January 1, 1801, and three more soon after. As no more seemed to be forthcoming, the search was relinquished in 1816. A fifth was found in 1845, and nearly five hundred since. Since 1891 photography has been wondrously serviceable in finding these bodies. A sensitive plate, on being exposed toward that part of the sky which it is desired to examine, will record all the perceptible stars as round disks; while any planets that appear in the field of view will, by their motion, leave their trace in the form of elongated trails or streaks, thus betraying themselves at once on the photographs. In this way Charlois, of Nice, Italy, has found nearly ninety small planets. All these planetoids, as the minor planets are often termed, are quite small, being but twenty to one hundred miles in diameter, and not consequential members of the solar system. Bode's law thus fulfilled its temporary mission; but egregiously failed when Neptune claimed admission to a place in the solar system, for its distance from the sun was utterly out of harmony with that required by the law of Bode.

III. HOW NEPTUNE WAS FOUND.

The patience of Job had a strong parallel in the labors of those tireless toilers to whose minute computations we owe our knowledge of Neptune's path in the skies. For this far-off planet was discovered not by the use of a telescope, or any optical instrument, but simply by a process of mathematical reasoning. The story is simply this. For sixty years after Uranus was recognized, there were irregularities in its motion that could not be satisfactorily accounted for. In the orbit that it was believed to pursue, it was sometimes in advance of its proper position, and sometimes it seemed to fall behind. Sometimes it appeared to be drawn a little to the right, and at other times as far the other way.

The thought at last came separately to several penetrating minds, not that the observations of its position were in error, but that Uranus must be drawn away from its supposed path by the attraction exercised upon it by some unseen body. And if such an object existed, was it a planet? Where was it? How large was it? What was its path in the far-off ether?

The inner circle shows the position of Uranus at various dates; the outer circle the position of Neptune. The arrows show the direction toward which Uranus was drawn.

In the year 1842, the Royal Society of Sciences of Göttingen proposed as a prize question the full discussion of the theory of the motions of Uranus. It was specially sought to learn the cause of the large and increasing error of Bouvard's Tables that had been relied upon to show its motion and its precise position at any time. Several able mathematicians undertook this intricate problem. Among them were John C. Adams, of Cambridge University, England, Sears C. Walker, of Washington, a man whose sad fate it was to pass away ere his magnificent abilities could receive extended recognition, and M. Le Verrier, of Paris. Working unknown to each other, they reached similar conclusions almost at the same time. Though not the first to solve the problem, the brilliant Frenchman was the first to announce his result, which he did by writing a letter to Dr. Galle, of the Berlin Observatory, where there was one of the largest telescopes in Europe, and asking him to search for his computed planet, and assigning its supposed place in the heavens. The very night he received the letter Dr. Galle found the planet within one degree of the point designated. The next night it had moved one minute of space, and was also seen to have a perceptible disk. This settled the question, and stamped it as a planet. Le Verrier well merited the title bestowed upon him, "First astronomer of the age."

IV. METEORITES.

The nineteenth century will be forever memorable for its witnessing the closing career and final destruction of a famous comet. First noticed in France, in 1772, and rediscovered, in 1826, by an Austrian officer named Biela, it bears his name. His computation showed that it traversed its orbit in six and one half years. When it reappeared in 1846, and again in 1852, it was seen to have split into two unequal fragments. It has not been seen since; but at every time when its return should have taken place the earth has passed through showers of meteors supposed to be its constituent particles, and to indicate its entire disintegration.

During the meteoric shower of 1885, on the 27th of November, a large iron meteorite fell in Mazapil, Mexico, and chemical and physical investigation joined to pronounce it a part of the lost Biela's comet.

The large cabinets of the world contain hundreds of specimens of meteorites, known to be such by their chemical composition, but only a few have actually been seen to fall. The most remarkable fall ever witnessed was that of May 10, 1879, in Iowa, in which the heaviest stone weighed 437 pounds. On April 8, 1893, an aerolite fell near Osawatomie, Kansas, and struck the monument to John Brown that had been erected through the efforts of Horace Greeley in 1863. The meteor broke off the left arm of the statue. A Texas meteorite, owned by Yale University, weighs 1635 pounds. A meteorite that fell in Jiminez, in 1892, now deposited in the city of Mexico, weighs twenty tons; and one lying on the coast of Labrador, which it is proposed to bring to the United States, is said to be still more massive.

V. DO METEORS OFTEN STRIKE THE EARTH?

It must not be thought that meteors usually strike the earth. In truth, but few of them do. The earth is surrounded by them, cold, dark, invisible, because unillumined. It is only when they become heated by rapidly impinging on the atmosphere that they can be seen at all; and unless they come near enough to become subject to the dominant power of the earth's attraction, they pass off into space unnoticed, and their presence unsuspected.

A case in point is the brilliant "fire-ball" of July 20, 1860, that moved rapidly over the United States, from Wisconsin to Cape Cod, and then passed off into the skies. The entire time of its visible flight over a path of thirteen hundred miles was about two minutes. It was seen about ten o'clock in the evening. It was estimated to be from one hundred to five hundred feet in diameter, allowing for an increase as it expanded by reason of its striking with such velocity the lower and denser layers of the air. Its size and brilliancy were such as to arrest the attention of hundreds of persons, some of whom crouched in fear, and even alleged that they heard it hiss as it flew over their heads. Some fishermen in Lake Huron had ropes over the sides of their boat, ready to spring into the water if it came too near.

James H. Coffin, LL. D., then Professor of Astronomy in Lafayette College, made an exhaustive study of this unusual phenomenon, and, under the patronage of the Smithsonian Institution, published a volume containing many observations that he collected, with the mathematical results derived from them. Professor J. Hann, of Vienna, the highest authority on this subject, said that it was the most comprehensive study of a meteor's path ever accomplished. Six years were spent in making the computations.

Self-illumined by the heat evolved in striking the various layers of the earth's atmosphere, it became sufficiently bright to be first seen when seventy miles above the surface of the earth. It was within forty miles of touching us at the time it was over the Hudson River, when the great heat acquired by its rapid transit caused it to burst into two masses, which—like Biela's comet—continued to pursue separate courses, side by side, until they were lost to view in their ascending flight, being last seen from the deck of a vessel off the island of Nantucket.

No part of the fire-ball struck the earth. Its orbit was an hyperbola, a curve not often found in nature, such that it can never come near us again unless, by the superior attraction of some celestial body, its course may be changed, and a new orbit result.

VI. ASTRONOMICAL OBSERVATORIES.

The Royal Observatory, at Greenwich, England, was founded by Charles the Second in 1675. Its main purpose was to extend astronomical knowledge, so that navigators might better find the position of their ships at sea. This institution retains its prominence. All the longitudes on our maps are reckoned from it, and Greenwich time is used on every ship that traverses the ocean. The "Nautical Almanac," issued by the Observatory, was an indispensable part of the outfit of every sea captain until, in 1852, the United States provided its own American Ephemeris, a collection of tables of the motions and places of the sun, moon, and planets for every day and hour, and occultations of the stars, with rules for calculating longitude and the like.

Many valuable observations of the transit of Venus in 1769 were made at points near Philadelphia; but almost seventy years ensued before America witnessed the erection of any permanent buildings devoted to the purposes of this science.

President John Quincy Adams, who was highly versed in science, and held the position of president of the American Academy of Arts and Sciences in Boston for twenty years, often urged this matter on the attention of Congress, but without success.

President Thomas Jefferson, who was also a man of no small scientific information, as evidenced in his keeping a systematic weather record at his home in Monticello, Virginia, proposed an elaborate survey of the national coast. This was authorized by Congress in 1807. In the year 1832, in reviving an act for the continuance of the Coast Survey, Congress was careful to append the proviso "that nothing in the act should be construed to authorize the erection or maintenance of a permanent astronomical observatory."

The expected return of Halley's comet in 1835 again stimulated popular interest in the science, and aroused an intense desire to provide serviceable instruments, and to establish buildings suitable for their care and use. To Williams College, Massachusetts, belongs the honor of erecting, in 1836, the first astronomical observatory on this continent. Under its revolving dome was mounted an Herschelian telescope of ten feet focus, which later became the property of Lafayette College, where it is still preserved. In 1843, John Quincy Adams laid the corner-stone of the Longworth Observatory in Cincinnati, and delivered a commemorative address, his last great oration. The construction of the United States Naval Observatory at Washington soon followed, and before 1850 there were fourteen observatories established in this country. Nearly all the instruments they contained were made abroad, chiefly in Munich and London. Since then the number has risen to two hundred recognized observatories, of which twenty-four are of superior order, where systematic work is daily pursued, and the results are regularly published in book form. About two hundred observatories exist in other nations.

VII. IMPROVED INSTRUMENTS; THEIR EFFECT ON THE SCIENCE.

The great improvements in telescopes made during the century have been fruitful in two ways; a better knowledge of the surface of the moon and of the planets has been gained, and we have been enabled to learn with precision the exact motions and times of revolution of these bodies and of their accompanying moons. This information, by the use of the laws ascertained by Kepler and La Place, gives us their exact distance, dimensions, and mass. With the increase of telescopic power, the census of the starry host has been so augmented that the number of stars within reach of our modern instruments exceeds 125,000,000. But we had gone little beyond this sort of information until the invention of the spectroscope.

Previous to the year 1859 a few meteors, composed chiefly of stone or iron, some of which had been actually seen to fall from the sky, had been subjected to chemical analysis; but outside of this naught was known of the physical constitution of other worlds than ours. Our ignorance on this point was complete. All our attempts to become better acquainted with the structure of the planets, the composition of the sun, and the nature of the fixed stars would probably have been in vain but for the invention of the spectroscope. This surprising instrument is a master-key with which to unlock many of Nature's mysteries; her recesses are brought to view, and the farthest star is subjected to an accurate chemical analysis, so far as the light that comes from it is sufficient to disclose the materials of which it is composed.

The wondrous use of electricity as an agent for the production of light, heat, and power is no greater achievement, in its way, than is Spectrum Analysis in bringing to our earthly laboratories the work of the Divine Hand performed in distant regions of space. Yet the story of the spectroscope is easily told. In its essential elements it is merely this: A ray of light, entering a darkened room through a hole in the window shutter, produces a bright beam on the opposite wall. A triangular glass prism held close to the crevice turns this beam into a band of rainbow hues. If the hole can be changed into a small slit, say one fourth of an inch high and one fiftieth of an inch wide, and if the light can further be made to pass in succession through several prisms, instead of through one, the band will be so elongated thereby that its various and surprising markings can be thoroughly traced and fully studied.

To this band of bright colors Sir Isaac Newton gave the name of the solar spectrum. The image formed by the light of any luminous body, after it has passed through a prism, is said to be the spectrum of that body.

VIII. THE SPECTROSCOPE AND ITS TRIUMPHS.

The spectroscope consists essentially of three tubes joined in the form of the letter Y, one of which is a small telescope, in the focus of which a narrow slit is placed to admit the ray of light that is to be examined; a prism, or a ruled grating that disperses the light, so as to form a spectrum; and a view telescope, with which to observe the various parts of the spectrum.

By using a small telescope to view the spectrum of the sun, Fraunhofer, a German optician, in 1814, discovered that the whole length of the spectrum was crowded with dark lines, very narrow, indeed, but scattered all through the seven hues. He found that sunlight, whether taken directly or reflected from clouds or from the moon or planets, invariably gave the same spectrum; but in no case did light from the stars give a spectrum of the same sort as that from the sun.

Dr. Kirchhoff, of Heidelberg, in 1859, explained the origin of the dark lines, and showed that there are three kinds of spectra: first, that of an incandescent solid or liquid, which is always perfectly continuous, showing neither dark lines nor bright; second, the spectrum of a glowing gas, which consists of bright lines or bands separated by dark spaces. These lines are characteristic of the chemical elements that cause them; and so, from the composition of the bright lines in a spectrum, it is possible to tell their origin. Third, a spectrum crossed by dark lines; which occurs when an incandescent solid is viewed through absorbent vapors.

In the solar eclipse of 1868, M. Janssen first noticed that the solar prominences gave a spectrum of the second kind, and thus proved that the prominences consist of glowing gas. Since that time the march of discovery has been exceedingly rapid.

This simple instrument has thus led the way to a knowledge of the elements composing every heavenly body, no matter what its distance, provided only it is giving out light intense enough to reach our gaze. For the perfection both of the telescope and spectroscope we owe much to the optical skill and mechanical dexterity of the Clarks and Rowland, Hastings and Brashear, all Americans.

About forty chemical elements have now been recognized in the sun. The most prominent are iron, calcium, hydrogen, nickel, and sodium. A distortion, or displacement, of some of the lines in the spectrum enables us to calculate the speed at which the gases are rushing toward or from us. A given line in the spectrum of Aldebaran is displaced toward the violet in such a way as to show that the star is approaching the sun at the rate of thirty miles a second; while a similar line, in the case of Altair, so deviates toward the red end of the spectrum as to prove that it is receding from the solar system at a velocity of twenty-four miles a second. By this principle, recognized by Doppler in 1842, the motions of about one hundred stars toward or from the solar system have been ascertained.

There is no question but that the solar system, as a whole, is steadily moving away from Sirius, and toward the constellation of Hercules; whether faster than at a rate of twelve miles every second is still scarcely decided; but this rate would be about a million miles a day, or three hundred and seventy million miles a year.

IX. WHAT IS DONE IN A LARGE OBSERVATORY; ITS WORK.

A visitor who wants to know what is done in a great observatory might go to Harvard some evening. He would probably find the large refractor pointed toward the satellites of Jupiter, Uranus, or Neptune, with a view of noting their precise places, so as to compute tables of their exact motions; or he might find a laborious observer watching such double stars as have considerable proper motion, and making drawings of conspicuous nebulæ, so that future astronomers may be able to decide whether time has wrought any changes in their constitution or figure. The great glass at Princeton, under the charge of Professor Charles A. Young, is largely used for spectroscopic work, examining the sun’s photosphere by day, and noting the spectra of the stars at night. Spectral observation is an important part of the routine at the Yerkes Observatory in Wisconsin.

Many faint comets have been successfully photographed at the Lick Observatory, on Mount Hamilton, California, and elsewhere by the use of very sensitive plates and a long exposure.

S. W. Burnham, of Chicago, is famed for his acuteness of vision, tested in having detected and measured over one thousand double stars which to other eyes had appeared only as single stars. The discovery of these objects belongs wholly to the nineteenth century; for in 1803, Sir William Herschel first announced the existence of sidereal systems composed of two stars, one revolving around the other, or both moving about a common centre. Some of these binary systems have periods of as great a length as fifteen hundred years; and some are as brief as four, and even two days. Some of them afford curious instances of contrasted colors, the larger star red or orange, and the smaller star blue or green.

X. THE NATIONAL OBSERVATORY AT WASHINGTON.

Professor William Harkness, U. S. N., M. D., LL. D., is widely known as the author of numerous astronomical and physical papers and books. He has also designed a number of instruments and made important discoveries. He has long been connected with the United

States Naval Observatory, and now holds the position of Astronomical Director. His report for the year 1898 shows that the twenty-six inch reflector at Washington is now nightly engaged in mapping the relative positions of Rhea and Iapetus, the fifth and eighth satellites of Saturn, with the intention of securing a new and final determination of the mass of that planet, which has been heretofore reckoned as one 3492d of the sun. The twelve-inch telescope is chiefly employed in studying comets and asteroids, and on Thursday evenings is at the service of the public. In the year 1898, 3778 observations were made with the nine-inch transit circle, for which two men were detailed, with the services of five computers.

A transit circle and an altazimuth instrument, each turned out of solid steel, have recently been added to the equipment, and are of a workmanship that compares favorably with anything ever manufactured in Europe. It is asserted that the latter instrument will give more accurate measurements of declination than a transit circle, which is an innovation on long-cherished ideas.

Professor Simon Newcomb, of the United States Navy, is about to issue new tables of Mars, Uranus, and Neptune, and a “Catalogue of Fundamental Stars for the Epoch 1900.” During the year 1898 three thousand copies of the American Nautical Almanac were published. This is but an illustration of the scientific labor accomplished at this busy hive of industry. During the year this observatory issued to the navy 230 chronometers, 200 sextants and octants, and 1400 other nautical instruments of value.

XI. STAR MAPS AND CATALOGUES.

In the year 128 B. C. Hipparchus put out a catalogue of 1025 stars observed at Rhodes. Twenty such works succeeded this up to the year 1801, when Lalande, of Paris, brought out a list of 47,390 stars. It will be remembered that few stars have names, except those known to the Arabians of old, but are designated by their positions in the heavens. It is customary to refer to them by their declinations and right ascensions, as so many degrees north or south of the celestial equator, and so many degrees, or hours, east of the vernal equinox—fifteen degrees being the equivalent of an hour of right ascension—just like the latitude and longitude of cities on a common globe.

During the nineteenth century many celestial atlases and astronomical catalogues have been published. These contain lists of comets and nebulæ, and the places of the double stars and of the fixed stars. Of the latter alone over one hundred have appeared, of which Argelander’s is by far the largest, as it contains the places of more than 310,000 stars. The catalogue prepared by the British Association in 1845 is of great value, containing 8377 stars. Yarnall’s, of 10,658 stars, published in Washington in 1873, is most accessible to us.

Professor C. H. F. Peters, of the Hamilton College Observatory, Clinton, N. Y., the discoverer of so many asteroids, has prepared a valuable series of star charts. By dividing the heavens into small squares and carefully photographing each of them, the places of a vast number of stars can be recorded with far greater accuracy than by the old plan of a separate instrumental measurement of the position of the stars. By the use of microscopes the determination of their positions can be made with precision. These plates are preserved with care, and when those of the same region of the skies, made in different years, are compared, any variation in the relative positions of the objects can be detected with certainty. The perfection of this method of star-mapping is justly deemed one of the most important achievements of the century.

For an amateur star-gazer who is not provided with a set of maps, Whitall’s Planisphere is a very ready aid, as it can be instantly adjusted to any day and hour. The inexperienced, and those who have no instruments, can use it with ease and satisfaction to locate a thousand of the most conspicuous stars.

XII. ASTRONOMICAL BOOKS AND THEIR WRITERS.

In England this attractive study has been popularized chiefly by the interesting works of the two Herschels, who were voluminous writers, the lectures of Proctor, and the admirable compend of facts so assiduously gathered by G. F. Chambers in his delightful treatise on astronomy.

In our own country the heights of theoretical astronomy have been scaled by such minds as Benjamin Pierce, the profound mathematician of Harvard University; James C. Watson, of Ann Arbor, whose early death was a great loss to science; and Simon Newcomb, the genial savant of Washington. Chauvenet and Loomis have taught us the meaning of practical astronomy; and Olmsted, Young, Todd, and not a few others of distinction have prepared text-books that fully present the elements of the science.

Nor is this fascinating study limited to the students of the 484 colleges and universities of the land. The last report of the United States Commissioner of Education shows that in the public and private high schools of the nation there are over nine thousand boys and sixteen thousand girls pursuing the study of astronomy.

XIII. THE PRACTICAL USES OF ASTRONOMY AS AN AID TO NAVIGATION AND GEODESY.

The practical value of this science is best appreciated by the navigator, who sees in the sun and moon his clock, and in the stars and planets the ready means of learning his latitude and longitude. It is one of the first tasks of the midshipman to become familiar with the use of the sextant, by which he works out the problem of ascertaining the exact place of the ship upon the ocean. Navigation is helpless without the assistance of astronomy. Yet it is only the A, B, C of the science that the sailor has any use for; its higher mysteries are away beyond his needs and of no practical profit to him.

Nathaniel Bowditch, of Salem, Mass., in 1802, issued a book entitled “The New American Practical Navigator,” which is still a standard treatise for seamen. His rare acquirements as a mathematician were signally displayed, and in a form that has proved enduring, when, in 1814–17, he translated into English, accompanied with copious notes of his own, the profound work, “Celestial Mechanics,” penned by the gifted La Place in 1799. Although in name a translation of a foreign book with a commentary, it is in many respects an original work. Professor Elias Loomis, who left to Yale University three hundred thousand dollars as an endowment fund to aid in prosecuting astronomical research, said of him, in 1850, “Bowditch has probably done more for the improvement of physical astronomy than all other Americans combined.” Dr. Bowditch published the work in four ponderous quarto volumes wholly at his own private cost. These volumes he did not expose for sale, but generously gave them to such persons as proved to him their ability to appreciate and comprehend them. This outlay impaired the fortunes of his family, but became his own unique monument.

This work remains one of the most profound efforts of mathematical research on record. Bowditch’s accuracy has passed into a proverb. He gave the latitude of all the principal seaports of the world with marked precision; while some of the longitudes are now found to be slightly in error, it is surprising that his determinations of those of Boston and Philadelphia should be exactly the same as those obtained by the best methods in use to-day. But he makes San Francisco and Halifax seven miles too far to the east, and New York eight miles too far west. But we are to remember that for this computation the best available instruments were the chronometers of a century ago, and that lunar observations were made with the old-time sextant.

Made for University of Pennsylvania by Warner & Swasey.

As applied to geodesy, astronomy has added a process of ascertaining geographical latitude with marvelous accuracy and speed by the use of the zenith telescope, an instrument devised by Major Talcott in 1835. This instrument can be set in a vertical direction with ease, and be pointed alternately to two stars that cross the meridian at a brief interval of time, the one north and the other south of the zenith. Difficulties that arise from refraction are avoided, and the resulting latitude is quickly computed. This method is largely employed in the surveys of the public lands, as also in establishing the boundary between the United States and British America.

XIV. NOTABLE EPOCHS IN THE NINETEENTH CENTURY.

Worth marking as epochs of the nineteenth century were such dates as October 10, 1846, when the first determination of difference of longitude of two places was made by the use of the telegraph wire. Sears C. Walker, in Washington, and E. Otis Kendall, in Philadelphia, compared their clocks by interchanging telegraphic signals, and thus found their respective longitudes.

In 1850, Professor William C. Bond, of Harvard College, invented the chronograph. Through the urgency of Sir David Brewster, it was shown in the great exhibition of that year in London, where a medal was awarded for it. The chronograph was speedily adopted throughout Europe, and together with other apparatus made by Bond constituted what there became known as the “American method” of recording observations. Through it the errors for which the “personal equation” is a partial remedy are largely eliminated, and a superior definiteness of record is obtained.

On August 7, 1869, the first application of the spectroscope to the examination of the corona of the sun was the beginning of the revelation of the inner mysteries of the constitution and activities of the great luminary. The transit of Venus that occurred on December 6, 1882, was fruitful in measurements, by which the estimates of the distance of the sun were reduced from the long-accepted figures, 95 to 92 millions of miles. Yet this loss of three millions of miles resulted from the apparently trifling change of reckoning the sun’s parallax at 8.82″, instead of 8.57″. An occurrence of vast practical advantage to the whole nation was that of November 18, 1883, when the four standard meridians of railroad time were adopted and put into use. From that day the clocks of the Union were set to keep either Eastern, Central, Mountain, or Pacific Coast time.

Professor Edward E. Barnard had used the magnificent telescope of thirty-six inches aperture, belonging to the Lick Observatory in California, but a short time before he astonished the world by discovering a fifth satellite of Jupiter, although it appeared as but a faint speck of light. Besides other honors for this achievement, in 1894 the French Academy of Sciences awarded him the Arago medal, of the value of a thousand francs, a distinction given but twice before, first to Le Verrier, for the discovery of Neptune in 1846, and to Asaph Hall, for finding the two moons of Mars in 1877.

“Personal equation” is the name given to the amount of error to which any person is habitually liable in attempting to note the time of a fixed occurrence. When the astronomer looks at a star passing the cross-wires of his transit, he is likely to make the record one or two tenths of a second after the true time, or possibly a like small amount of time before the actual occurrence, by anticipation. This is not a matter of wrong intention, nor due to willfulness. But in precise observations, especially where comparisons are to be made between the records of several persons, the "personal equation" must be determined, if possible, and allowed for. Various methods of correcting this inaccuracy have been used. But the best is that of Frank H. Bigelow, of the Nautical Almanac Office, Washington, who, in 1890, devised a process of taking star transits by photography. It entirely does away with this source of error, and has proved of great value.

XV. DISCARDED DOCTRINES AND ABANDONED IDEAS.

A few generations ago an eight-day clock was to be found only in the homes of well-to-do people, and a gold watch was a symbol of wealth, such as to subject its wearer to a special tax. In this age of dollar clocks and Waterbury watches, almanacs are no longer indispensable. We do not regulate our time-pieces by the rising and setting of the sun; nor can a future Jay Gould lay the foundation of his fortune, as did the one best known by that name, by setting up rural noon-marks for a fixed fee.

Some pleasant dreams of past decades have vanished in the light of recent knowledge. The nebular hypothesis, that wondrous conception of Swedenborg, elaborated by La Place and espoused by William Herschel and so many others, as affording a full explanation of the method by which our worlds were shaped into their present forms, has ceased to have general acceptance. M. Maedler, director of the Dorpat Observatory in 1846, had a firm persuasion that the collective body of stars visible to us has a movement of revolution about a centre situated in the group of the Pleiades, and corresponding to the star Alcyone. But this notion of a central sun around which all the solar system is circling has lost ground.

The distortion in the orbit of the planet Mercury has been accounted for by the urgent suggestion that there must be some planet, as yet undiscovered, that disturbs the regularity of Mercury's movements, but whose orbit is so near to the sun as to baffle all ordinary efforts to see it. It has received, by anticipation, the prenatal name of Vulcan. Many eyes have peered most intently into the region indicated, and some few have imagined they had found what they sought. A physician of the village of Orgeres, France, M. Lescarbault by name, on March 20, 1859, saw such an object pass over the sun's disk. The skillful Le Verrier was much impressed by this physician's minute account of the occurrence. But there was no confirmation of the alleged discovery. At the time of subsequent eclipses that part of the heavens has been repeatedly examined closely, but in vain. So we must wait longer before believing that Vulcan does exist.

When, in 1877, Professor Hall, through the powerful telescope at Washington, saw that Mars was attended by two tiny satellites, he put a permanent injunction on the further use of the once favorite phrase,

"The snowy poles of moonless Mars."

And so of the question oft discussed in the old-time debating societies, "Are the planets inhabited?" It may still be left in the hands of young collegians, notwithstanding the fact that our largest telescopes give only negative testimony.

In a solar eclipse in February, 1736, that was annular in shape, just before the sun was completely hidden, the narrow horn of light seemed to break into a series of dots, or luminous points, which, when noted again a century later and described by Francis Baily, received the name of "Baily Beads." It was attempted to explain this as caused by the moon's mountains cutting off the last rays of sunlight, or else as produced by irradiation. But with the advent of stronger telescopic power the phenomenon has come to an end.

David Rittenhouse, of Norristown, whom Thomas Jefferson considered "second to no astronomer living," built an orrery worth a thousand dollars, to illustrate mechanically the motions of all the planets, and though the instrument is still treasured in the University of Pennsylvania, and its duplicate at Princeton, among the relics of a past age, it is assigned to the category of toys. Mural circles, much depended upon to measure the declination of heavenly bodies, have fallen into disuse, supplanted by improved transit instruments.

XVI. PROBLEMS FOR FUTURE STUDY.

Many problems are in store for the future. The field for research still opens wide. How the solar activity is to be maintained was answered by Newton in the suggestion that comets falling into it kept up its supply of matter and energy. Waterston, in 1853, propounded the thought that meteoric matter may be the aliment of the sun. Now the prevalent theory is that a contraction of the sun's volume, constantly in progress, but so slight as to be invisible to the most powerful telescope, is competent to furnish a heat supply equal to all that can have been emitted during historic periods.

Professor Newcomb answers the question, "How long will the sun endure?" by saying, "The physical conclusion to which we are led by a study of the laws of nature is that the sun, like a living being, must have a birth and will have an end. From the known amount of heat which it radiates we can, even in a rude way, calculate the probable length of its life. From fifteen to twenty millions of years seems to be the limit of its age in the past, and it may exist a few millions of years, perhaps five or ten, in the future."

Story Of Plant And Flower

By THOMAS MEEHAN,
Vice President Academy of Natural Sciences, Philadelphia.

Botany, in its general sense, signifies the knowledge of plants. In the earlier periods of human history plants appealed to mankind as material for food or medicine; and down to comparatively recent times botanical studies were pursued mainly in these directions. Dioscorides, a Greek, who lived in the first century of the Christian era, is the earliest writer of whom we have knowledge that can lay a claim to botanical distinction, but the medical property of plants was evidently the chief incentive to his task. It was not until the beginning of the sixteenth century that botany, in its broad sense, became a study, and Le Cluse, a French physician, who died in 1609, may be regarded as one of its patriarchs. Still the medical uses of plants were steadily kept in view. The English botanist, John Gerarde, who was a contemporary of Le Cluse, or Clusius, as botanists usually call him, wrote a remarkable work on botany,—remarkable for his time,—but this was styled a “Herbal,” as were other famous botanical works down to the beginning of the present century.

Following the year 1700, the knowledge of plants individually became so extended that systematic arrangement became desirable. The first real advance in this direction was made by Carl Von Linné, commonly known by its Latin form, Linnæus, a Swede, born in 1707, and whose talents for botanical acquirements seemed almost innate. In his twenty-third year he saw the need of a better system, and commenced at once the great work of botanical reform. He saw that plants with a certain number of stamens and pistils were correlated, and he founded classes and orders on them. Flowers with five stamens or six stamens would belong to his class pentandria or hexandria, respectively, and those with five pistils or six pistils pentagynia, or hexagynia, accordingly; and so on up to polyandria, or polygynia—many stamens or pistils—of which our common buttercup is an illustration. He further showed that two names only were all that is necessary to denote any plant, the generic name and its adjective, as, for instance, *Cornus alba*, the white Dogwood; and that the descriptions should be brief, covering only the essential points wherein one species of plant differed from another. This became known as the sexual system. It fairly electrified intelligent circles. People generally took to counting stamens and pistils, and large numbers took pride in being botanists because they could trace so easily the classes and orders of the plants they met. The grand old man died in 1778, and though his artificial system had to give way to a more natural method, he is justly regarded as the father of modern botany.

With the incoming of the nineteenth century, botany took a rapid start. It ceased to be a mere handmaid to the study of medicine. Chemistry, geography, teleology, and indeed the chief foundations of biology had become closely interwoven with botanical studies; and thus the progress of botany through the century has to be viewed from many standpoints.

In classification, what is known as the natural system has replaced the sexual. Plants are grouped according to their apparent relationships. Those resembling in general character the Rose form the order *Rosaceœ*; the Lily, *Liliaceœ*. Sometimes, however, a striking characteristic is adopted for the family name, as *Compositœ*, or compound flower, for the daisy and aster-flowered plants; *Umbelliferœ*, or umbel-flowering, as in carrot or parsley; *Leguminosœ*, having the seed vessels as legumes, like peas and beans.

Classification has, however, derived much assistance from a wholly new branch of the science known as Morphology. This teaches that all parts of plants are modifications of other parts. What Nature may have intended to be a leaf may become a stem; the outer series of floral envelopes, or calyx, may become petals; petals may become stamens; and even pistils may become leaves, or even branches. The green rose of the florists is a case in which the leaves that should have been changed into petals to form a perfect rose flower have persisted in continuing green leaves, though masquerading as petals; and it is not unusual to find in the rose cases where the pistils have reverted to their original destination as the analogue of branches, and have started a growth from the centre of the flower. So in an orange, the carpels, or divisions, are metamorphosed primary leaves. Two series of five each make the ten divisions. Sometimes the axis starts to make another growth, as noted in the rose, but does not get far before it is arrested, and then we have a small orange inside a larger one, as in the navel orange. Just the reverse occurs sometimes. The lower series is suppressed, and only the upper one develops to a fruiting stage, when the small red oranges known as the Tangerines are the results. Illustrations of these transformations of one organ to another are frequent if we look for them. The annexed illustration shows a condition of the white clover, which, instead of the usual round head, has started on as a raceme or spike.

These wanderings from general forms were formerly regarded as monsters, of no particular use to the botanical student, but are now welcomed as guiding stars to the central features of Morphology. The importance of this branch of botany, in connection with classification, can readily be seen.

The studies in the behavior of plants have made remarkable progress during the century, and this also derives much aid from morphology. The strawberry sends out runners from which new plants are formed; but, tiring of this, eventually sends the runner upward to act as a flower stalk. What might have been but a bunch of leaves and roots at the end of the runner is now converted into a mass of flowers and pedicels at the end of a common peduncle. In some cases Nature reverses this plan. After starting the structure as an erect fruit-bearing stem, it sends it back to pierce the ground as a root should do. This is well illustrated by the peanut.

In the common *Yucca*, the more tropical species have erect stems; but in the form known in gardens as Adam's needle and thread—*Yucca filamentosa*—the erect stem is sent down under the surface of the ground, and is then a rhizome, instead of a caudex, or stem.

Modification in connection with behavior is further illustrated by the grapevine and Virginia creeper. The whole leading shoot is here pushed aside by the development of a bud at the base of the leaf, that takes the place of a leading shoot. The original leader then becomes a tendril, and serves in the economy of the plant by clinging to trees or rocks, or in coiling around other plants in support. Great progress has been made in this department of botany within recent years. Darwin has shown that the tendrils of some plants continue in motion for some time in order to find something to cling to. The grapevine especially spends a long time in this labor if there is difficulty in reaching a host. The plant preserves vital power all this time, but no sooner is support found, than nutrition is cut off, and the tendril dies, though, hard and wiry, it serves its parent plant as a support better dead than alive. The amount of nutrition spent in sustaining motion is found to be enormous. A vine that can find ready means of support grows with a much more healthy vigor than one that has difficulty in finding it. Many plants present illustrations.

Much advance has been made in the knowledge of the motions of plants as regards their various forms. Growth in plants is not continuous; but is a series of rests and advances. In other words it is rhythmic. The nodes, or knots, in the stems of grasses are resting-places. When a rest occurs, energy may be exerted in a different direction, and a change of form result. This is well illustrated by the common Dogwood of northern woods, *Cornus florida* on the eastern, and *Cornus Nuttallii* on the western slope of the American continent. On the approach of winter the leaf is reduced to a bud scale, and then rests. When spring returns these scales resume growth and appear as white bracts. In the annexed illustration the scales that served for winter protection to the buds are seen at the apex of the bracts. In other species of Dogwood the bud scales do not resume growth. Energy is spent in another direction. In this manner we have an insight as to the cause of variation, which was not perceived even so recently as Darwin's time. We now say that variation results from varying degrees of rhythmic growth—force; and that this again is governed by varying powers of assimilation.

The Darwinian view, that form results from external conditions of which the plant avails itself in a struggle for existence, is still widely accepted as a leading factor in the origin of species. Those which can assume the strongest weapons of defense continue to exist under the changed conditions. The weaker ones do not survive, and we only know of them as fossils. This is termed the doctrine of natural selection.

The origin and development of plant-life, or, as it is termed, evolution, has made rapid advancement as a study during the century. That there has been an adaptation to conditions in some respects, as contended by Mr. Darwin and his followers, must be correct. The oak and other species of trees must have been formed before mistletoe and other parasites could grow on them. In the common Dodder—species of *Cuscuta*—the seeds germinate in the ground like ordinary plants. As soon as they find something to attach themselves to, they cut loose from mother earth and live wholly on the host. As a speculation it seems plausible that all parasites have arisen in this way. Some, like the mistletoe, having the power, at length, to have their seeds germinate on the host-plant, have left their terrestrial origin in the past uncertain. A number of parasites, however, do not seem to live wholly on the plants they attach themselves to. These are usually destitute of green color. The Indian pipe, snow plant of the Pacific Coast, and Squaw root of the Eastern States are examples; the former called ghost-flower from its paleness. These plants have little carbonaceous matter in their structure, and hence are regarded as having formed a kind of partnership with fungi. This is known now as symbiosis, or living together of dissimilar organisms, each dependent mutually. The fungus and the flowering plant in these cases are necessary to the existence of each other. They demand nitrogen instead of carbonhydroids. The Squaw root, *Conopholis Americana*, though attached to the subterranean portions of the trunks of trees, is probably sustained by the fungus material in the old bark, or even in the wood, rather than by the ordinary food of flowering plants. Lichens, as it is now well known, are a compound of fungi and water weeds (algæ), and this doctrine of symbiosis is regarded as one of the great advances of the century.

It is but fair to say that the doctrine of evolution by the influence of external conditions in the change of form, though widely accepted at this time, is not without strong opponents, who point to the occasional development or suppression of parts on the same plant, though the external conditions must be the same. For instance, there are flowers that have all their parts regular, as in the petals of a buttercup; and irregular, as in the snap-dragon or fox-glove. But it has been noted that irregular flowers have pendulous stalks, while the regular ones are usually erect. But once in a while, on the same plant, flowers normally drooping will become erect. In these cases the flowers are regular. In the wild snap-dragon or yellow toad-flax, *Linaria vulgaris*, one of the petals is developed into a long spur; the other four petals have, in early life, become connate and transformed into parts of the flower wholly unlike ordinary petals. But now and then the original petals will all develop spurs, resulting in the condition technically known as peloria.

Linnæus gave this name to this condition because it was supposed to be "monstrous," or something opposed to law and order. Through the advance in morphological botany we have learned to regard it as the result of some normal law of development, innate to the plant, and which could as well be the regular as the occasional condition. In other words, there is no reason why Nature might not make the five-spurred flower as continuous in a wild snap-dragon as in a columbine. Many similar facts are used by those who question the Darwinian law of development.

That nutrition has more to do in the evolution of form than external forces has received much aid, as a theory, from the advance during recent times of a study of the separate sexes of flowers. On coniferous trees, notably the firs, pines, and spruces, the male and female flowers are produced separately. The female, which finally yield the cones, are always borne on the most vigorous branches. When these branches have their supply of nutrition shortened and become weak, only male flowers are produced. On the other hand, branches normally weak will at times gain increased strength, and then the male flowers give female ones. This is often seen in corn fields. The generally weak tassel will have grains of corn through it. It is not infrequent to find what should normally be perfect ears on stalks weaker than usual. In these cases the upper portion of the ear will have male flowers only.

In connection with the doctrine of development, much attention has been given during the century to fertilization of flowers and the agency of insects in connection therewith. On the one hand it is contended that in all probability the flowers in the earlier periods of the world's history had neither color nor fragrance. In this condition they were self-fertilizers, that is, were fecundated by their own pollen. In modern phraseology they were in and in breeders. When the struggle for existence became necessary, those which could get a cross with outside races became more vigorous in their progeny, and thus had an advantage in the struggle. In brief, without an occasional introduction of new blood, as it might be termed, there was danger of a race dying out. To support this view, Mr. Darwin published the result of a number of experiments. Many of them favored either side, but the average was in favor of the view that crossing was advantageous. Against this it has been urged that an average in such cases is not conclusive. If a number, though the minor number of cases, showed superiority by close breeding in his limited experiments, a new set of observations might have changed the averages, so as to make the minor figures in one instance the major in others. Again, it is contended that to increase a plant by other means than by seeds must be the closest kind of reproduction; yet some plants, coeval with the history of man, have been continued by offsets and are as strong and vigorous as ever. The Banana is an illustration. Under cultivation it produces only seedless fruits. It is raised wholly from young suckers or offsets from the roots. Mythology gives it a prominent place in the Garden of Eden, and its botanical name, *Musa paradisiaca*, originated in this legend.

Though much has been recorded in this line to weaken the force of the speculations that flowers late in the history of the earth developed color and sweet secretions in order to attract insects to aid in cross-fertilization, they are strongly supported by the fact that a large number of species, notably of orchids, are seldom fertilized without insect aid in pollination.

But there are anomalies even here. Some plants capture and literally eat the insects that should be regarded as their benefactors. These are classified as insectivorous plants. Some seem to catch the insects in mere sport, while in the act of conveying pollen to them. These are known as cruel plants. There are numerous illustrations of this among the families of *Asclepias* and *Apocynum*, the milk-weed family. In our gardens a Brazilian climber, *Arauga*, or *Physianthus albens*, is frequently grown for its waxy flowers and delicious odor, but the treacherous blossoms are frequently strung with the insects it has caught.

In the northern part of America a common wild flower of one of these families, *Apocynum androsmæfolium*, has this insect-catching habit. Numerous small insects meet death, and hang to the flowers like scalps to the wild Indian.

Considerable advance has been made in vegetable physiology, though no one has as yet been able to reach the origin of the life-power in plants. The power that enables an oak to maintain its huge branches in a horizontal direction, or that can lift or overturn huge rocks, or split them apart as the lightning rifts a tree trunk, is yet unknown. On the opposite page is an illustration of a circumstance frequently observed, wherein even a delicate root fibre can pierce a potato or other structures.

Possibly the greatest botanical advance of the century is in relation to cryptogamic plants, those low organisms which as mildews and moulds are most familiar to people generally. As microscopes increase in power, new forms are discovered. Over forty thousand species have already been described, and we may fairly say that there are nearly half as many forms of vegetable life invisible to the naked eye as can be seen by our unaided visual organs. Their wants and behaviors are very much the same as in the flowering plants or higher orders, as they are usually termed. But there is one great difference in this, that they feed mainly on nitrogen, and have no use for carbon. They care little for light, but yet have an upward tendency under certain forms, as do those which seek the light. The agarics that revel in the darkness of a coal mine, yet curve upward as heartily as a corn sprout in the open air. Just as in flowering plants, also, they are mostly innocuous, and indeed many absolutely beneficial to man, a very small portion only being poisonous, or connected with the diseases of the human race. Even in these cases their power is closely guarded by nature. The spores of fungi are found to require such a nice combination of conditions before they germinate, that, unless these occur, they will retain their vegetative power many years in a state of absolute rest. The mycelium of the mushroom, as the real plant—the cobwebby portion under ground—only starts to grow when just so many degrees of heat, neither more nor less, with just so much moisture, and the proper food, are all at hand together; and large numbers are known to be very select in the kind of food they will make use of at all. One genus, known as *Cordyceps*, will only start when the spore comes in contact with the head of a caterpillar. And various species of the genus will avoid a kind of caterpillar that another would enjoy. In our own country we have one that feeds on the larvae of the May Beetle, and is known as *Cordyceps Melolonthæ*. In Australia is a very pretty species, which takes on the appearance of the antlers of a deer. This is known as *Cordyceps Andrewsii*.

The most minute of these are known as microbes. They are chiefly composed of a single cell, in the midst of which is the protoplasm, or material in which life resides, but the exact nature of which is still a mystery.

One of the most useful and fascinating studies in modern times is Geographical Botany. It is found to have a close relation to the history of man, and to the changes which have occurred on the surface of the earth. Plants follow man wherever he wanders; and though every other trace of man should be abolished on the American continent, the plants that came with him from the Old World would enable the future historian to follow his tracks here pretty well. No one has any historical evidence that what is now the Pacific Ocean was once land, and that the area between the Pacific Ocean and the Mississippi was once a huge sea, but botany tells the plain story. Only for botany we should not know that the land now serving as the poles was once within the tropics; and mainly by fossil gum trees on the American continent, and the existence still of a few plants common to Australia, have we the knowledge of some land connection between these distant shores. Island floras, some of the species of which are now found only in very limited areas, tell of large tracts submerged of which only the mountain peaks are left as small islands, lonely in a wide expanse of water, while other islands, with only a limited number of well known species, tell of new upheavals within modern times.

It is in these lines chiefly that botany has advanced during the century. Herbariums for dry and botanic gardens for living plants are essential. The latter are not as necessary to the study as formerly, as the facilities for travel bring the votaries of the science to distant places in a short time. Nature furnishes the living material for study at a less outlay of time and money than in the old way of growing the plants for the purpose. Few modern botanic gardens have the fame of those of the past. It is the great Herbarium of Kew, rather than the living plants, that makes that famous spot the great school for botany to-day. In our own country, the Herbariums of Cambridge, Mass.; Columbia College, New York; the National at Washington; and that of the Academy of Natural Sciences of Philadelphia, are the most famous in America.

Progress Of Women Within The Century

By MARY ELIZABETH LEASE,
Ex-President Kansas State Board of Charities.

The whole woman question may be briefly summed up as a century-old struggle between conservatism and progress. Women are moving irregularly, and perhaps illogically, along certain lines of development toward a point that will probably be reached; while conservatism, halting and fearful, is struggling blindly to hold points and maintain lines that must be given up.

Unfortunately for the rapidity of women's advancement, women themselves have no thoroughness, no clearness, as to the fundamental cause of their grievances or the ends to be attained, and are not yet alive to a consciousness of the fact that the question of woman's rights is simply and purely a question of human rights, the basic solution of which, on the broad plane of justice, will solve all the social, political, and industrial problems of which the woman question forms a part.

The time when woman suffered silently and toiled patiently without once questioning the justice of her lot has happily passed forever. Confusion and antagonism are engendered because of misunderstanding of the real movement. Women are consciously or unconsciously struggling for that selfhood which has hitherto been denied them, and are seeking for opportunity to develop that personality which Browning, Ruskin, and other broad thinkers declare "is the good of the race." The most discouraging feature of the situation is the fact that women as a whole do not realize that a politically inferior class is a degraded class; a disfranchised class, an oppressed class; and that her economic dependence upon man is the basic cause of her inferiority.

The grievances openly proclaimed by the advocates of woman suffrage as causes of hostility are too frequently childish, unreasonable, and unworthy of serious attention. In the majority of cases they centre around some fancied wrong that is a result rather than a cause. The keynote not only to the woman question, but to the labor question may be found in the words of that deep thinker and able writer, August Bebel: "The basis of all oppression is economic dependence upon the oppressor." The widespread discontent with present social conditions is an augury of hope for the future. There is no element in the unrest which need excite grave apprehension. Thoughtful people perceive clearly that women are intensely human, nothing more, and that as human beings they are entitled not only to food, clothes, and shelter, but to an opportunity for development.

It is only as we are familiar with the oppression that has been the common lot of women since the beginning of time that we can realize that her lot has been sweetened, her condition ameliorated, and her progress within the century marvelous indeed. The woman question, historically considered, contains all the physical subjugation and consequent inferiority which constituted all the differentiation between the physical and mental powers of men and women. It contains all the humiliation, uncertainty, and ultimate hope of her future. The history of the woman question is analogous with the history of the labor question, with the difference that woman slavery had its origin in the peculiarities of her sexual being, while the laborer's slavery began when he was robbed of the land which is the birthright of every human being. It will be seen, therefore, that woman's slavery antedates the thralldom of the thrall, and "was more humiliating, more degrading, because she was treated and regarded by the laborer as his servant, his inferior.” This condition largely prevails among laborers to-day, and was indirectly given utterance to a few weeks ago, when some of the members of the American Federation of Labor formulated a traditional resolution demanding that “women be excluded from all public work and relegated to the home,”—a demand that would be to some extent reasonable, and no doubt acceptable, to the great army of working-women, had the chivalrous laborers who formulated the demand the ability and industry to provide a home for the women whom they would render paupers by deprivation of work, and for the children for whom their fathers were unable to provide. It is gratifying to know that this resolution was lost in the committee room, and that its formulation was greeted by the press of the whole country with a storm of deserved disapproval.

Inasmuch as the rapidly increasing number of bread-winners among women makes it evident that men are either unable or incompetent to provide for them, it remains for the working-women of the country to formulate a resolution demanding that men be excluded from all work that has hitherto been considered as belonging to or peculiarly adapted to women. What an army of mosquito-legged men from the eating-houses, laundries, and dry-goods establishments would rise up to proclaim the idiocy of women and protest against such injustice!

On the threshold of the world’s morning, says a distinguished writer and worker in the German Reichstag of to-day, we may correctly assume that woman was man’s equal in mental and physical power. But she became his inferior physically, and consequently dependent upon his bounty, during periods of pregnancy, childbirth, and child-rearing, when her helplessness forced her to look to him for food and shelter. In the childhood of the race might made right; brute strength was the standard of superiority; the struggle for existence was crude and savage; and thus this occasional helplessness became the manner of her bondage.

That nature is primarily responsible for the centuries of woman’s enslavement there can be no doubt. And as nature’s laws are unchanging, the advocates of woman’s political advancement would do well to remember that woman’s greatest importance as a public factor can only begin when the function of motherhood ceases. “In a real sense, as a factory is meant to turn out locomotives or clocks, the machinery of nature is designed in the last resort to turn out mothers. Life to the human species is not a random series of random efforts; its course is set as rigidly as the pathway of the stars; its laws are as immutable as the laws of the Medes and Persians.” (Drummond’s Ascent of Man.)

Nature’s great work for the individual is reproduction and care of the species. The first, Drummond terms the cosmic process; the second, the moral process. Statistics show that one child out of every three dies before maturity, and nature’s task is incomplete unless at least two children be reared to the adult age by every family. Every couple, then, at marriage, assumes the responsibility to society and posterity of bringing three children into the world. Woman’s part in the stupendous economy of nature is first and distinctively most important, that of motherhood. She can only pay her debt to nature, fulfill her mission to the world, and discharge her obligations to humanity by faithfully discharging the duties of motherhood. But as the function of motherhood ceases when the woman is in the prime of life, ripened by experience and fortified by maternal ties, she may yet have ample opportunity to exert her far-reaching influence in public work when she has exemplified in her own life the words, Home, Love, Mother. And there is, there can be, no rational objection to granting the fullest suffrage to woman at this period.

Having located the basic cause of her dependence, it will be seen that the only solution possible for the complete emancipation and mental and physical development of woman is to render her, through industrial freedom, so economically independent in every way of man’s grudging bounty that she will scorn his pity, resent his abuse, and claim her right to fullest individuality and opportunity as a human being.

For countless ages women were separated from the world by a barrier as effective as the myriad-miled wall of China; vacillating between the condition of slave and superintendent of the kitchen; taught nothing but those flimsy accomplishments that would catch the eye of the prospective husband and master; sneered at, ridiculed, and abused whenever she attempted to cross the line which hoary prophets and patriarchal slaveholders had marked across her path; subject to man’s whim and caprice; her physical development, in time, became meagre and crippled. And as her mental faculties were repressed and imprisoned in the narrowest circle of feminine opinions, it became difficult for her to rise above the most commonplace trivialities of life. Thus it came about that the term “Weaker Sex,” originally used to convey only the acknowledged truth that women are inferior to men in physical strength, came to include the mind as well as body. Be this as it may, the position of women for long centuries was inevitably one of extreme cruelty and oppression. Countless bitter and unnecessary limitations hedged her pathway and obstructed her development from the cradle to the grave. It is not to be wondered at that she in time became so inured to her degrading servitude as to accept it as her natural position. Madame De Staël has truly said, “Of all the gifts and faculties which nature has lavishly bestowed upon woman, she has been allowed to exercise fully but one, the faculty to suffer.” The extent of this suffering and the deteriorating influence which it has exerted upon the race can never be estimated till Finis is written to the story of humanity.

In the noonday of Grecian power and learning, woman trod not beside man as helpmate and companion, but followed as his slave. Demosthenes defines the wife as the “bearer of children, the faithful watch-dog who guards the house for her master.” At the Council of Macon, held in the sixth century, the question of the soul and humanity of women was gravely weighed and debated, profound doctors of theology maintaining that “woman is not a subject but an object for man’s use and pleasure.” For centuries theological divines whetted their wit on helpless woman; and the church in holy zeal persecuted the woman who was guilty of a fault as a “daughter of the devil,” and held her up to public contumely as the concentration of all evil.

Christianity, indeed, offered emancipation to women. It proclaimed a startling doctrine,—the equality of the rich and the poor, the weak and the strong, in the sight of God the Father. And it became evident that such teachings would inevitably break down the barriers of class and caste, eliminate injustice, and usher in a time when all should stand equal before the law. But alas, the world, with the exception of isolated and individual instances, has never been offered an opportunity to test the efficacy of the all-corrective principles of the religion which Christ gave to the world. The repression of women biased the reformatory tendencies of Christianity, and rendered it as ineffective as a medium of relief to the oppressed as our one-sided political system of to-day. Christianity, under masculine domination, was lost in the rubbish of churchianity, which, professing but failing to practice the religion of Christ, has held woman in the same contempt in which she has been held by all the ancient and idolatrous religions of the world. Yet despite the fact that the great Master, were He to come to-day, would scarcely recognize in the churches a trace of the code which He lived and died to exemplify, it must not be forgotten that the vital principle of religion never dies. It eventually attains fullest development, and becomes identified with the progress of civilization and the highest purpose of a people. Therefore, we may reverently believe that in the ultimate triumph and rehabilitation of practical Christianity lies the hope of the oppressed, and true liberty not only for women, but for every human being.

Even now the mists are lifting. The great change in the position of women—legal, social, and educational—within a hundred years is breaking even the hard shell of orthodox usage. Whole denominations have dropped the word “obey” from the marriage service. Many ministers frequently omit it, or, if administered, it is pronounced by the bride with mental reservation and looked upon as a word that has only the most remote and shadowy significance. The new wine is breaking the old bottles; the spirit of the nineteenth century is too progressive for the usages and traditions of the eleventh century. Modern churchianity, realizing that women constitute three fourths of its membership, no longer wages a merciless warfare upon them. It has relaxed its Pauline grip upon her throat, “I suffer not a woman to speak in the churches.” And the more advanced theological bodies have offered her the intellectual hospitality of the pulpit, where her eloquence is a pleasing change to those who have grown tired of preachers’ platitudes. Clerical decrees are no longer hurled at her defenseless head. The doors of churches, schools, and colleges are swinging wide at her approach, though they sometimes creak on their hinges. The ministers no longer openly advocate that the gates of opportunity be bolted and barred against her. There is everything to stimulate hope; the wings of feminine nature have expanded till a return to the chrysalis is impossible.

It is true that a very large number yet profess to believe that a woman fulfills her whole mission in the world when she makes herself as pretty and agreeable as possible, and devotes all her time and attention to the discharge of domestic duties. But there has been a wonderful modification of opinion since Schopenhauer declared that “woman is not called to great things. She pays her debt to life by the throes of birth, care of the children, and subjection to her husband.” Two things have tended to bring about this modification of opinion; the broader education and increased opportunities for development attendant upon the growth of individual liberty and republican forms of government; and the capability of self-maintenance due to improved mechanical appliances. It is not mere inclination on the part of the individual, nor is it the voice of the agitator, that is bringing about these changes; it is the irresistible logic of events.

One hundred years ago the education of women in the most progressive and wealthy families went little beyond reading and writing. In 1819, when Mrs. Emma Willard issued an address to the members of the New York legislature advocating the endowment of an institution for the higher education of women, there was not a college in the country for girls. In 1892, the colleges of the United States numbered more than 50,000 female students. In 1888, the ratio of female students to the whole number of students pursuing a higher course of education in universities and colleges in this country was 29.3 per centum, or a little more than one fourth. At the same time the ratio in England was 11 per centum; in France, 2 per centum; while in Germany, Austria, and Italy the ratio was so slight as to be but a mere fraction of 1 per centum.

Such a thing as a female president of a college was unknown and probably undreamed of in the eighteenth century; but we learn from the Report of the Commissioner of Education for 1887–88 that there are in the United States forty-two colleges and institutions for the superior instruction of women having a woman for president.

In the high and secondary schools, in 1888, over one half of the students were girls. And in the same year, tabulated statistics reveal that 63 per centum of the teachers were women. And this percentage will become greater and greater as we grasp the truth that woman is, by gift of greater intuition and sympathy, the natural instructor of the human race. The salaries paid to women teachers are grossly unfair when compared to the pay of male teachers for the same or less work. But as the difference in compensation is growing smaller every decade, there is at least room for hope that this injustice will soon be righted.

The law of evolution is the discoverer and formulator of woman's advancement. The invention and use of gunpowder placed the peasant on an equal war-footing with the mailed knight. The enormous increase in mechanical appliances and productive machinery has taken woman out of the rank of unpaid menials, has given her leisure for mental development, opportunity to receive recompense for toil, and is largely breaking down the physical barriers which had hitherto been considered unsurmountable. Statistics show that there are forms of machinery in the operation of which the production of a woman is even greater than that of a man, thus furnishing an actual proof of the falsity of the idea that woman is incapacitated for competition with man in the physical world. And the trend of events is indicated by the statistics given in the Report of the Commissioner of Labor, from which we learn that in some trades and professions the percentage of women engaged has increased fivefold in the last decade.

While woman's work has always been a recognized factor in the world's progress, yet her admittance to the field of remunerative work is limited to the last one hundred years; is, in fact, the prominent feature of the nineteenth century. There is overwhelming evidence that her work in every department to which she has been admitted is as capable, acceptable, and in every way as faithfully performed as the work of her brother man. In the last century it is estimated that not more than 1 per centum of artists and teachers of art were women; while in 1890 women comprised 48.08 per centum, or nearly one half of that profession. Nearly the same proportion of increase is found in the ranks of teachers and musicians,—women now forming over 60 per centum of the teachers of the United States.

There are now about three million women and girls in this country who earn their own livelihood. And the eleventh census reveals the startling information that in the city of New York there are twenty-seven thousand men who are supported by their wives. Yet these men, useless to society, a burden to the women who support them, are permitted the immunities and privileges of law and custom, while women have equality only in the duties and punishments.

At the beginning of the eighteenth century there were but few occupations in which women were permitted to engage. Their abilities and ambitions were restricted to the school and the home. In the latter they received food and shelter as compensation; in the former, but one half or one third the salary allowed to male teachers. The first noticeable change in woman's condition, when she became something more than a mere household drudge, whose busy hands carded and wove, spun and knit, the family supply of cloth, dates from the first bale of cotton grown in this country in the early years of the eighteenth century. In that bale of cotton lay the seeds of not only a new movement in labor, but the beginning of a new epoch for woman, in which her work and wages were destined to take coherent shape and form. In all industrial progress since that time women have taken an active part while receiving a meagre share of the product. Forced by the course of events to emerge from seclusion and repression, she has passed from one stage of development to another, always a step or two behind man in the progress of social evolution, till the close of the nineteenth century reveals myriad changes and the actual realization of Tennyson's prophetic lines in the "Princess," "We have prudes for proctors, dowagers for deans."

One hundred years ago it was the duty of a woman to efface herself. She was expected to make of herself a mental blank-book upon which her husband might inscribe what he would. Thus it is only lately that women have begun actively to compete with men in expression of any kind. Indeed, previous to that time, with a few notable exceptions, they were denied recognition of individual life. The woman, if unmarried, was merged in the family, or, if married, merged in the husband. Her name, her religion, her gods, were changed on marriage. But, married or single, the absorption was complete. So it has happened that woman, throbbing with poetic sympathy, has, with the exception of Sappho, produced less high and unmistakable poetry than man. With more harmony, more music in her nature, her very soul attuned to symphony and rhythm, she has been little known as a composer. With far vision and clear literary insight, she has been suppressed in art and literature. George Eliot gave her sublime literary productions to the world under a masculine *nom de plume*, because of the prejudice of even that not remote day. Fanny Mendelssohn was compelled by her family to publish her musical compositions as her brother's. Mary Somerville met only discouragement and ridicule in her mathematical studies. In every sphere, in every department of science and art, abuse, injustice, and the croaking of reactionary frogs have greeted each step of her upward way. The wonder is, then, not that she has accomplished so little, but that she is not in the same condition to-day that she was when Paul thrust a gag in her mouth in the shape of a Corinthian text, "And if a woman would learn anything, let her ask her husband at home." It will be seen, therefore, that the oft-repeated assertion that women have not given to the world as much evidence of genius as men is a Lilliputian assertion tainted somewhat with envy. "There has been no Shakespeare among women," says the advocates of man's supremacy. With all the world as their own, and the gates of boundless opportunities swinging wide, there has been but one Shakespeare among men. It has been asserted that George Eliot is the Shakespeare among women and Mrs. Browning the counterpart of Bacon. But their immortality has not been tested. They lived but a little while ago. But there is one woman, at least, who has established her claim thoroughly, and whose genius twenty-five centuries have tested. Sappho is truly immortal. Her fame and genius have been sealed by the approval of all the great literati of the centuries. Coleridge, who occupies no uncertain place in the world of letters, says of her, "Of all the poets of the world, of all the illustrious artists of all literature, Sappho is the one whose every word has a peculiar and unmistakable poetic perfume, a seal of absolute perfection and illimitable grace." Swinburne, the greatest living master in the world of verbal music, declares that, "Her verses are the supreme success, the final achievement, of poetic art." Sappho's claim to immortality exceeds that of Shakespeare's by twenty-three hundred years.

Men, viewing the literary productions of women, are apt to give them the color and bias of masculine thought. As instance the poetic critic of a New York periodical, who wantonly affronts the gifted author of "Poems of Passion" by declaring that her "fervent verses are but the burning of unseemly stubble that fails to give forth light or heat." Yet Ella Wheeler Wilcox, all fair-minded critics will admit, has won a place in the ranks of poetic genius. Her poems throb with human sympathy, and from the exalted plane of her splendid womanhood she reaches down, fulfilling the law of Christly service, to lift up the fallen and soothe and bind the bruised and bleeding. Such masculine criticism is dying out, but it has not been uncommon in the past. Mrs. Browning and Jane Austen were accused of "breaking down by their writings the safeguards of society," and they were admonished to "cease their literary efforts and devote themselves to sewing and washing dishes if they would retain the chivalrous respect of men." "Jane Eyre" was pronounced too immoral to be ranked as decent literature. "Adam Bede" was classed as the "vile outpourings of a lewd woman's mind." Yet Charlotte Brontë, George Eliot, Mrs. Browning, and Jane Austen have won an exalted and enviable place in the ranks of literature. Their writings have thrilled, uplifted, and sweetened humanity.

The test of literary genius is to create a character of universal acceptance. The record of half a century has but one world-wide, world-known character of that kind. That character was created by a woman. In all literature, no book since the Bible has been so widely circulated, so extensively translated, or has so thoroughly commanded the profound attention of all classes as Harriet Beecher Stowe's "Uncle Tom's Cabin." Mrs. Stowe impressed her genius upon the race and time, and marked a new epoch for freedom. Previous to the publication of her book only a few men recognized slavery as wrong, but a woman's sympathetic heart and throbbing genius laid bare the evil and disclosed to a horrified world the wrong underlying slavery.

In philanthropy and the domain of morals there is none who is doing more heroic and effective work than Mrs. Elizabeth B. Grannis. She deals not with theories, but with real conditions. Her sympathies, her broad work, her manifold charities, go out to flesh and blood, men and women. She has the intuitive faculty of probing deep into human nature, leading those she would reform to mourn real defects, rejoice in real victories, and hope and struggle for better things.

The constantly broadening sphere of woman's usefulness is in a large measure due to the organized forms of intellectual activity among women known as clubs. Half a century ago club-life for women was unknown. Their social sympathies were limited to the political party that claimed the franchise of their male relatives, or the church at whose shrine the women worshiped. But so rapid has been woman's development in this direction that to-day women's clubs form a chain from ocean to ocean, binding them as one great whole. The effect upon the members is magical; nature is enlarged; charity broadened; capacity for judgment increased; and hitherto unsuspected faculties are called into life and power.

The first organized demand by women for political recognition in the United States was made in 1848, at what was known as the Seneca Falls Convention. Ridiculed, persecuted, kicked like a football from one generation to another, this brave demand for political recognition was destined to become an agency that would work a peaceful revolution. That the movement is progressing, and will eventually succeed, is evinced by the record of half a century. In that time school suffrage has been granted in twenty-three States and Territories, partial suffrage for public improvements in three States, municipal suffrage in one, and in four States full political equality. Wyoming was the first State to accord citizenship to her women, and she bears testimony to its efficacy in the progress, honor, and sobriety of her people. In 1893, the Wyoming state legislature passed resolutions highly commendatory of woman suffrage and its results, and among other things said, "We point with pride to the fact that after nearly twenty-five years of woman suffrage, not one county in Wyoming has a poor-house, that our jails are almost empty, and crime, except that by strangers in the State, is almost unknown."

From the banks of the far-off Volga come the good tidings that even Russia is preparing to take a great step in advance by granting to women many legal and political privileges now enjoyed only by men. England granted municipal suffrage to women a quarter of a century ago, and has more recently granted partial parliamentary suffrage. And to the influence of English law, more particularly the Married Women's Act, is largely due the betterment of the legal status of women throughout the world. In England we find women prominent in art, literature, politics, the school and the church. While in this country the middle classes have heretofore carried on the suffrage agitation, in England it finds active workers among the peerage.

Woman in politics meets with the opposition of job politicians, but she realizes that every step of her progress, from the unveiling of her face to a seat in the legislature of a State, has been taken in the face of fierce opposition and in violation of conventionalities and customs. Undismayed she advances for the ultimate betterment of humanity.

The historian of the future will record the nineteenth century as the Renaissance of womankind. And the ultimate effect upon the human race of having individuals, not servants, as mothers will surpass the progress made in science and in art.

The eighteenth century found woman an appendage; the nineteenth transformed her into an individual. The wonderful altruistic twentieth century, whose dawn even now is breaking, will so develop this individuality that women will contend for all the rights of the individual, coöperating with the nation in the fulfillment of its mission, and with the world in the development of the eternal law of progress.

"Through the harsh voices of our day
A low, sweet prelude finds its way;
Through clouds of doubt and storms of fear
A light is breaking calm and clear."

The Century's Textile Progress

By ROBERT P. HAINS,
Examiner of Textiles, U. S. Patent Office.

Antiquity conceals nothing more completely than the origin of the textile industry. Back in the dark ages and beyond authentic records, evidence is furnished that this art was not unknown. Egyptian mummies shrouded in fine linen fabrics give their silent testimony of ancient knowledge, but when or where the art had its inception still remains wrapped in mystery. Nearly every nation of the earth lays claim to its invention at some epoch in traditional existence. Thus the Chinese attribute it to the wife of their first emperor, the Egyptians to Isis, the Greeks to Minerva; but probably it had its birth in the Orient, where the making of cloth was known and practiced from the earliest times.

Whatever the merits of rival claimants, certain it is that for many centuries the simple distaff and spindle were the only instruments used for spinning, while the warp and weft were woven together by hand implements not less primitive in structure.

In the first spinning device, a mass of fibre was arranged on a forked stick, and, as drawn therefrom by hand, it was twisted between the fingers and wound on a spindle. During the reign of Henry VIII. of England, however, the spinning-wheel replaced the distaff and spindle, and in every cottage and palace it became an indispensable article of household equipment. The young women in all walks of life were taught to spin. Spinning became the female occupation of the age, and it is interesting to note that the modern term spinster, meaning an unmarried woman of advanced age, here had its origin.

The spinning-wheel, though superior to the distaff and spindle, was yet a crude machine. It consisted of a stand on which was mounted in horizontal bearings a spindle driven by a band from a large wheel propelled by hand or foot, and as twist was imparted to the fibre drawn through the fingers, the resulting yarn was wound on the spindle.

The art of weaving was not more advanced. It is true that the middle of the eighteenth century found the hand loom developed from the original Indian structure to contain many of the essentials of the modern power loom. It embodied the heddles, the lay, the take-up and let-off beams, the shuttle for passing the weft, and in 1740, John Kay added the fly shuttle motion, whereby the shuttle was thrown through the shed by a sudden pull on the picking stick; then in 1760, Robert Kay, son of John Kay, invented the drop box, whereby several colors of filling might be employed.

Brilliant as these achievements were, the hand loom remained the crude embodiment of the simple principles of weaving until near the dawn of the nineteenth century, when, by the invention of Cartwright, a period of development was introduced in all lines of textile manufacture unsurpassed in the annals of industrial progress. The first great stride, and that which opened the door for further advance, was the creation of the spinning-jenny, in England, by Hargreaves, about 1767, whereby eight or ten yarns could be spun at one time. Drawing rollers were subsequently added by Arkwright, and then traverse motion was given the bobbins in order to automatically build the yarn into a cop. It has developed since that the drawing-rollers constituted one of the most important fundamental improvements in the spinning art. Their function was to draw out the fibres into a proper size of roving, and to feed this to be spun. Without them the modern spinning-frame would not have been possible.

Arkwright's drawing-rollers and Hargreaves's spinning-jenny combined under the invention of Crompton to produce, in principle at least, the modern spinning-mule.

Fairly good machines were thus provided on the advent of the nineteenth century for spinning unlimited quantities of yarn, but this, in turn, required proper loom structures to use the same and a corresponding supply of raw material. Inventive genius was abroad, and the necessity met by Eli Whitney, who, while at the home of General Greene, of Georgia, built the first practical machine for separating cotton fibre from its seed.

Whitney's gin was constructed on the broad and simple principle that cotton fibre could be drawn through a smaller space than the attached seed, and this same principle is the soul and spirit of every saw-gin of the present day. Prior to Whitney's gin, cotton fibre was separated from the seed by hand, a day's work being represented by two or three pounds of cleaned fibre. The daily product of the gin now reaches between three and four thousand pounds.

Such figures demonstrate the important position taken by the cotton gin among the developing agents of the cotton growing States. It has rendered possible and profitable the cultivation of large districts of otherwise waste lands; it has stimulated cotton production; given employment to thousands of idle hands; cheapened the price of cotton cloths, and placed within the reach of the humblest people wearing apparel of fine and beautiful texture.

Unlimited supply of raw material being thus provided, attention reverted to perfecting the machines for spinning it, and under the magical touch of Richard Roberts, of Manchester, England, in 1830, the crude mule of Crompton took practical shape. He gave to it the quadrant winding motion, provided for the harmonious working of the counter and copping faller wires, perfected the "backing off" and "drawing up" mechanisms, and gave attention to construction of details that placed the mule before the world as a practical success.

Equipped in its present form, the self-acting mule presents one of the most striking examples of complex automatic mechanisms that can be found in the industrial world. The work of the attendant is confined to piecing broken ends and supplying roving, the machine passing through the entire cycle of its complicated movements without human direction. An idea may be had of its delicate and accurate operation when it is considered that one pound of cotton has been spun by it into a thread one hundred and sixty-seven miles long. Improvements have been made, indeed, on Roberts's mule, but aside from changes in details and form, the machine, as it left the hands of this mechanical genius in 1830, remains unchanged.

During this period, the fly frame was developed from the machines of Hargreaves and Arkwright, but while it constituted a great advance over these machines, it presented no radical departure in principle.

We may pause here, as we pass through the third decade of the present century, to witness the introduction of a spinning-frame, which, for originality of conception and far reaching influence on the textile industry, closely approximates the achievements of the pioneer inventions of this art. Reference is made to the ring frame in which the flyer is omitted, the bobbin being attached to the spindle and revolving with it. On the traverse rail, and surrounding each bobbin, is secured a flanged ring having loosely sprung thereon a light traveler, through which the yarn, as it comes from the drawing-rolls, is led to the bobbin. Revolution of the bobbin carries the traveler around the ring imparting twist to the yarn, and as it is spun it is wound on the bobbin in proportion to the feed of the drawing-rolls.

The invention of this machine is attributed to John Thorpe, of Rhode Island, in 1828, and so popular did it become by reason of decreased power necessary to drive it, incidental to the omission of the flyers, and good quality of yarn produced, that, between 1860 and 1865, it nearly replaced all other machines in America for spinning cotton.

The speed of the ring frame, as well as its output, appeared unbounded; but at high speeds, under unbalanced loads, the spindles were found to vibrate in their bearings, and the quality of yarn, in consequence, degenerated, the spindle bearings became worn, and the limit seemed to be reached at five thousand revolutions per minute. A careful examination of the ring frame revealed no vulnerable part of its general structure that could be improved so as to readily secure increased speed and steadiness of the spindles when unevenly loaded; but with admirable foresight, developing intellects set to improve the spindles themselves, and, in 1871, Jacob H. Sawyer introduced and patented a spindle and bearing, which was one of the most important improvements in the ring frame. He chambered the bobbin, and by carrying the bolster T well up inside supported the former near its load centre.

The evolution of the spindle was not yet complete. The Sawyer type, at more than seven thousand revolutions, would vibrate, and of the many attempts to cure the defect none succeeded fully until the very simple change made by Mr. Rabbeth in 1878. He gave the spindle a small amount of play by making the bolster loose in its supporting case, and placed a packing between the two.

A. H. Sherman improved upon the Rabbeth structure by making the bolster and step in one piece and omitting the packing, the cushioning being dependent upon the lubricating oil.

The acme of development in this small but most important part of the ring frame was now reached; and in its approved form it embodies the sleeve whirl extending into the bobbin, the loose, yet adjustable bolster, tapering spindle, removable step, and lubricating reservoir. Such spindles are capable of unlimited speeds,—twenty thousand revolutions per minute have been given,—and under absurdly unbalanced loads they run steadily and with less expenditure of power than the older forms at their slower speeds.

Increased speed in the spindles, however, brought increased breakage in the yarn, and although stop motion devices had been employed for several years, yet economy demanded ready means of piecing broken ends. This has been provided recently by mounting the stop clamp upon the roving rod well up near the first pair of drawing rolls, so that on pulling the stop wire into place the roving is at once fed between the drawing rolls and issues in front, over the spindle, to be easily pieced by one hand. Prior to this, the operative was required to reach over the machine, feed the roving to the rolls with one hand, hold the stop wire down with the other, and the broken end of yarn in his teeth.

Excessive ballooning was also incidental to the use of high speed spindles, and, while inventive skill has never mastered it, yet the injurious effects have been obviated by an ingenious mounting of separators, one between each two spindles.

Aside from minor details perfecting the mechanical construction, such has been the evolution of the modern spinning frame. In 1830, it required the constant attention of one spinner to oversee twenty slow-running spindles, whereas, in 1896, the same attendant could, with less effort, “tend” seventy-five or more of the high speed type; and whereas, in 1790, when the first American cotton mill was established by Samuel Slater in Rhode Island, there were only seventy-five spindles on cotton fibre, in 1830, the number had increased to 1,246,703, and in 1890, to 14,188,103.

Under such competition no wonder the spinning-wheel of our grandmothers has followed the economic law, that the fittest alone survive, and has been relegated to the wood-pile or garret, or, bedecked with ribbons, finds a resting-place in the chimney-corner as a decorated curiosity. Its mighty rival is here. Its attendants have been liberated to more ennobling pursuits. The homespun has been replaced by beautiful fabrics, and the monster spinning frames of to-day pour forth their hourly product in miles of spun fibre, where the wheels of our grandmothers were taxed to the utmost to produce a very small fraction of the amount. To appreciate the wonderful change, pause beside the domestic wheel used within the memory of the living, and compare its "whirr," in slowly producing its single thread, to the "buzz" of the modern spinning frame turning out its product from a thousand spindles.

The production of yarn required something more than spinning. The fibres in the massed cotton or wool, as delivered to the manufacturer, must be opened, untangled, straightened out, and laid parallel by a series of preparing machines prior to being spun, among which the carding engine ranks first. In the incipient form, this machine dates as far back as the middle of the eighteenth century, when, by hand manipulation, two cylinders covered with small teeth and working in close proximity disintegrated the fibrous mass; but the fibres were much broken and not evenly arranged. The addition of the workers and strippers around a rapidly revolving swift gave increased utility to the machine, and Bramwell's feed, in 1871, so regulated the amount of fibre fed at intervals that the resulting lap possessed the desired even character. This feed weighs the fibre as it is fed, stops the lifting apron while the scale pan dumps its load, resets the scale pan, and automatically starts the lifting apron to again feed the scale,—a cycle of operations indicating a near approach to human intelligence.

One additional machine at least, the comb, requires notice before passing to the all-important progress made in the loom structure. With advancing civilization and refinement came demands for superior fabrics, which could only be answered by a supply of better fibre. Such fibre could only be secured from the bale by separating the long from the short, a problem well calculated to tax the ingenuity of an enlightened age. Attempts had been made to do this by hand implements not unlike the curry-comb of to-day, except that the teeth were long and tapering. This remained the only means employed for years, while other textile machinery passed through its phenomenal period of development. At last, in 1841, it occurred to Heilman, while watching a lady comb her hair, that a machine might be constructed to comb wool by drawing a bunch of fibres over pins. He constructed a device on this principle, and in a developed form it is used still and known as the Heilman or nip comb.

In 1853, James Noble gave to the world the circle comb, wherein two flat circular rings, having projecting from one face vertical pins, were mounted, one eccentrically within the other, and revolved in the same direction, the object being to dab the fibre on the rings where they met; and then as they revolved and separated the short fibre would be drawn off the large ring, leaving the long fibre freed from the short. These machines were successful, and above all they were practical—the operation of the hand comber disappeared from the face of the earth.

The sudden birth and rapid development of mechanically perfect means for preparing and spinning fibres were due largely to the comparatively simple movements required to draw and twist the yarn, but in the loom no such problem was presented. Here the movements were complicated and varied, and the application of power to the manipulation of the delicate threads was not susceptible of sudden and successful solution. The warps, stretched in a sheet between two beams, had to be opened to form the shed, the shuttle had to be passed therethrough, the weft beaten to place, and means provided to feed the warp and to take up of the fabric an amount at each beat-up corresponding to the size of the weft. These were the movements necessary in the most simple kind of weaving, and though fully understood for many centuries, as evidenced by the Indian and Egyptian looms, and as embodied in hand machines of the seventeenth century, it was not till 1787 that they were clothed with the application of power. Even then the first embodiment did not emanate from the hands of a weaver or engineer, but from Dr. Cartwright, a clergyman in the church of England. It was not surprising that these looms failed of their expectations, for the shuttle would frequently get trapped in the shed, the driven power-lay would break out the warp threads, the take-up and let-off motions were not graduated to compensate for the decrease of the warp and increase of the cloth beams, resulting in thin and thick places in the cloth. But this application of power to the loom was the initial step in the industrial supremacy of the machine, which to-day works with the perfect cadence of an automaton.

The first years of the present century were of unsurpassed activity in the inventive field. The spinners were putting forth more yarn than the hand-looms could use. It remained for the loom to keep pace with the times. Miller, in 1800, Todd and Horrocks in 1803, Johnston in 1807, Cotton in 1810, Taylor in 1815, and many others, concentrated their efforts to develop the plain power-loom; but the second decade of the present century saw the old hand-loom with its slow and cumbrous movements still mistress of the art.

The name of Richard Roberts stands preëminent at this period, between 1820 and 1825, as giving to the power-loom several perfecting touches in the means for letting off the warp the small amount necessary at each pick, the means for taking up the finished cloth, the means for shedding the warp for the passage of the shuttle, and the adaptation of the stop motions of his predecessors. These changes gave practical life to the machine, and overthrew the barrier that obstructed the advance of the textile industry. They were, however, only a few of the improvements added in perfecting the power-loom, such as the automatic temple to hold the cloth extended and prevent drawing of the weft, the shuttle-guard to prevent accidental jumping of the shuttle from the race, the perfect weft-stop to bring the loom to a stand on breakage or failure of the weft, the protector mechanism to obviate a “smash” when the shuttle failed to box, and the loose reed, all of which stand out in bold relief as evidences of the progressive tendencies of the age, and combined in about the year 1838, more than a half century after Cartwright’s first conception of the idea, to complete the practical power-loom.

The loom had not reached a stage of mechanical perfection; much yet remained to be done, but the plain power-loom of this period was both a practical and financial success. By its immediate predecessor, the hand-loom, a good weaver and assistant could work from forty to fifty picks per minute, and weave plain cloth. By the power-loom of 1840, one weaver could “tend” two looms running from 100 to 120 picks per minute and produce the same cloth. Without passing through the various steps which culminated in the power-loom for plain cloth, now in use, and tracing the causes that led to perfection of details, the amazing advance from the ancient and 18th-century hand loom to the power-loom of 1840 and that of to-day may well be shown by comparing the machines themselves.

Such was the simple form of the power-loom. One half of the warps were alternately raised and lowered for the shot of weft; but as a woven fabric is one in which the warp and weft are united by passing them over and under each other, the figure or pattern of the cloth will be varied as the threads are crossed in different combinations, and this will depend on the order of raising and lowering the warp threads, and the introduction of different characters and colors of weft. This brings up for review the most important parts of the loom structure—the shedding mechanism and shuttle-box motions—through whose agencies the most beautiful and complicated designs are produced.

Shedding mechanism was present of course in all looms, but in the power-looms of the early part of this century it was confined to tappets adjusted on a revolving shaft, and the number of heddles was limited to six or eight. Fairly good twills and other like fabrics could be produced within the limits of the few heddles, but with the introduction of the “dobbie,” or that part of the loom which raises and lowers the harness-frames, a new era in fancy weaving was inaugurated. By this ingenious device as many as thirty-six or even forty heddles could be used and raised at will to form figures. The creation of the dobbie belongs to the 19th century, and it is found in practical form about 1863 in the United States under the name of the American or Knowles dobbie. The essentials are the two cylinder gears revolving constantly, the vibrating gears, carried on the end of pivoted arms and having teeth on a part of their periphery, the harness jacks connected to the heddle frames, and the links joining the vibrating gears and harness jacks in such manner that part revolution of the former causes the latter to move the connected heddle frame, and consequently the warp threads, up or down. A pattern chain determines what vibrator gears shall engage the cylinder gears, and, once the chain is fitted to the design to be woven, nothing remains for the loom tender but to oversee the operation of the machine.

Another form of dobbie, not less popular than the Knowles, developed into a perfect automatic device about fifty years ago in England. Here two reciprocating knives are engaged, under the direction of a pattern chain, by one of two hooked jacks connected to the harness levers, and the shed is again formed without human intervention. Other forms of dobbie structures have been evolved during the last fifty years, but these two, with some modifications and additions of details, have come extensively into practical use, and represent the zenith of development at the present time. By their aid great variety is rendered possible in the design on the resulting fabric. The figured tablecloths, damasks, twills, satins, bordered and cross-bordered fabrics, are now possible at a cost of a thousandth part only of that incurred when produced by any of the old types of machines.

The subject of shedding, i. e., of opening the warp-threads to afford a passage for the shuttle, is so inseparably connected with the name of Jacquard, that attention is now carried to that wonderful invention evolved in the first few years of the present century, and by the use of which it may truly be said that anything can be woven as figure in a fabric that can be designed by the hand of man. It is as well adapted for the finest silks as for heavy carpets and figured velvets, and by an operation theoretically so simple as to excite wonder that it remained hidden until this age. Jacquard was a native of France and exhibited his machine complete in 1804, but so bitter was the opposition that the first machine was destroyed and burned. Its merits were clear, however, and reconstruction and general adoption in France followed soon after. It has since been applied not only for shedding but for every purpose where mechanical operations could be controlled by a pattern. In brief, this machine simply controls each warp thread separately by a cord having a hook attached. These hooks are arranged near the path of a reciprocating griffe or frame carrying cross bars, and are controlled, as to engagement with the bars, by a card perforated according to a pattern; thus any one or any number of threads can be raised at will. The dobbie controls harness frames each carrying a large number of warp threads; the Jacquard controls every thread separately. The greatly increased capacity of the latter machine is apparent. Thus a 1500-hook Jacquard will do the work of thirty dobbies of fifty jacks each.

The hand-shuttle box mechanism of Kay’s time has developed into the machine operated as a sliding or revolving shuttle-box controlled by pattern devices, which, being added to a dobbie or Jacquard equipped loom within the last twenty-five years, presents the highest point of perfection attained in the textile art. In such looms the warp threads, arranged in any colors, may be raised at will collectively or individually, any one of ten or twelve different colored wefts may be introduced as desired, and combinations may thus be formed to produce designs of the most complicated nature.

Pile fabrics, cut, uncut, and tufted, represent a type quite distinct from those produced on the ordinary fancy loom just described, and, in the form of velvets, imitation animal skins, and Brussels carpet, were almost unknown prior to the invention of Samuel Bigelow of Boston, in 1837. Fabrics of this character, if made at all, were the products of tedious hand methods, and on account of the consequent high price were the exclusive property of the very wealthy. Carpets with pile surface had been made by the Persians and Turks ages ago, by tying pieces of woolen yarn around longitudinal or warp threads, and binding the whole together by a weft at intervals; and such tufts, being carefully selected as to color, were made to present rich designs, but, like all other hand-produced fabrics, these were the property of the few.

The pile fabric loom of Bigelow opened the way for an advance in the carpet industry which continues to the present time; its ultimate effect being to place carpets within the reach of the humble cottager; and floors which were strewn with brush, or at best concealed by the home-made rag carpet, now became covered by a soft and beautifully figured fabric. This loom was a practical machine, and at once commended itself to the manufacturer. It consisted of the old power-loom provided with a Jacquard, already well understood, to which was added an attachment to introduce wires at intervals as false weft, and bind the warp around them by the usual weft threads. The wires being withdrawn after a few shots had been woven, left the warp loops standing, and these loops being formed under the dictates of the Jacquard, any character of beautiful design could be produced. Velvets, brocades, even the fine imitation of sealskin, are the simple products of this form of power-loom when the pile loops are cut. Greater cheapness in weaving cut pile fabrics has been secured by a slight modification in the Bigelow loom, so that two fabrics could be woven at one time. This idea was introduced about 1850, and it contemplated weaving the two fabrics face to face, keeping them separated by the usual pile wires of Bigelow, and passing the pile threads from one fabric to the other. Upon cutting the two cloths apart through the threads uniting them, two cut pile or velvet fabrics resulted. This loom required the service of two shuttles and double the number of warp-beams, but it worked well, and is to-day largely in use and well adapted to its purpose.

The demand for tufted pile fabrics, meaning those in which the pile is formed from tufts or yarns, individually tied to the foundation fabric, and of which the rich Turkish and Persian rugs are examples, had not been met by the Bigelow loom; in fact it was only about forty years ago that the mechanical production of such fabrics became possible. Smith and Skinner were the pioneers to enter this field, and the first, by the aid of machinery, to compete with the cheap hand-labor of the orientals. The invention of a machine that will select any desired color from a large number of yarns, carry it between the warp-threads at the exact spot necessary to form the figure, tie it around these threads, cut it off to the length necessary to form an even and smooth surface, return the unused portion to place, and do all quickly, accurately, and with little cost, is an achievement that may rightly claim the admiration of the industrial world. Yet this is what the machine inaugurated by Smith and Skinner does to-day. The general movements and complicated parts of the power-loom are present as for weaving a plain fabric, and on beams or large spools carried by a chain, under the control of a pattern, are arranged the tuft yarns, in the order in which they should appear in the figure. Through the pattern devices the proper spool or beam is brought into position to be seized by a pair of fingers which rise, take the spool from the chain, lower it to the warp, pass the ends of the tuft yarn through and around the proper warp thread, hold them till the insertion of a binding weft, then, when they have been properly cut to length, return the spool into its place in the chain. This creation of mechanical genius takes rank with the wonders of the spinning mule and, like that machine, passes through its entire operation with the *precision of an automaton*. By its aid close imitations of the oriental hand-made rugs are placed before the world at one quarter the former price, and, as a result, the fine moquette and axminster carpets lend their beauty to nearly every home in the land.

The credit for improving the power-loom so as to adapt it for weaving fancy cassimeres and suitings, belongs to William Crompton, a native of England, who came to the United States in 1836, and shortly thereafter, in the Middlesex Mills at Lowell, Mass., constructed and operated the first fancy cassimere power-loom, not only in this country, but in the world. Prior to this the harness for all woolen and worsted power-looms was worked by cams, and the cloth was woven plain; but Crompton's loom of 1840 started a new era in the woolen industry, rendering it possible to produce any fancy weave by an arrangement of pattern chain and large number of harnesses in connection with the change shuttle-boxes. Improvements followed, by the substitution of the reverse shuttle-box motion in 1854, the perfection of the general loom structure in 1857, the addition of the upright lever harness motion in 1864, and the centre-stop in 1879, so that at the present time this machine is adapted to run at high speeds and weave at moderate cost the most complicated designs in woolen and worsted—such as shawls, checks, suitings, and all forms of fancy cassimeres.

The general industrial activity in all matters pertaining to textile manufacture between the years 1835 and 1860, brought forth many forms of looms of special adaptation to meet the increasing demands of society. The narrow-ware loom appeared in the third decade of this century, and the addition of the dobbie, or Jacquard, later, equipped this loom for the simultaneous production of several ribbons, or narrow fabrics, side by side, having plain or figured effect. The lay was divided into several reed spaces, and a corresponding number of shuttles, operated by rack and pinion, carried the weft-threads through the adjacent warp.

About the middle of this century, and until the adoption of the more rich and delicate fabrics, hair-cloth was the accepted covering for furniture, and power-looms for its production quickly answered the demand. They reached such a degree of perfection and efficiency in this country that almost the entire industry was centred here. This fabric was made from the hair of horses' tails as weft, and a strong cotton warp; and as the weft could not be wound upon bobbins, as usual, each separate hair was inserted by an ingenious device made to reciprocate through the shed, and select one out of a bundle of hairs cut to the same length. The conception of a power device capable of the delicate operation necessary to weave hair-cloth, could never have been realized except in a highly intelligent manufacturing community; but in 1870, Rhode Island alone produced on such machines over 600,000 yards, consuming thereby the hair of about eight hundred thousand horse-tails.

The evolution of the lappet loom started between 1840 and 1850 in England and Germany. It sought to enhance the pleasing effect of plain fabrics, by placing an embroidered or raised figure over the surface during the weaving process. Near the lower edge of ladies' skirts, on the ends of neckties and like articles, an embroidered effect was desirable; and this has been secured by the lappet attachment to the present power-loom. In this a needle is mounted in appropriate location, usually back of the lay, and through an eye in the end thereof the lappet thread is led from a suitable supply. This needle is normally either above or below the warp. When a spot or figure is wanted, it is caused to move into the plane of the opposite warps of the shed, under the direction of suitable controlling pattern mechanisms. The shuttle being then shot, the lappet thread appears upon the surface, and it may be made to thus appear as often as desired; its position being shifted as necessary under the guidance of a pattern-chain to form, in embroidery effect, any character of small design.

Closely allied to the lappet loom in the effect produced is the swivel-shuttle loom, which has come extensively into use during the last thirty years to supply demands for spotted or embroidered figures. The loom is of the plain type, having small swivel-shuttles movable in carrier blocks, which are secured to the supporting bar near the top of the lay-reed, in convenient location to permit the shuttles to be depressed into the shed. Each swivel-shuttle is provided with a rack engaging a suitable operating pinion to move the shuttles simultaneously from one carrier to the next. Normally these shuttles are held above the warp plane, and the loom in this condition weaves tabby or twill. At the desired moment, the supporting-bar is lowered by a cam or Jacquard to bring the shuttles in the shed; the shuttles are moved from one carrier to the next adjacent, and then all are raised to their normal position above the warp. The ground weft is laid and the beat-up takes place. Repetition develops a spot or figure at intervals across the entire fabric, and with the use of different colored swivel-threads the greatest diversity of embroidered effect is secured over the entire ground. Some of the most beautiful spotted silks for ladies' dresses and fancy scarfs, never before contemplated, are now woven on this loom at prices that are very moderate for such a class of goods.

A radical departure from the paths traveled by prior inventors was inaugurated about 1859, in adapting the power-loom for weaving tubular fabrics, resulting twenty years later in perfecting a machine in which the warp threads were arranged in circular series and the weft laid in the circular shed by a continuously moving shuttle. Fire-hose and like tubular cloths resulted. Rapid development continued from the middle of the present century, so that nearly every conceivable form of loom, from the light running plain fabric and gingham looms to the heavy structures for weaving canvas and wire cloth, claimed the attention of the inventor; and in this last decade of the century looms are constructed to weave anything that can be woven. Wire, slats, cane, straw, and glass, as well as the light fibres of cotton, wool, or silk, are now easily manipulated on the power-loom and woven into cloths, mattings, baskets, cane-seats for furniture, bottle-covers, and ever so many irregular forms that, in the dormant condition of this industry prior to the nineteenth century, were quite beyond consideration of the most active enthusiast of the art.

Wonderful as these achievements have been, the restless ambition of inventive genius remains unsatisfied. Improvements continue—especially in the United States, under the fostering care of a liberal patent system—and attempts are now being made, and with success, to form the power-loom into a thoroughly automatic machine incapable of producing any but the best quality of cloth. Upon the breakage or undue slackening of a warp thread, the loom would continue to weave and produce imperfect fabric until the attendant had pieced the broken end or adjusted the slack thread. Means were devised some years ago to remedy this defect, but with only partial success until near the close of this century. Breakage or failure more often occurred in the weft, however, and though the weft stop-motion successfully detected the fault and stopped the loom, yet much valuable time was lost, and constant attention was needed to supply new filling. Progressive tendencies of the closing years of this decade have sought to meet this difficulty. As a result, means are now provided whereby, on failure or breakage of the weft, the loom discharges its imperfect filling from the shuttle, supplies itself with a new weft from the hopper, places it in the shuttle, and continues to weave. Such a loom provided with a warp stop-motion is almost incapable of producing imperfect cloth, and so long as the warps remain intact and the hopper is kept supplied with weft-bobbins, it will continue to weave. In fact, in many mills of the New England States these looms are now left to run during the dinner hour without an attendant, and no imperfect cloth is produced.

Such machines are almost independent of human attention, yet they are the evolution of the old-time hand loom. Just one hundred years ago the hand loom, running at 40 or 50 picks to the minute, required the watchful care of an expert weaver; in 1840, the same weaver could "tend" from two to four power-looms running 100 to 120 picks; to-day he oversees from 10 to 16 looms running from 150 to 200 picks.

The homespun, with its old familiar butternut dye, has disappeared. The spinning-wheel and loom no longer occupy a part of every home. In their stead, the farmer, as he looks beyond the thriving cornfields, beholds the reeking chimneys of a thousand mills as they proclaim the majesty of the power machines. The fabrics produced are beautiful and varied in design, and their cost so low as to excite wonder that such progress could have been the result of one hundred years of industrial activity.

The emancipation of knitting, as a domestic occupation, dates from the romantic experiences of William Lee, a subject of Queen Elizabeth, of whom it is related that while watching the deft fingers of his lady-love guide the knitting needle from loop to loop, conceived the idea of performing the operation by mechanical means. It is a singular coincidence also that the invention of this the first machine for knitting purposes, like that of the power-loom for weaving, should have emanated from the hands of a student and clergyman, unfamiliar with the art.

Lee's device was naturally crude. It contained only twelve needles, arranged in a row with about seven or eight to the inch, but it successfully formed a knitted web. Further progress in the art was slow, on account of the strong opposition to all machines which seemed likely to deprive the hand artisan of occupation. The Queen refused to grant a patent to Lee for this reason, and knitting remained the exclusive prerogative of women for many years. Like the spinning-wheel, however, the hand knitting-needle beheld a rival, which in the diversity of human wants was destined to create one of the great industrial pursuits of the age.

Stockings, like all other garments, were first made by sewing together pieces of linen, silk, cotton, or woolen cloth, resulting in a poorly fitting article, prolific of uncomfortable seams. Knitting the entire hose in a single piece by hand needles overcame these defects to an extent, and the Lee machine opened the way for the production of such articles on a scale that now furnishes the civilized world.

Lee's machine produced a straight web which required to be cut and sewn to shape; then to it was added the ribbing device and the narrowing and widening attachment, to shape the web to fit the body without cutting; but still a seam existed in the stocking where the edges united. In 1816, however, M. I. Brunel built a circular machine having an endless row of needles, and in 1831, Timothy Bailey, of New York, applied power to the knitting frame; the result being that at this time a tubular seamless fabric could be produced on a power machine.

The latch-needle, which has given to the knitting machine great capacity and diversity of product, was not invented until about 1847, by Mr. Aiken, of New Hampshire. A period of development then set in that continues to the present time. The needles by cam mechanism were made independently operative in a circular carrier; narrowing and widening devices to produce pouches, such as the heels and toes of stockings, were added, as was also feeding mechanism for the introduction of different colored yarn, or a reinforcing thread. Such machines, of 1868 and 1870, would form a stocking or undergarment well fitted to the form; but they required the constant attention of a skilled knitter, until pattern mechanism was introduced to control the time of introduction of the colored or additional thread, and the place for formation of the narrowed or widened web. In forming the heel and toe pockets, a part of the needles are thrown out of action, and the movements to operate the active needles are changed from round and round, or circular work, to reciprocating. At each reciprocation one or more needles, at the end of the series, are rendered inactive, until one half the required pocket is formed; then they are successively returned to action, and circular knitting resumed. It may be also an additional thread is introduced to reinforce the wearing qualities of the heel and toe, or a differently colored yarn may be thrown in to give figure, but all such movements are now automatically controlled by a pattern mechanism. The ribbed leg portion of a stocking is formed either in the same machine that fashions the foot or in a separate machine to which the foot is transferred, but in either case the pattern mechanism again controls.

Within the last twenty years this art has been so greatly improved, especially in the hosiery line, that the automatic machine of to-day passes through the entire operation of knitting the article, finishing it off, and starting afresh without other aid than a supply of yarn. Moreover, the machine now to be considered practical must be so constructed that it will continue thus to operate without repairs or loss of time from month to month; and its daily output will average more than the old hand machines could accomplish in a week. By hand knitting one hundred loops could be formed per minute; by Lee's machine as many as fifteen hundred were possible in the same time; but to-day, the automatic machine will average between 300,000 and 400,000 loops, and at the same time will produce a finer web, shaped to fit the form of the wearer.

Such comparisons reveal the vitally important progress made in the knitting industry, through which most of our underwear, stockings, scarfs, neck-comforts, and woolen gloves are supplied. The labor and time saving devices developed in this class of machines, and the fact that unskilled workmen may "tend" from fifteen to twenty of them, largely accounts for the universal adoption of warm and comfortable wearing apparel by all classes of society.

The number of patents granted on textile machinery during the nineteenth century furnishes an index to the progress made. Prior to 1800, less than one hundred patents were granted in the United States, while since that time, and up until July, 1895, about 15,200 patents were issued, covering tangible and material improvements over the old structures. The beneficent effects of these inventions are attested by the wonderful and continuous reduction in cost to the consumer of all kinds of textile fabrics. For the manufacturer, these have made possible increased production in a given time with less manual labor. When it is remembered that the labor cost is about one half the total cost of production of textile fabrics, it will be apparent that the beneficial effects of any labor-saving device are felt as well by the consumer as the producer.

In 1870 the number of textile establishments in the United States was 3035, giving occupation to 146,897 employees, and consuming annually 359,420,829 pounds of textile fibres, while in 1890 the number of establishments had increased to 4114, employing 511,897 hands, and consuming the enormous amount of 1,572,548,933 pounds of fibres; representing progress and growth in the textile arts not excelled by any other manufacturing industry.

Food and clothing constitute the primary wants of man. The former grew ready for his use as a natural product of the soil. The latter he had to produce by artificial means to afford that protection which nature failed to provide. Next to agriculture, therefore, man's early attention was directed to securing a covering for the body. Looking back through the vista of years dimmed by the mists of very remoteness, we find the animal and vegetable kingdoms destined to contribute to his needs. There were the blue flax-fields; cotton-bolls, scattered like powdered snow about the land, coquetting in wanton abandon with winds tempered by an all-wise Power to the shepherd-watched sheep; goats roaming the vale of Cashmere; silk-worms of Ceres, and the grasses of spring, overflowing with allurements of assistance for his adornment. With these essentials has man wrought a mighty miracle. The genius of Industrial Art, awakened by the fascinating influence of Nature, invoked the Goddess of Invention, approaching her temple not with loud acclaim, as marked the herculean strides in other arts and sciences, but modestly, though tenaciously and most effectually. For not more is woman emancipated by the sewing machine than both sexes by the doing away of the spinning-wheel, the household knitter, and hand-worked loom. Not more do electricity and steam power facilitate the various occupations of man than do the many textured fabrics add to his needs.

In all the phases of social life is this industry manifest. If the banquet hall is warmed and lighted by electricity, so, also, is it adorned with tapestries, silken and artistic, napery surpassingly smooth, and laces intricately wrought.

How like a fairy tale reads the evolution of textile progress! Conceptions, infinite in range and variety, alike pleasing to the eye and gratifying to vanity, have been spun, woven, knit, and embroidered, until, standing as we do at the dawn of another century, upon the summit of unparalleled achievements, we ask, “Can the mind conceive, the heart desire, or the hand execute more.”

The Century's Religious Progress

By GEORGE EDWARD REED, S.T.D., LL.D.,
President Dickinson College, Carlisle, Pa.

The closing years of the nineteenth century, both in Europe and the United States, are characterized by a religious life as phenomenal with respect to development and influence as those of the eighteenth were phenomenal for lethargy and decline. "Never," says a writer in the North British Review, "has a century risen on England so void of soul and faith as that which opened with Anne (1702), and reached its misty noon beneath the second George (1732–1760),—a dewless night succeeded by a sunless dawn. The Puritans were buried and the Methodists were not born." In this opinion, all historians and essayists concur.

Among the clergy were many whose lives were of the Dominie Sampson order, described in Scott's "Guy Mannering"—men whose lives were the scandal and reproach of the church; who openly taught that reason is the all-sufficient guide; that the Scriptures are to be received only as they agree with the light of nature; pleading for liberty while running into the wildest licentiousness. Montesquieu, indeed, did not hesitate to charge Englishmen generally with being devoid of every genuine religious sentiment. "If," he says, "the subject of religion is mentioned in society, it excites nothing but laughter. Not more than four or five members of the House of Commons are regular attendants at church."

From the colleges and universities, the great doctrines of the Reformation were well-nigh banished, a refined system of ethics, having no connection with Christian motives, being substituted for the principles of a divinely revealed law.

On every side faith seemed to be dying out; indeed, would have died out but for the tremendous reformation in life and morals induced by the self-denying and heroic labors of the Wesleys and their coadjutors, to whom, more than to any beside, England owes her salvation from a relapse into barbarism,—a service which in later years won for the Wesleys a memorial in Westminster Abbey.

On the Continent, religious conditions were no better. In France the masses were yet reeling amid the excesses of the Revolution. Voltaire and Rousseau were the oracles and prophets of their times,—the popular idols of the hour. Voltaire, indeed, openly boasted that he alone would laugh Christianity out of the court of public opinion, declaring the whole system to be outgrown and powerless. Germany, given over to theological speculation, crushed beneath the weight of the Napoleonic wars, and torn by internal dissensions, gave but little hope that upon her altars the dying fire of the great Reformation would ever again flame forth as in the older and more heroic days.

In the United States, similar conditions prevailed, especially during the last decade of the eighteenth century and the first of the nineteenth. Forms of infidelity the most radical and revolting prevailed throughout the land. Many of the leading statesmen, in private at least, did not scruple to confess themselves atheists or deists. Thomas Paine was the popular idol; his "Age of Reason" almost as common as the Bible itself. The majority of the men taking part with him in the founding of the government, with but few exceptions, held theological sentiments akin to his, although declining to participate in his violent and brutal assaults upon the Scriptures and the institutions of Christian society.

Speaking of the earlier days of the century, Chancellor Kent, in one of his published works, declared that in his younger days the men of his acquaintance in professional life who did not avow infidelity were comparatively few. Bishop Meade, of Virginia, in his autobiography, states that "scarcely a young man of culture could be found who believed in Christianity."

The colleges and universities were so filled with youthful skeptics that when, in 1795, Timothy Dwight assumed the presidency of Yale, he found but four or five willing to admit that they were members of churches. So far did they go in their devotion to the French infidelity prevalent at the time, that the seniors of the college were commonly known among themselves by the names of Diderot, D'Alembert, Robespierre, Rousseau, Danton, and the like. Harvard, Princeton, William and Mary, the University of Virginia,—all the colleges indeed,—were as thoroughly hotbeds of skepticism as nurseries of learning.

The period, too, was one of internecine strife among the feeble churches themselves. Divisions on doctrinal lines were incessant; departures from the faith as numerous as they were disastrous. Of the missionary spirit so gloriously characteristic of the nineteenth century there was not even a trace. Up to 1793, not a missionary society was in existence on either side of the ocean. The same was true of hospitals, asylums, of every form of organized effort for the reclamation of the masses or the amelioration of human ill.

In Boston, as late as 1811, men of literary or political distinction, eager to listen to the marvelous revival preaching of the celebrated Dr. Griffin, attended his services surreptitiously, or in disguise, fearful lest knowledge of attendance upon religious services of such vulgar character should detract from the dignity of their social standing.

If, however, the times were bad, the outlook for Christianity dark, the period, nevertheless, was not wholly without gleams of light. The spiritual leaven imparted by Whitefield in his mighty preaching tours, by Edwards, Dwight, Asbury, Griffin, and others of equally heroic stamp, gradually began to work,—slowly at first, but with ever accelerating movement,—until at last the triumphant successes of the present century began their stately march. By degrees a new life appeared among the churches, heralding the dawn of a new and brighter day. Revivals of religion, many of them powerful and sweeping, broke out in many parts of the country. Massachusetts, Virginia, Kentucky, Tennessee, the Carolinas, Georgia, were in succession the theatres of movements which, before they had spent their force, had completely revolutionized the conditions of unfaith, immorality, and spiritual apathy so long prevailing. These upheavals of spiritual power, continuing during the first twenty-five years of the century, laid broad and deep the foundations of the mighty achievements of the church which we are now to consider. How extensive, how wonderful, have been these achievements can perhaps best be understood by a consideration of the changed conditions marking the close of the century.

In the first place, that the people of the United States are a religious people may be inferred from the amazing number and variety of religions abounding and flourishing within our borders. It may be doubted that in any other Christian country of the earth there can be found so many varieties of religion, so many church organizations, so many and diverse peculiarities of doctrine, polity, and usage, as here. It is a land of churches; churches for whites, churches for blacks; churches large and churches small; churches orthodox and churches heterodox; churches Christian and churches pagan; churches Catholic and churches Protestant; churches liberal and churches conservative, Calvinistic and Armenian, Unitarian and Trinitarian; representing nearly every phase of ecclesiastical and theological thought. As Americans have distanced the world in the extent and variety of their material inventions, so have they distanced the world in the extent and variety of their theological and ecclesiastical forms. The state cannot control the church, and the church is as free as the state. As a man may freely transfer his citizenship from one State to another, to each in turn, so may he, if he shall so desire, pass from one ecclesiastical communion to another, until he shall have exhausted the list. If, perchance, no one of the one hundred and forty-three distinct denominations enumerated in the census tables shall suit him, there remain innumerable separate, independent congregations, no one of which lays claim to denominational name, creed, or connection, in some one of which he yet may find an ecclesiastical home. The principle of division, indeed, has been carried so far in America that it would be a difficult task to find the religious body so small as, in the judgment of some, to be incapable of further division.

It is to be observed, however, that the differences of the one hundred and forty-three denominations into which our religious population is divided are, in many instances, so slight that, should consolidation be attempted, the one hundred and forty-three could easily be reduced to a comparatively small number, and this with but little change in doctrine, polity, or usage. Consolidation into organic union, however, is hardly likely to occur in the near future, even were such consolidation desirable. In the first place such a result would be contrary to the genius of Protestantism, based, as it is, on the absolute right of private judgment with respect to matters of faith and morals, and, in the second place, it would be contrary to human experience. “Religious controversies,” as Gladstone says, “do not, like bodily wounds, heal by the genial forces of nature. If they do not proceed to gangrene and mortification, at least they tend to harden into fixed facts, to incorporate themselves into laws, character, and tradition, nay, even into language; so that at last they take rank among the data and presuppositions of common life, and are thought as inexorable as the rocks of an iron-bound coast.” In religion, when men separate, the severance is like the severance of the two early friends of whom the poet speaks:—

“They parted, ne’er to meet again,
But neither ever found another
To free the hollow heart from paining.
They stood aloof, the scars remaining,
Like cliffs which have been rent asunder,
A dreary sea now rolls between.”

If, however, the diversities are great—increasing rather than diminishing—the “unity of the spirit in the bonds of peace” with respect to all essentials of doctrine is as remarkable as the diversity in the outward form. Never, indeed, since the dawn of Christianity, were the members of the diversified bodies of the general church of Christ in such thorough accord, in such closeness of attachment, with such generous recognition of all that is good in each of the several bodies, as now. Even the Roman Catholic Church, intolerant in all lands where its sway is practically undisputed, in the United States, at least, has caught something of the broader toleration of Protestants, giving to its millions of communicants a better and truer gospel than in those countries where it does not come into contact with Protestantism, while freely coöperating with other churches in various works of philanthropy and reform.

In the next place, that we are a religious, a Christian people may be argued from the steady and enormous increase during the century of the material and spiritual forces of the church of Christ, an increase phenomenal even amid the wonders of a phenomenal century. Whether we look at the increase of edifices or the multiplication of communicants, the results in either case are sufficient for both congratulation and amazement. Were it possible to obtain from the earlier records exact statistics of the actual number of edifices and communicants existing at the opening of the century, comparison would be comparatively easy. Such, however, is not the case, the records having been imperfectly kept and indifferently preserved. The census of 1890, indeed, was the first to furnish exhaustive and really reliable results.

Taking that census as a basis, and adding to its figures those to be obtained from the year books of the various bodies up to and including 1894, the religious strength of the United States may be summarized as follows: Churches, 189,488; religious organizations, 158,695; ordained ministers, 114,823; members or communicants, 15,217,948; value of church property, $670,000,000; seating capacity of churches, 43,000,000, while in the 23,000 places where organizations which own no edifices hold their services, accommodations could be found for 2,250,000 more. In the majority of the Protestant churches, at least two services are held on each Sabbath; in the Catholic, six or seven.

Granting these premises, it is but reasonable to say that if, on any given day, the entire population of the country should desire to attend at least one religious service, accommodations could readily be found for the entire number,—ample proof that the spiritual interests of the millions are by no means neglected so far as privileges of worship are concerned. It is a showing all the more remarkable when we consider that all this vast provision is furnished on the basis of voluntary offerings, the state contributing not a dollar for religious purposes. It is probable that in these churches and edifices, on Sabbaths and on weekdays, not less than 15,000,000 services are held each year, to say nothing of sessions of Sunday-schools, meetings of Young People's Associations, and gatherings of kindred character. In them, too, not less than ten millions of sermons and addresses on religious themes are annually delivered.

The number of enrolled communicants, or members, however, by no means expresses the real strength of the religious life of the nation. To get at that, we must multiply each Protestant communicant by the 2.5 adherents allowed in all statistical calculations. Proceeding on this basis, omitting for the time all Catholics, Jews, Theosophists, members of Societies for Ethical Culture, Spiritualists, Latter-Day Saints, and kindred bodies, and multiplying the 15,200,000 Protestant members by 2.5, we have over 50,000,000 as the total Protestant population of the country. Adding to these 50,000,000 the Catholic population, estimated by Catholic authorities as being 15 per cent. larger than the number of Catholic communicants, we have 57,062,000 as the total Christian population, leaving only about 7,000,000 who are neither communicants nor adherents. Of the 7,000,000 opposed, for various reasons, to the churches, comparatively few are to be reckoned as either infidels or atheists; while, on the other hand, it is true that of the 57,000,000 reckoned as either communicants or adherents, millions are Christians only in name, either never attending the services of the churches, or at the best only at rare intervals. Gratifying as is this splendid exhibit of religious devotion on the part of the American people, the fact that there are millions in our land whose allegiance to Christian doctrine is but nominal, with millions more upon whose lives religion exercises no appreciable influence whatever, is a sufficient proof of the enormous task yet confronting the churches of Christ, if we are to stand before the nations as the great distinctive Christian nation of the world. The stupendous gain, however, in ninety-four years, of over 14,853,076 in Protestant churches alone is a record of religious progress unparalleled in the history of the world.

Advancing to the question of distribution of the religious forces enumerated, we find that while these forces are distributed throughout every State and under one hundred and forty-three denominational names, they are, nevertheless, massed largely in a few denominations and in a comparatively few States. Competent authorities estimate that the five largest denominations comprise fully 60 per cent. of the entire number of communicants; the ten largest, 75 per cent. With respect to communicants, the Catholic Church is first, with

7,510,000; the Methodist (all bodies) second, with 5,405,076; the Baptist third, with 3,717,373; the Presbyterian fourth, with 1,278,332; the Lutheran fifth, with 1,233,072.

With respect to population, reckoning the Catholic population at 7,510,000—which figures include children under ten years of age—and adding to the communicant strength of the four other bodies mentioned the 2.5 adherents allowed for each communicant, we have the following: Methodist population, 18,918,466; Baptist, 12,990,805; Presbyterian, 5,525,162; Lutheran, 4,358,752; total Protestant population, 50,000,000; Catholic, 7,510,000.

With respect to value of church property, the Methodists are first with $132,000,000; the Catholics second, $118,000,000; the Presbyterians third, with $95,000,000; the Episcopalians fourth, with $82,835,000; the Baptists fifth, with $82,390,000. The total value of church property, reckoning all denominations, reaches the enormous sum of $670,000,000.

To further particularize with respect to the lesser groups into which the religious forces are divided is impossible within the limits allowed for this chapter. To do it would require a volume instead of a chapter.

When one remembers that one hundred years ago it was a common boast of infidels that "Christianity would not survive two generations in this country," the above exhibit shows a religious progress unequaled in the history of the kingdom of God in any land or any age.

Turning to the field of missionary effort, we find that the spread of the Christian religion by missionary efforts, particularly during the last one hundred years, forms one of the brightest chapters in the records of human progress. Within this period, the triumphs of the first three centuries have been far more than repeated.

Following these early victories of the Christian faith came on, as all know, ages of darkness, dreary centuries, during the progress of which the power of the church gradually waned, and, with respect to purely spiritual activities, seemed to die away. The voice of exhortation ceased to be heard. Christian song was hushed. Even prayer closed its supplicating lips, and the church, overladen with corruption, worldliness, and human ambition, passed into the thick darkness of the long and disastrous eclipse of the Middle Ages. But amid the widespread darkness enveloping the world, even the ages known as the "Dark Ages" were not without their gleams of light. Among the Saracens and in the lands of the Orient, always were to be found heroic men and women toiling ceaselessly for the conversion of heathen nations to the Christ. Later on, subsequent to the thirteenth century, and especially during the centuries immediately following the discovery of the New World, the desire for the Christianizing of the world flamed into an all-absorbing passion. The tremendous labors of Xavier, of Loyola, and their followers, in every quarter of the globe, have long been the wonder and admiration of the world. Checked in Europe by the rise of the great Protestant Reformation, the Catholic Church turned its energies to the acquisition of spiritual power in other lands, and with enormous success. Along the banks of the St. Lawrence, amid the wilds of Canadian forests, far away on the shores of the Great Lakes, thence southward to the Ohio, along the Mississippi, even to the Gulf; in far Cathay, in Ceylon, in Japan, in China, in Africa,—everywhere its missionaries could be found, heedless of hunger, of cold, of peril, reckless even of life, if by any means, whether by life or by death, they might "sprinkle many nations" and establish the holy emblem of the Christian faith.

Absorbed in the struggles going on in their own lands, Protestants made but little effort for the extension of the gospel in foreign fields, save the few but successful attempts made by the Moravians of Germany, always the most zealous of all Protestant bodies in lines of missionary service. What, however, was lacking in the way of missionary effort in the seventeenth and eighteenth centuries has been more than made good in the glorious nineteenth, the distinctive missionary century of the Christian era. In the room of seven societies organized for world-wide gospel evangelization at the end of the last century, there are now in Europe and America between seventy and eighty organizations, employing a force of nearly three thousand American and European missionaries, and perhaps four times that number of native assistants. Full $10,000,000 are annually raised among the Protestant bodies alone for missionary service, while the great Roman Catholic Church prosecutes its work with a zeal equally unflagging. A brief survey of the progress of a hundred years of missionary effort will make it clear to all minds that the day is not far distant when the declaration of the prophet, “The earth shall be filled with the knowledge of the glory of the Lord, even as the waters cover the sea,” shall have abundant and magnificent realization.

At the beginning of this century, every island of the vast Pacific was closed against the gospel. To-day, nearly every one is under the influence, more or less extended, of Christian civilization. India, from Cape Comorin to the Punjaub, from the Punjaub to the Himalayas, from the Himalayas to Thibet,—at whose gates the gospel is now knocking,—has been covered with a network of mission stations, schools, colleges, and churches, closer by far in its interlacings than that which at the close of the third century had spread itself over the vast empire of the Cæsars. Of the Indian Archipelago, Sumatra, Java, Borneo, the Celebes, New Guinea, not to mention smaller groups of islands, are feeling the new life ever imparted by the advent of the Cross. Japan, too, hungry for reform, and full of the stir of the age, by granting entrance to the gospel, has within its borders already a numerous Christian population with scores of evangelical congregations. The same is true of the hermit nation, Corea. In the lands of Islam, from Bagdad to the Balkans, from Egypt to Persia, and throughout all Turkey, are to be found centres of missionary enterprise, the vast influence of which is now being sensibly felt in the changing life of those remarkable peoples. In Burmah, and recently in Siam, after years of patient and apparently hopeless service, fields are everywhere “white unto the harvest.” China, most populous of all heathen lands, is open to missionary effort from Canton to Peking, from Shanghai to Hon-Chow. Africa also, once, in its northern sections at least, the home of the learning, the art, the science, the religion of the world, awakening from the sleep of long and dreary centuries under the influence of Christian civilization, again demands the attention of the great nations of the world. Everywhere, east, west, north, south, it is being invaded all along the line of Cecil Rhodes’ great railway, stretching northward from Cape Town for three thousand miles, to meet the twenty-six hundred pushing down from the north,—from Senegal to Gaboon and from Gaboon to the Congo; on the shores of Tanganyika and along the banks of the Zambesi shine the lights of the gospel, which, wherever it has gone, has been the harbinger of a new and brighter day. Within the mighty domains of our own continent, upon the immense plains reaching from Labrador to the Pacific, upon the sterile coasts of Alaska, in the land of the Montezumas, in Central America, in South America, from Panama to Terra-del-Fuego, equally marvelous have been the steady gains resulting from a Christianity the forces of which, like the waters that enrich the continent, penetrate all the bays and estuaries of human society and influence all classes and conditions of men. Looking upon the transformations effected by the labors of a single century of Christian effort, one may surely say, “The peoples that walked in darkness have seen a great light; they that dwell in the land of the shadow of death, upon them hath the light shined.”

Equally wonderful have been the vast contributions of the church in America to the great causes of education, philanthropy, and reform, particularly in the line of educational work. The service of the church in the great cause of education has never yet been fully recognized. Men forget, when charging the church with hostility to human progress, to freedom of thought and action, that until within a period of seventy years nearly everything accomplished for popular education was carried out under the auspices of the churches rather than under the direction of the state. Until 1825, the state had done next to nothing even in the development of its common schools. In the great State of Pennsylvania, the system had no existence until the year 1835. Even to-day, among the four hundred and fifty institutions of higher education in the various States, nearly all owe their foundation to the energy and sacrifice of Christian men and women. The total gifts of the churches to the cause of education, still existent in plant, in grounds and buildings, or in the form of endowment funds, reach the enormous aggregate of nearly $350,000,000, while the total of gifts to institutions of learning, largely from Christian sources, aggregate nearly $10,000,000 per year.

The religious activity of the century is further manifested in the enormous sums raised and expended for purposes of charity, reform, and general philanthropy. It would require an octavo volume of four hundred pages to catalogue the various benevolent and charitable organizations in the city of New York alone. Add to that volume the hundreds more which would be required to enumerate the additional thousands to be found in Philadelphia, Chicago, Boston,—in fact in every city, town, and hamlet from the Atlantic to the Pacific, nine tenths of which are distinctively Christian,—and you have a faint idea, at least, of the vastness of the spiritual forces at work in these closing years of the century for the amelioration of human ill, the dispelling of moral and spiritual darkness, and the ushering in of the era of peace and good will, for the coming of which the church has so ceaselessly prayed. What these philanthropies are we cannot in detail enumerate. Classified, they are for the poor, for the laboring classes, for the sick, for fallen women, for free schools, for the aged, for the blind, the deaf, the insane, the impotent, the degraded, the outcast, for sailors, for the protection of animals, for city evangelization, for home missions, for foreign missions, for religious publications, for the publishing of the Holy Scriptures, for peace, for Young Men's Associations, Young Women's Associations, for every cause that appeals to the sentiment of brotherhood so characteristic of the age. In number they are legion. In origin, three fourths are the outgrowth of that spirit of Christian love without which they could not have been originated, and by which they are maintained and perpetuated. Those who assert that within this century Christianity has done more for humanity than in all the centuries preceding are doubtless correct. It has made men kind, made them humane. It has penetrated prisons, and with beneficent change. It has lifted the prisoner from damp and dreary dungeons into commodious structures, the pride of city and State. So far, indeed, have the reforms inspired by the gospel been carried, that men are beginning to inquire whether the limit has not been reached beyond which it may be dangerous to go.

Such are the general facts of the religious progress of a century in the United States. Reviewing them, we can easily discern the vast and commanding influence of religion—the Christian religion—upon the character and fortunes of our people. Among the forces working for the upbuilding of the Republic, religion stands preëminent, the most powerful, the most pervasive, the most irresistible of them all. A free church in a free state, all its edifices have been built by private contribution, all its magnificent benefactions sustained by voluntary offerings, induced in every instance by the principle of Christian love. A corporation, it holds its vast properties for the common good of all. A relief society, the scope of its sympathies is as wide as the wants of man. A university, it does more for the education of the masses than the public school system itself. An employer of labor, it utilizes the brains and energies of the most highly educated body of men to be found in the Republic's broad domain. An organized beneficence, it outwatches Argus with his hundred eyes, outworks Briareus with his hundred arms. An asylum, it gathers within its protecting arms the halt, the maimed, the wounded of life's great battle, comforting them in trouble, sustaining them in adversity, while ceaselessly pointing them to Him "who taketh away the sins of the world." "Every corner-stone it lays," as one has said, “it lays for humanity; every temple it opens, it opens for the world; every altar it establishes, it establishes for the salvation of men. Its spires are fingers pointing heavenward; its ministers are messengers of good tidings; its ambassadors, ambassadors of hope; its angels, angels of mercy.” Under all our institutions rest the Bible and the school-house,—Christianity and Education. Without them, the Republic is impossible; with them, we have Republican America for a thousand years.

Great Growth Of Libraries

By JAMES P. BOYD, A.M., L.B.

Libraries are as old as civilization. Nothing marks civilized progress more distinctly than the collections of writings, whether on clay, stone, wood, papyrus, or parchment, which went to make up the libraries of ancient peoples. Such writings generally related to religion, laws, and conquests, and found their abode, in the form of archives, in capitals and temples. Recent explorations in Mesopotamia reveal collections, or libraries, of books inscribed on clay tablets, many of whose dates are beyond 650 B. C. These libraries seem to have found a home for the most part in royal palaces, and to have contained works abounding in instruction for the kings' subjects. As unearthed and their contents deciphered, they throw much valuable light upon the remote history, as well as the arts, sciences, and literatures of Babylonia and Assyria.

In ancient Egypt collections of hieroglyphic writings were made in temples and in the tombs of kings from the earliest known dates. Some hieroglyphics still extant bear date prior to 2000 B. C., and one papyrus manuscript has been discovered whose supposed date is 1600 B. C. What were known as the sacred Books of Thoth—forty-two in number—constituted the Egyptian encyclopædia of religion and science, and became such a fruitful source of commentary and exposition, that by the time of the Grecian conquest they had grown in number of volumes to 36,325.

Of the libraries of the Greeks we have little positive knowledge, though it is abundantly asserted by late compilers that large collections of books (writings) once existed in the various Grecian cities. Pisistratus is said to have founded a library at Athens as early as 537 B. C. Strabo says that Aristotle collected the first known library in Greece, which he bequeathed to Theophrastus (B. C. 322), and which, by the vicissitude of war, finally found its way to Rome. At Cnidus there is said to have existed a special collection of works upon medicine. Xenophon speaks of the library of Euthydemus. Euclid and Plato are mentioned as book collectors. But by far the most renowned book collectors of the Greeks were the Ptolemies of Egypt, who gathered from Hellenic, Hebrew, and Egyptian sources that wonderful collection of volumes, or rolls, which became famous as the Alexandrine Library. This was composed of two libraries, one estimated at 42,800 volumes, or rolls, connected with the Academy, the other estimated at 490,000 volumes, or rolls, deposited in the Serapeum. It is said that these immense collections were regularly catalogued and kept under the supervision of competent librarians, till consumed by the Saracens at the time of their conquest of Egypt, A. D. 640.

The Romans at first paid little attention to literature. It is not until the last century of the republic that we hear of a library at Rome, and then it was not a native collection but a spoil of war. It was captured from Perseus of Macedonia and brought to Rome in B. C. 167. So Sulla captured the library of Apellicon, at Athens, in B. C. 86, and brought it to Rome. Lucullus brought to Rome a rich store of literature from his eastern conquests (B. C. 67). Wealthy men and scholars now began to form libraries at Rome, some of which became very large and valuable. It is here we first hear of the dedication of libraries to the public,—a step which made Rome for a time the resort of scholars from other nations, especially Greece. The most famous of the many imperial libraries of Rome was that founded by Ulpius Trajanus. It was called the Ulpian Library, and was at first founded in the forum of Trajan, but afterwards removed to the baths of Diocletian. In the fourth century there are said to have been as many as twenty-eight public libraries in Rome. Great, indeed, must have been their destruction under various vicissitudes, for when the Emperor Constantine moved the Roman capital to Constantinople, and founded his imperial library there, it numbered but a few thousand books. It was, however, greatly enlarged after his death—some say to 100,000 volumes. It was destroyed in A. D. 476, with the close of the Western Empire.

With the spread of Christianity there arose a new incentive to write and collect books. The church required both a literature and libraries as part of its organization. Pamphilus is said to have collected a library of 30,000 volumes, chiefly religious, at Cæsarea (A. D. 309), his object being to lend them out to readers. But as book-making and collecting became narrowed to the church, general literature was proscribed and libraries ceased to flourish, except as encouraged by the monastic orders. Such libraries were necessarily small and of a private character. Their books were manuscripts written or copied by the priests, up to the date of the invention of printing. The libraries of this class which grew in importance were those of the Swiss and Irish monasteries, not omitting those in England, as at Canterbury and York. The invasion of the Norsemen, in the ninth and tenth centuries, was generally fatal to the monastic libraries on both sides of the English channel.

In France, the library at Fulda seemed to retain its books and respect. It was greatly enlarged by Charlemagne, who also founded a more ostentatious one at Tours. With the revival of learning, and with the hope of opening a wider field to secular literature, Charles VI., of France, founded a royal library which numbered 1100 volumes by A. D. 1411. A similar library in England, that of the British crown, numbered 329 volumes at the time of Henry VIII. In contrast with these early royal efforts stood that of Corvinus, king of Hungary, whose library numbered 50,000 volumes, mostly manuscripts, in 1490. This imperial collection was burned by the Turks in 1540. About this time the nucleus of the modern Laurentian Library of Florence was formed.

In 1556, the Bibliothèque Nationale, or royal library of France, at Paris, was endowed by the king with power to demand a copy of every book printed in France. This power became the basis of the copyright tax, now universally levied by civilized nations, and which has been the means of greatly enriching all government libraries. In 1556 the royal library of France could boast of but 2000 volumes. In 1789 it contained 200,000 volumes, the largest number of any library then existing. At the end of the nineteenth century it still retains the distinction of being the most extensive library in the world, containing approximately 3,000,000 volumes.

In Italy the libraries, though venerable and very rich in rare collections of manuscripts, are not noted for the number of books which represent modern literature. The most noted library is the Biblioteca Vaticana, or library of the Vatican. It traces a vague history back to the fifth century, but its real foundation was in 1455. The number of volumes and manuscripts on its shelves is approximately 300,000.

In Spain and Portugal are national libraries in their respective capitals, Madrid and Lisbon. The national library of Spain contains some 560,000 volumes and manuscripts, while that of Lisbon contains over 200,000. Belgium and Holland are rich in libraries. The royal library at Brussels contains over 400,000 volumes. In 1830 it was made a part of the state archives and thrown open to the public. The national library of Holland was established in 1798 by uniting the library of the princes of Orange with the smaller libraries of the defunct states. It thus became the library of the States-General, but in 1815 it was converted into the present national library. It has a very valuable collection of books, numbering over 400,000. One of the best arranged and managed libraries in Europe is the Royal Library at Copenhagen. It was thrown open to the public in 1793, and has since been conducted under national auspices.

Two copies of every book published in the kingdom must be deposited in this library. Its volumes have increased very rapidly during the nineteenth century, and now number over 550,000. The Royal Library of Sweden is located at Stockholm. It contains over 350,000 valuable volumes, and is admirably arranged and conducted. The University Library at Upsala is also a very valuable one, containing 300,000 volumes. There is also an excellent library of over 100,000 volumes connected with the university at Lund. The libraries of Norway, though not so large as those of Sweden, are numerous, valuable, and well managed. The University Library at Christiana contains over 330,000 volumes. In Russia, large and valuable libraries are not numerous outside of the cities of St. Petersburg, Moscow, and Warsaw. The Imperial Library at St. Petersburg ranks as the richest in Europe, excepting the libraries of Paris and the British Museum. It is open to the public, and contains approximately 1,200,000 volumes.

Germany, with her multiplicity of minor capitals, her love of books and book-making, her numerous universities, excels every other European country in the number, extent, and value of her libraries. The largest is the Royal Library at Berlin, with approximately 1,000,000 volumes. It was founded by the "Great Elector" Frederick William, and opened as a public library in 1661. The Royal Library at Munich long rated as the largest in Germany, with its 1,200,000 volumes, inclusive of pamphlets, the latter numbering some 500,000. But it was thought to be unfair to class so many small and inconsequential works as books, so that the library at Berlin was given precedence. Still the Munich library is particularly rich in incunabula and other treasures derived from the monasteries, which were closed in 1803. The University library at Munich is also very rich in similar treasures. It contains well nigh 500,000 volumes. The other large libraries of Germany are the University library at Leipsic, with over 500,000 volumes; the Royal and City library at Augsburg, with 123,000; the Royal, at Bamberg, with 300,000 volumes; the University at Bonn, with 220,000 volumes; the Grand Ducal at Darmstadt, with 400,000 volumes; the Royal Public, at Dresden, with 410,000 volumes; the University at Erlangen, with 185,000 volumes; the City, at Frankfort, with 190,000 volumes; the University at Freiburg, with 250,000 volumes; the University at Giessen, with 160,000 volumes; the Ducal Public, at Gotha, with 210,000 volumes; the Royal University at Göttingen, with 490,000 volumes; the City at Hamburg, with 510,000 volumes; the University at Heidelberg, with 410,000 volumes; the University at Jena, with 200,000 volumes; the University at Kiel, with 225,000 volumes; the University at Rostock, with 310,000 volumes; the University at Strassburg, with over 700,000 volumes; the University at Tübingen, with 320,000 volumes; the Grand Ducal at Weimar, with 230,000 volumes; the Brunswick Ducal, at Wolfenbüttel, with over 300,000 volumes. Besides these there are numerous others attached to various universities or publicly organized which have 100,000 volumes each.

In Austria-Hungary, the largest library is that of the Imperial Public, at Vienna. It was founded in 1440 by Emperor Frederick III., and has ever since been munificently supported by the Austrian princes. Few libraries in Europe contain more important collections or are better organized and housed. Its volumes number 540,000. Admission to its reading room is free, but the books are loaned out under rigid restrictions. The University Library of Vienna was founded by Maria Theresa, and has grown very rapidly, numbering nearly 500,000 volumes. In Vienna alone the number of libraries exceed one hundred, many of them of considerable extent. The various university libraries throughout Austria-Hungary are rich in volumes, particularly that at Cracow, with over 306,000 volumes, and at Innsbruck, with 175,000 volumes. The National Library at Budapest, Hungary, and also the University at the same place, have rich collections, numbering 465,000 and 212,000 volumes respectively.

In Switzerland libraries are very numerous and well conducted. The largest is that at Basel. It is called the Public University Library, and numbers 187,000 volumes. The next largest is the City Library, at Zurich, with 135,000 volumes. The smaller libraries of Switzerland exceed two thousand in number, and are, as a rule, rich in literary treasures descended from the ancient monasteries.

Though by no means as ancient as some others, the leading library of Great Britain, and the second in extent and importance in the world,—the National, at Paris, France, being first,—has had a phenomenal growth. It is located at London, and is known as the British Museum. It dates from 1753, when Parliament purchased, for £20,000, the Sir Hans Sloane collection, and afterwards consolidated therewith many other valuable collections. It was given the privilege of copyright, by which means, and by frequent and fortunate private bequests of books, it grew apace and became a national repository, not only of home-written works, but of the literature and rarities of all nations. The number of its volumes at present exceeds 1,650,000. London does not contain many public libraries, but there are numerous collections of scientific and special works of great value to those pursuing certain lines of knowledge. The second largest and most important collection in England is that of the Bodleian Library of Oxford, with some 530,000 volumes; followed by that of the University of Cambridge, with some 510,000 volumes. Next in extent and importance in Great Britain is the library of the Faculty of Advocates, in Edinburgh, Scotland. It dates from 1682, and contains at present about 400,000 volumes. The library of Trinity College, Dublin, was founded contemporaneously with the Bodleian, and easily ranks as the largest and most important in Ireland, with its 200,000 volumes, to which about 3000 are added annually. What has been said of the dearth of public libraries in London is in part true of all Great Britain. There are not a score of libraries in all her European domain that number over 100,000 volumes, and it is only within the nineteenth century that the public or free library system began to grow in favor. Indeed, such growth may be said to date from as late a period as 1850, when the Manchester Free Reference Library was established. It has shown in fifty years a most marvelous growth, and contains at present some 255,000 volumes.

Great Britain has not neglected to encourage the use of libraries among her colonists. At Ottawa, Canada, is the library of Parliament. It was founded in 1815, and grew slowly till 1841, when the two libraries of Upper and Lower Canada were consolidated. It was subsequently destroyed by fire, and in 1855 reëstablished. Since then it has grown rapidly, and at present contains over 150,000 volumes. The Laval University library, at Quebec, is the next most extensive in Canada, containing over 100,000 volumes. The South African Public Library was founded at Cape Town in 1818, and has grown to contain some 50,000 volumes, many of them of great importance as bearing on the languages and customs of African peoples. In Australia are many libraries of considerable extent, whose volumes are, as a rule, free to all readers. The largest of these is at Melbourne, and is called the Public Library of Victoria. It is a collection of considerably over 150,000 books and pamphlets, many of which relate to Australasian themes. The Sidney Free Public Library is next to that at Melbourne in importance. It is said to contain the largest collection of works special to Australia in the world.

The book collections of China, and indeed throughout the Orient, are by no means inconsiderable, and the favorite works relate to religion, philosophy, poetry, history, and the sciences. They are generally large and of encyclopædic style and proportions. Thus a Chinese history of national events from the third century B. C. to the seventeenth A. D. occupies sixty-six volumes, as bound in European style for the British Museum. Libraries in Japan are more numerous, convenient, and extensive than in China and elsewhere in the Orient. The University library at Tokio, Japan, contains well nigh 200,000 volumes.

Of South American libraries the largest is the National, at Rio Janeiro, Brazil, with some 240,000 volumes. The other republics of South America which passed through their wars for independence and their formative periods, not to say their internal jealousies and strifes, during the nineteenth century, have had but little opportunity or inclination to collect large libraries. Yet the spirit of education is by no means dormant, and the nuclei of many libraries have been formed, in which much pride is taken, and which bid fair to grow great in importance as scholarship expands and other fostering conditions come to prevail more generally. Even in the small and tumultuous republics of Central America there are some valuable collections of books which, in the course of time, will be greatly augmented and prove a source of literary and national pride. Notwithstanding all the ups and downs of the Mexican republic during the century, she has, since the separation of church and state in 1857, evolved a creditable educational system, and built up many excellent libraries, especially in the capital, Mexico. The largest of these is the National, which contains over 100,000 volumes.

The growth of libraries in the United States during the nineteenth century has been phenomenal. If its leading libraries have not yet matched those of the old world in extent, they are, nevertheless, unique in their freshness, exceptional in their number, original in their systems, and most effective in their uses. And what is here said of the leading libraries is still more true of the smaller, for in no country has the library system so ramified as in the United States, and come down to such close touch with the people. Not only cities, towns, and even villages have their libraries, but States, schools, and myriads of special organizations, all of which are centres of culture and sources of literary pride.

The oldest library in the United States is that of Harvard College. It was founded in 1638, and was destroyed by fire in 1764. It was speedily restored, and became the recipient of many private donations, which not only greatly increased the number of its volumes, but placed it in possession of a handsome endowment fund. Since its removal to Gore Hall, in 1840, it has been open to the public for reading within its walls, but only the students of the university and other privileged persons may borrow books. Its present collection numbers over half a million of volumes of books and pamphlets. In the year 1700, two other libraries were founded,—that of Yale College, and that which afterwards became known as the New York Society Library. The first of these grew very slowly until the beginning of the nineteenth century, when it took on new life, and at the end of the century contains some 250,000 volumes. The latter also grew very slowly, and in 1754 became a subscription library. It is peculiarly the library of the old Knickerbocker families and their descendants, and the number of its volumes gravitates around 100,000.

In 1731, Benjamin Franklin projected what he called a “subscription library” at Philadelphia. It was incorporated as the Library Company of Philadelphia, and grew rapidly through bequests of books and money. In 1792 it absorbed the very valuable Loganian Library, and in 1869 Dr. Benjamin Rush left a bequest of over $1,000,000 to found its Ridgeway Branch. The building erected for this purpose is, with the exception of the new Library of Congress structure at Washington, the handsomest, most commodious, and best arranged for library purposes of any in the United States. The collection of the Library Company of Philadelphia, commonly called the Philadelphia Library, now numbers well nigh 200,000 volumes. Of the sixty-four libraries in the United States reported to have been founded before the year 1800, thirty were established between 1775 and 1800. The more important of these—that is, those which rank as 20,000-volume libraries and over—are the Massachusetts Historical Society Library, at Boston, founded in 1791; the Georgetown College Library, at Georgetown, D. C., founded in 1791; the Dartmouth College Library, at Hanover, N. H., founded in 1769; the Columbia College Library, New York City, founded in 1754; the library of the College of

Physicians, at Philadelphia, founded in 1789; the College of New Jersey Library, at Princeton University, founded in 1746; the Brown University Library, at Providence, R. I., founded in 1768; the Department of State Library and House of Representatives Library, Washington, D. C., founded in 1789; the Williams College Library, at Williamstown, Mass., founded in 1793.

From this standpoint we get a fair view of the tremendous strides of library growth in the United States during the nineteenth century. The sixty-four libraries of 1800 have grown to well nigh four thousand, not counting those of less than 1000 volumes; and the less than 500,000 volumes of 1800 have increased to well nigh 30,000,000, omitting those in libraries of less than a thousand volumes. Over six hundred libraries in the United States take rank as 20,000-volume libraries and over, at the end of the century; and in the six statistical years between 1888 and 1893, which mark the greatest ratio of increase in volumes, there was a growth equal to 66 per cent over all that had preceded.

Nor has the century been more triumphant and wonderful in the accumulation of volumes and the number of book repositories than in the variety of systems and multiplicity of agencies by means of which library information is arranged and disseminated. Conspicuous among these has been the inauguration and growth of the free library system, by means of which public funds are provided for the support of libraries whose use is free to all. Hardly less conspicuous, and perhaps even more far reaching, has been the adoption by many States of the school-district library system, which draws upon a certain proportion of the school fund for the collection and maintenance of the district library. Again, most of the States have established libraries of their own for public use, and as centres to which may be gathered and whence may be disseminated the knowledge that appertains to the respective State localities. Special library systems have grown into great favor, covering and encouraging collections of historic works, of scientific literature, of information relating to law, medicine, theology, etc. In fact, there is hardly a line of investigation and mental activity that has not come to be represented in its library collections.

At the head of all the century’s library triumphs in the United States stands the Library of Congress. It is the national repository, and is to the country what the British Museum is to Great Britain and the Bibliothèque Nationale is to France. It was founded in 1800, when the seat of government was moved to Washington. In 1814 it was burned by the British soldiers, its home being then in the Capitol, which was also destroyed. The government purchased Thomas Jefferson’s collection of 7000 volumes as the nucleus of a new library. This grew to contain 55,000 volumes by 1851, when all but 20,000 volumes were again destroyed by an accidental fire. In 1852 it was refitted, the government appropriating $75,000 for the purpose. On the restoration of its halls in the Capitol, in fire-proof form, it began to grow rapidly in volumes. In 1866, it received the 40,000 volumes which constituted the library of the Smithsonian Institute. In 1870, the privilege of copyright was transferred to it from the Patent Office. This, together with the annual appropriation made by Congress, served to give it a more rapid growth than ever, and to nationalize its importance. It speedily grew rich in collections of history, science, law, and every branch of literature appertaining to this and other countries. Under its privilege of copyright, two copies of every volume desiring such protection are required to be deposited within it. It must, therefore, ere long become quite fully representative of the literary productions of the country. In 1882, it was augmented by the presentation of the private collection of the late Dr. Joseph M. Toner, of Washington, containing 27,000 volumes and nearly as many pamphlets. By 1890 it had outgrown its ability to accommodate its collections, and Congress made a very liberal appropriation for the erection of a new and separate library building, which was completed and occupied by 1897–98, the late Hon. John Russell Young being its first librarian. It is the largest, most elegant, and best fitted repository of books in the world, being capable of accommodating over 2,000,000 volumes. The public are privileged to use its books within the building, but only members of Congress and certain designated officials of the Departments may take them away. It is open from 9 A. M. to 4 P. M., except upon Sundays and other legal holidays. Its location is on Capitol Hill, quite contiguous to the Capitol itself.

A pioneer of the system of free libraries, and the one which comes next to the Library of Congress in the number of its volumes, is the Public Library of Boston, founded in 1848. It has had a phenomenal growth, and is the centre of a wide range of literary influence. Its numerous branches extend throughout the city and surrounding towns, bringing free reading to every locality. The number of its volumes exceeds 700,000. The free library system stands sponsor for a host of libraries throughout the larger cities. The Public Library of Cincinnati was founded upon this basis in 1867. It at once attained great popularity and speedily grew till, by the end of the century, its volumes numbered approximately 220,000. The same popularity and rate of growth characterized the Public Library of Chicago and that of Philadelphia. The former was founded in 1872, and now contains over 220,000 volumes. The latter was not founded until 1891, but by the year 1900 it grew to contain 203,102 volumes, with fifteen branches, or divisions, throughout the city, and an annual circulation of 1,778,387 volumes.

Other libraries of the United States founded or rehabilitated during the nineteenth century, and which ere its close have taken rank as libraries containing over 100,000 volumes, are the New York State Library, at Albany, with approximately 190,000; the State Library at Annapolis, Md., with 100,000 volumes; the Enoch Pratt Free Library, at Baltimore, with 165,000 volumes; the Peabody Institute Library, at Baltimore, with 125,000 volumes; the Athenæum Library, at Boston, with 185,000 volumes; the City Library, at Brooklyn, N.Y., with 120,000 volumes; the University Library, at Chicago, with nearly 400,000 volumes; the Newberry Library, at Chicago, with 125,000 volumes; the Public Library at Detroit, with 135,000 volumes; the Cornell University Library, at Ithaca, N. Y., with 175,000 volumes; the library of the State Historical Society, at Madison, Wis., with 110,000 volumes; the Mercantile Library, at Philadelphia, with 175,000 volumes; the library of the University of Pennsylvania, with 120,000 volumes; the Astor Library, New York City, with 265,000 volumes; the Mercantile Library, New York City, with 250,000 volumes; the Public Library at St. Louis, Mo., with 105,000 volumes; the Sutro Library, at San Francisco, with 210,000 volumes.

Of those libraries founded during the century in the United States, and which have secured a rank as over 20,000-volume libraries, there are very many that approach the 100,000 mark, and their average of volumes would gravitate around 50,000. It is by no means true that the importance and usefulness of a library must be measured by its number of volumes. Very many of the best managed, serviceable, and popular libraries contain even less than 20,000 volumes.

The spirit of knowledge which has created in the United States such a demand for libraries has been happily supplemented by a spirit of liberality. Nowhere in the world have there risen so many and such munificent donors of means to found and support libraries. Without appearing invidious, mention may well be made of some of these munificent givers and founders. Conspicuous among them is John Jacob Astor, founder of the Astor Library in New York City, with its splendid endowment fund of $1,100,000; James Lenox, who founded the Lenox Library of New York City, and invested in buildings and endowment $1,247,000; George Peabody, who founded, in 1857, at Baltimore, the Peabody Institute and Library, with an endowment of $1,000,000; Walter L. Newberry, of Chicago, who, in 1889, left $2,000,000 to found a free public library in the northern part of the city; John Crerar, of Chicago, who left an immense estate to found and endow the Crerar Library; Enoch Pratt, of Baltimore, who gave $1,150,000 to found the Enoch Pratt Free Library; Dr. James Rush, of Philadelphia, who left, in 1869, a bequest of over $1,000,000 to form the Ridgway Branch of the Philadelphia Library; Andrew Carnegie, who founded the Pittsburgh Free Library and several others in different places.

The century's progress in library management has kept pace with the growth of volumes. Cataloguing and arranging of books have been reduced to a science. Training of librarians and of students in the use of books has become an educational course in many higher institutions of learning. Library architecture and the numerous appliances for distributing books or rendering them accessible on the shelves, have all been improved, so that the library of the end of the century is as much a seductive retreat as a world of knowledge.

Progress Of The Century In Architecture

By WILLIAM MARTIN AIKEN, F.A.I.A.,
Former U. S. Supervising Architect.

Towards the close of the last century there arose in England a decided fashion for Greek columns and pediments, which was brought about by the publication in 1762 of the discoveries by Stuart and Revett at Athens, and was still further stimulated by the bringing to England of the Elgin marbles in 1801, so that every building of any importance, whether church or school or country residence, had its portico with Doric, Ionic, or Corinthian columns. Thus began the Greek revival; then followed the more slender columns, with arches and vaults, of the Roman; and to these were very shortly added the cupola or the dome and the balustrade of the Renaissance.

In London, the Bank of England by Sir John Soane, the British Museum by Robert Smirke (a pupil of Soane's), the University by Wilkins, were all built early in this century, as were the Fitzwilliam Museum, Cambridge, and the High School at Edinboro, magnificent colonnades adorning the front of each. St. Pancras Church, in London, has a spire of superimposed copies of the Temple of the Winds at Athens—each smaller than the one beneath it,—and there are side porches which reproduce the caryatid portico of the Pandroseum. But the most successful building in England which was designed upon Greek lines is St. George's Hall, Liverpool, which has a central hall lit from above; at either end is a court-room, and beyond, at one end, is an Odeon, or Music Hall.

The taste for classical design gradually declined in England, and a new cult was assiduously propagated through the writings of Pugin, Brandon, Rickman, and Parker, whose text was that classicism represented paganism, and this, together with the remodeling of Windsor Castle, in 1826, by Sir Jeffrey Wyatville, caused a general interest in the revival of Gothic architecture; for some time, however, much illiterate work was done in the adjustment of old forms to new conditions.

Throughout the last half of this century, the battle of the styles has been maintained by the adherents of the differing schools with varying success, and, although there may be notable examples to the contrary, it has virtually resulted in the adoption of Gothic designs for ecclesiastical buildings, conditions being much the same as formerly for these structures; whereas, for secular buildings, with ever-changing requirements, the classic or the Renaissance, which has shown even greater pliability, has been considered more appropriate.

Among those whose success has been greatest in Gothic work may be mentioned Sir Charles Barry, who was knighted for designing the Parliament Buildings, begun in 1840 and completed twenty years later; George Gilbert Scott, who did the Assize Courts, in Manchester, and New Museum, Oxford; George Edmund Street, whose Law Courts in London are so full of defects in plan yet so excellent in details; Alfred Waterhouse, whose interesting (Norman) Museum of Natural History gave substantial encouragement to the use of terra cotta; T. G. Jackson, the author of much collegiate architecture at Oxford and elsewhere; J. L. Pierson, the designer of eight churches in London; William Burgess, Sir Arthur Blomfield, and James Brooks, all well known for the high character of their work, as is also J. D. Sedding, whose broad sympathies and refined spirit ranked him as one of the most talented men of his day.

The first international exposition was held in London in 1851, and the single building in which it was contained was perhaps the most marvelous exhibit. It was designed by Sir Joseph Paxton, and was the first example of the use of iron and glass on a scale of such gigantic proportions.

The so-called “Victorian Gothic” was used to a great extent for secular work as late as 1870, and as it was much stimulated by the writings of Street upon Spain and Northern Italy and by Ruskin’s “Stones of Venice,” there were frequent attempts at polychromy, shown in the use of different colored stone, brick, and terra cotta, and, in the Albert Memorial, by means of mosaic.

R. W. Edis and E. W. Godwin were among the foremost practitioners of the time, but in spite of the cleverness and boldness of design shown in some of their city and suburban buildings, neither they nor others could prolong the life of the fashion, and it presently yielded to the revival of a previous one, and the Renaissance forms of the time of Queen Anne became the vogue, especially for country houses,—nowhere more homelike than in England.

In the suburb of Bedford Park, in Lowther Lodge, as in his designs for the Alliance Assurance Company and the new Scotland Yard, Norman Shaw showed the facility of his clever pencil, and Ernest George Peto gave many evidences of his skill and taste; their work, however, often having a flavor of the Flemish.

The building of the Thames Embankment, the opening of new streets,—such as Holborn Viaduct and Shaftesbury Avenue,—with the widening and straightening of others, have done much for the improvement of modern London.

In France, there were very many important public buildings begun in the first ten years of this century,—during the reign of Napoleon I.,—although some of them were not completely finished until the time of Napoleon III. (1848–1870). Among those in Paris were the Arc de l’Étoile by Chalgrin, the largest triumphal arch ever built, being similar in height and width to the front of Notre Dame Cathedral, omitting the upper portion of the towers; Arc du Caroussel by Percier & Fontaine—both these arches commemorating the victories of Napoleon; the churches of the Madeleine by Vignon, and of Ste. Geneviève, in honor of the great men of France; and the wing connecting the palaces of the Tuileries with the Louvre, parallel to (but furthest from) the river.

The Corps Législatif, which was formerly the Palais Bourbon, was remodeled in 1807 by Poyet, and has for its river front a portico with pediment sustained by twelve columns, a greater number than any other existing building can show.

If there be one style more than any other which needs sunshine and a clear atmosphere to show it to advantage, it is the classic; and a Greek or Roman temple in the atmosphere of fog, rain, and snow, of Edinboro, London, Munich, or even Paris, does not produce at all the same impression as if it were under the blue skies of Italy, Sicily, or Greece; however, the frequent employment of classical *motifs* since the beginning of the century has contributed, to a degree unprecedented in modern times, towards placing Paris in the very foremost rank among the capitals of the world in the dignity and impressiveness of its public buildings.

The encouragement given to architecture in France by Napoleon I. was revived by Napoleon III. The remodeling of the streets, avenues, and boulevards of Paris, under the direction of Baron Hausmann, while it swept away many landmarks of mediæval Paris, contributed wonderfully to its stately elegance as well as to its hygiene; the work begun upon the Louvre was completed from designs by Visconti & Lefuel, and much entirely new work erected. There was a group of men, some of whom brought about the Neo-Grec movement, whose work was especially interesting, and although not extensively copied, yet exerted a marked influence for many years afterwards. These men were Labrouste, who designed the Library of Ste. Geneviève, about 1830; Duc, who remodeled the Palais de Justice; Duban, who built the library for the School of Fine Arts, about 1845; Viollet le Duc, who restored the Château de Pierrefonds, and wrote treatises and dictionaries upon architecture, furniture, etc., and was instrumental in the organization of the Society for the Preservation of Historical Monuments.

Still later than these works are Vaudremer's Neo-Grec Church of St. Pierre de Montrouge, built in 1860, and Abadie's Byzantine Church of the Sacred Heart, still unfinished; Baltard's Church of St. Augustin, of brick and cast-iron, and Central Market, of cast-iron and glass; Garnier's Opera House, Hitorff's Northern Railway Station; the Trocadéro, built for the Exposition of 1878; the Machinery Hall and Eiffel Tower, for that of 1889; together with a host of other public buildings, not only in Paris, but in other portions of France, many of which have served as examples to the student of architecture in other lands.

In this connection we should not forget the debt we owe to the French nation. During the reign of Louis XIV. the School of Fine Arts was founded in Paris, where free instruction in painting, sculpture, and architecture is still given to all who pass satisfactorily the entrance examinations; and in this school many of our successful architects have received gratuitous instruction from some of the distinguished men above mentioned. In the Department of Architecture the chief characteristics are the thorough and systematic study of the plan, and the adaptation of building materials to the conditions of the design.

Other European cities besides Paris have profited by the general prosperity of the century. St. Petersburg produces the effect of a city of palaces, the many residences of grand dukes and nobles, the number of public institutions, the riding schools,—much used on account of the severity of the climate,—and even the barracks, in spite of the free use of stucco, each contributing to a certain impression of stateliness; the palace of the Archduke Michael, built by an Italian, Rossi, in 1820, is perhaps the most refined and dignified. Muscovite architecture is most conspicuous in the elaborate and bulbous domes, curious not only in form, but in color, of the churches of St. Petersburg, of Moscow and Warsaw.

King Louis of Bavaria, having lived in Rome when Crown Prince, cultivated so great a fondness for the architecture of Greece and Italy, that when he came to the throne he commissioned his architects to design for his capital city of Munich the Walhalla, Ruhmeshalle, Glyptothek, and Pinakothek, after classical models.

In Dresden, the most interesting buildings designed upon Greek or Italian traditions are the theatre and the picture gallery, by Semper, who will long be ranked as the foremost German architect of his day.

In Berlin there is a theatre,—unique of its kind, with stage in the centre, and an auditorium for winter use at one end and one for summer at the other,—designed by Titz; at Carlsruhe, Stuttgart, and Strasburg there are theatres and schools in the same style. The present Emperor has added many schools throughout the empire, but they are of late German Renaissance.

The public buildings of Germany and Belgium show few designs of interest in recent years; the Parliament House at Berlin, by Wallot, and the Palais de Justice at Brussels, by Polaert, being colossal in mass and clumsy in detail. Many of the private houses designed in the Italian Renaissance were very elegant and attractive, but within the past decade there has been a woeful deterioration in the character of both surface and line—the grotesque replacing the graceful.

The villages built for their employees by Krupp, the gun manufacturer, and Stumm, the maker of steel, are notable instances of the application of private capital to the improvement of the domestic conditions of the laboring class.

In Austria, Vienna has developed wonderfully since the days of Maria Theresa. The classic Parliament House by Hansen, in 1843, is one of the most delightful of its kind to be found anywhere; Schmitt's Gothic town-hall is interesting, but cannot be said to be so successful in design; the Votive Church by Ferstel, in 1856 (also Gothic), the Opera House by Siccardsburg and Van der Nüll, with the City Theatre, an elaborate Renaissance structure, by Semper and Hasmauer, are all worthy of note. The University with the two Museum buildings, facing each other upon a small park, and other public buildings and residences along the Ring Strasse, are extremely satisfactory, in spite of the fact that stucco has been so extensively employed.

Only a few years ago the municipality of Buda-Pesth offered immunity from taxation for fifteen years to all prospective builders, under certain conditions as to character and cost of buildings, with the result that the newer portion of the Hungarian capital was quickly occupied by buildings of the most desirable kind; the Parliament House, Opera, Cathedral, Technical School, and several club-houses and private residences, each testify to the spirit with which the citizens responded to this desire to beautify the city.

Since the unification of Italy there has been considerable building in some of the principal cities, but very little of special importance. In Rome, the changes are more perceptible than elsewhere; the excavations of the Forum, the embankment of the Tiber, the widening and straightening of the Corso, and the opening of the Via Nationale and other streets, have destroyed comparatively little of the picturesque that was worth retaining, have brought to light many treasures of art, and, supplemented by the drainage of the Campagna by Prince Torlonia, have certainly made it a healthier city to live in. The monument to Victor Emmanuel, the National Museum, and the Braccia Nuovo of the Vatican Museum, are among the few public structures of interest; the many blocks of apartments and tenements are orderly and inoffensive, though brick and stucco are the materials used in their construction.

Turin is the modern manufacturing city, while Florence preserves its mediæval air, and Venice dreams of the bygone days when the splendor of the Renaissance attracted the wealth, beauty, and talent of all Europe to the city of the Doges.

Bologna and Genoa have each built in the suburbs a magnificent Campo Santo, or cemetery, with chapels, colonnades, and other accessories of architectural value; in Milan and Naples there are lofty glass-covered arcades through the centre of a block and connecting with cross streets, and the semi-circular colonnades of St. Francesco di Paolo, at Naples, surround a piazza which is the great public resort of summer evenings.

During the reign of King George a new Athens has sprung up alongside of and overlapping the old city; although the nation is not wealthy, the individual bequests of certain Greeks have given her the Museum, University, and Academy, each of strict classic design, and a hospital of Byzantine design. Under the sunny skies of Greece those buildings certainly appear to much greater advantage than if in a more northern atmosphere, and their statuary and polychromy show the value of these accessories to such architecture in this climate.

Abdul Aziz, the predecessor of the present Sultan of Turkey, had so great a fondness for building that his extravagance in this respect was one of the causes which led to his downfall. The Dolma Bagtche palace, erected directly upon the shores of the Bosphorus from the designs of Balzan, an Armenian architect, suggests Spanish work of the sixteenth century. In Constantinople and at Therapia,—a summer resort at the northern end of the Bosphorus,—many of the foreign governments have built official residences for their representatives.

As for the architecture of our near neighbors on the north, the buildings of Canada have been sturdy and substantial rather than comely; but the long continuance of cold weather and the lack of means have often hampered the builders. Since the completion of the Canadian Pacific Railroad, the prosperity of city and country seems more assured; the older cities growing in importance and extent, and new towns springing up along the line to the West. In Ottawa the Parliament Buildings and the octagonal Library, in Toronto, and, to some extent, in Montreal, the Universities' buildings, are Victorian Gothic. The later buildings of the University in Montreal, excepting the Girls' College, are not so interesting; but there are two railroad stations, a hotel, cathedral, with several banks, insurance buildings, and residences that call for more than passing notice. Perhaps the finest building in all Canada is the Château Frontenac, in Quebec,—built by Bruce Price of New York,—on the Dufferin Terrace, overlooking the St. Lawrence River, and commanding a view that is hardly surpassed on the Bosphorus, the Rhine, or the Hudson.

Although the history of architecture in America cannot be written without some reference to contemporary work in Europe,—since so much of our architecture in the first half of the century is adopted from that of our ancestors and adapted to our uses, and in the last half so many of our architects have studied there and so many of our citizens have traveled there,—the problems and their conditions in the Old World are very different from those of the New. Europe was already mature when steam and electricity were introduced; precedent was always to be considered, and modern requirements were often forced to conform to existing circumstances. There has, therefore, been comparatively less change there during the century than during the past thirty years with us. With our republican institutions, many of the monarchical formulas soon became obsolete, though the general trend of our architecture has been in the direction of classic models. As the country has grown larger and more wealthy, the problems given to architects have become more complex; less reliance could be placed upon precedent and a premium was placed upon originality, which, in spite of innumerable vagaries, has brought American architecture, at the end of the century, to be the most notable of the day.

At the end of the eighteenth century, this republic consisted of hardly more than a number of communities extending at intervals along the Atlantic seaboard, with an occasional settlement beyond the Alleghany Mountains and across the Ohio River. Their resources were extremely limited, their wants very few, and their intercommunication irregular; but their methods of living were simple and frugal, and their courage and endurance phenomenal.

Among the settlers of New England were many mechanics and manufacturers, and these soon began to replace the primitive log cabins with frame dwellings; those of the Southern States were chiefly planters, who imported much of their labor, and often the bricks as well as the glass, hardware, tiles, and other materials for their houses. Many of those who colonized the Middle States had come from countries in Europe where these materials were made, and brought their secrets with them, while others were farmers and stock growers, whose snug little cottages and enormous barns may be seen to this day in New York and Pennsylvania.

At the beginning of the nineteenth century we possessed a national style of architecture, which, although it had come to us from Italy, through France and England, was yet distinctly American. It was, however, almost exclusively confined to residences, and there were very few public buildings of any description, except certain churches,—said to have been designed by followers of Sir Christopher Wren, some of whom were doubtless ship carpenters who had studied the works of Sir William Chambers.

The Colonial style, as we now term it, was sufficiently elastic in its adaptability to conform to the requirements of the merchant, manufacturer, or mariner living at Salem, Boston, or Newport, as well as to those of the planter living at Charleston or Savannah. There were certain differences, more or less pronounced, peculiar to each section and to each city, but all houses were alike in this respect,—there was no gas or water, and the open fireplace was depended upon for heat.

In New England the dwelling-houses were placed near the ground; the chimneys built in an interior cross wall, the kitchen, with its accessories, as near to the dining-room as possible; the ceilings were low, with cornices sometimes of plaster, sometimes of wood. The roof,—which was often hipped and often of the gambrel shape, but rarely a gable of even slope,—was always covered with shingles, which covering was occasionally used also on the exterior walls.

In the South, some of the characteristics were the high basement, broad piazzas, frequently at the level of the second as well as the first story, and placed on the south and west sides; the chimney on outside walls; the kitchen in a separate building, detached from the dwelling; a broad hall through the centre, giving access to large rooms with high ceilings; the roof quite as frequently hipped as gabled, and often—in either case—a huge fanlight set in a low gable on the front for ventilation of the attic; dormers were seldom used, as the attic was not inhabited; the gambrel roof was uncommon; slate, and occasionally tile or shingle, was used for roof covering.

Our first public buildings of any importance, and which show the influence of contemporary work in England, were the White House, designed by Hoban in 1792; the Capitol, begun by Dr. Thornton in 1793 and completed by B. H. Latrobe in 1830; the wings, containing the present Senate and House of Representatives, were added later; the dome, designed by Thomas U. Walter, was begun in 1858, but not completed until 1873.

Our early Presidents took much interest in architecture, Washington directing and criticising the planning of the Capitol and building his own home at Mount Vernon, and Jefferson designing the dome and colonnades of the University of Virginia, at Charlottesville, and his own home at Monticello.

Massachusetts was the first State to erect its capitol,—the State House in Boston, by Bulfinch, dating from 1795.

The City Hall of New York was our first work of unmistakable French character, and shows the influence of the time of Louis XVI. It was designed by Mangin, a Frenchman, begun in 1803, and completed in 1812.

After the war of 1812, many state and national buildings were erected; from that time colonnades and domes seem indispensable to the proper dignity of the capitol or court house. The use of both brick and stone became more general, and, for private houses, the form of the gambrel roof gradually disappeared in favor of the hip and gable. Subsequent to 1830, the accepted type of the larger or more pretentious house was the Italian villa, with a square tower accentuating the front entrance, often one story higher than the main building; all roofs of low pitch, covered with tin; the exterior walls faced with stucco. About this time bay windows and sliding doors for principal rooms of first story, and better facilities for the use of heat, light, and water were introduced and the symmetrical disposition of parts often neglected.

The very steep pointed Gothic roof denoted the modest cottage, and the perforated wooden tracery of windows and porches, or the barge-boards of gables, became the simple beginning of that riotous growth of jig-sawed fretwork afterwards so prominent upon those houses constructed with Mansard or French roofs of rectilinear, concave, or convex form. The works and writings of Downing had much influence at this time, and it was shown not only in these Italian villas or Gothic cottages, but also in landscape gardening about suburban residences.

The political disturbances in various countries of Europe in 1848 brought very many immigrants to our shores, and the discovery of gold in California, in 1849, was the beginning of that steady flow of settlers which has since then peopled so many of our Western States and Territories.

Then followed our own Civil War, from 1861 to 1865, and subsequent to that the period of reconstruction, during which time there was some building, but very little architecture, throughout the country.

In 1869 the Pacific Railroad was completed, and this not only gave a new impetus to Western mining and farming, but created a new market for Eastern manufactures.

So great was this manufacturing and commercial activity that vast fortunes were made, and there were many opportunities calling for the services of architects; but as they had hitherto been rarely employed, except in a few of the larger cities, upon churches or public buildings, a great proportion of them were untrained amateurs or self-taught carpenters and masons. However, the first school of architecture had just been organized at the Massachusetts Institute of Technology, in Boston, and to William E. Ware,—who was its professor of architecture from 1866, and who organized a similar school at Columbia College, New York, in 1880,—the profession and the public owe more than to any other one man for well-directed efforts towards the development of such, qualifications as may eventually give a national character to our architecture. These schools came none too soon, and within the past twenty-five years many others have been founded and many traveling scholarships endowed; collections of books, photographs, and casts have been provided in various cities; architectural periodicals published, and architectural societies and sketch clubs formed, each of which has contributed to the higher education of the profession and to the greater appreciation by the public.

Prior to this time, each section and each city had certain peculiarities of architecture, as of speech, which were unmistakable. The white New England meeting-house, the red school-house, the country house with its kitchen, wash-room, and wood-shed trailing in the rear, or the swell-front city house, were as characteristic as the endless blocks of brown stone, high stoop houses of New York, or the monotonous rows of red brick dwellings with white marble trimmings of Philadelphia, or the broad verandas and halls of the Southern home.

Cast-iron was the recognized material for the front of business buildings, the designs being chiefly in the Corinthian or composite orders, and the arch or lintel used indiscriminately; and when the dry goods store of A. T. Stewart & Co. was built, in 1872, to occupy the whole block from Broadway to Fourth Avenue, and from Ninth to Tenth Streets, it was the largest and most important of its kind. Before this class of commercial architecture disappeared, a front was designed by R. M. Hunt, about 1878, for a store on Broadway, near Broome Street, where the plastic forms of the tile and stucco of Saracenic architecture were used as being more logical for this material than an imitation of Roman forms in stone.

There were not many summer resorts, and a few weeks at Saratoga, Newport, or the Virginia Springs was the limit of the annual vacation; the orthodox hotel was a rectangular frame building, with veranda on one or more sides, covered by a flat roof supported by square piers having the height of several stories; the length, width, and height of the building were governed by no other proportion than that of the number of guests.

In the South and West there were virtually no hotels, and the belated traveler applied for food and shelter for himself and his horse to the nearest friendly farm.

These were the prevailing conditions when the *nouveau riche* appeared upon the scene; to him as citizen prosperity meant a better home, to the congregation a larger church, to the community a new city hall or court house, to the State a more expensive capitol.

While these buildings were being everywhere erected, in accordance with the time honored fashions of construction and with elaborate finish, the disastrous conflagrations of 1871 in Chicago, and of 1872 in Boston, called general attention to the necessity for more permanent building; and the precautions now taken against similar occurrences were the beginning of efforts toward methods of fireproof construction. Granite, marble, and limestone were discarded in favor of sandstone, brick, and terra cotta; iron beams carrying brick or concrete (subsequently hollow terra cotta) arches were introduced, and metal laths were substituted for the wooden strips to a certain degree; but as these fires were mainly in the business districts, such reforms have been confined almost exclusively to commercial architecture.

In 1873 the financial panic gave a check to many building operations, but it was of comparatively short duration, for in 1876 all the other nations of the earth were invited to unite with us at Philadelphia in celebrating the centennial anniversary of our independence.

This was our first international Exposition, and it was not remarkable that in our eagerness to learn, and in the enthusiasm of prosperity, we sought inspiration from all those peoples who had brought their goods for our inspection. At once we began to build Queen Anne cottages or to remodel existing houses with many bays and towers, rooms set at all angles, floors at different levels, walls of many materials, and roofs of varying slopes, as well as to apply many tints and shades of color within and without.

The summer hotel and summer cottage began to appear at the seashore, in the mountains, and along the shores of the great lakes, and the winter resorts of the Carolinas, Florida, and California to attract the seekers for health and pleasure.

The interior decoration of our houses was the chief lesson of 1876, and having once seen the European and Oriental hangings, draperies, rugs, and bric-à-brac, we set about furnishing our rooms with them.

Hitherto American architecture had been most influenced by English precedent, and the Victorian Gothic had able advocates, especially in Boston, where the Art Museum by Sturgis & Brigham, as well as many stores, residences, and churches by Cummings & Sears, Peabody & Stearns, and others, showed much vigor and originality. William A. Potter, as supervising architect for the Government, adopted this style, in 1875, for his buildings at Fall River, Mass., Nashville, Tenn., and Covington, Ky., and R. M. Upjohn designed for Hartford, Conn., the only Gothic State Capitol in this country.

R. M. Upjohn and Henry M. Congdon of New York had already done much Gothic ecclesiastical work and, with the possible exception of Grace Church in 1840, and St. Patrick's Roman Catholic Cathedral in 1886 by Renwick, there is no example of this style which shows such appreciation of proportion or of form, in mass and in detail, as Trinity Church (1843) by the first-named architect.

It was perhaps rather fortunate that just as the Queen Anne fashion, with its multiplicity of detail, was brought to us from England, H. H. Richardson, of Boston, called our attention to the bigness and (almost brutal) simplicity of the Romanesque from Southern France. From the date of the building of Trinity Church, in Boston (1876), may be reckoned the parting of the ways. Heretofore everything we had done of any importance had an English stamp upon it; henceforth the work that was done showed the result of training of the Parisian *atelier* or of the well-filled sketch books of Continental travel.

Not only in this church, but in his libraries at Woburn, North Easton, Quincy, Milford, Burlington, and New Orleans, did Richardson show his grasp of the subject. Trinity is unmistakably a Christian temple, and its bigness most conducive to the sense of awe and reverence. His libraries leave no doubt as to their having been built for the storing and reading of books; his stone buildings, whether the Court House and jail in Pittsburg, the Chamber of Commerce in Cincinnati, or private houses in Buffalo or Chicago, show their purpose and emphasize their material; his brick buildings, whether a college building at Cambridge, railway station at New London, or residence at Washington, tell their story in brick; and his country houses about the suburbs of Boston, to be what they are, could not have been other than of wood.

His influence upon the architecture of the day was therefore not surprising, but there was a subtleness in the character of his designs that his imitators could never acquire and even his immediate successors could not long retain after his personality was lost to them; and from the lack partly, perhaps, of true sympathy, partly from the modification of conditions, his art may be said to have died with him.

As R. M. Hunt had the last word on the cast-iron front, so he had the first on the modern sky-scraper, a peculiarly American production; the walls of the Tribune Building, however, carry both their own weight, and that of the floors, being built before the days of the methods of steel skeleton construction. Hunt was trained in Paris, as was Richardson, and had assisted in the design of the Pavillon de Flore under Lefnel, and he showed his appreciation of the Neo-Grec movement in his design for the Lenox Library. It is somewhat unusual for an artist to do his best work in his latest years, but surely no better work of its kind has been done in modern times than the residences which he designed for three members of the Vanderbilt family at Newport, in New York city, and at Biltmore, N. C. The design which he left for the Fifth Avenue front of the Metropolitan Museum, now being carried out by his son, is a magnificent Corinthian order, whereas much of his other work is late French Gothic.

That he was called upon to design the base for Bartholdi's Liberty in New York Harbor, and the Administration Building at the International Exposition of 1893, and that a portrait bust has been erected to his memory, all testify to the appreciation in which he was held by the profession.

To McKim, Mead & White, of New York, we are greatly indebted for their influence upon secular architecture, and their Casino at Newport, built in 1880, was probably more far-reaching in its effect upon country houses than any other building at that time. Among the other work from their office may be mentioned the Boston Public Library, the Madison Square Garden (reproducing in its tower the Giralda of Seville), the Library and other buildings for Columbia College, the Metropolitan and University Clubs, the Agricultural Building (of staff) in Chicago in 1893, now being reproduced in marble for the Brooklyn Institute, the Tiffany, the Villard, and other city houses, and a host of country houses at Newport, Lenox, and elsewhere.

There is another architect whose talents should be acknowledged; for about 1880, when the shingle house had just begun to take shape, there was none more clever at that sort of thing than W. R. Emerson, of Boston, and his resources seemed endless in harmonizing form and color with conditions of seashore or mountain, as shown in his houses at Bar Harbor, Milton, Newport, and many other summer resorts.

Philadelphia, which had hitherto always been extremely conservative in architecture, soon began to erect some of the most singular and fantastic structures that could well be imagined; but fortunately the refined simplicity and fertile originality of such men as Wilson Eyre, Frank Miles Day & Bro., and Cope & Stewardson have prevailed, and in both city and suburban work they and certain others have done and are doing much to counterbalance the character of the eccentricities of their predecessors, as shown in buildings for the University of Pennsylvania and the Academy of Arts and Sciences.

But the restless activity of Eastern loom and machine shop, and of Western farm and mine, seemed to meet and concentrate in Chicago—the *entrepôt* for the raw material of the West and the finished product of the East. The unprecedented increase in value of land, the low price of iron and steel, with the introduction of high-speed elevators, combined to develop a new type of sky-scraper; and as the nature of the soil was entirely unlike that of other cities, the foundations of these buildings presented problems which were solved by Chicago architects in various ways hitherto untried. The Rookery by Burnham & Root, Pullman Building by S. S. Beman, and the Auditorium (opera house, hotel, and office building in one) by Adler & Sullivan, at the time of their completion were most notable examples of architectural engineering, and were soon followed by many others more or less similar, designed by W. L. B. Jenny, Holabird & Roche, Henry Ives Cobb, and others. The buildings for the Chicago University, the Athletic Club, and Newbury Library, by the last-named architect, show a high degree of ability; the peculiarly rich arabesque ornamentation designed by Louis H. Sullivan, and the direct and rational handling of the buildings upon which it was used, are certainly indicative of the spirit of enthusiasm and conscientiousness of a well-trained mind. It is by such characteristics that John W. Root was able to accomplish so much for the advancement of architecture in the West.

What Krupp and Stumm had done for the employees in their works in Germany, Pullman determined to do for his men and their families here; and a town, with dwellings, schools, churches, water-works, etc., for many thousand inhabitants was designed and built by S. S. Beman, which has been reported by experts to be the best of its kind.

In Chicago, in 1893, was held our second international Exposition; and that the exhibits should be suitably housed, some of the most prominent architects of the country were called together, buildings were assigned to each of them, and Frederick Law Olmsted was appointed to lay out the grounds, waterways, and bridges.

Except for the difference in material, never did Rome in the days of Augustan magnificence show buildings similar to those grouped about the Court of Honor. A Greek would surely have been proud to walk through the Peristyle, or to have visited the Art Galleries, and a Roman to have sauntered about the Terminal Station or the triumphal arches of the Manufactures Building. Right nobly was the Spanish aid to Columbus acknowledged in the design of Machinery Hall; but to France, whose generosity had trained so many of our architects, sculptors, and painters to do such things, was the greatest triumph in the unanimity with which they had all worked and the success which crowned their labors.

The building occupied by the Federal Government was one of the few unworthy of its location or of the occasion. While the architecture of the people had been advancing steadily for fifty years, that provided by the Treasury Department in Washington had been quite as steadily retrograding. The Custom House, Boston; Sub-Treasury, New York; the Mint, in Philadelphia; the Treasury, Post Office, and Interior Department buildings, in Washington, have stood almost alone since the middle of the century. The few Gothic buildings referred to previously were honest and intelligent attempts to improve the quality of design for the government, but the politicians decided that artistic ability was not a prerequisite for the office of Supervising Architect.

Since 1895, there has been some infusion of new life into the designing-room, and such work as the designs by William Martin Aiken, for the Buffalo and San Francisco Post Offices and Court Houses, the Denver and the Philadelphia Mints, and the New London Post Office, were about being materialized, when once again the politicians, who cared not a whit for one design more than another, interfered to oblige the government contractor. But the good seed had been planted, and the work of the present incumbent, James Knox Taylor, is likely to show a marked advance over that of many previous years.

The general scheme of the Congressional Library was conceived by Smithmeyer & Pelz, the details carried out subsequently by General Casey and his able assistants and successors, and the building opened to the public in 1896. The experiment of the collaboration of sculptor and painter with the architect had resulted so favorably in Chicago, that the artists invited to decorate this building gladly responded; and although the remuneration was inconsiderable, their loyalty to the country, as to Art, resulted in such mural decoration as had not been seen since W. M. Hunt decorated the Senate Chamber in Albany, or La Farge did the figures in Trinity Church, Boston, and St. Thomas Church, New York. Blashfield's dome, typifying all the nations of the earth; Vedder's Minerva, in mosaic; H. O. Walker's large lunettes, illustrating English poems, and Simmons' small lunettes, filled with exquisite little figures, are but a few of the many interesting works in color. Two of the main entrance doors of bronze were modeled by Olin L. Warner, but he did not live to complete them. The marble stairway is by Martini, and the statues which adorn the main reading-room are by Adams, Bartlett, Partridge, Ward, and others.

The plan of the building is that of a central octagon containing the general reading-room, connected by wings containing the book-stacks with a surrounding hollow square containing rooms for special collections. There are ample reading-rooms for representatives, senators, and the public, and a tunnel by which books are sent to the Capitol. This is the last building of considerable importance constructed by the government, and it was built on time and within the appropriation of $6,000,000; it may be said to be dignified and suitable to its purpose, and to be representative of the people at the close of the century.

It now seems probable that New York will build the handsome library designed by Carrère & Hastings; the Egyptian lines of the reservoir occupying the site—emphasized by the varying hues of the ivy for so many seasons—will give place to those of an example of modern French Renaissance.

Among the changes incidental to the growth of this city is the recent disappearance of the old Tombs prison, which was another building of Egyptian architecture, good of its kind, and quite dignified and impressive.

There are certain other buildings designed in the style of a country almost as tropical as Egypt, and as light and airy as that is sombre and gloomy, but which seem quite as appropriate for their different purposes: they are the Casino Theatre and the Synagogue at Fifth Avenue and Forty-third Street,—each an excellent example of Saracenic architecture,—the former of brick and terra cotta, and the latter of vari-colored sandstones. Another synagogue, by Brunner & Tryon, further up the avenue and facing Central Park, has a decided Byzantine flavor,—the large arch accentuating the entrance, carrying a small arcade, and being surmounted by the traceried dome.

The largest and most expensively elaborate hotel in America is the Waldorf-Astoria; and although certain features of the exterior may not be justified by interior arrangements, it has certainly been planned with a view to great comfort and luxury.

While New York has the largest and most expensive private residences,—the chief of these is that of Cornelius Vanderbilt,—Philadelphia has the greatest number of small houses owned by their occupants; and of late years, there are a greater number of attractive homes in St. Louis than anywhere else in this country. Very many of them have been designed by Eames & Young, or by Shepley, Rutan & Coolidge; and with much open space about them, they have an air of elegance and hospitality that is lacking to the homes in most other cities.

New York, from its position as the commercial and financial centre of the country, in spite of its situation on a long, narrow island, may be accepted as the typical city. What is done here architecturally is done (only to a different degree) elsewhere, and its growth horizontally in the northern portion of the city has kept pace with its perpendicular growth in the more congested business portion. This general expansion has altogether changed the character of many streets, the residences becoming apartment houses, and the shops becoming office buildings from ten to twenty stories,—or even more,—the masses becoming larger and the detail proportionately less prominent.

The sky-line has entirely changed; the spire of Trinity is lost in such surroundings as the Bowling Green, Empire, Washington Life, and American Surety buildings, and in the vicinity where the Tribune tower was once conspicuous, now the St. Paul Building rises twenty-five stories, and the Ives Syndicate Building even higher; further and further up Broadway, and to the right and left of it, these monster buildings continue to rise. But among them all there is not one which shows a more masterly handling of the problem than the Surety, where the architect, Bruce Price, has emphasized the entrance with a colonnade and six figures of much dignity and grace, and has concentrated the ornament about the upper part of the building, crowning it with a fine cornice, which is more effective from the simplicity of the four walls beneath. This building holds its own among such others as the Washington Life and St. James buildings, New York, or the Ames Building, Boston, Harrison Building, Philadelphia, Schiller Theatre, Chicago, Wainwright Building, St. Louis, or Examiner Building, San Francisco.

It is impossible, in so brief a survey of the field, to enumerate more than a very small fraction of the buildings illustrating the progress of the architecture of the century; and aside from the residences, apartments, and hotels where we live winter or summer, and commercial buildings in which our working hours may be occupied, there are very many examples of churches, schools, colleges, libraries, and museums, donated, equipped, and endowed for our instruction, theatres and music halls for our entertainment, railroad stations for transportation, storage warehouses for the safety of valuables, and armories for the use of our militia.

Besides these, there are engineering works of considerable importance, such as the Eads Bridge, at St. Louis, or the Roebling Bridge, between New York and Brooklyn, and the works of the sculptor St. Gaudens, the Washington Arch by Stanford White, the Farragut and Lincoln statues in New York and in Chicago, which should surely be mentioned, since monumental works are the poetry, whereas the secular and commercial works are but the prose of architecture.

As we review our productions, we should certainly feel encouraged to believe that if we continue to meet and solve each problem in the same direct, honest way that we have been doing for the last quarter of the century, there need be no misgivings as to the future of architecture in these United States.

The Century’s Progress In Chemistry

By HARVEY W. WILEY, M.D., PH.D., LL.D.,
Chief Chemist Agricultural Department, Washington, D. C.

The science of chemistry, as it is known to-day, had its real origin towards the end of the eighteenth century. Before and up to that time it is true there were many great workers in chemistry, whose names are associated with investigations in chemical science, such as Boyle, Stahl, Black, and Scheele. Contemporary with the close of the eighteenth century and the beginning of the nineteenth must also be mentioned particularly the names of Priestly (1733–1804), Cavendish and Humphry Davy (1778–1829). All these workers had to contend, first of all, with erroneous theories, which made it difficult to rightly interpret the data of experiment. The old theory of phlogiston produced an environment in which it was difficult for true scientific methods to survive. The great investigator, who did more than any other one man to overturn this false theory and place chemistry on a firm foundation, was Lavoisier (1743–1794). Born near the middle of the eighteenth century, his scientific activity began about 1770, and before he was twenty-five he was made a member of the French Academy of Sciences. At the age of forty he was recognized as the foremost scientist of his age.

Priestly discovered oxygen in 1774, but failed to recognize its true relations to other bodies. It was Lavoisier who discovered oxidation (1776), an achievement which meant more to chemistry than the discovery of oxygen.

The observation that metals when heated in confined air increased in weight while the volume of the confined air decreased, is the crucial experiment upon which the whole science of chemistry rests. This experiment was made most rigorously by Lavoisier, and the apparatus which he used is still preserved in the Museum of L’École des Arts et Métiers in Paris. This apparatus, simple in character and yet almost perfect in construction, has for the chemist a peculiar significance and sacredness, producing an impression similar to that inspired in the devout Christian by the relics of the Cross and the Holy Sepulchre.

In the brief space which is assigned for a discussion of the progress of chemistry during the nineteenth century, economy of words will be secured by briefly tracing some of the salient points in the progress of some of the more important branches of chemical science. In the following pages, therefore, will be found a brief statement of what has been accomplished, of the most important character, in the science of chemistry, under the following heads:—

Inorganic chemistry; physical chemistry; organic chemistry; analytical chemistry; synthetical chemistry; metallurgical chemistry; agricultural chemistry; graphic chemistry; didactic chemistry; chemistry of fermentation; and lastly electro-chemistry.

No attempt will be made in this paper to enter upon the discussion of the progress which has been made in medical, pharmaceutical, and physiological chemistry. The discussion outlined under the above heads does not by any means embrace the whole subject. It will be sufficient to indicate only the lines of progress along which the greatest advances have been made.

I. INORGANIC AND PHYSICAL CHEMISTRY.

The three propositions established by Lavoisier, which serve as the foundation for inorganic and physical chemistry, are the following:—

1. Bodies burn only in contact with pure air.

2. The air is consumed in the combustion, and the increase in weight of the burnt body is equal to the decrease in weight of the air.

3. In combustion the body is generally changed, by its combination with the pure air, into an acid, and metals are changed into metal calx.

The total number of elementary bodies known at the beginning of the century was probably less than thirty. Many had been recognized as such since remote antiquity, but none of the non-metallic elements, except oxygen and sulphur, was known, and even their properties were not established with any degree of precision.

Not only did Lavoisier establish the fundamental principles of modern chemistry, but in connection with Fourcroy (1755–1809), Berthollet (1748–1822), and Guyton de Morveau (1737–1816), laid the foundation of modern chemical nomenclature.

The contributions to chemical knowledge at this time were greatly increased by the works of the Swedish chemist, Scheele (1742–1786), and in the beginning years of the century the great work which was accomplished by Sir Humphry Davy advanced very rapidly the general knowledge of chemical science.

Davy’s first works served to elucidate the connection between electricity and chemical processes, and it was through the classical experiment with an electric current that he isolated (1807) the metals sodium and potassium, and described their properties.

This achievement of Sir Humphry Davy’s was the second great step in the progress of chemistry, after the one taken by Lavoisier. By means of the metals sodium and potassium other metallic elements were separated, notably aluminium by Wöhler (1845). Basing his work upon the above experiment, Sainte Claire Deville developed the metallurgy of aluminium (1854), and Bussy isolated magnesium (1830).

In 1811 iodine was discovered by Courtois, and its properties examined simultaneously (1814) by Davy and Gay-Lussac.

The contributions made by Berzelius (1779–1848), who was a contemporary of Davy and Gay-Lussac (1778–1850), were of the most important character. Berzelius not only added to the knowledge of inorganic chemistry but also established many of the important theories on which chemical action depends. His elaboration of the employment of the blowpipe in chemical analysis was of the greatest practical value.

In 1807 Dalton published a work entitled “New System of Chemical Philosophy,” in which was announced for the first time the law of the definite proportions of bodies forming a definite union. The atomic theory of matter was also developed by Dalton, who gave it a definite form and expression. Chemists now began to consider the elements as definite indestructible particles of matter, forming unions among themselves and with different kinds of atoms to form molecules, which were considered as the units of substances. As a result of this supposition, the development of the principle of the relative weight with which bodies combine was the logical consequence.

Now for the first time the elements began to assume not only names and descriptions of properties but also numbers, showing the relative weight of their atoms or final conditions of existence. It was only necessary, therefore, to assume the standard of comparison for any one element, in order to determine the relative weights with which it combined with others. Thus the system of atomic weights was developed.

As a result of the law of chemical action, that most elementary bodies exist in a condition where two atoms are joined together to form a molecule, it follows, that in most instances the molecular weights of the elements are double their atomic weight. There are, however, many notable exceptions to this rule.

The supposition of the existence of atoms was followed soon by another theoretical proposition, advanced by Prout (1815). Assuming that the atomic weight of hydrogen was one, Prout's hypothesis asserted that the atomic weights of all other elementary bodies were multiples of that of hydrogen. The most rigid investigations of recent years have shown that Prout's hypothesis is untenable; but the remarkable fact still remains, that in a great many cases the atomic weights of the elements are almost whole numbers, or differ from whole numbers by almost a half unit.

The determination of the atomic weights of the various elements during the past one hundred years has been worked on by hundreds of chemists whose names it would be impracticable to mention. The most important of them are Berzelius, Cooke, Cleve, Delafontaine, Dumas, Hermann, Marchand, Marignac (1817), Morley, Noyes, Pelouse (1807–1867), Richards, Schneider, Stas (1813–1891), and Thompson. Of all these workers Stas, a Belgian chemist, is perhaps the most renowned. Among those mentioned, Cooke, Morley, Noyes, Delafontaine, and Richards are citizens of the United States.

From the less than thirty elements which were known at the beginning of the century, there are known to-day seventy-two with certainty, and perhaps one or two more whose identity has not yet been fully established. The chemists who have become most renowned by the discovery of elementary bodies are: Cavendish, Scheele, Berzelius, Wöhler (1800–1882), Davy, Gay-Lussac, Priestly, Bunsen (b. 1811), Crookes (b. 1832), and Ramsay.

II. PHYSICAL CHEMISTRY.

In strictly physical chemistry the relations of electricity and heat to chemical action have been extensively developed during the century. The specific heats of the elements and of most of their compounds have been carefully determined, and thermo and physical chemistry under the leadership of such master minds as Berthollet, Thompson, Van't Hoff, and Ostwald have been brought to the highest degree of perfection.

The chemist now does not consider that he knows any body until he knows thoroughly its relations to heat and to electricity. The action of light must also be included, but this subject will be more thoroughly discussed under graphic chemistry.

The nature of solutions has also been developed by the studies of Ostwald and Van't Hoff, and as a result of these studies, a flood of light has been thrown upon the constitution of compound bodies.

In the development of physical chemistry, attention should be directed to the help afforded by Newlands (1864) and Mendelejeff (1869) and others, showing that the elements form groups which tend to recur with a periodicity which is sufficiently definite to enable the investigator to foretell to some extent the properties of the elements which have never yet been discovered, and whose existence is necessary in order to fill up the gaps in existing groups.

By this method the existence, atomic weight and properties of scandium, gallium, and germanium were foretold years before their discovery. Such actual realization of a scientific-prophetic method is one of the strongest indications of the basis of fact upon which it rests. Although a rigid application of the principles of the periodic law is not possible, yet its discovery and elaboration mark one of the great forward steps of chemical philosophy.

If we regard any material system by itself, i.e., independently of any other system or influence by which it may be surrounded, we recognize it as consisting of essentially two things,—matter and energy. A precise definition of either matter or energy is difficult, if not impossible; but what is connoted by these names is sufficiently well understood by their well-known properties. Both energy and matter are essential to each and every system. They are coexistent. In the light of human experience, we cannot conceive of one existing without the other; and in the study of any material system, consideration of one of these components without the other can only be regarded as incomplete. But, for the sake of convenience, this has been the practice, and, generally speaking, chemists have concerned themselves with matter changes of equilibria, while physicists have more especially directed their attention to energy equilibria. The object of the physical chemist is to follow equilibria changes in given systems, having due regard for both the matter and energy involved.

Berthollet may be regarded as the first true physical chemist, on account of his classical views on mass action. Largely because the time was not ripe for it, his views were not generally adopted.

A quarter of a century later (1867), Guldberg and Waage gave a precise mathematical expression of the law, but still it attracted very little attention from investigators. A tremendous impetus was given to the subject by the electrolytic dissociation theory of Arrhenius (1887), and the extension of the additive laws of gases to dilute solutions, by Van't Hoff (1885). This was but a comparatively small field in the subject, but it stimulated activity along the whole line, the wonderful increase of our knowledge concerning the velocity or rates of reaction, the heat changes involved, and the marvelous development of electrolytic chemistry being pertinent instances.

The generalization of Gibbs, known as the phase rule (1876), which accurately states the condition for equilibrium in the system, and the Theorem of Le Chatelier (1884), that any change in the factors of equilibrium from outside is followed by a reverse change within the system, together with the mass law, now give us a consistent theoretical foundation for the subject. In general terms, it may be said that all chemistry, at least all theoretical chemistry, properly belongs to the province of physical chemistry, and the title, while in many ways convenient, is misleading.

III. ORGANIC CHEMISTRY.

Compounds containing carbon enter into all the products of a living cell. For this reason the chemistry of carbon compounds came to be known as organic chemistry. This should not be taken as a definition, however, without limitations. Many of the compounds containing carbon are not known to enter into living tissue in any way, and their connection with it is very remote and not essential. On the other hand, it should be remembered that many organic compounds, and those even of most importance, contain some other element,—nitrogen, for example,—as the significant one.

While nearly all the known elements can enter into organic compounds, the vast majority of such substances are composed of but very few. For instance, those classes of which sugar, starch, the fats, etc., are examples, contain only carbon, oxygen, and hydrogen. With nitrogen, sulphur, and phosphorus added to these elements, almost the entire range of organic chemistry is covered. Organic chemistry, therefore, differs from inorganic chemistry in that, while the number of compounds is much larger, the number of elements involved is very limited.

Berzelius may be regarded as having founded organic chemistry in the beginning of this century. As a result of his analyses of the salts of organic acids, he clearly demonstrated that the laws of definite and multiple proportions hold equally for organic compounds and for inorganic ones. The work of this master was ably furthered by Liebig (1803–1873), who devised most elegant methods for the analytical investigation of organic compounds, methods which are in use to-day without any essential change.

Very soon, however, it was found that organic compounds existed having the same percentage composition, but quite dissimilar properties, physical and chemical, as, for instance, sugar and starch. Other striking examples are Faraday's discovery (1825) of a compound identical in composition with ethylene, but wholly different in properties; and Wöhler's classical synthesis (1828) of urea by the transformation of ammonium cyanate. Similar facts in the domain of inorganic chemistry, though now well known, were at that time wanting, and thus this most fruitful idea, designated as isomerism, was introduced into the science.

The next great step was the introduction of the theory of radicles, first suggested tentatively by Berzelius (1810), but put forward in a definite way as one of the results of the classical investigation on benzoyl by Liebig and Wöhler (1832). That is to say, a group of elements, or radicle, can pass through a series of compounds, from one to the other, as though the group were one single element. For years this idea was the guiding principle in chemical investigations, and was most useful in aiding the classification of chemical compounds and bringing order out of the chaos of accumulating observations.

But the search for radicles was in a sense a vain one. We now know that *no* radicle exists as such by itself. Meanwhile, Dumas and his pupil Laurent had introduced and developed the theory of types, whereby all chemical compounds could be classified under four types, which marked a distinct step in advance. Laurent, together with his colleague Gerhardt (1816–1856), recognized the shortcomings of both the radicle and type theories in their earlier forms, and showed their inter-relation, when modified so as to do away with certain inconsistencies.

Dumas had before this demonstrated the theory of substitution (1834),—that is, that in certain compounds one or more of the elements can be driven out and replaced by others without changing the essential characteristics of the compound. For instance, chloracetic acid, in which part of the hydrogen of acetic acid has been replaced by chlorine, contains all the essential characteristics of acetic acid; in fact, some of them—its acidic properties, for example—being markedly accentuated. This theory was fiercely assailed at first, notably by Liebig. Like all theories of science, it was in the beginning pushed to the extreme, and put forward to explain things to which it was not applicable. It gradually came to demonstrate its own right to existence, largely as a result of the work of Laurent and Gerhardt, and made its influence felt in the exposition of their ideas, to which reference has just been made.

The development of these theories, about the middle of the century, was greatly hastened by the work of many brilliant investigators, notably Wurtz (1817–1884), Hofmann (1818–1892), Williamson (1824–), Kolbe (1818–1884), and Frankland (1825–) among others.

Kekulé proposed a new type, marsh gas or methane. Shortly afterwards, his well-known formula for benzene, the starting-point and foundation of the vast class of aromatic bodies, was proposed. He insisted that the time had come when chemists must ask what those ultimate particles, or atoms, of the elements themselves were doing in these compounds of various types. The answer was a grand one, and the result, our magnificent store of information concerning the *constitution* of organic compounds, or the way in which the atoms are connected with each other. It is not to be inferred that our knowledge on this subject, in any one case, is complete. Far from it! Much that is most interesting and important is apparently as remote from our grasp as ever. But we do know something about the general relations of the atoms in the molecule, and our knowledge, so far as it goes, is definite and precise.

Somewhat later, Van't Hoff and Lebel, at the same time but independently, introduced the study of the space relations of organic compounds by suggesting the simplest possible space formula (the tetrahedron) for marsh gas or methane, of which all other organic compounds may, theoretically at least, be regarded as derivatives. Many inexplicable relations, especially among isomers, now became clear. The theory was at first bitterly assailed, especially by Kolbe. It found an able champion in Wislicenus (1838–), however, and has so thoroughly established itself, that it may be safely said that at the present day it is the controlling idea in the large majority of organic investigations.

The carbon atom is characterized by a wonderful facility in uniting not only with other elements, but with itself. It would even appear as though its influence in this regard extended to other elements united with it, as nitrogen, for instance, shows an unexpected ability to unite with nitrogen in organic compounds.

Further, the carbon atom is characterized by an unusually constant valency, namely, four. These two characteristics account for homology, that is, for a series of similar compounds differing in composition one from the other by—CH_2, and enables us to trace back all organic compounds to one mother substance—marsh gas or methane.

These ideas have also been more or less successfully applied to the study of the composition of inorganic compounds. The assistance organic chemistry has given to the general subject is incalculable. Finally, it may be said, that while in the nature of the case our ideas of structure in organic compounds cannot be regarded as proved, or as not subject to possible future modifications, we have, at least, a consistent theory and good working hypothesis. A homely illustration of our present ideas may be drawn from the modern high city building. The skeleton of this building is made of iron, about which are grouped the brick, stone, wood, and other materials to form a complete building. So the organic body is built on a chain or frame-work or skeleton of carbon atoms, about which are grouped the atoms of hydrogen, oxygen, and nitrogen, or radicle compounds thereof.

It is not possible here to even name some of the more eminent workers who for a quarter of a century have contributed to our knowledge of organic chemistry. This branch of chemistry has been the vogue, and has been pushed almost to the limit of possibility since 1875. Many almost unexplored fields still remain, but chemists recognize the fact that in theory and practice organic chemistry has reached a high degree of perfection, and they are returning to continue the researches in other fields which have for so long been almost neglected.

IV. ANALYTICAL CHEMISTRY.

No branch of chemical science has a more general interest for the public than that which relates to the determination of the materials of which bodies are composed, and the proportions in which they exist.

At the beginning of the century considerable progress had been made in this branch of knowledge by the researches of Boyle (1626–1691), Hoffmann, Margraff (1709–1780), Scheele and Bergmann (1735–1784). Berzelius, as has already been mentioned, had added a new and valuable factor to chemical analysis by the development of the blowpipe, and in the early part of the century mineral analysis was still further advanced by Klaproth (1743–1817), Rose (1798–1873), and many others.

No one man did so much to advance this branch of chemical science as Fresenius (1818–1897). He collated and proved all the proposed methods of analysis, both qualitative and quantitative, and out of a confused mass of material formed a logical system of procedure, which has proved invaluable to the progress of chemical science in all its branches.

The volumetric methods of analysis, which save so much time and labor without sacrificing accuracy, were developed by Gay-Lussac, Vauquelin (1763–1879), Mohr (1806–1879), Volhard, Sutton, Fehling, and Liebig.

The methods of gas analysis have been worked out chiefly by Bunsen, ably assisted by Winkler and Hempel.

The methods of determining the elementary bodies in organic compounds have been developed by Dumas, Liebig, Will, Varrentrap, and Kjeldahl, to the last of whom chemical analysis owes a debt of gratitude for the invention of a speedy and accurate method of determining nitrogen.

Not much less is the debt due to Gooch for the invention of the perforated platinum crucible, carrying an asbestos felt for securing precipitates by filtration, in a form suitable to ignition without further preparation.

Through the classic researches of Arago (1786–1853) and Biot (1774–1862), polarized light has been made a most valuable adjunct to chemical research, serving as it does to measure the quantity of various alkaloids, essential oils, and sugars.

Based on these researches of Biot and Arago, Ventzke, Soleil, Scheibler, Duboscq, Landolt, and Lippich have constructed apparatus, which have made an exact science of optical saccharimetry. Optical analysis is not without its relation to theoretical chemistry, for by it has been proved the assumption that optically active bodies contain an asymmetrical carbon atom,—that is, one which combines with four different atoms or radicles.

Electricity has become also one of the most useful factors in chemical analysis. Many metals are easily deposited by electrolytic action, and their separation and determination rendered easy and certain.

Chemical analysis has not only given us accurate knowledge of the constituents of matter, but by revealing the deportment of molecules and groups of molecules in inorganic and organic compounds, has opened up a path for organic and synthetic chemistry which otherwise must have remained forever closed.

The discovery and development of spectrum analysis is one of the great achievements of the nineteenth century in chemical science.

Wollaston, in 1802, first noticed that the spectrum of the sun’s light, when greatly magnified, was not composed of colors gradually changing from one to the other, but that the continuity of the colors was interrupted by dark bands. Fraunhofer, in 1814, had made a map of the solar spectrum, showing 576 of these dark lines. Fraunhofer was entirely ignorant of the cause of these dark lines, but when he had found them, not only in the light from the sun, but also from the moon and the fixed stars, he properly concluded that they were due to something entirely independent of the earth.

It remained for Bunsen and Kirchhoff, in 1860, to point out the fact that these dark lines were characteristic of certain chemical elements existing in the sun and its photosphere, and this fact is the foundation of spectrum analysis. The broad black band in the sun’s spectrum, called by Fraunhofer D, corresponded exactly in position and in width with the yellow band produced by a flame containing incandescent sodium. There was no doubt whatever, therefore, that the two phenomena were due to the same cause; but why in the one case should the band be black and in the other yellow? This question was answered by the discovery of the fact that a ray of light colored by incandescent sodium, passing through a luminous atmosphere of the same metal, would lose by absorption all of its yellow color, and would display a black band where before the yellow color existed.

Based upon this observation, the development of spectrum analysis went forward with amazing rapidity. The hundreds of lines in the sun's spectrum were found to occupy exactly the position of luminous lines in the spectra of various metals, and thus it was possible for the chemist to extend his investigations beyond the limits of the earth, and distinguish the chemical elements in the sun and in the fixed stars billions of miles farther away from us than the sun itself. Celestial chemistry has thus become a fixed and definite science.

But the value of spectral examinations has extended still farther. Many luminous lines were observed in the spectrum which were not found in the spectra of any known element. The inference then logically arose that there were elements yet undiscovered to which these lines were due. From this starting point investigations proceeded which have led to the discovery of a large number of elementary bodies. Among the important elements that have been discovered by means of spectrum analysis may be mentioned: cæsium, rubidium, thallium, indium, gallium, ytterbium, and scandium.

Spectrum analysis is also extremely useful in proving the verity of supposed new elements; for if a supposed new element should be found to give a series of spectral lines coincident with those already known, it would be a positive proof of the fact that the supposed new element was but a mixture of bodies already known to exist.

V. SYNTHETICAL CHEMISTRY.

This branch of chemical science has for its object the building up of the more complex from the simpler forms of matter. In the early part of the century, Chevreul and Wöhler laid the foundation of the science by the synthesis of fatty-like bodies and urea. Berthellot and Friedel (1832–) in France, and Williamson and Frankland in England, added much to our knowledge. Kolbe, in Germany, made salicylic acid so abundantly as to banish the natural article from the market. The synthesis of coloring matters resembling indigo was also a great blow to that industry. From the products of the distillation of coal, chemists were able to make thousands of valuable bodies of the greatest utility. Many medicinal substances and nearly all the common dyes trace their origin to coal.

Fischer (b. 1852), in Germany, has contributed his remarkable results in the synthesis of sugar to the last years of the century. Lillienfeld, in Austria, has gone still further, and has built up a body which has many of the properties of protein, one of the most highly organized of organic substances.

In the inorganic world synthesis is not so difficult a matter as the vast number of compounds attest. By means of the electric furnace, Moissan, in France, has succeeded in uniting carbon with many of the metallic elements, and thus opened the path for new achievements in passing directly from inorganic to organic compounds.

The progress of chemical synthesis has already blotted out the old distinction between inorganic and organic chemistry, and we can no longer say of organic bodies that they are the products of living cells. Organic bodies are those which contain a carbon or other elementary skeleton, to which are attached the elements or groups of elements forming the complete body.

The claim which has been made that synthetical chemistry would in the near future produce the food of man, and thus relegate agriculture to the domain of the useless or forgotten arts, is, however, wholly without scientific foundation. The function of the farmer will not be usurped by the chemist. The future will see the most important contributions to chemistry coming from the field of organic chemistry, but it will also see the farmer following in the furrow, and man depending for his food on the fields of waving grain.

VI. METALLURGICAL CHEMISTRY.

This is the oldest branch of chemical science, and naturally the one which was furthest advanced at the beginning of the century. Nevertheless, the advances which the past one hundred years have seen in this science are most surprising. Gold and silver are now secured from ores so poor as to have rendered them of no value a hundred years ago. The Bessemer process of steel making (1856) has revolutionized the world, and made possible railroads and steamships. The basic Bessemer process of making steel from pig-iron rich in phosphorus, has opened up rich mines of iron ore hitherto valueless. The basic phosphatic slag, resulting from this process, is of the highest value in the fields, and has brought agriculture and metallurgy into intimate relationship. The electric furnace has made aluminium almost as cheap as iron, bulk for bulk, and electric welding bids fair to take the place of the old process, with the cheapening of metals.

VII. AGRICULTURAL CHEMISTRY.

Sir Humphry Davy, in the beginning of the century, delivered a course of lectures on the relations of chemistry to agriculture, and these were published in book form. In France, important contributions were made to agricultural chemical science by Vauquelin, Chevreul (1786–1889), and Boussingault (1802–1887), who made important researches before the middle of the century. The most important work in agricultural chemistry, however, was done by Liebig. His achievements so overshadowed those of his predecessors that he is generally regarded, although improperly, as the father of that branch of the science.

The early achievements of these workers showed the relatively small portions of the crops that were derived from the soil. The study of the ash constituents of plants laid the foundation of rational fertilizing, and the utilization of the stores of plant food preserved in great natural deposits.

Beginning with the middle of the century, the attention of agronomists was called to the desirability of utilizing the deposits of guano, found in the islands along the west coast of South America; of the deposits of phosphate rock existing in many localities; and later, of the potash salts, discovered near Stassfurt, which completed the trio of available natural foods most useful to plants.

The establishment of an agricultural experiment station by Sir John Lawes at Rothamstead (1834), before the middle of the century, set an example which has been followed by the establishment of experiment stations in all the civilized countries of the world.

Under the great stimulus given to agricultural research by these stations, progress during the latter half of the century has been very rapid. There now exist in Europe nearly one hundred stations devoted to agricultural research, and in this country the number is half as great.

Conspicuous achievements, marking the closing years of the century, have been the discovery of the methods whereby organic nitrogen is rendered suitable for plant food, and atmospheric nitrogen fixed and rendered available by leguminous plants. In the first instance, it has been established that organic nitrogen in the soil can only be utilized by plants after it has been oxidized by bacterial action. In the case of leguminous plants, nitrogen is rendered available for nutrition by means of bacteria inhabiting nodules in the roots of the legumes. These two great discoveries have proved of incalculable benefit to practical agriculture. Chemical science in its relations to agriculture has shown that the fertility of the soil may be conserved and increased, while the magnitude of the crops harvested is sustained or augmented. Thus, no matter how rapid may be the increase of population, agricultural chemistry will provide abundant food.

VIII. GRAPHIC CHEMISTRY.

The honor of discovering that prints could be made by the action of light on certain salts, such as those of silver, belongs to Daguerre, in 1839.

The fundamental principle of graphic chemistry is that metallic salts, sensitive to the light, when in contact with organic matter, suffer a complete or partial reduction and are rendered insoluble. The intensity of the reduction is measured exactly by the intensity of the light. When light is reflected from any object capable of producing different degrees of intensity, as from the hair and face of a man, the reduction of the metal is greatest by the light from that portion of the physiognomy which gives the greatest reflection. Thus, when the unreduced metallic salt is washed out, a permanent record, the negative, of the object is left.

It is a long step from the first daguerreotype to the modern photograph, but the principle of the process has remained unchanged.

Photographs in natural colors have of late years been obtained. One method is by interposing a film of metallic mercury behind the sensitive plate which must be transparent. The reflected rays of light, having different wave lengths, precipitate the metal in superimposed films, corresponding to the wave or half-wave length. When a negative thus formed is seen by reflected light, the emergent rays from the superimposed films acting as mirrors are transformed into the original colors of the photographed object.

The various methods of printing by heliotypes, photolithographs, photogravures, etc., are illustrations of the application of graphic chemistry to the arts.

IX. DIDACTIC CHEMISTRY.

The lectures of Davy and Faraday in England, of Wöhler and Liebig in Germany, of Chevreul and Dumas in France, and of Silliman (1779–1864) in this country, made the study of chemistry attractive and easy during the early part of the century.

It was noticed, however, that the students who finished these courses, while well versed in the principles of the science, were not able to apply them in practice. Towards the middle of the century, therefore, a radical change in the system of instruction was inaugurated. The student was put to work and taught to question nature for himself. The universities of France and Germany were equipped with working desks where students of chemistry put into practice at once the principles of the science which they heard elucidated in the lecture room. Cooke, at Harvard, was the chief apostle of the laboratory method in this country, and this method of instruction has now spread, until even the high and grammar schools have their chemical laboratories.

In our universities, students may now begin their chemical studies associated with laboratory practice in the first year of their course, and continue it to the end. Graduates of such courses are not only grounded in the theories of chemistry, but are thoroughly familiar with its practice. Under this system, coupled with the demand for chemical services in every branch of industry, the number of trained chemists has speedily increased. At this time (1899) there are more than four thousand trained chemists in the United States.

X. CHEMISTRY OF FERMENTATION.

Our knowledge of fermentation and bacterial action is practically all comprised in the achievements of the nineteenth century. Prior to this time it was known that fermentation took place, but its causes and character were wholly mysterious. The great work of Pasteur (1859) resulted in the fact that fermentations were chiefly caused by the activity of living cells, which have the capacity of reproduction. The most common form of fermentation is that whereby sugar is converted into alcohol and carbon dioxide. The name of the organism that produces this change is *saccharomyces cerevisiae*.

Another class of fermentation is seen in the process of digestion. This species of fermentation is typified by the action of sprouted barley on starch, whereby the starch is converted into sugar. The active principle of the saliva, ptyalin, has the same property, and when starchy bodies are masticated, a part, at least, of the starch which they contain is converted into sugar. The active principle of malt is known as diastase, and this, as well as ptyalin, belongs to a class of ferments which are incapable of reproduction.

All the decompositions of organic matter, such as the decay of meats and vegetables, are now known to be forms of fermentation, due to the action of certain organisms known by the group name of bacteria. This discovery led naturally to the process of preserving organic compounds by sterilization. The principles on which this process depends are very simple. If an organic body, such as a fruit or vegetable, be subjected for some time to a high temperature,—that of boiling water will usually suffice,—the fermentation germs which it contains will be destroyed. If then it be sealed in such a way, either hermetically or with a plug of sterilized cotton, so that no living germ can reach it, decomposition cannot take place. Certain chemicals, such for instance as salicylic acid and formaldehyde, have the property of paralyzing or suspending germ action, and hence organic bodies treated with these substances may also be protected against decomposition.

The activity of fermentation is made use of in the technical arts. Bread is made light by fermentation, and wine, beer, and cider are made by the fermentation of fruits and grains. Alcohol is produced by the fermentation of grains and potatoes, their starch having previously been converted into sugar by malt.

Buchner has lately shown that all fermentation is of one kind, namely, that due to ferments of the diastase type. The fermentation produced by yeast, for instance, is not due, according to his observations, to the living cells, but to the products of their activity. By destroying yeast cells, by grinding and high pressure, and using their contents, he has secured a vigorous fermentation similar in every respect to that caused by the cells themselves.

XI. ELECTRO-CHEMISTRY.

The electric furnace, which affords a higher heat than chemists had been able to secure, has been the promoter of great advances in inorganic chemistry. Moissan (b. 1852), a French chemist, has been the most successful in applying the heat of the electric furnace to analytic and synthetic studies. One of the practical results which has come from these studies has been the virtual bridging over of the chasm which has been supposed to exist between organic and inorganic compounds. Under the influence of the heat of the electric furnace, carbon, which is the keystone of organic compounds, has been made to combine directly with the metals, forming a series of bodies known as metallic carbides. The carbide of calcium, under the action of water, yields a gas known as acetylene, which by a series of reactions can be converted into alcohol. Thus alcohol, which only a short time ago was supposed to be solely the product of organic life, is shown also to result from a simple inorganic reaction such as has been shown above.

The importance of electrolysis in metallurgical and analytical chemistry has already been noticed. So rapid has been the progress along these lines that the terms metallurgical chemistry and electro-chemistry are in some respects almost synonymous.

Electricity has also been employed in many of the chemical arts; *e. g.*, in the promotion of crystallization and purification of organic solutions as practiced in the sugar industry.

Though belonging rather to analytical than to electro-chemistry, one may here mention the wonders of that discovery which belongs to the close of the nineteenth century, and which is known as “liquid air.” Until 1877 air—oxygen and nitrogen—was regarded as a permanent gas. Oxygen liquefies at 300° below zero and nitrogen at 320°. When air is cooled to those degrees it assumes a misty form and falls like raindrops to the bottom of the vessel. It then gives off vapor, like boiling water. If poured out on a conductor, as iron or ice, it assumes the gaseous state so rapidly as to amount to an explosion. The many experiments with it are simply wonderful, and the practical claims for it are without end. Already it runs an engine and motor vehicles. It is claimed that it will complete the problem of aerial navigation; that it is the coming power in gunnery and blasting; that it affords the ideal sanitation; that in surgery it offers the most perfect chemical cauterization.

CONCLUSION.

There is no branch of science that holds such an intimate relation to the progress and welfare of man as chemistry. First of all, it is chiefly instrumental in providing him with food and clothing, as has been shown in the paragraph on agricultural chemistry. In the second place it has extended his domain over matter and, in connection with physics, has established the identity of the composition of the universe with that of the earth. The universe has thus been shown to be of a single origin and of uniform properties. By understanding the constitution of matter, with which he is surrounded, man is able to utilize to the best advantage the material at his disposal. Thus invention is promoted and the application of chemical knowledge in the arts extended.

The Century's Music And Drama

By RITER FITZGERALD, A.M.,
Dramatic Critic "City Item," Philadelphia.

I. MUSIC.

Music finds its highest artistic development in the happy combinations which go to make up the opera. These combinations passed through various historic stages, and ripened into noble maturity by the end of the eighteenth century, under the guiding genius of the Handels, Mozarts, and Glucks of the times. Their legacy passed, in the nineteenth century, to a host of worthy successors, among whom stands, as a central figure, Verdi, the great Italian operatic composer; while Wagner, of Germany, has striven with herculean might to revolutionize the lyrical drama by polemical writing, by twofold authorship of words and notes, and by a new application of principles gathered from antecedent reformers. His efforts produced a commotion in the art world which might be compared to that excited by the rivalry between Buonocini and Handel in London, or Piccini and Gluck in Paris, but for the fact that in each of these instances the contention was between one composer and another, whereas in the case of Wagner it was the opposition of one composer to all others in the world, save the few who, believing in the man, his teachings, and his wonderful powers of application, undertook propagandism as a duty, and endeavored to make proselytes to their faith. He did not live to see the day when his efforts could be called completely successful, and his death in 1883 left judgment quite wide open as to his theoretical and practical merits. The nineteenth century closes with the question still on as to the permanence or evanescence of his many unique, ponderous, and revolutionizing productions.

Verdi, who still lives, surpasses all the composers of his time in the beauty of his melodies and the intensity of his dramatic power.

Rossini, whose "Guillaume Tell," which was produced in Paris in 1829, was his masterpiece, ruled the operatic world before Verdi, until he died in Paris in 1868.

Meyerbeer, whose principal operas are "Les Huguenots," "Le Prophète," and "L'Africaine" (the latter produced in Paris in 1865, the year after its composer's death), was regarded as a remarkable composer, whose knowledge of effect was unsurpassed, and whose fine intelligence and musical knowledge almost made the world forgive him for frequent lack of inspiration.

Halévy, whose only lasting success was "La Juive," composed other operas, such as "Charles VI.," "La Reine de Chypre," "L'Eclair," and "Les Mousquetaires de la Reine," that achieved a certain amount of success in France, which success was interrupted by Halévy's death at Nice in 1862.

Gounod, in 1859, made his most remarkable success with his greatest opera, "Faust," which, after the subject had been treated by Spohr, Lindpainter, Schumann, Berlioz, and other distinguished composers, has remained the only completely successful opera on the subject, although Boito's "Mefistofile" (another version of the subject) achieved a marked success in Italy in 1868, and placed Boito among the remarkable composers of the day. As for Gounod, his other operas never equaled his "Faust." Next in merit comes "Roméo et Juliette" (produced in Paris in 1867) and then his "Mireille," which appeared in 1864, and "Philémon et Baucis," an exquisite little comic opera produced in 1860. His last opera, "Le Tribut de Zamora," was given at the Grand Opera, Paris, in 1881, and failed.

Donizetti, who died in Bergamo in 1848, was for many years one of the most popular operatic composers. He possessed undoubted ability, but wrote carelessly, as the Italians did in that day. But his operas contain much that is beautiful, and often show fine dramatic power. His "Lucia" contains inspired pages, while other portions are inexcusably commonplace. The same remark applies to his "Lucrezia Borgia," "La Favorita," and "Maria di Rohan;" while in his comic operas, such as "Don Pasquale" (which was composed in three weeks), his "L'Elisire d'Amore" and "La Fille du Régiment," Donizetti appears to better advantage. They are melodious and very agreeably written. His fertility may be imagined when you are told that he composed over sixty operas during his career, as well as other compositions.

Bellini, whose career was a short one, as he was born in 1802 and died in 1835, was badly trained and could not be called a well-schooled musician, being rather a musician by instinct. But he possessed remarkable ability, and, perceiving that the persistently florid style of Rossini (which all the composers of that time blindly imitated) was approaching an end, treated his melodies with a simplicity and directness that at once attracted attention and met with approval.

Bellini's knowledge of instrumentation was childish, but his intimacy with Rubini, the famous tenor, aided him in achieving an admirable treatment of the voice. His operas were very sweet and melodious. The two operas by which he will be remembered are "La Sonnambula" and "Norma," the latter being, with all its faults, a great opera.

Another talented and prolific operatic composer was Mercadante, whose "Il Giuramento" (produced in 1837) achieved considerable popularity. But Mercadante's successes were generally confined to Italy. He composed sixty operas, and died in 1870 in Naples.

Ponchielli, who was born in 1834 and died in 1886, will be principally remembered by his remarkably beautiful opera, "La Gioconda" (produced in 1876), which, together with a re-written version of his first opera, "I Promessi Sposi," gave him great popularity in Italy and spread his reputation to other countries.

As for Italy's young composers that profess to represent the modern Italian school of opera, they are led by Puccini, whose "Manon Lescaut" and "La Bohême" are melodious and full of merit.

Mascagni and Leoncavallo, whose "Cavalleria Rusticana" and "I Pagliacci" achieved popularity, have not realized expectations. Nor has Giordano, whose "Andrea Chenier" was well received in Italy.

Bizet, whose "Carmen" is one of the most remarkable of modern operas, died in Paris in 1875. "Carmen" has remained in the repertoire. His other opera, "Les Pécheurs de Perles," only achieved a moderate success.

One of France's greatest musicians, Hector Berlioz, was born in 1803 and died in 1869. His operas, "Les Troyens," "Benvenuto Cellini," his "Damnation de Faust," his "Roméo et Juliette" symphony, are all great and afforded Wagner a model that he imitated persistently.

In 1871 France lost one of its most talented operatic composers, Auber, whose "Masaniello" and "Fra Diavolo" are two of the most popular operas ever written by a Frenchman. Auber composed comic operas charmingly, and his "Domino Noir," "Diamants de la Couronne," "Haydée," and other works of a similar character, entertained the French people for many years. Auber's death has left a vacancy that has not been filled.

The modern French composers cannot be called great. Saint-Saens, whose most successful work is “Samson et Dalila” (which is more of an oratorio than an opera, and which was produced in 1877), has composed other operas, such as “Henri VIII.,” “Ascanio,” et cetera, which lack originality and inspiration.

Massenet has composed “Le Roi de Lahore,” “Hérodiade,” “Manon,” “Werther,” et cetera, that have had passing successes.

Both Saint-Saens and Massenet have attempted to follow Wagner in their sonorous orchestration; but their works lack distinction. The French composers of to-day have been demoralized by Wagner’s affectations.

The death of Ambroise Thomas, in 1895, caused France the loss of one of her most successful and accomplished operatic composers, whose “Mignon” will be long admired as a very charming opera comique, while his “Hamlet,” though containing portions that are ably written, has never attained outside France any remarkable success.

Reyer, whose “Sigurd” was produced in 1884 with considerable success, is a follower of Meyerbeer. His “Salammbo” was produced in 1890, but did not attract the attention expected outside of France.

German opera of the latter part of the century has been so demoralized by the influence of Wagner that the German composers have become little more than imitators of his pronounced mannerisms.

Weber’s “Der Freischütz” remains the most popular of German operas, just as Verdi’s “Il Trovatore” is the most popular of Italian operas.

Spohr, Lindpainter, and many other German composers of ability have been laid on the shelf.

Marshner, who died in Hanover in 1861, showed in his “Hans Heiling” that he was a follower of Weber, as well as in his “Templar and Jewess.”

Cornelius, who died in Mainz in 1874, made his principal success with his “Barber of Bagdad,” a comic opera in which the manner of Wagner was imitated. In 1864 “The Cid” was produced in Weimar, but it was found depressingly heavy and labored.

Goldmark, a follower of Meyerbeer, made a success in 1875 with his “Queen of Saba” that was not equaled by his “Merlin,” produced in 1886, or his “Prisoner of War,” produced in 1899.

To return to the great leader of opera—Verdi—one may say of him that his operas are divided into three periods. The first included the works written in the old Neapolitan style as he had found it. To this class belong “Nabucco,” “Attila,” et cetera. To the second period, which shows remarkable dramatic color and beautiful melody, belong “Rigoletto,” “Ernani,” and “Ballo in Maschera” (in which Verdi began to pay attention to his instrumentation). To the third period belongs “Aïda,” which is his most characteristic and remarkable opera, in which the melody is wonderfully fresh and beautiful, combined with remarkable science.

“Otello” is also a great work, written at a time of life when most composers retire, and broadly dramatic in its treatment of the situations, illuminated by rich and expressive instrumentation.

As for “Falstaff,” the latest opera that Verdi has written, and probably the last he will write, it is the greatest modern comic opera, just as Mozart’s “Nozze di Figaro” is the greatest comic opera of the past. It convinces the world that Verdi’s genius is inexhaustible.

Next to Verdi comes Wagner, the anarchist of music, who began in “Rienzi” and “The Flying Dutchman” by imitating the Italian forms of melody. In “Tannhäuser,” portions are very beautiful and melodious; in “Lohengrin,” portions are fine; but Wagner’s idea of effect was bad and he never knew when to stop, so that many of the scenes are interminable. This fault increased as Wagner composed the “Nibelungen” series for the crazy king of Bavaria. Melody vanished, the singers became secondary to the orchestra, which was persistently noisy. Wagner’s effort was to create a new school of opera, in which everything should be minutely descriptive. He went too far and opened the question of failure. In opera the voices claim the first place, and the orchestra is an accompaniment, so that Wagner’s method was radically wrong.

Independent of this, he attempted to infuse life into the “Nibelungen” series, whereas he adopted a tangled and childish fairy-story that was more absurd than impressive. The later Wagner operas, which the composer calls “music dramas,” are tiresome and monotonous to such a degree that, with all the remarkable talent of Wagner, they may never become popular, and may be eventually laid on the shelf, to be regarded in the future as musical curios.

The musicians of the United States are steadily developing, and for so young a country we have a large number of composers of first-class ability, such as Macdowell, Foote, Lang, Chadwick, Gilchrist, and many others who have produced important compositions.

In opera the American composers have done nothing, for the reason that there are no opportunities for the production of such works. If there were, we should soon have many operatic composers, and should speedily take high rank in the lyric drama.

II. DRAMA.

The theatre of the latter part of the century shows a remarkable advance, in certain respects, over the theatre of the past, which consisted of a “star,” an inferior company, poor scenery and appointments, et cetera; whereas to-day there are many more really good actors and actresses, the theatres are far more comfortable and artistic, the scenery, costumes and details are beautiful and correct.

We have no Mrs. Siddons, no Kemble, no Rachel, no Talma; but we are confident that the actors and actresses of to-day are like the theatre of to-day,—they have more finish, and the results, while they may not rise to the plane of the school of Shakespeare, are nearer nature than they have ever been.

The school of declamation, which belonged to the plays of the past, is the severest loss the stage of to-day has felt. The actors and actresses fail in elocution. They do not know where to put their emphasis. They seem lost when they appear in costume, and Shakespeare to-day has no distinguished exponents.

The English-speaking stage of the century has been adorned by such eloquent interpreters and powerful tragedians as Edwin Forrest, Charlotte Cushman, Edwin Booth, and Henry Irving. But this illustrious roll has been almost extinguished by death; and, especially if applied to America, the question may well be asked, where is the actor or actress who can play Hamlet, or Macbeth, or King Lear, or Shylock as we were wont to see them rendered by those masters of the dramatic art, or as they should be rendered? Salvini and Rossi have both passed away. Irving verges on retiracy. Of the great dramatic actresses left to the closing of the century, Mme. Sarah Bernhardt stands preëminent. The day of the imposing declamatory drama seems to have lost its lustre at the sunset of the century.

But the modern dramas and comedies are acted, even in the smaller parts, with admirable intelligence and effect, and we may add that the vice that disgraced the stage of the past is by no means so visible in the theatre of the present.

The coarseness that clung so long to the theatre is gradually disappearing, and the theatre-goers of to-day have discovered that the theatre, which was created to entertain the world, can do so without recourse to vulgarity.

The theatres of the United States are the handsomest and most convenient in the world. This Mme. Sarah Bernhardt acknowledged the other day, while criticising the theatres of Paris, which lack many conveniences.

Up to within twenty-five years of the close of the century, plays written by American authors were rare. Managers had to rely upon those composed in Europe. But at present the United States possesses many able and successful playwrights, just as it does its artists in all departments. There has not been a time during the century when the personal character of actors and actresses has escaped discussion, and sometimes violent criticism, by those prejudiced against the theatre. This does not seem to have lessened the estimation in which dramatic art is held, nor to have seriously diminished in number the legion who find in the drama their most pleasurable recreation and keenest intellectual delight. In answer to challenges of the morality of the stage, Bronson Howard has fittingly said: “I have never yet seen anybody who wanted a bad picture just because it was painted by a good man. It is society that corrupts the stage, not the stage that corrupts society.”

The Century's Literature

By JAMES P. BOYD, A.M., L.B.

In contrasting the world's nineteenth century literature with that of the eighteenth, one is impressed with the many remarkable differences. But by no means all of such differences are to the discredit of the older literature. As instances, the prose literature of the nineteenth century may not surpass that of the eighteenth in elegance and accuracy of expression, though its progress has been very marked in the diversity of its applications to mental needs; and the poetical literature of the nineteenth century may not excel that of the eighteenth in beauty and virility, though it has advanced in loftiness of theme and tenderness of mode. And so, when literature is divided into its many minor branches, as history, philosophy, the sciences, etc., various features of the old compare favorably with the new.

It is in its general tone and universal aptitude that the literature of the nineteenth century stands out preëminent. The wonderful intellectual activity of the century has been, as it were, compelled to go forth along literary lines quite parallel with those that distinguish other fields of activity. This may have had a tendency in some instances to rob the century's literature of some of the sweetly imaginative elements, and to harden it in some of its essential forms, but the process was necessary to secure for it just that quality which would best meet a progressive demand. As the drift of human energy was toward the practical, so the dominant literary thought took on the form of direct and exact expression. There was less and less room for the indulgence of literary foible or speculative whimsicality. Even where elegance of style met with occasional sacrifice, it was more than compensated by that general rise in literary tone which has characterized the century. Literature could not be untruthful amid active inquiry and scientific progress. It must reflect, more accurately than ever before, its birth inspirations and its legitimate uses. It must keep even pace with the demands for it. A world crying for intellectual bread could not be put off with an antiquated stone.

Without closer analysis, the above is true of the literature of all reading and writing peoples who have kept touch with the century's progress. But it is especially true in the literature of English speaking peoples. History has, in accordance with a growing spirit of research, become more truthful, philosophy more expressive, and science more exact. The outcrop of books shows the yearnings of the century, not only as to their number but as to theme and treatment. Authors have multiplied as during no other world's era, and the proportion of those who have attained permanent distinction was never larger.

"German literature," says Professor Ford, in "Self Culture" for February, 1899, "has had its measure of ups and downs, but its first age was its golden age. From the beginning of the century to the present day is a far cry in German letters. Romanticism, idealism, realism—the Fatherland has lived through them all. And for what? In a land of scholars no great philosopher; among hosts of verse-makers no great poet; among innumerable story-writers, not one who has become known over a continent.

"Still these last years in Germany have not been without some good work done, though often achieved under the spur of wrong ideals and improper motives. From the days of '48, when Young Germany felt for the first time the seductive charm of revolutionism, a new feeling has possessed German literature—a feeling that the past is past and out of date, potent once but potent no longer, and that the new age of man demands new principles, new ideals, a new faith. And so the modern literature, particularly so since 1870, has been marked by iconoclasm and startling innovation; it has discarded sentiment and line writing, and made a plea for scientific methods, with the privilege of exhibiting exact, scientific results. Crimes, disease, and grinning skeletons have been dragged forth to the public gaze, for art is no longer art that portrays the ideal and not the true. Such, in short, is the creed by which the realistic or naturalistic school has thought to overthrow the old, conventional, and frivolous, to foster the spirit of the new nationality, and prepare a balm for the wounds of the poor.

“Two men stand to-day as leaders of this new movement,—Hermann Sudermann and Gerhardt Hauptmann,—the most commanding figures in contemporaneous German literature.”

During the nineteenth century the United States took a high and firm place in the domain of literature, and, it may be said, has evolved a literature that in scope and style is peculiar to her institutions and environment. Her array of authors, both in number and reputation, compares favorably with that of countries boasting of a thousand years of literary domination, and her literature is as diversified and practical as her activities. Among the many illustrious historians of the century she numbers her Bancroft, her Hildreth, her Prescott, her Motley, worthy counterparts of England’s Lingard, Hallam, Macaulay, Buckle, and Kinglake. Among her poets are Longfellow, Whittier, Bryant, Lowell, Halleck, fit companions of Tennyson, Browning, Wordsworth, Scott, Swinburne. Among her novelists are Cooper, Hawthorne, Stowe, worthy congeners of Dickens, Thackeray, and Eliot. And so, the comparison holds in travel, philosophy, theology, law, and science.

If in dramatic literature the United States has, during the century, produced few authors of permanent reputation, and perhaps none to be compared with Knowles, Boucicault, Taylor, and Robertson, of the Old World, nevertheless it cannot be said of these that their plays have had more than a stage value. The drama of the century in following the demand for artistic and commercial results has sustained only in part the reputation of its literature. But in lieu of this partial decadence, there have sprung up new branches of literature which are, in a measure, compensatory. Among these are the critical literature of arts and design, the literature of philology, or of language, and the literature of political and social science. To these must be added two other kinds or classes of literature which, if not peculiar to the century, have yet found in it their most surprising evolution, greatest glory, and widest influence. These are the literature of the newspaper and magazine, as distinguished from that of the book.

But before making further mention of these, let us read somewhat of New World literature as viewed from a critical English standpoint. Says the critic, “English critics are apt to bear down on the writers and thinkers of the New World with a sort of aristocratic hauteur; they are perpetually reminding them of their immaturity and their disregard of the golden mean. Americans, on the other hand, are hard to please. Ordinary men among them are as sensitive to foreign censure as the *irritable genius* of other lands. Mr. Emerson is permitted to impress home truths on his countrymen, as ‘Your American eagle is very well; but beware of the American peacock.’ Such remarks are not permitted to Englishmen. If they point to any flaws in transatlantic manners or ways of thinking with an effort after politeness, it is ‘the good-natured cynicism of well-to-do age;’ if they commend transatlantic institutions or achievements, it is, according to Mr. Lowell, ‘with that pleasant European air of self-compliment in condescending to be pleased by American merit which we find so conciliating.’

“Now that the United States have reached their full majority, it is time that England should cease to assume the attitude of guardian, and time that they should be on the alert to resent the assumption. Foremost among the more attractive features of transatlantic [American] literature is its *freshness*. The authority which is the guide of old nations constantly threatens to become tyrannical; they wear their traditions like a chain; and, in canonization of laws of taste, the creative laws are depressed. Even in England we write under fixed conditions; with the fear of critics before our eyes, we are all bound to cast our ideas into similar moulds, and the name of 'free thinker' has grown to a term of reproach. Bunyan's 'Pilgrim's Progress' is perhaps the last English book written without a thought of being reviewed. There is a gain in the habit of self-restraint fostered by this state of things; but there is a loss in the consequent lack of spontaneity; and we may learn something from a literature that is ever ready for adventures. In America the love of uniformity gives place to impetuous impulses; the most extreme sentiments are made audible, the most noxious 'have their day and cease to be;' and the truth being left to vindicate itself, the overthrow of error, though more gradual, may at last prove more complete. A New England poet can write with confidence of his country as the land

"'Where no one suffers loss or bleeds
For thoughts that men calls heresies.'

"Another feature of American literature is *comprehensiveness*. What it has lost in depth it has gained in breadth. Addressing a vast audience, it appeals to universal sympathies. In the Northern States, where comparatively few have leisure to write well, almost every man, woman, and child can read, and does read. Books are to be found in every log-hut, and public questions are discussed by every scavenger. During the Civil War, when the Lowell factory-girls were writing verses, the 'Biglow Papers' were being recited in every smithy. The consequence is, that, setting aside the newspapers, there is little that is sectional in the popular religion or literature; it exalts and despises no class, and almost wholly ignores the lines that in other countries divide the upper ten thousand and the lower ten million. Where manners make men, the people are proud of their peerage, but they blush for their boors. In the New World there are no 'Grand Seigniors' and no human vegetables; and if there are fewer giants, there are also fewer manikins. American poets recognize no essential distinction between the 'village blacksmith' and the 'caste of Vere de Vere.' Burns speaks for the one; Byron and Tennyson for the other; Longfellow, to the extent of his genius, for both. The same spirit which glorifies labor denounces every form of despotism but that of the multitude. Freed of the excesses due to wide license, and restrained by the good taste and culture of her nobler minds, we may anticipate for the literature of America, under the mellowing influences of time, an illustrious future."

In treating of newspaper literature, one cannot proceed without blending its origin, style and aims with the business enterprise that cultivates and supports it. And this may be done all the more cheerfully and properly, for the reason that there is no history more interesting than that of the evolution of the newspaper, and no consummation of mental and physical energy that places the nineteenth century in more vivid contrast with preceding centuries.

For the fatherhood of the newspaper we have to travel to a land and date calculated to rob modern civilization of some of its boastfulness. The oldest known newspaper is the "Tsing-Pao," or "Peking News," mention of whose publication is made in Chinese annals as far back as A. D. 713, when it was then, as now, the official chronicler of the acts of the emperor, the doings of the court, and the reports of ministers. It has appeared daily for nearly fourteen hundred years, in the form of a yellow-covered magazine, some 3¾ by 7½ inches in size. The pages number twenty-four, and are printed from wooden movable type. Two editions are published, one on superior paper, for the Court and upper classes; the other on inferior paper, for general readers. Its editorship is in the Grand Council of State, which furnishes to scribes or reporters the news deemed fit for publication. As an official organ, it first finds circulation among the heads of provinces, and is by them further distributed to patrons. This ancient purveyor of news seems to have pretty fully gratified the Chinese taste for that kind of literature; for even at the present day there are few newspapers in the empire published in the native language. The few that have sprung up are confined to the larger cities, as Shanghai, Hongkong, and Peking, where they are liberally patronized. But their circulation and influence do not extend far into the interior, owing to the lack of postal facilities. The modern Chinese newspaper can hardly be called a native enterprise. It grew out of the necessity for a literature and a means of news communication which arose at the time the Chinese ports were forced open to the world's commerce. As a consequence, a majority of the Chinese publications have found their inception in foreign brains and capital, and remain under the management of foreigners. The same is true of Japan, where the modern native newspaper practically dates from the arrival of the foreigner. But by reason of their greater mental and commercial activity, and the rapidity with which they adjusted themselves to modern modes of civilization, the Japanese have far outstripped the Chinese in their evolution of newspaper literature and enterprise. Whereas, what may be called the first modern Japanese newspaper was founded in 1872, there sprang up in the following twenty years the almost incredible number of 648 newspapers and periodicals, not only due to native capital and enterprise, but under native control. This wonderful growth took place, too, in the face of the severest code of press laws existing in any country.

In Europe, the earliest inklings of a newspaper literature consisted of news pamphlets of infrequent and uncertain publication, and dependent for circulation upon temporary demand. The earliest departure from this stage was in Germany, in 1615, when the "Frankfurter Journal" was organized as a weekly publication, for the purpose of "collecting and circulating the news of the day." Antwerp followed with a similar enterprise in 1616. The first attempt to do likewise in Great Britain was in 1622, when "The Weekly News" was founded in London. None of these enterprises were by editors, in a modern sense, but by stationers, in the line of their ordinary trade. They did not depend for patronage on regular subscribers, but sold their publications on the streets through the agency of hawkers, corresponding to our modern newsboys, though they bore the classical name of "mercuries."

The foundation of the first newspaper in France that attained permanence and fame was in 1631. It was called the "Gazette de France," and owed its origin to a demand for mingled news and original discussion. It was largely under the control of Richelieu, and, of course, reflected his sentiments. In these beginnings of the newspaper, we find little or no attempt at journalism, as now understood and practiced; no promise and potency of a literature peculiar to newspaper enterprise. The journalist had yet to come into being. He first appeared as a writer of "news-letters," generally from some capital, or seat of legislation, or commercial centre. His duty was to keep a line of masters or patrons supplied with news during their absence from court, legislative hall, or business mart. His duty evolved into a calling. His patrons became regular paying subscribers, to each of whom he wrote. These letters, coming from all countries of the continent of Europe, and covering a wide field of information, became of great interest, and many collections of them are still in existence in libraries, adding no little to their historic value.

The step was easy from this journalistic stage to the regular periodic publication, open not only to the "news-letter," but to discursive thought. Thus, in 1641, "The Weekly News," of London, began the publication of parliamentary proceedings in addition to its budget of "news-letters." This era witnessed a rapid establishment of weekly newspapers, requiring editorial supervision and regular contributions. They were not without their vicissitudes. Many of their careers were brief and marked with pecuniary losses; yet out of the wreckage sprang some of the most important of the modern journals.

By 1703 Great Britain was ripe for a daily newspaper, and in that year one appeared under the name of “The Daily Courant.” The advent of this enterprise gave further impetus to newspaper publication. The English press of the eighteenth century rose into great popular favor. It was able, and quite too independent for royalty and royal courtier. For corrupt and ambitious government it often became a whip of scorpions, and in revenge was both severely taxed and invidiously censored. But it seemed to prosper amid opposition and persecution, and by 1776 fifty-three newspapers were published in London alone. During the reign of George III. (1760–1820) the history of the English newspaper is one of criminal persecutions, amid which editors and contributors were repeatedly defeated, and sometimes severely punished; yet it is doubtful if at any period the press gained greater strength from protracted conflict, or turned ignominious penalties into more signal triumphs. It is significant that out of this dark, tumultuous, and forbidding era sprang many of the newspapers whose influence is most potential to-day in English affairs of state and in the literature of journalism. The era marks the turn in newspaper values. The establishment became a concrete thing, a lively property, an energy composed of practical business minds, surrounded and supported by the best procurable literary talent, adapted for treating diversified topics. Thus “The London Morning Chronicle,” founded in 1789, rose to be a property in 1823 which sold for $210,000; while “The Morning Post” not only gave to Coleridge his fame as one of the greatest of publicists, but enlisted the brilliant attainments of Mackintosh, Southey, Young, and Moore. The sturdy “London Times,” which dates from 1785, and for years encountered malignant royal hostility, proved itself strong enough to brave the government and at the same time sufficiently enterprising to introduce steam printing and every mechanism calculated to give it precedence as a metropolitan journal. As a property, it is to-day worth a figure incredible at the beginning of the century, and so powerful was its hold on popular favor for the first half of the century that no other daily could compete with it. Indeed, it may be said to have had a lone field up to the establishment of “The Daily News,” in 1846, “The Daily Telegraph,” in 1855, and “The Standard,” in 1857.

The nineteenth century journalism of Great Britain is characterized by its great plenitude. Morning and evening papers abound in all the centres. The weekly paper is still an important literary and news factor. Class papers are numerous and excellent in their way. Again, the century’s journalism is characterized by its property value. Many of the leading English journals have become immense properties worth millions of dollars each, and requiring the ablest management to improve and perpetuate them. Further, the English press is characterized by able and conservative, if prosaic, editorial methods. Its correspondence is cautious, and covers every important field. Its news columns, so far as they depend on the telegraph and telephone, are sprightly and well filled, but limited and dull when the local reporter is the source of supply.

As already stated, the annals of French journalism began with the founding of the “Gazette de France” in 1631. The evolution of the French newspaper was not rapid till the eighteenth century was well along, when the era of the first revolution called for a news and literature peculiar to bloody and exciting times. Myriads of newspapers sprang into existence, all but two of which found their graves with the passing of the emergency which called them into being. Early in the nineteenth century (1836) the introduction of cheap journalism gave great impetus to enterprise, and by the middle of the century the number and circulation of French newspapers had more than trebled. This rate has been, in great part, sustained throughout the latter half of the century, and the French people are to-day abundantly supplied with a newspaper literature which for vivacity and amplitude is unexcelled. It may not have the solid and lasting influence of the soberer outcrop of other nations, but it is singularly adapted to a sprightly and mercurial people, and is well sustentative of the great political transition of the people and empire since the beginning of the nineteenth century.

The evolution of the newspaper in Germany was slow. Between 1615, the date of the founding of the “Frankfurter Journal,” and 1798, when the “Allgemeine Zeitung” (General News) was founded by the bookseller Cotta, at Leipsic, no journals of a high order made their appearance, and it needed the inspiration of the French Revolution to beget in the German mind a desire for a livelier newspaper literature than had preëxisted. Thus, the “Zeitung” soon sprang into great popularity as a purveyor of news and as a medium of discussion, and has ever since maintained a leading place in the German political press. It not only set the style of the press at the turn of the century, but proved to be a pioneer in that wonderful journalistic march which spread over all German-speaking countries during the nineteenth century, giving to them media of news and discussion as able and influential as exist in any land. By 1870 there existed in Germany proper 3780 newspapers and periodicals; in Austria-Hungary, 700; in Switzerland, 300; not to mention the many hundreds printed in German in other countries, especially in the United States. A proportionate increase would greatly augment the above figures by the end of the century. The rise of German socialism proved to be a prolific source of journalism. The socialist seems to be a born editor and literary combatant. He is also a great reader and bold and independent thinker. Under the socialistic demand for a literature peculiar to itself, there has arisen a score of German printing-offices and perhaps fifty political journals, a third of which are dailies.

In the Netherlands, Belgium, Denmark, Norway, Sweden, Russia, Italy, Spain, Portugal, and other European countries, the press of the nineteenth century has kept pace with the mental needs and spirit of enterprise of the respective peoples. Indeed, there is no such an accurate criterion of the general make-up of a people, of their place in the lines of progress, of their influence upon civilization, as that afforded by their press. The Belgian press is nimbly commercial, that of the Netherlands prosy and substantial, while that of the Scandinavian countries is rugged, accurate, and solemnly influential. The Russian press, where free, is despotic and unprogressive. But it is so frequently under censorship that it can hardly be said to reflect with any degree of certainty the popular spirit of the empire. The Italian press is indolent and easy-going, inaccurate, spicy by spasms, of little relative influence, except as it has been improved since the unification of the Italian States. Spain is a country of 18,000,000 people, but has fewer newspapers and periodicals than the single State of New York. Of Spain’s 1200 papers, only 500 are newspapers. Of the rest, 300 are scientific journals, mostly monthly, 100 are devoted to religion, and 30 to satire, music, poetry, art, etc. Barcelona and Madrid are the great centres of journalistic literature. The political papers are the most powerful. The reading public of Spain is limited, and the average circulation of a Spanish newspaper is only about 1200 copies.

In the New World the demand for newspaper literature during the nineteenth century has proven quite as strong as in the Old World, and, in certain localities, even stronger. Even among the youthful and tumultuous republics of South America, with their large percentages of lower classes and illiterates, there are few centres of importance that do not support respectable and fairly influential journals. The news-gathering and news-consuming spirit may not be so active as elsewhere, nor the commercial sense so acute, yet the century has laid the groundwork of journalistic enterprise so firmly that future years can afford to build upon it with certainty. The same may be said of journalism in Mexico and the other Latin republics of North America.

In Canada, the century shows a highly complimentary growth in newspaper literature and influence. Great pride is taken in accurate and able editorship, and in that kind of management which is best calculated to convert investment into permanent and profitable property. What they lack on the reportorial, or strictly newsy, side, they make up in free, clean, and independent discussion. The people are readers and, therefore, generous supporters of the enterprises designed to supply them with their periodical literature. During the century the newspapers and periodicals of Canada increased in number from a very few to 862, as reported in 1894. Of these, 87 are dailies, 583 weeklies, 138 monthlies, 3 tri-weeklies, 22 semi-weeklies, 6 bi-weeklies, 21 semi-monthlies, 2 quarterlies. The largest centres of circulation are the province of Ontario with 507 newspapers and periodicals, and Quebec with 132.

The century's grandest field for journalistic opportunity has been the United States. Here journalism has developed with the greatest rapidity, exemplified its manifold features to the fullest extent, most successfully proved its influence as an educative and civilizing agency. Starting with the great and essential encouragement of freedom, it has found unremitting and energetic propulsion in the unprecedented growth of population, in the marvelous activities requiring intercommunication of thought, in an intelligence which constantly recruited armies of omnivorous readers, and in facilities for the preparation and dissemination of the literature at command.

The beginning of newspaper enterprise in the United States was in Boston, in 1690, when the "Publick Occurrences" appeared under the auspices of Benjamin Harris. It was designed to be a monthly, and was printed on three sides of a folded sheet, each side being only eleven inches long by seven wide. It was suppressed after its first issue by the colonial government of Massachusetts, thus restricting the avenues of news to the foreign journals or local coffee-houses. But the demand for home news was not thus to be crushed. There sprang up a medium of communication by news-letters, such as then existed in England; and in 1704 the postmaster of Boston undertook to keep certain functionaries informed of the course of events by a periodical news-letter in printed form. This he called "The News-Letter," a title which, with some, is treated as that of a newspaper. It was to appear weekly, and would be sent to subscribers for such reasonable sum as might be agreed upon. After a lapse of fifteen years, without competition, it had attained a subscription list of only three hundred copies. A subsequent postmaster started an opposition sheet in 1719, called "The Boston Gazette." Its appearance caused him to lose his office, but the rival papers continued to exist, "The News-Letter" up to the evacuation of Boston by the British troops in 1776, and the "Gazette" up to 1754.

"The Boston Gazette" appeared on December 21, 1719. One day after, December 22, 1719, Andrew Bradford started "The American Weekly Mercury" at Philadelphia. On August 17, 1721, James Franklin started "The New England Courant," on which Benjamin Franklin learned the trade of printer. After an existence of seven years its publication ceased. On October 23, 1725, William Bradford started "The New York Gazette." "The New England Weekly Journal" succeeded "The Boston Gazette" and "Courant" in 1727. "The Maryland Gazette," the first paper published in that colony, appeared in 1727. In 1728 Samuel Keimer started "The Universal Instructor in all the Arts and Sciences and Pennsylvania Gazette," at Philadelphia. The following year Benjamin Franklin bought Keimer's plant, and shortened the name to "The Pennsylvania Gazette." The first paper in the colony of South Carolina, called "The South Carolina Gazette," was published on January 8, 1731. On November 5, 1733, "The New York Weekly Journal" appeared as a rival to the "Gazette." In 1736 the first newspaper appeared in Virginia. It was published at Williamsburg, and was called "The Virginia Gazette." In 1739 a German newspaper appeared at Germantown, Pa., and another, in 1743, at Philadelphia. All these pioneer papers, with the exception of a few, notably "The Pennsylvania Gazette" under Franklin, and "The New York Weekly Journal" under Zenger, were merely news purveyors, or, if any opinions were expressed, they were in accord with the authorities of the day.

After 1745 the press of the colonies became more independent and progressive, in obedience to a demand for literature bearing upon the questions relating to the coming revolution. New journals of the weekly class sprang up with considerable rapidity and, for the most part, in opposition to England's methods of colonial government. Among these were "The Boston Independent Advocate," started under the auspices of Samuel Adams, in 1748; "The New Hampshire Gazette," in 1756; "The Boston Gazette and Country Gentleman," in 1755; the "Newport (R. I.) Mercury," in 1758; "The Connecticut Courant," in 1764.

By 1775, the commencement of the struggle for independence, the colonial press numbered thirty publications, all weekly. Of these, seven were published in Massachusetts, one in New Hampshire, two in Rhode Island, three in Connecticut, eight in Pennsylvania, and three in New York. In the first year of the war eight new weeklies were added to the list, four of them being in Philadelphia. On December 3, 1777, the first newspaper, "The Gazette," appeared in New Jersey, and in 1781, the first in Vermont, "The Gazette or Green Mountain Post Boy." Such was the fatality overhanging the colonial press that, of the sixty-three newspapers which had come into existence prior to 1783, only forty-three survived at that date.

From 1789, the date on which the Constitution went into operation, till the close of the eighteenth century and early beginning of the nineteenth, several newspapers were founded, most of which were ardently political, and, though employing writers of ability, were bitterly vituperative. The most powerful of this class were "The Aurora" of Philadelphia, Jefferson's leading organ; "The Evening Post" of New York, the organ of the Federalists; and "The American Citizen" of New York, an organ of the Clintonian democracy. The close of the eighteenth century witnessed also the advent of the press in the Mississippi Valley. "The Centinel of the Northwestern Territory" was started at Cincinnati, November 9, 1793; and "The Scioto Gazette," at Chillicothe, in 1796.

The press of the early part of the nineteenth century grew rapidly in number, circulation, and influence. While it was largely partisan, the field of discussion gradually broadened, and the news departments became more vivacious and comprehensive. Many of the newspapers founded during the first decades of the century exist at its close, having enjoyed their long careers of influence with honor, and become properties of incalculable value. During this period the transition from the weekly to the daily newspaper gradually went on in the large cities. The first American daily paper, "The American Daily Advertiser," was published at Philadelphia in 1784. With it came the first use of reporters, or regularly employed news-gatherers, an innovation as important to the public as the advent of the daily itself. Special, or class, newspapers also began to get a firm foothold during this period. "The Niles's Weekly Register" appeared in Baltimore in 1811. The first religious newspaper attempted in the United States appeared at Chillicothe, O., 1814. The first of the agricultural press was "The American Farmer," which appeared at Baltimore, April 2, 1818, to be followed by "The Ploughman," at Albany, N. Y., in 1821, and by "The New England Farmer," in 1822. Several strictly commercial and financial papers found an origin in this period, the most successful of which was "The New Orleans Prices Current," established in 1822.

During this period the newspaper, whether daily or weekly, was distributed only to the regular subscriber,—the price of a single copy on the street being prohibitory. The slow-going mail facilities of the time prevented the large circulations that are credited to modern journalism. Prior to 1833 no leading newspaper could throw sufficient enterprise into its business to raise its circulation above 5000 copies. This kept the price of advertising low, and consequently limited a source of profit which has since grown to enormous proportions.

The period ended with the advent of the penny press, in New York, in 1833. The initial experiment in this line was made by H. D. Shepard with his “Morning Post,” and it proved a failure in the short period of three weeks. The next was “The Daily Sun,” September 23, 1833, claiming to be “written, edited, set up, and worked off” by Benjamin Franklin Day. It remained a penny paper for a long time and attained a large circulation. It was reorganized in 1867, when Charles A. Dana became its editor. Though the price was put up to two cents, it became under his control one of the most potential news and political factors of the century, and attained a circulation of over 100,000 copies daily. In May, 1835, James Gordon Bennett followed in the tracks of Day with “The New York Herald.” Its sprightly news columns and fantastic advertisements commended it to popular favor, and proved a source of great profit. It has since greatly varied its prices; but by dint of stupendous, if peculiar, enterprise, it has grown into enormous circulation, and become a property worth millions. In 1841, Horace Greeley started “The New York Tribune,” at first as a penny paper, though on an elevated plane. It soon grew into popular favor, and with its weekly and semi-weekly editions for country circulation became one of the most widely circulated and influential journals in the country. “The New York Times” also began as a penny paper in 1851, under the control of Henry J. Raymond.

While the era of a distinctive and popular penny press was short-lived, it witnessed one of the most notable advances of the century in journalism. It stimulated newspaper enterprise throughout the entire country, and journals multiplied enormously. The era practically ended with the outbreak of the Civil War in 1861, which event caused a rise in the price of paper, a demand for expensive correspondence, telegraph news and battle scenes, and a consequent necessity for enlarged and quadrupled sheets. Many of the penny papers went up to a five-cent price under the stimulus of war excitement, the improved system of collecting news, and the added expense of publication. This era of phenomenal newspaper expansion extended even to the end of the century. It has witnessed the wonderful evolution of the newspaper in all its modern phases,—the advent of the Sunday newspaper; the growth of the daily sheet to mammoth proportions; the incorporation of the Associated Press, with its thousands of agents in every part of the country gathering and sending the minutest events of the day; correspondence from every quarter of the globe, and covering every field of activity; a highly improved and more independent editorship; a greatly enlarged, more active, and more conscientious reportorial staff; the coming of the interviewer, at first an impertinent pest, but now recognized as a valuable journalistic adjunct in reflecting opinions and sentiments not otherwise obtainable; the employment of the thousand and one new appliances for printing, such as stereotyping, electrotyping, improved types, typesetting machines, rapid presses, folding machines, etc.

By 1883 a reaction came on in the prices of leading journals, and they were forced to reduce them by reason of the strong competition offered by the numerous and powerful two-cent journals which had come into being and had proven to be valuable properties. Indeed, this reaction did not leave the two-cent journals untouched, for it brought many of that class to a one-cent basis, with the claim that a consequently increased circulation would enhance the profits from advertising. This claim is a debatable one, and it may be safely said that most of the newspapers established near the end of the century have adopted a two-cent basis as a golden mean between the one-cent and three-cent journals.

Proportionally speaking, the growth of the press in the United States has been as even as it has been rapid. No leading city is without press establishments and prominent journals, some of them conducted on the largest scales of expenditure,—the West vying with the East, and the South with the North, in liberality and enterprise. The newspaper office of the early part of the century was generally dingy and cramped. The abode of many, especially in the larger cities, has become a handsome pile, conspicuous in architectural effects, capacious and cleanly,—fitting hive for the myriad of workers that toil at midday and midnight in pursuit of the “art preservative.” The annual expenditure of a single newspaper operated on a large scale has been thus computed: Editorial and literary matter, $220,000; local news, $290,000; illustrations, $180,000; correspondence, $125,000; telegraph, $65,000; cable, $27,000; mechanical, $410,500; paper, $617,000; business office, $219,000; a total of $2,153,500.

Nearly every town in the United States of 15,000 population has come by the end of the century to have its daily newspaper, and few of even 1000 population, especially if a county-seat, are without their weekly newspapers. It has become possible to conduct a rural weekly of fair proportions and with quite readable matter upon a very economic basis, by means of a central office in some large city. This office prints and supplies to the rural offices, of which it may have hundreds on its list, the two outside pages of a weekly, leaving to the local office only the duty of supplying and printing on the inside pages its domestic news.

In the number of its newspapers and periodicals the United States easily leads the world. Only approximate figures for the close of the century are at hand; but these, for the United States, gravitate around a total of 20,000 newspapers and periodicals, while those for other countries which report are as follows: Great Britain, 4229; France, 4100; Germany, 5500; Austria-Hungary, 3500; Italy, 1400; Spain, 1200; Russia, 800; Switzerland, 450; Belgium, 300; Holland, 300; Canada, 862. In the report of 1894 for United States newspapers and periodicals, the following subdivision appears: Dailies, 1853; tri-weeklies, 29; semi-weeklies, 223; weeklies, 14,077; bi-weeklies, 62; semi-monthlies, 290; monthlies, 2501; bi-monthlies, 70; quarterlies, 197. The States in which over one thousand newspapers and periodicals are printed are, New York, with 2001; Illinois, with 1520; Pennsylvania, with 1408; Ohio, with 1108. The States next in order, and with a number of newspapers and periodicals between 500 and 1000, are, Iowa, with 978; Missouri, with 907; Indiana, with 753; Kansas, with 732; Michigan, with 727; Massachusetts, with 664; Texas, with 656; Nebraska, with 639; California, with 637; Wisconsin, with 551; Minnesota, with 549.

The century’s newspaper literature in the United States has been further characterized by the introduction of the comic feature. The comic newspaper came into being about the middle of the century, but did not strike a practical minded people with favor. It was not until the century was well rounded out that the cartoonist’s and joker’s art came into sufficient demand to make a comic newspaper a commercial success. Even now their number is limited to a very few that can boast of permanent success.

The daily newspapers of the latter part of the century have not been dissuaded by earlier attempts to make illustrations a conspicuous feature. On the contrary, newspaper illustration has grown to the proportions of a special art, and all of the larger and better equipped dailies have organized departments into which are gathered photographs and engravings ready for reproduction as events demand. So the correspondent and reporter have added to knighthood of the pen that of the camera, and the scenic view has become an essential part of serious correspondence and sprightly reporting.

An immense, imposing, and highly useful current of literature flows through the magazines, which have, by their number, beauty, and adaptation, come to be a distinguishing feature of the nineteenth century. This class of literature is usually called “Periodical,” and it embraces the magazines and reviews devoted to general literature and science, the class magazines devoted to particular branches of science, art, or industry, and the publications of schools and societies. Most periodicals published in the English language are monthlies. The same is true of those published on the continent of Europe, save that there the old-fashioned quarterly style is still much affected.

Periodical literature found a beginning in France as early as 1665, in what is still the organ of the French Academy. The first English periodical was published in 1680, and was hardly more than a catalogue of books. The growth of the periodical or magazine proved to be very slow. Up to 1800, not more than eighty had found mentionable existence as scientific and technical periodicals, and only three as strictly literary periodicals. The advent of “The Edinburgh Review,” in 1802, gave great impetus to periodical literature in Great Britain, and the period from 1840 to 1850 was one of special development, but to be surpassed by that of 1860 to 1870, when the shilling magazine came into vogue. This class of literature also developed very rapidly in France during the century, Paris having 1381 periodicals of all kinds by 1890. There was an equally rapid development in Germany, Austria, and throughout the continent.

The English magazine found several imitators in the United States during the latter part of the eighteenth century, most of which had brief existences. Such was the fatality overhanging this class of enterprise, that until 1810 but twenty-seven periodicals could be counted in the United States. While the next forty years were marked by several magazine successes, such as the “Knickerbocker,” “Graham’s Magazine,” and “Putnam’s Monthly,” they were, nevertheless, strewn with long lines of melancholy wreckage. Indeed, it was not until the middle of the century that the demand for magazine literature became sufficiently intense to make investment in it profitable and permanent. Since then the development has been almost phenomenal, keeping even pace with that of the newspaper. At the end of the century the number of monthlies published in the United States approximates 2800; and there are over 300 fortnightlies, 56 bi-monthlies, and 192 quarterlies. These cover the vast domains of general literature, religion, science, art, and industry, and in many respects vie with the newspaper in popularity and influence. Many of them have developed into magnificent properties, whose value would appear incomprehensible to our grandfathers. They employ excellent talent when special topics are treated, and rise to occasions of war or other excitement through graphically written and highly illustrated articles. Indeed, one of their most impressive features is the high degree to which they have carried the art of illustration. Toward the close of the century, periodical literature has been greatly expanded and popularized by the introduction of the cheap magazine. The older and more dignified periodicals had not thought of permanent and profitable existence at a price less than twenty-five to fifty cents a copy; but those of the younger and ten-cent class, by dint of what seems to be a newly discovered enterprise, have found cheapness no barrier to commercial success. Within a decade they have duplicated patrons of magazine literature by the million, and proven quite as clearly as the newspapers have done that we are a nation of readers.

The Records Of The Past

By MORRIS JASTROW, JR., PH.D.,
Professor of Semitic Languages, University of Pennsylvania.

The present century has so many distinguishing features that it is a hazardous undertaking to summarize its achievements. All branches of science—Philology, History, Mathematics, Medicine, Theology, and Philosophy—have felt the stimulating influence of a new spirit that made its appearance after the French Revolution. New methods of investigation have not only led to profound modification of views in all departments of science, but have brought about considerable additions to the sum of human knowledge. In the domain of natural science, the discovery of new principles and of hitherto unknown forces has widened the horizon of humanity and created new mental disciplines; but while perhaps less conspicuous, because not so directly connected with the actual concerns and needs of the present, the fertility of historical research during this century is not less remarkable. The larger area now embraced under the caption "history of mankind" furnishes the best proof for the success that has signalized the labors of scholars—philologists, historians, and explorers—devoted to the study of the past. Ancient history no longer begins with the Greeks or the Hebrews. Its *certain* limits have been removed to as remote a date as 3000 B. C., while the anthropologist, supplementing the work of the historian, has furnished a picture in detail of the life led by man in various quarters of the globe during that indefinite period which preceded the rise of culture in the true sense of the word. This extension of knowledge in the domain of human history is primarily due to the spade of the explorer, though it required the patience and ingenuity of the philologist and archæologist to interpret the material furnished in abundance by the soil that happily preserved the records of lost empires. Documents in stone, clay, and papyrus have been brought forth from their long resting-places to testify to the antiquity and splendor of human culture. By the side of written records, monuments of early civilization have been dug up, palaces, forts, and temples filled with works of art and skill, to confirm by their testimony the story preserved by those who belonged to the age of which they wrote.

Researches in Mesopotamia.—The archæological researches conducted during this century have definitely established the fact that the earliest civilizations flourished in the Valley of the Euphrates and in the district of the Nile. Until the beginning of this century, Egypt, Babylonia, and Assyria were little more than names. The spirit of skepticism which accompanies the keen desire for investigation led scholars to question the tales found in classical writers of the great achievements of the Babylonians and Egyptians. At the beginning of this century scarcely a vestige remained of the cities of ancient Mesopotamia. The site of Nineveh was unknown, and that of Babylon was in dispute. A profound sensation was created when, in 1842, P. E. Botta, the French Consul at Mosul, discovered the remains of a palace beneath a mound at Khorsabad, some miles to the north of Mosul on the east bank of the Tigris. Botta's discovery marked the beginning of an activity and exploration in Mesopotamia which continues to the present day. At first the excavations were confined to the mounds in the north, in which the palaces of the great Assyrian kings, Sargon, Esarhaddon, Sennacharib and Asurbanibal (or Sardanapalus as he was called by Greek writers) were unearthed, as well as the great sacred edifices that formed one of the glories of ancient Assyria. The buildings exhumed abound in long series of sculptured slabs, on which are depicted incidents in the campaigns of the kings and in their private life. Historical records on stone and clay furnished the needed details in illustration of the scenes, and lastly, literary remains in profusion were found, which revealed the intellectual life and religious aspirations of the masses and of the secular and religious leaders. To England and France belongs the glory of these early explorations. Through Botta and Sir Austen Henry Layard, the ancient cities of Nineveh, Calah, and Ashur, were rediscovered. But as the field of activity extended to the mounds in the south, in the Valley of the Euphrates, other countries, notably Germany and the United States, joined in the work. The excavation of the remains of the city of Babylon were first conducted by Sir Henry Rawlinson in 1854, and much work was afterward done by Hormuzd Rassam; but the most notable achievements of recent years are the excavations conducted by DeSarzec, under the auspices of the French Government, at Telloh, from 1881 to 1895, and those of the University of Pennsylvania at Nippur, begun in 1888, and which are still going on.

Through these excavations the history of Babylonia has been carried back to the fourth millenium B. C., and while there are still some important gaps to be filled out, the course of events in Babylonia and Assyria from this remote period down to the year 587 B. C., when Cyrus the Mede established a new empire on the ruins of Babylonia and Assyria, is tolerably clear. Hand in hand with the excavations has gone the decipherment of the inscriptions found in such abundance beneath the mounds. On clay, stone, and metals, rulers inscribed records of their reigns; and added to pictorial illustrations accounts of their achievements in war as well as in the internal improvements of their empires. Clay, so readily furnished by the soil, became the ordinary writing material both in Babylonia and in Assyria, and in the course of time an extensive library, embracing hymns and prayers, omens and portents, epics, myths, legends, and creation stories, arose. In every important centre there gathered around the temples bodies of priests devoted to the preservation and the extension of this literature. Assyrian culture being but an offshoot of the civilization in the south, Assyria reaped the benefit of the literary work accomplished by the scribes of Babylonia, and the most extensive collection of the literary remains of Babylonia has come to us from a library collected through the exertions of Asurbanibal, and discovered in 1849 by Layard in the ruins of that king’s palace at Nineveh.

The basis for the decipherment of the cuneiform inscriptions, as they are called from the wedge-shaped characters, was laid by George F. Grotefend early in this century, whose system was further worked out with great ingenuity by Edward Hincks, Jules Oppert, and Sir Henry Rawlinson. These pioneers have been succeeded by a large coterie of scholars in all parts of the world, who are still busy studying the large amount of material now forthcoming for the elucidation of the past. Not merely have we learned much of the public and official events and religious ideas and customs during the period covered by the Babylonian and Assyrian Empires, but through thousands of little clay tablets that formed the legal and commercial archives deposited for safe keeping in the temples, an insight into the life of the people has been obtained, of their occupation, of their business enterprise and commercial methods, and of many phases of social life, such as the position of women and slaves, of the manner in which marriages were contracted and wills drawn up. Perhaps the most characteristic feature of the remarkable civilization that arose in the Valley of the Euphrates is the domination of the priesthood over all except the purely political interests of the people. Thus the priests, as scribes, as judges, as astronomers, as physicians, brought that civilization to its high degree of excellence, while under their guidance, likewise, the religion of the country developed from a crude nature worship to an approach to a monotheistic conception of the universe. The heir of the Babylono-Assyrian empire was Persia, which, from the days of Cyrus till the advent of Alexander, swayed the fortunes of the ancient world. In all that pertains to art and architecture, Persia remained largely dependent upon Babylonia. Extensive excavations conducted at Susa by Dieulafoy, about ten years ago, and quite recently continued by M. de Morgan, have proved most successful in revealing the general nature and interior decoration of the great royal palace at that place. In brilliant coloring of the brick tiles which, as in Babylonia, formed the common building material, the Persians passed beyond the Babylonians and Assyrians. One of the most interesting rooms in the Louvre at Paris is that devoted to the exhibition of the colored wall decorations from the palace at Susa, representing such various designs as a procession of archers and a series of lions. The columns still standing at Persepolis have long been famous; and it is here likewise that the first cuneiform inscriptions were found which, couched in Persian, Median, and Assyrian, formed the point of departure for the decipherment of cuneiform scripts.

Egyptian Researches.—The civilization of Egypt rivals in age and grandeur that of Babylonia and Assyria. Here, witnesses to the past that survived in the shape of obelisks and pyramids gave scholars in this century a good start in the work of unraveling the fascinating narrative of Egyptian history. Notwithstanding this, our present knowledge of the history is due largely to the remarkable series of excavations which have been conducted in Upper and Lower Egypt since the early decades of this century, and which continue with unabated activity at the present time. The stimulus to Egyptian research was given by Napoleon in 1798, who, when setting out upon his Egyptian expedition, added to his staff a band of scholars entrusted with the task of studying and preparing for publication the remains of antiquity. The result was a monumental work that forms the foundation of modern Egyptological studies. Another direct outcome of the expedition was the discovery of the famous Rosetta stone, in 1799, which, containing a hieroglyphic inscription accompanied by a Greek translation, served as the basis for a trustworthy system of decipherment of the ancient language of the Nile. The Frenchman, Jean François Champollion, and the Englishman, Dr. Thomas Young, share the honor of having found the key that unlocked the mystery of the hieroglyphic script. As in the case of Babylonian archæology, so here, excavations and decipherment went hand in hand. A few years after the advent of Botta at Mosul, Mariette inaugurated in Egypt a series of brilliant excavations under the auspices of the French government. About the same time the German government sent Richard Lepsius on an expedition to Egypt, which resulted in the establishment of a large Egyptian Museum at Berlin. In 1883 England entered the field through the formation of the Egyptian Exploration Fund, and since that time a large number of cities in Lower Egypt, in the Fayum district, and in Upper Egypt have been unearthed. Year after year W. Flinders Petrie, Edouard Naville, F. L. Griffith, and others have gone to Egypt and returned richly laden with material that has found its way to the Museum at Ghizeh, to the British Museum, to Boston, to New York, and to the Museum of the University of Pennsylvania. The activity of the French was continued after the death of Mariette, through Gaston Maspero, E. Grebaut, J. DeMorgan and E. Amelineau, so that the mass of material at present available for Egyptologists is exceedingly large.

The cities of Memphis and Thebes have naturally come in for a large share of these excavations. Through the texts discovered within the pyramids at Thebes and the surrounding district, the history of the early dynasties was for the first time revealed. At Balas and Nagadah, a short distance to the north of Memphis, the excavations have brought us face to face with the indigenous population of the Nile that maintained its primitive customs long after those who founded the real Egyptian Empire had established themselves in the country. In the district of the Fayum, notably around Arsinoe, at Hawara, Illahun, and Gurob, traces of early foreign influence—Phœnician and Greek—were discovered, while in Lower Egypt the towns of Naukratis and Tanis represent extensive Greek settlements made in Egypt as early, at least, as the seventh century B. C. Through the magnificent illustrations in the tombs of Beni-Hassan, which have recently been carefully copied by English artists, almost all phases of ancient Egyptian life have been revealed. Though dating from the eleventh and twelfth dynasties, the picture that they afford applies to earlier and later periods as well. Thus, through the work done in all parts of the ancient empire, the links uniting the earliest period to the sway of the Ptolomies and the invasion of the Romans have been determined. Wonderful chapters, replete with interest, have been added to the history of mankind, and though much remains to be done, we are much nearer to a solution than ever before of that most important problem as to the origin of the mysterious Egyptian culture. We know for a certainty that when the Egyptians came to the region of the Nile, they found a fertile district populated by a people, or by groups of people, that had already made some progress on the road to civilization, though not yet knowing the use of metals. The Asiatic origin of the Egyptians is regarded as clearly established by so eminent an archæologist as M. DeMorgan, though it is likely that his views will be somewhat modified by further research. The infusion of Greek ideas, we now know, begins at a much earlier age than was formerly supposed, so that it becomes less of a surprise to find, even before the advent of Alexander, considerable portions of Egypt absorbed by foreign settlers.

A noteworthy feature of archæological work in Egypt during the past decade has been the discovery of a vast amount of papyri containing long lost portions of Greek literature. The famous work of Aristotle on the Constitution of Athens and the poems of Bacchylides may be mentioned as the most notable among these discoveries, and the sources from whence these treasures have come seem still far from being exhausted.

Greek Ruins.—The mention of Greek literature leads one naturally to speak of the work done in this century in that land which stands so much nearer to us and to modern culture in general than either Babylonia or Egypt. While, thanks to the activity and industry of Greek and Roman historians, the records of the inspiring history of the Greek states during their most glorious epoch are well preserved, the earlier periods were enveloped in doubt and obscurity, while of the remains of Greece, of her beautiful temples and her famous works of art, comparatively few vestiges remained above the soil.

The most notable of these were the Parthenon and the Erechtheum, with their works of art, that stood on the Acropolis, and it is precisely here that some of the most remarkable archæological discoveries of the century were made. The Parthenon dates from that glorious period in the history of Athens which follows in the wake of disasters in the fifth century, when the Persians entered the city and laid waste its beauties. The earlier Athens, which reached its zenith in the days of Pisistratus, has been brought to light through the excavations conducted by the Greeks themselves. In 1882 a systematic excavation of the Acropolis, under the auspices of the Greek Archæological Society, was begun. The foundations of the ancient Temple of Athena that stood close to the modern Parthenon were discovered, and numerous works of art, statues, fragments, pediments, bases and vases, dating from the earlier period, by means of which we are enabled to trace the development of Athenian sculpture from the rough beginnings to the perfection that it reached in the days of Phidias. The style of these earlier works differs totally from that which we had hitherto been accustomed to regard as the type of Athenian art, and yet even the rudest of the earlier statues possess already some of that charm which is so strongly felt in the works of the later period. Most remarkable, perhaps, among the remains of the earlier Athenians are a large series of figures that appear to have been set up in rows within the Temple of Athena. It is through these figures, dating from various periods, that we are best able to trace the evolution of Greek art. They are unquestionably votive offerings, the gift of faithful followers of Athena, and, while intended probably as representations of the goddess herself, but little care was taken to give the goddess those accompaniments in dress and ornament which are never absent in the best specimens of the later period. As a result of these excavations on the Acropolis, aided by the investigations of numerous scholars, among whom Ernst Curtius and William Doerpfeld merit special mention, the entire plan of the little sacred city that stood on the Acropolis can now be traced in detail. The construction of the beautiful Propylæa by Mnesicles, of which remains are still to be seen, has been determined, and various temples to Athena, worshiped under the different guises that she assumed, have been discovered. The place where the great bronze statue of Athena, one of the master works of Phidias, stood, has been fixed, and through the inscriptions found on the Acropolis, numerous problems of Greek history have been solved. Every one knows the story of the Elgin marbles that once formed the decoration of the friezes of the Parthenon, and which in the early part of this century were brought to London by Lord Elgin. That act, though frequently denounced as a piece of vandalism, has probably done more to arouse an interest in Greek archæology throughout Europe than anything else. Even the indignation which Lord Elgin's act provoked has served a good purpose, not only in leading Greece to take better care of her great treasures, but in inducing scholars of England, France, Germany, and the United States to establish, in Athens, architectural schools where young archæologists may be trained, and where expeditions can be organized for the systematic investigation of the numerous cities of ancient Greece and the surrounding islands. The most important work done through these schools is the excavation of Olympia by the Germans, and of Delos and of Delphi by the French, while only some degrees less noticeable is the work done by a zealous Greek, M. Carpanos, at Dodona, by the Greek Society at Eleusis, Epidaurus, and Tanagra, and by the American School at Eretria and at Argos. At Olympia the discovery of the great Temple to Zeus, the grand theatre in which the famous games took place, the numerous shrines erected in honor of various deities that belong to the court of Zeus, and of hundreds of votive inscriptions commemorating the victors in the games, have enabled scholars to restore for us the ancient glories of the place, and to trace the history of the sacred city through its period of glory to its decline and fall. The master work of antiquity, the golden statue of Zeus made by Phidias, is, alas! forever lost, but it was at Olympia that the Germans found the wonderful statue of Hermes by Praxiteles, a find that in itself was worth the million marks spent by the German government as a tribute to ancient Greece. At Delos and Delphi, the careful work done by the French has added to our material for tracing the course of Greek religion. Next to Olympia there is, perhaps, no place in ancient Greece which had such a strange hold upon the people as the seat of the great oracle at the foot of Mount Parnassus. The work at Delphi is still progressing, but enough has been found to justify the great reputation of this religious centre in ancient times. We can now traverse once again the sacred way leading past numerous buildings to the great shrine of Apollo, and to the cave from which the Pythian priestess obtained her inspiration. Fewer works of art have been discovered here than in Olympia, though perhaps the soil still harbors treasures which the coming years may reveal.

The worship of Demeter and the nature of the Eleusinian mysteries are much clearer since the successful excavations that were conducted at Eleusis. Tanagra is of interest because of the clay figurines, the manufacture of which was one of the specialties of ancient Bœotia. Those figures, prepared partly from religious motives, partly as a tribute to the dead, are valuable as illustrations of popular customs. Great credit is due to the American school for the thorough manner in which excavations have been conducted by it, and while the results are not as striking as in some other places, so fundamental a problem as the arrangement of the Greek theatre, which has been engaging the attention of archæologists for the past decade, has been brought nearer to its solution through excavations at Eretria. At Argos a head of Hera was discovered, which is now famous as one of the best specimens of the Polycletan school.

No sketch of Greek archæology, however brief, would be complete without mention of a man who exhibited singular devotion and rare enthusiasm for the study of the past. Heinrich Schliemann, by dint of individual effort, laid bare the remains of pre-Grecian civilization at

Mycenæ and Tiryns, and, prompted by a theory which for a long time provoked naught but ridicule, devoted many years and a large fortune to excavations at Hissarlik, on the coast of Asia Minor, which, he believed, was the scene of the Trojan War. At the latter place no less than nine cities, erected one above the ruins of the other, have been found, but the theory of Schliemann which identified the second layer with ancient Troy, afterward known to the Greeks as Ilium, has been shown to be false. It is the sixth layer that represents the ruins of Homer's Troy. At the same time, it must be remembered that the Homeric poems, while based upon historic events, are not history, and the attempt to test their supposed historical accuracy by the results of excavations is now regarded by Greek students as futile and unscientific. But this view in no way diminishes the credit due to Schliemann, who not only did more to stir up popular interest in ancient Greece than any other man living, but has illuminated the early chapters of Greek history which were almost unknown to the scholars of this century. It now appears that Phœnician traders, settling on the coast of Asia Minor and in districts adjacent to the islands of the Ægean sea and harbors, which furnished a refuge for their ships, gave the first impulse to Greek art, and, although they were outdistanced by their apt pupils, the traces of Phœnician influence remain in Greek architecture, and more particularly in Greek cults, down to the latest times. Apart from the direct bearings of the excavations conducted in various parts of Greece upon the development of Greek art, the most important results of the work consist in the vast increase of material for Greek history, which is now being rewritten on the basis of the many thousands of inscriptions that have been found in the great centres of ancient Greece. As the work of excavation continues, each year brings its quota of new facts, and it is safe to predict that the recovery of ancient Greece will be noted in future ages as one of the most notable achievements of the nineteenth century.

Phœnician Ruins.—With Egypt, Babylonia, and Greece we are still far from having exhausted the field covered by archæology in this century. At Cyprus much has been done by Löhr, Cesnola, and Ohnefalsch-Richter. The cities of Cyprus are interesting as forming a meeting-ground for such various civilizations as Phœnician, Egyptian, Proto-Grecian, and to a limited extent Babylono-Assyrian. The result is a curious mixture of art and of equally strange syncretism in religious rites. It is one of the disappointments of scholars that we as yet know so little of the Phœnicians who played such an important role in history. The traces of this people of wanderers and merchants have been found in tombs and votive inscriptions throughout the lands bordering on the Mediterranean, in Northern Africa, in Southern Spain, in Sicily, Malta, Asia Minor, Cyprus, Crete, Italy, and even Southern France; but in Phœnicia itself but few inscriptions have been unearthed, and only scanty remains of the important cities of Sidon and Tyre, which once flourished on the coast of the Mediterranean. The fate of these cities, subjected in the course of centuries to so many different powers, is a sad one. Almost everything that belonged to a high antiquity has disappeared, and such scanty excavations as have been undertaken, the most notable of which is that of Um-el-Awamid by the late Ernest Renan, in 1861, have been of little value. Tombs have been discovered, but only few of them belong to the Phœnician period in the proper sense. The Sarcophagus of Eshmunazar, king of Sidon, with a long Phœnician inscription, is however a most notable monument and of great historical importance. But the most remarkable find within the limits of ancient Phœnicia was made a few years ago by Hamdi Bey under the auspices of the Turkish government. In the necropolis at Sidon a series of sarcophagi were unearthed which, belonging to the Greek period, are valuable as furnishing a specimen of the art of Greece transplanted in foreign soil.

Researches in Palestine.—Ancient Palestine, likewise, so full of sacred recollections for millions, has been chary of yielding up the treasures which there is every reason to believe still lie somewhere beneath the soil. In 1870, a stone was found in the land of Moab which commemorated the victory of King Mesha over Israel, about 800 B. C., and forms one of the most valuable monuments for tracing the history of the Phœnician alphabet, of which the one we use is a direct successor. At Jerusalem a single inscription, belonging probably to the age of Hezekiah, was found by accident at the pool of Siloam. This paucity of archæological returns is not due to any lack of interest in recovering the monuments of ancient Palestine. In Germany and England, societies for the exploration of Palestine have been in existence for the past twenty years, and much important work has been done by them in making careful surveys of the country, in identifying ancient sites, and in adding material to our knowledge of the geography of the country. The combined opposition of fanatical Turks, Arabs, Christians, and Jews has prevented, until recently, the undertaking of excavations in the important centres of the country, such as Jerusalem, Samaria, Bethlehem, Hebron, and the like. A few years ago the mound Tel-el-Hesy, covering the site of the ancient city of Lachish, was thoroughly explored by F. J. Bliss, and no less than ten layers of cities identified by him; but the results, except for some pottery and a most important discovery of a cuneiform tablet which belongs to the El-Amarna series and dates from the fifteenth century B. C., have been rather disappointing. Recently Mr. Bliss has succeeded in obtaining permission to undertake excavations at Jerusalem. He has begun his work by tracing carefully the walls of the ancient city, but until this work is pushed to the extent of actually digging down some forty feet below the level of the present Jerusalem, it is not likely that significant discoveries will be made. There are good reasons for hoping that the time is not far distant when systematic work, such as has been done in Egypt, Babylonia, and Greece, will also be undertaken in Palestine. When that time does come, we may expect that many of the problems besetting students of the Old and New Testaments will find their solution.

Hittite Remains.—Archæology does not only solve problems, but frequently raises new ones. Such a new problem is that of the Hittites. During the past fifteen years, a large series of monuments, many of them sculptured on rocks, have been found in various parts of Asia Minor, from the district of Lake Van almost to the Mediterranean coast, and notably at Hamath, on the Orontes. They all betray the same art, and are accompanied by inscriptions in characters to which the name Hittite has been given. It is to be borne in mind that this term Hittite is to a large extent a conventional one, covering a series of peoples that may have belonged to different races. We hear of these Hittites in the Asiatic campaigns of Egyptian kings from the seventeenth century B. C. down to 1400 B. C. Establishing an empire on the Orontes, they gave the Assyrians a great deal of trouble, and it was not until the end of the eighth century that they were finally conquered. Though we know a good deal of the history of these Hittites from the records of Egyptians, Babylonians, and Assyrians, their origin remains wrapped in obscurity. The Hittite characters have not yet been deciphered, although various attempts of interpreters have been made. The last of these is that of Professor Peter Jensen, of the University of Marburg, who believes that the Hittite language is a prototype of the modern Armenian. Although a number of prominent scholars have acknowledged their acceptance of the Jensen system, it cannot be said as yet to have been definitely established, nor is it likely that a satisfactory key will be found until a large bilingual inscription containing a record in Hittite characters with a translation, perhaps, in Assyrian or Aramaic, shall have been found. Such a find may be expected at any moment. Meanwhile, it may be said that from an ethnological point of view, it seems more plausible to regard the Hittites as a part of the Turanian stock rather than belonging to the Aryan or Semitic races. The exploration of India, China, and Japan can scarcely be said to have more than begun. The notable series of inscriptions that recall the period of Indian history connected with Acoka may be regarded as a specimen of what we may expect when once those distant lands are as thoroughly explored as the countries situated around the Mediterranean sea.

Roman Ruins.—Coming to the last and greatest of the empires of antiquity, Rome, a word should be said about the activity that has characterized the excavations at Herculaneum and Pompeii, and recently in the city of Rome, which are carried on so successfully by Rudolfo Lanciani. While our knowledge of Roman history has always been much more complete than that of Greece, still many questions of detail have only recently been settled through these excavations. An insight has been afforded into the public and private life of the Romans which supplements that which was to be gained from the study of the classical writers. Europe and America have also been seized with the archæological fever. In Germany, Austria, France, Sweden, Denmark, Holland, Switzerland, North America, and South America, the knowledge of the past has been extended through exploration and excavation. So large is the field of archæology at present, that it is impossible for one person to make himself familiar with more than a small section; but, on the other hand, so close is the sympathy between the various branches of mankind scattered throughout the world that there is no work carried on in one division of archæology which has not its bearings upon many others. What Goethe said of human life may be said of archæology: “Wo ihr’s packt, da ist’s interessant.”

Progress In Dairy Farming

By MAJOR HENRY E. ALVORD, C.E., LL.D.,
Chief of Dairy Division, U. S. Department of Agriculture.

Nearly all industries have their branches or specialties. Farming is no exception, and one of the most interesting, highly developed, and remunerative of its branches is dairying. To be successful, dairying requires good judgment, knowledge of the relations of modern science to agricultural production, constant study, system, and close attention to details. Hence it is regarded as among the highest forms of farming. The occupation is itself so stimulating and the rewards are so substantial, when brains and brawn are applied to it in judicious combination, that dairying districts are commonly conspicuous as the most enterprising, prosperous, and contented of the rural communities of their section of country.

In all lines of farming at least one "money crop" seems to be the aim, although this term may include animals and animal products. A great disadvantage in certain kinds of farming is that the returns come at long intervals, perhaps but once a year, while the expenses are continuous for twelve months. Dairying, as conducted by modern methods, distributes the farm income through the year; the cash returns are monthly, or oftener, the pernicious credit system disappears, money circulates, and at all seasons a healthy business activity prevails in the whole community.

It is a noteworthy fact, that during periods of agricultural depression experienced in the United States during the nineteenth century, the products of the dairy have maintained relative values above all other farm products, and dairy districts seem to have passed through these periods with less distress than most others.

The greater part of this country, geographically, being well adapted to dairying, this branch of agriculture has always been prominent in America, and its extension has kept pace with the opening and settlement of new territory. For many years a belief existed that successful dairying in the United States must be restricted to narrow geographical limits, constituting a "dairy belt" lying between the fortieth and forty-fifth degrees of latitude, and extending from the Atlantic Ocean to the Missouri River; and the true dairying districts were felt to be in separated sections occupying not more than one third of the area of this belt. These ideas have been exploded. It has been shown that good butter and cheese can, by proper management, be made in almost all parts of North America. Generally speaking, good butter can be profitably produced wherever good beef can. Decided advantages unquestionably exist, in the climate, soil, water, and herbage of certain sections; but these influences are largely under control, and what is lacking in natural conditions can be supplied by tact and skill. So that, while dairying is intensified and constitutes the leading agricultural industry over wide areas, including whole States, where the natural advantages are greatest, the industry is found well established in spots in almost all parts of the country, and is developing in unexpected places, and under what might be considered as very unfavorable conditions.

Dairying existed in colonial times in America, and butter and cheese are mentioned among the early exports from the settlements along the Atlantic coast. But this production was only incident to general farming. Dairying, as a specialty in the United States, did not appear to any extent until well along in the nineteenth century. The history of this industry in this country is therefore identical with its progress in that century. This progress has been truly remarkable. The wide territorial extension, the immense investment in lands, buildings, animals, and equipment, the great improvement in dairy cattle, the acquisition and diffusion of knowledge as to economy of production, the revolution in methods and systems of manufacture, the general advance in quality of products, the wonderful increase in quantity, and the industrial and commercial importance of the industry, have kept pace with the general material progress of the nation and constitute one of its leading features.

During the early part of the century, the keeping of cows on American farms was incident to the general work, the care of milk and the making of butter and cheese were in the hands of the women of the household, the methods and utensils were crude, the average quality of the products was inferior, and the supply of our domestic markets was unorganized and irregular. The milch cows in use belonged to the mixed and indescribable herd of “native” cattle, with really good dairy animals appearing singly, almost by accident, or, at the best, in a family developed by some uncommonly discriminating yet unscientific breeder. The cows calved almost universally in the spring, and were generally allowed to go dry in the autumn or early winter. Winter dairying was practically unknown. As a rule, excepting the pasture season, cattle were insufficiently, and therefore unprofitably, fed and poorly housed. In the Eastern and Northern States, the milk was usually set in small shallow earthen vessels or tin pans, for the cream to rise. Little attention was paid to cooling the air in which it stood in summer, or to moderating it in winter, so long as freezing was prevented. The pans of milk oftener stood in pantries and cellars than in milk rooms specially constructed or prepared. In Pennsylvania and the States farther south, where spring-houses were in vogue, milk received better care, and setting it in earthen crocks or pots, standing in cool, flowing water, was a usual and excellent practice. Churning the entire milk was very common. Excepting the comparatively few instances where families were supplied with butter weekly, and occasionally a cheese, direct from the producers, the farm practice was to “pack” the butter in firkins, half-firkins, tubs, and jars, and let the cheese accumulate on the farms, taking these products to market only once or twice a year. Not only were there as many different lots and kinds of butter and cheese as there were producing farms, but the product of a single farm varied in character and quality, according to season and other circumstances. Every package had to be examined, graded, and sold upon its merits. Prices were low.

These conditions continued, without material change, up to the middle of the century. Some improvement was noticeable in cattle and appliances, and in some sections dairy farming became a specialty. With the growth of towns and cities, the business of milk supply increased and better methods prevailed. Butter-making for home use and local trade, in a small way, was common wherever cows were kept, and in some places there was a surplus sufficient to be sent to the large markets. Vermont and New York became known as butter producing States. “Franklin County butter,” from counties of this name in New York, Vermont, and Massachusetts, was known throughout New England, and the fame of “Orange County” and “Goshen” butter, from New York, was still more extensive. New York, Ohio, and Northern Pennsylvania produced large quantities of cheese; and the total supply was so much in excess of domestic demand, that cheese exports from the United States, mainly to Great Britain, became established, and ranged from three to seventeen million pounds a year.

The twenty-five years following 1850 was a period of remarkable activity and progress in the dairy interests of the country. At first, the agricultural exhibitions or “cattle shows,” and the enterprise of importers, turned attention towards the improvement of farm animals, and breeds of cattle specially noted for dairy qualities were introduced and began to win the favor of dairymen. Then the early efforts at coöperative dairying were recognized as successful, and were copied until the cheese factory became an established institution. Once fairly started, in the heart of the great cheese-making district of New York, the factory system spread with much rapidity. The “war period” lent additional impetus to the forward movement. The foreign demand for cheese grew fast, and the price, which was ten cents per pound and less in 1860, rose to fifteen cents in 1863, and to twenty cents and over in 1865. There were two cheese factories in Oneida County in 1854, and twenty-five in 1862. The system spread to Herkimer and adjoining counties, and in 1863 there were 100 factories in New York, besides some in Ohio and other States. The number increased to 300 in the whole country in 1865, to 600 in two years more, and to over 1000 in 1869. From that time the coöperative or factory system practically superseded the manufacture of cheese on farms. Establishments for the making of butter in quantity, from the milk or cream collected from numerous farms, soon followed the cheese factories. Such are properly butter factories, but the name of “creamery” has come into general use for an establishment of this kind, and seems unlikely to change. Placing the real beginning of cheese factories as a system of dairying in 1861 or 1862, the first creamery was started in 1861, in Orange County, New York. In Illinois, the first cheese factory was built in 1863, and the first creamery in 1867; in Iowa, the respective dates were 1866 and 1871.

The effect of these industrial establishments, comparatively new in kind, is to transfer the making of butter and cheese from the farm to the factory. Originating in this country, although now extensively adopted in others, the general plan may be called the American system of associated dairying. The early cheese-factories and creameries were purely coöperative concerns, and it is in this form that the system has usually extended into new territory, whether for the production of butter or cheese. The cow owners and producers of milk coöperate and share, upon any agreed basis, in organizing, building (perhaps), equipping, and managing the factory and disposing of its products. Another plan is for the plant to be owned by a joint-stock company, composed largely, if not wholly, of farmers, and milk or cream is received from any satisfactory producer; the factory may be allowed a certain rate of interest on the investment, or may charge a fixed price per pound for making butter or cheese, and then divide the remaining proceeds *pro rata* according to the raw material supplied by its “patrons.” The proprietary plan is also common, being managed much like any other factory, the proprietor or company buying the milk or cream from the producers, at prices mutually agreed upon from time to time. And all these plans have their variations and modifications in practice.

The third quarter of a century was also a period of unprecedented progress in the application of mechanics to the dairy. The factories and creameries required new equipment, adapted to manufacture upon an enlarged scale, and equal attention was paid to the improvement of appliances for farm dairies. The system for setting milk for creaming in deep cans in cold water—preferably ice-water—was introduced from Sweden, although the same principles had been in practice for generations in the spring-houses of the South. Numerous creaming appliances, or creamers, were invented, based upon this system. Shallow pans were changed in size and shape, and then almost disappeared. Butter workers of various models took the place of bowl and ladle and the use of the bare hand. Churns appeared, of all shapes, sizes, and kinds, the general movement being towards the abolition of dashers and the substitution of agitation of cream for violent beating. About this time the writer made a search of the United States Patent Office records, which revealed the fact that forty or fifty new or improved churns were claimed annually, and after rejecting about one fourth, the patents actually issued provided a new churn every fifteen days for more than seventy years. This illustrates the activity of invention in this line. It was admitted by all that at this period the United States was far in advance of any other country in the variety and excellence of its mechanical aids to dairying.

The same period witnessed the organization of dairymen in voluntary associations for mutual benefit in several States, the formation of clubs and societies of breeders of pure-bred cattle, and the appearance of the first American dairy literature of consequence in book form. The American Dairymen's Association was organized in 1803. Its field of activity was east of Indiana, and accordingly the Northwestern Dairymen's Association was formed in 1867. Both of these continued in existence, held periodical meetings, and published their proceedings for twelve or fifteen years. Then the formation of State dairy associations in Vermont (1870), Pennsylvania (1871), New York (1877), Wisconsin (1872), Illinois (1874), Iowa (1870), and other States took the place of the pioneer societies which covered wider territory.

The Short-horn breed led in the introduction of improved cattle to the United States, and for a long time the representatives of this race, imported from England, embraced fine dairy animals. Short-horn grades formed the foundation, and a very good one, upon which many dairy herds were built up during the second and third quarters of the century, and much of this blood is still found in prosperous dairying districts. This was the period of greatest activity in importing improved cattle from abroad. But Short-horns have been so generally bred for beef qualities that the demand for them is almost exclusively on that line, and they are no longer classed as dairy cattle. Ayrshires from Scotland, Holstein-Friesians from North Holland, and Jerseys and Guernseys from the Channel Islands, are the breeds recognized as of dairy excellence, and upon which the industry mainly depends for improvement of its milch cows. The first two named are noted for giving large quantities of milk of medium quality; the other two breeds, both often miscalled "Alderney," give milk of exceeding richness, and are the favorites with butter makers. There are also the Brown Swiss and Simmenthal cattle from Switzerland, the Normandy breed from France, and Red Polled cattle from the south of England, which have dairy merit, but belong rather to what is called the "general purpose" class. Associations of persons interested in maintaining the purity of all the different breeds named have been formed since 1850, and they all record pedigrees and publish registers or herd-books. Pure-bred herds of some of these different breeds are owned in nearly all parts of the country, and half-breeds or higher grades are found wherever cows are kept for dairy purposes. The quality and production of the average dairy cow in America are thus being steadily advanced.

The development of dairying in the United States during the closing decades of the nineteenth century has been uninterrupted, and marked by events of the greatest consequence in the entire history. The importance of two inventions during this period cannot be overestimated. The first is the application of centrifugal force to the separation of cream from milk. This is based upon the specific gravity of the milk serum or skim milk, and of whatever impure matter may have entered the milk, such gravity being greater than that of the fatty portion or cream. The dairy centrifuge, or cream separator, enables the creaming or "skimming" to be done immediately after milking, preferably while the milk is still warm. The cream can be at once churned, while sweet; but a better practice is to cure or "ripen" it for churning: this can be done at a comparatively high temperature, dispensing with the necessity of so much ice or cold water. The skim milk is available for use while still warm, quite sweet, and in its best condition for feeding to young animals. This mechanical method is more efficient, securing more perfect cream separation than the old gravity system, and the dairy labor is very largely reduced. The handling and caring for the milk may be thus wholly removed from the duties of the household. A usual plan is to have a "skimming station," to which the milk is hauled at least daily from the producing farms in the vicinity, and where one or more separators are operated by power. Separators are also made of sizes and patterns suited to farm use, where they may be operated by hand or by light power,—electricity, steam, water, a horse, a bull, a sheep, or a dog. Besides its economy and its effect upon labor, this machine almost eliminates the factor of climate in a large part of dairy management, and altogether has worked a revolution in the industry. The centrifugal separator is still a marvel to those who see it working for the first time: the whole milk, warm, flows into the centre of a strong steel bowl, held in an iron frame; the bowl revolves at a rate of 1500 to 25,000 times per minute, and from two projecting tubes cream and skim milk flow in continuous streams to separate receptacles. The machines can be regulated to produce cream of any desired thickness or quality. These separators, of different sizes, are capable of thus skimming or separating, or more properly, creaming, from 15 to 500 gallons of milk per hour. A machine of standard factory size has a speed of 6000 to 7000 revolutions a minute, and a capacity for separating 250 gallons of milk an hour. The world is indebted to Europe for this invention, at least as a dairy appliance. Yet investigations were in progress contemporaneously in this country along the same line, and many of the material improvements in the cream separator and several entirely new patterns have since been invented here. The first separators were put into practical use in this country and Great Britain in the year 1879. The century closes with 35,000 to 40,000 of these machines in operation in the United States.

The second great dairy invention of the period is the fat-test for milk,—being a quick and easy substitute for chemical analysis. This is one of the public benefactions of the Agricultural Experiment Stations which, under State and national endowment, have been established during the last part of the century, so that there is now at least one in every State. A number of these have done much creditable work in dairy investigation, and from them have come several clever methods for testing the fat content of milk. The method which has been generally approved and is now almost universally adopted in this and other lands is named for its originator, Dr. S. M. Babcock, the able chemist and dairy investigator, first of the New York Station at Geneva and since of the Wisconsin Station at Madison. This tester combines the principle of centrifugal force with simple chemical action. The machine, on the Babcock plan, has been made in a great variety of patterns, simple and inexpensive for home use, more elaborate and substantial for factories. By them from two to forty samples of milk may be tested at once in a few moments; and by slight modifications in the appliances, the fat may be determined in samples of milk, cream, skim-milk, or butter-milk. This fat test of milk has wide application, and is second only to the separator in advancing the economies of dairying. The percentage of fat being accepted as the measure of value for milk for nearly all purposes, the Babcock test may be the basis for city milk inspection, for fixing the price of milk delivered to city dealers, to cheese factories and creameries, and for commercial settlements between patrons in coöperative dairying of any kind. By this test, also, the dairyman may prove the quality of milk from his different cows, and (with quantity of milk-yield recorded) may fix their respective value as dairy animals. With perfect apparatus in careful hands, the accuracy of the test is unquestioned, and it is of the highest scientific value. It should be noted that although clearly patentable, and offering an independence through a very small royalty, this priceless invention and boon to dairying was freely given to the public by Dr. Babcock.

The advent of the twentieth century finds the dairy industry of the United States established upon a plane far above the simple and crude domestic art of three or four generations ago. The milch cow itself, upon which the whole business rests, is more of a machine than a natural product. The animal has been so bred and developed to a special purpose, that instead of the former short milking period, almost limited to the pasture season, it yields a comparatively even flow of milk during ten or eleven months in every twelve; and if desired, the herd produces as much in winter as in summer. It is not unusual for cows to give ten or twelve times their own weight of milk during a year. And the quality has been so improved that the milk of many a good dairy cow will produce as much butter in a week as could be made from three or four average cows of the olden time. Instead of a few homely and inconvenient implements for use in the laborious duties of the dairy, generally devolving upon the women of the farm, perfected appliances skillfully devised to accomplish their object and lighten labor are provided all along the way. The factory system of coöperative or concentrated manufacture has so far taken the place of home dairying, that in entire States the cheese vat or press is as rare as the hand-loom, and in many counties it is as hard to find a farm churn as a spinning-wheel. Long rows of shining tin pans are no longer seen adorning rural dooryards, as one drives along country roads; but in their place may be found the bright faces of "the women-folks," who rejoice over the revolution of modern dairying.

Here is an example of this radical change in the system of making butter: Northern Vermont has always been a region of large butter production. St. Albans, in Franklin County, is the natural business centre. During the middle of the century the country-made butter came to this town to market every Tuesday from miles around. The average weekly supply was 30 to 40 tons. This was very varied in quality, was sampled and classified with much labor and expense, placed in three grades—prime, fair, and poor—and forwarded to the Boston market, two hundred miles distant. During twenty-five years ending in 1875, 65,000,000 lbs., valued at $20,000,000, passed through this little town. All of this was dairy butter made upon a thousand or two different farms, in as many churns. In 1881, the first creamery was built in this county. Now, the Franklin County Creamery Company, located at St. Albans, has fifty-odd skimming stations distributed through this and adjoining counties. To them is carried the milk from 30,000 cows or more, and the separated cream is sent by rail to the central factory, where from ten to twelve tons of butter are made every day. A single churning room for the whole county! All of this butter is of standard quality, and sold on its reputation upon orders from distant points received in advance of its manufacture. The price is relatively higher than the average for the product of the same farms fifty years ago.

In one respect dairy labor is the same as a hundred years ago. Cows still have to be milked by hand. Although numerous attempts have been made, and patent after patent issued, no mechanical contrivance has yet been a practical success as a substitute for the human hand in milking. Therefore, twice a day, every day in the year, the dairy cows must be milked. This is one of the main items of labor in the dairy, as well as a most delicate and important duty. Allowing ten cows per hour to a milker,—which is pretty lively work,—it requires the continuous labor of an army of 300,000 men, working ten or twelve hours a day throughout the year, to milk the cows of the United States.

The industry is becoming thoroughly organized. Besides local clubs, societies, and unions, there are dairy associations in thirty States, most of them incorporated and receiving financial aid under State laws. In some States, the butter makers and cheese makers are separately organized. Sixteen States provide by law for officials known as Dairy Commissioners or Dairy and Food Commissions. These officers have a national association, and there are also two national organizations of dairymen. At various large markets and centres of activity in the commerce of the dairy, there are special boards of trade. The United States Department of Agriculture has a Dairy Division, intended to watch over and promote the dairy interests of the country at large. Dairy schools are maintained in several States, offering special courses of practical and scientific instruction in all branches of the business. These schools and the agricultural experiment stations, with which most of them are closely connected, are doing much original research and adding to the store of useful information as to the applications of modern science to the improvement of dairy methods and results. Weekly and monthly journals, in the interest of dairy production and trade, are published in various parts of the country. And during the last decade or two a number of noteworthy books on different aspects of dairying have been published, so that the student of this subject may fill a good-sized case with substantial volumes, technical and practical in character.

The business of producing milk for town and city supply, with the accompanying agencies for transportation and distribution, has grown to immense proportions. In many places the milk trade is regulated and supervised by excellent municipal ordinances, which have done much to prevent adulteration and improve the average quality of the supply. Full as much is being done by private enterprise, through large milk companies, well organized and equipped, and establishments which make a specialty of serving milk and cream of fixed quality and exceptional purity. This branch of dairying is advancing very fast, and upon the substantial basis of care, cleanliness, and improved sanitary conditions.

Cheese-making has been transferred bodily from the realm of domestic arts to that of manufactures. Farm-made cheeses are hard to find anywhere, are used only locally, and make no impression upon the markets. In the middle of the century about 100,000,000 pounds of cheese were made yearly in the United States, all of it on farms. At the close of the century the annual production of the country is about 300,000,000 pounds, and 96 or 97 per cent of this is made in factories. Of these establishments there are some 3000, varying greatly in capacity. New York and Wisconsin each have over a thousand; the former State makes nearly twice as much cheese as the latter, and the two together produce three fourths of the entire output of this country. The other cheese-making States, in the order of quantity produced, are Ohio, Illinois, Michigan, and Pennsylvania; but all are comparatively unimportant. More than nine tenths of all made is of the familiar standard variety copied after the English Cheddar, but new kinds and imitations of foreign varieties are increasing. The cheese made in the country, with the small importations added, gives an allowance of less than four pounds a year to every person; but as thirty to fifty million pounds are still annually exported, the per capita consumption of cheese in the United States does not exceed three and a half pounds. This is a very low rate, much less than in most European countries.

Great as has been the growth of the factory system of butter-making, and fast as creameries are multiplying, especially in the newer and growing agricultural States, such as Minnesota, Nebraska, Kansas, and South Dakota, there is still much more butter made on farms in the United States than in creameries. Creamery butter controls all the large markets, the dairy product making comparatively little impression on the trade. But home consumption and the supply of small customers and local markets make an immense aggregate, being fully two thirds of all. Estimating the annual butter product of the country at 1,400,000,000 pounds, not much over 400,000,000 of this is made in the 8000 or 9000 creameries now in operation. Iowa is the greatest butter producing State, and the one in which the greatest proportion is made on the factory plan. This State has 850 creameries, only three counties being without them; about two fifths are coöperative. In these creameries about 90,000,000 pounds of butter are made annually from 750,000 cows. It is estimated that in the same State 50,000,000 pounds of butter in addition are made in farm dairies. The total butter product of the State is therefore one tenth of all made in the Union. Iowa sends over 80,000,000 pounds of butter every year to other States. New York is next in importance as a butter-making State, and then come Pennsylvania, Illinois, Wisconsin, Ohio, Minnesota, and Kansas. Yet all these combined make but little more than half of the annual butter crop of the United States, and in no one of them, except Iowa, is half of the butter produced made in creameries. The average quality of butter in America has materially improved since the introduction of the creamery system and the use of modern appliances. No butter is imported, and the quantity exported is as yet insignificant. Consequently the home consumption must be at the yearly rate of twenty pounds the person, or about one hundred lbs. annually to the family of average size. If approximately correct, this shows Americans to be the greatest butter-eating people of the world.

And the people of this country also consume millions of pounds every year of butter substitutes and imitations, known as oleomargarine, butterine, etc. Most of this is believed to be butter by those who use it, and the State Dairy Commissioners mentioned are largely occupied in the execution of laws intended to protect consumers from these butter frauds.

The cows in the United States were not counted until 1840, but they have been enumerated for every decennial census since. It has required from 23 to 27 cows to every 100 of the inhabitants to keep the country supplied with milk, butter, and cheese, and provide for the export of dairy products. The export trade has fluctuated much, but has never exceeded the product of half a million cows. With the closing years of the century, it is estimated that there is one milch cow in the United States to every four persons. This makes the total number of cows about 17,500,000. They are quite unevenly distributed over the country, being largely concentrated in the great dairy States. Thus Iowa leads with a million and a half cows, followed by New York with almost as many, and then Illinois and Pennsylvania with about a million each. The States having over half a million each are Wisconsin, Ohio, Kansas, Missouri, Minnesota, Nebraska, and Indiana. Texas is credited with 700,000, but very few of them are dairy animals. In the Middle and Eastern States the milk product goes very largely to the supply of the numerous cities and large towns. In the Central West and Northwest butter is the principal dairy product. It is estimated that the dairy animals of the United States include nearly half a million which are pure bred, and that this blood has been so generally diffused that more than one fourth of the cattle are grades.

In a classification of the various annual farm products of the country by values, meats and closely related products stand first in order, the corn crop second, dairy products and the hay crop alternate in the third and fourth places, and wheat occupies the fifth. Hay and corn are so largely and directly tributary to the dairy as raw materials for its support, that it is fair to place the products of the dairy as second only to meat products in the general list. The cotton crop of the country is considered one of great importance, but during recent years it rarely equals the butter crop in value. The dairy aggregate exceeds all the mining products of the United States other than coal, oil, and gas. There never has been a year when the entire gold and silver product of the world was enough to buy the annual dairy products of this country at the present time. These comparisons show the commercial importance which the dairying of America has assumed. It is a branch of farming of such magnitude as to command attention and justify all reasonable provisions to guard its interests.

The Century’s Moral Progress

By SARA Y. STEVENSON, Sc. D.,
Secretary Department of Archæology, University of Pennsylvania.

In dealing with a subject so indefinite in its limits as the progress of morals in the nineteenth century, it may be well to establish by a brief survey of previous facts some solid basis upon which to rest the discussion.

The notion of Duty or of moral obligation—i. e., of well-doing viewed in the abstract and outside of expediency—does not appear to have been brought forward by the Greek philosophers, to whom is mainly due the origin of our own conceptions with regard to morality.

Even Plato, who dealt with nearly all duties, while insisting especially upon the negative duty of committing no injustice or evil, even against one’s foes, nowhere systematically treats of Duty. Indeed, the Greek equivalent for the word did not exist in his time, and the notion was conveyed by a periphrase.

That morals have a bearing upon the welfare and character not only of the individual and of the family, but of the whole body politic, was however early recognized. Theognis, for instance, who lived in the sixth century B. C., stigmatized in the most energetic terms the evil influence exercised upon the destiny of nations by the immorality of the upper classes.

In the earlier schemes of civilization, where worship played a dominant political rôle, morals were regarded as under the protection of the sacred law. Worship and law were closely united in the government, and morals were included in these and governed by motives of expediency.

Man’s obligation to the Deity was then mainly confined to material offerings and propitiatory rites, whilst the law dealt with conduct in so far as order must be enforced, authority respected, and certain mutual rights recognized, if the welfare of the nation was to be maintained.

That the moral standards of these early societies were high cannot be doubted. Those which prevailed in ancient Egypt, as preserved to us in the maxims of sages, as well as in certain chapters of the sacred books, prove that the rule of conduct which was to insure to the subjects of the Pharaohs respect and popularity in this world and happiness in the world to come was in no way inferior to our own. The men who taught their contemporaries “Do not save thy life at the cost of another” had little to learn from the high-bred Parisians who recently escaped unhurt from the burning walls of the French Charity Bazaar.

For the Greek thinkers, however, who first systematically dealt with the subject, Ethics was a branch of Politics, i. e., the Science of Government. Aristotle, like Socrates and Plato, took for the starting point of his argument the sovereign good, or the idea of absolute well-being. All that man undertakes has an aim which, under analysis, is found to be the greatest advantage to him who is acting. Accordingly all knowledge tends to this end; and as all its elements are more or less connected, there must be one, the final end of which is essential; this is the political science which aims at the highest well-being not only of each man, but of man collectively, i. e., of society.

The nature of this highest “well-being,” which is generally termed “happiness,” gave rise among Greek philosophers to discussions which have been revived by modern thinkers.

It may therefore be stated that in ancient thought, at least until the time of the Stoics, morals and virtue were studied, whether in connection with religion or with politics, under the light of expediency rather than under that of abstract right, and that “they were discussed as functions more than as moral obligations.”

The fullness of significance which at present is conveyed in the word “Duty” is mainly due to the gradual and complex development of religious, legal, and philosophical modes of thought, in which certain human acts are regarded as enjoined and others as forbidden by a higher power, and in which conscience enters as an important and ever increasing factor. A sense of duty is the legitimate product of human nature under cultivation. But although we should look in vain among the ancients for the abstract notions which the words “Conscience, Duty, and Right” evoke in the modern mind, we find in groping our way up the stream of time that germs of these concepts had long lain concealed in the precepts of ancient moralists. The fact of virtue existed long before it was made the subject of theoretical systems, and if with the development of the reasoning faculty our moral code has been elaborated and our ethical terminology enriched, broadly speaking, the rules of conduct laid down by civilized men in the remote past and those which govern us to-day are, in kind, virtually the same. Thou shalt not kill; Thou shalt not steal; Thou shalt not covet thy neighbor’s wife; Thou shalt not bear false witness, are coeval with the beginnings of communities. It is in the scope and degree of their application—not in their nature—that mainly lies the difference existing in this respect between the past and the present.

In the highest stage of our moral development the unselfishness which seeks gratification in the welfare of others and in duty accomplished, at the cost of self, may in final analysis be reduced to a refined egoism. The motive held up to man by most moralists is still expediency. The reward, whether it is promised on this earth or in the world to come, is still a reward, and to the “greatest advantage of him who is acting.”

Moreover, moral standards to-day, as in the past, have a strong bearing upon political government, and it is in studying the development of democratic ideas that we may best follow the evolution of modern ethics as characteristic of our epoch; for to this development is due a higher sense of justice, the recognition of the rights of men and of the unimportance of the ego as compared with the race, all of which form distinctive features of the modern creed for which the words “altruism” and “humanitarianism” have been coined. It may also be said, to the honor of the present century, that there exists a growing tendency to accept abstract truth and right outside of expediency as standards of conduct, and to apply these regardless of sex, class, or persons according to the inflexible logic of a trained reason.

Two thousand years ago Christianity established itself upon the wreck of ancient civilizations, preserving that which in them was immortal. Grafted upon the Roman world, the gospel of democracy which it preached could be accepted as the official religion of the Empire only at the cost of its own purity. How could God and Mammon rule together? How could a Constantine rise to an understanding of the Teacher who said: “Ye know that they which are accounted to rule over the Gentiles exercise lordship over them, and their great ones exercise authority over them.... But so shall it not be among you; but whosoever will be great among you shall be your minister; and whosoever of you will be the chiefest shall be servant of all.” (St. Mark x. 42–44.) Christ had established religion among his followers as distinct from worship. The people soon relapsed into worship, whilst for the clergy theology took the place of religion.

With the alliance formed between Church and State in the Christian community, much of the Sermon on the Mount was necessarily forgotten; many of the parables in which the Teacher embodied his doctrine of justice, of tolerance, of love and humility, were to lose their living force. Under the banner of faith, conduct sank to the second rank. The dry subtleties of scholasticism helped to crush morality beneath the words and formulæ of a learned dialectic. Although for centuries the spirit of Christ continued to protect the weak and the lowly, although from the very body of the Church, then ever ready in its arrogance to cast its anathemas upon every effort of man to assert his freedom, sprang reformers who endeavored to restore to the gospel some of its early significance, the Church strayed ever farther from its founder. Was this because, as Michelet said, the reformers themselves needed reforming? Once more man found himself crushed under the law which Christ had declared was made for him, until, at last, in the forcible words of Mr. Darmesteter, of all the Teacher's lessons Christian Rome seemed to remember only one, "Return unto Cæsar that which is Cæsar's." However fiercely monarchy might struggle against the temporal encroachments of the Church, it joined with it to repress the people. "Authority rested upon a mystery. Its right came from above. Power was divine. Obedience to it was a sacred duty and inquiry became a blasphemy."

Then from the great schools and universities the developing intellect of Europe awakened to a sense of its rights. Suddenly there came inquiries into the reality of this spiritual power over human souls and over the human understanding which Rome claimed to be derived from Heaven. In its revolt against dogma, from Abélard and Arnold di Brescia to Huss and Wickliff, from Luther and Pascal to Voltaire and Rousseau, the human thought struggled for freedom under the banner of learning and of reason, and fought for the rights of the people against the privileged few. "I will not speak of tolerance," cried Mirabeau, in his plea for the emancipation of the Jews in the National Convention (1791); "the freedom of conscience is a right so sacred that even the name of tolerance involves a species of tyranny."

At the close of the last century, freedom at last planted its standard in Europe above the ruins of despotism. In the fiery torrent which swept away the ancient traditions of the Church, as well as those of the State, it seemed for a time as though religion as well as the church, right as well as might, must disappear from the surface of the earth, and that, in the smoke of battles and the revelry of reason, truth and morals must perish and anarchy prevail. But a moral rule is indispensable to society, and "Religion is after all but the highest expression of human science and of human conscience." Its germ, innate in man, grows with his understanding in its constant strain to establish a relation between himself and the universe.

To the moral chaos that for a brief space followed the overthrow of the old order of things succeeded, in the beginning of this century, a period of readjustment, and now, in the words of a poet whose own mental processes are a type of those of his time, "Of a hopeless epoch is born a fearless age."

After the absolute negations of the early years of the nineteenth century, after the violent controversies not only of arrogant science and of prejudiced faith, but of scientific and theological schools *inter se* which fill the serious literature of the last generations, a reconciliation between faith and science is taking place, a certain unity of thought is being reached with regard to conduct and to the rights of men. And the century, at its close, shows us the Protestant churchman less tenacious of his dogma, the Romanist less certain of the infallibility of Rome, the scholar less convinced of the infallibility of his science, the agnostic less boastful of his skepticism, the monarchist awakened from his dreams of a divine right of kings and of a preordained subjection of men, the socialist sobered of his revolutionary frenzy and repudiating the extremes of anarchy and nihilism born of his earlier teachings, all marching shoulder to shoulder under the banner of a broad tolerance toward a common goal, in a united effort to lift the masses from the depths of poverty, ignorance, vice, and often crime, to which centuries of repression seemed to consign them, and seeking in friendly coöperation to bring about a better social order.

For in our time has taken place a great broadening of the moral standpoint from which the old rules of conduct are in future to be applied. Toward the end of the last century the equality and fraternity of men was proclaimed to the European world and received a baptism of blood. This official declaration of the rights of men professed to be universal; but, like other dispensations that had preceded it, in its application it fell short of the democratic ideal. All men were declared equal, yet with striking inconsistency those who proclaimed the new creed held others in bondage, and race disqualification survived.

The honor of leading in the greatest moral reform which the world has seen is due to the French Revolutionary leaders. On February 2, 1794, the Convention decreed the abolition of slavery throughout the French colonies, and all slaves were admitted to the rights of citizenship. It was only in 1833 that slavery was abolished in the British colonies by Act of Parliament, and that coolie labor was substituted. In 1861 Emperor Alexander II., following the policy inaugurated by his father, Nicholas I., freed the serfs in Russia. It is a curious fact that the United States, which for many reasons might have been expected to lead in the movement, only followed in 1863. The terrible struggle of the public conscience against expediency and class interest, which then took place upon this continent, must form one of the most important lessons which this century will offer to posterity.

Right prevailed, and with this triumph of justice the human conscience, throwing aside casuistry and evasion for a time, faced its problems honestly and asserted its own sovereignty.

The consequences of the mighty struggle did not stop here. Once the principles of abstract justice established, not only against might but against tradition and expediency; once the rights not only of men (as in 1776 and in 1789), but of all men, recognized in a broader application of the principles of a true democracy, there came a tendency to extend its application to mankind at large; and women, who according to their station in life had hitherto been dealt with theoretically as either useful or ornamental possessions, began to find their place as members of the community. The rights of slaves as men had been officially proclaimed. The rights of women as citizens began to be discussed.

In the widespread shifting of levels which has taken place in the last hundred years, affecting directly and indirectly the moral progress of all classes of society, certain important elements have entered which cannot be overlooked in the present discussion, and which in future ages must stand as preëminently characteristic of the nineteenth century and the Anglo-Saxon ascendency.

The reign of machinery in the industrial world, the advent of steam, of electricity, of compressed air, as motors, have done away with the human machine. Whether in peace or in war the skilled workman has crowded him out. Labor-saving inventions have done away with the necessity for a multiplicity of hands. The need to-day is for trained heads. From evaporated fruit and canned meats to heat, light, and inter-communication, science is brought to bear upon every detail of existence. As an immediate consequence of the part necessarily played by learning in our industrial and commercial life under modern conditions, public education has become the mainspring of national prosperity. Freedom and public education have made our laboring classes the self-respecting, thinking people they are. The human automaton upon which formerly played the greed, the vice, the craft of others now holds a comparatively small place in the modern community, outside of Latin Europe. The “vile multitude," as M. Thiers still stigmatized it (before he turned republican), no longer exists. The world has moved, and so have men.

"If the shuttle would weave of itself," said Aristotle in his apology for slavery, "there would be no need of slaves." The miracle, which seemed impossible to the founder of science, has been accomplished with the predicted result. The shuttle weaves of itself and slavery has disappeared.

Even in Oriental lands, under Anglo-Saxon supremacy the carrying out of great public works is stimulating a demand for education among the people, and the sum total of ignorance and poverty is gradually decreasing and making way for better conditions; for only a trained hand guided by a trained intellect can use the modern tools. This applies to agriculture as well as to industries.

In the rising tide of intellectual and material progress, woman has been carried along to a great extent unconsciously. It is a matter of grave doubt whether the early "suffragists" did more than be the first to recognize and herald the logical drift of contemporary events. It is through higher education that woman has quietly forged her way to the place she occupies in the modern community, and that she is claiming her share of the common heritage of freedom and independence. The prophecy embodied in Bulwer's "Coming Race" is being realized. From year to year her sphere is broadening. She is fast becoming self-supporting. In education she already holds a leading place. Her influence as a moving force is becoming patent. It is officially recognized to a varying degree in certain parts of the civilized world,—England, New Zealand, Russia, and twenty-two of the United States, where she stands before the law not only in her relation to man as his mother, wife, or sister, but in a direct relation to society, as a reasoning being and as a citizen.

The increased self-respect born in woman's mind of a consciousness of equal training and culture, the growing number of women whose ambitions have been stimulated to higher achievement, and the consequent increasing influence wielded by them in the community, suggest the thought that in time their legal status will be generally established, as it already is now in several localities.

Much leveling has taken place since the abolition of the "ancient régime," not only in the relations of the various classes composing society, but in the relation of men and women. The process is still steadily going on. And it is not unreasonable to believe that, with the gradual elevation of the ideals of one half of the population,—that half which is in control of the early training of children of both sexes,—a common standard of character and morality may in time be acknowledged which will admit of but one rule by which the actions of mankind, without distinction of persons, class, or sex, may be measured. The fact that all distinction in favor of the privileged class has already been removed in the eyes of modern public opinion holds out such a hope. The casuistry which still discriminates between evil-doers can but retard moral progress, and the more earnestly modern parents urge upon their sons the same observance of the laws of hygiene and propriety, of truth and self respect, as they exact from their daughters, the nearer to true civilization will society reach.

The world is yet far from this goal. No legislative act has as yet saved society from the ravages of vice, sensuality, and greed, and to-day every degree of savagery and immorality still exists in so-called civilized countries. Education, taking the word in its broadest sense, can alone, by its refining influence, force the savage to give way before reasoning man. And it is by the constantly increasing proportion of educated, self-respecting men and women that the coarser instincts of the human race are being controlled and brought to yield to reason. By holding up the same standards of conduct to humanity, the important place occupied by casuistry and expediency, in the discussion of the ethical problems set before the moralist, may be reduced, and a logical facing of the serious issues to be met may follow. Such a result must tend to strengthen the marriage tie and the family relation, upon which rests the whole moral structure of society.

At present, modern casuistry, if it no longer seeks to justify falsehood and crime committed on behalf of Church or State, still exonerates, in the world of affairs, the high railroad official or the industrial magnate of an infraction of the higher code by which his own personal integrity is judged, provided that infraction is committed in the interest of his constituents. Many a man of high standing, whose personal honor is beyond suspicion and whose conscience would not allow him to take an unfair advantage of another, does not hesitate to transgress when dealing with rival corporate bodies or with public interests. Hence the corruption which prevails in public life to a degree dangerous to the commonwealth, and which is in direct contradiction with the professed standards of the age. Must we then think that living up to the highest moral standard is incompatible with business success, and agree with M. Jules Lemaître that "the attaining to moral perfection is really possible only in the solitude of literary or artistic pursuits, in the humility of manual labor, or in the dignity of such disinterested functions as those of priest or soldier"?

However this may be, new conditions have created new problems which the public conscience alone can solve—as it has already solved that of slavery and of race—with unflinching logic.

The human mind, if less concerned than it was in the days of Molina with polemics on the nature of the human will,—a question, by the way, which Rome after eleven years and thirty-three Councils dared not then settle,—or with theological controversies regarding the value of indulgences, is not yet at peace with itself. Indeed, for being less immaterial, the issues now before it for adjustment are, owing to their bearing upon practical life, all the more vital to the moral health of the body politic.

To the respective rights and duties of labor and capital our best thinkers must turn their attention before an equitable solution can be reached. That such a solution must be reached cannot be doubted, for the interests at stake are fundamental.

Whilst individualism in thought and in conduct asserts itself at every turn, never were the principles of organization so actively carried out among all classes of society. To the strain caused by the forming of trades unions and of united labor leagues for the protection of the wage-earner is now succeeding the danger produced by the concentration of capital in the hands of powerful corporations and the creation of mighty trusts, the undue extension of which in this country seems to threaten the prosperity of the nation and to add to its political corruption. As against these monopolies, public ownership and operation of common utilities is being successfully tried, notably in England and the British Colonies, and the honest municipalization of all community service, carried on as the post-office is carried on among us, results in positive benefit to the people, that is, in good wages and reduced taxes. To discuss these important problems would encroach upon the domain of political economy and social science; but there is no doubt that the public morality is closely dependent upon their solution.

Whether so-called civilized nations, whilst regarding murder as a capital offense and punishing dueling when indulged in by individuals, will long continue to train their best men at enormous expense, in order that in cold blood they may scientifically destroy the greatest possible number of other trained and equally good men; whether peaceful communities of practical tradesmen will some day cease to emulate barbarians in their rejoicings over the slaughter of so-called enemies whom they are individually prepared to befriend and whose prowess they are ready to extol, are glaring contradictions offered by the problem of war which must be left to future generations to reconcile. The leading part which the Anglo-Saxon race has taken in urging arbitration as a proper means of settling international differences places it in the foremost rank of civilization; whilst the Peace Conference proposed by one of Europe's most powerful potentates, the Czar of Russia, must bring a ray of hope to the hearts of those who labor for the advent of universal peace.

Such are the great moral issues of the present day; and in these many minor ones are included. Everywhere and at all periods of history the theory of ethics has widely differed from practical conduct. The race conflict which is taking place in France as the result of the Dreyfus trial, more than a century after the emancipation of the Jews before the law was proclaimed, is a late illustration of this fact. To this, the corruption and failure of justice which recent exposures have revealed in the highest circles of republican France add peculiar significance. As already stated, the broad outlines established in precept remain unchanged, and it is in their logical application that lie all present growth and future hope.

To trace, even in sketchy outline, the debit and credit account of modern ideas upon the various subjects involved in the above mentioned issues would be a serious undertaking. A chapter must be devoted to each nation, for the moral progress of each differs as does its besetting sin. Moreover, every shade of opinion must be weighed and considered. Inherited traditional views are, in each modern mind, hopelessly interwoven with the new articles of a code of morals which public opinion is even now evolving from contemporary conditions. "Each of us," says Edmond Schérer, "belongs to two civilizations, that which is coming and that which is going; and as we are accustomed to the first, we are poorly placed to judge or enjoy the latter."

There never was an epoch when the struggle for existence was fiercer and when earthly possessions were more keenly prized. But despite the many survivals which still point to a semi-barbaric inheritance of selfishness descended through millenniums, a decided moral gain may, on the whole, be placed to the credit of our era. With the decrease of the sum total of ignorance, not only among the lower but among the upper classes, the sum total of well-doing and well-being has immeasurably increased.

The sympathy for suffering is more widespread than it has ever been. No middle-aged person can fail to note the rapid change which has taken place in the public mind with regard to the general treatment not only of children, but of animals. The present mode of dealing with school children according to their individual capacity, the trust in their honor which governs their relation to the teacher, the absence of any corporal punishment, form a recent departure in education well calculated to produce the best moral results.

The improvement of modern methods in relief work as well as in the treatment of vice—now viewed more in the light of a pathological condition than in that of a sin—must make this a memorable epoch in the ethical history of humanity. No branch of civilization has undergone greater change in modern times both in theory and practice than public and private charity. To-day the humanitarian endeavors to lift up the fallen and the needy, and almsgiving on the part of the well-to-do is fast becoming relegated to the category of a self-indulgence which is not to be encouraged. The distinction between the old methods and the new is given in the formula that "henceforth the chief test of charity will be the effect upon the recipient." Any relief calculated to undermine self-reliance and independence is discouraged by those who have in view the prevention of our moral ills rather than their relief.

Indeed, the new school preaches scientific charity as against emotional charity. What it may have lost in impulse it has more than made up in effectiveness. The attempt to teach the needy to help themselves, the work of college settlements and of the organized efforts in the poorest and most neglected districts of large cities, with a view to fostering by personal contact and example habits of thrift and self-respect where those virtues are most lacking, are among the truest if more homely glories of the closing century.

Verily, never was a more thoughtful effort made everywhere to mitigate the cruel distinctions of race and sex, of wealth and poverty, and to “harmonize the social antagonisms” of modern life. Never was so much consideration given to the betterment of humanity, nor was the aggregate of earnestness so great.

In our more robust intellectual world the tree is judged by its fruit, and acts tell, not creed. The principle that well-doing, unless it is disinterested, forfeits its claim to the highest respect of men, is growing in strength, whilst the feeling is gaining ground among the thoughtful that in the development of personality may be found a sufficient motive for the exercise of virtue, and that character, not reward, *being* not *having*, are the highest aims.

If we resume the moral progress of the nineteenth century, allowing for its inconsistencies, carefully weighing its negative and positive results, and taking as a balance what is original in its contribution to the ethical development of the human race, we will find that this contribution mainly lies in the direction of tolerance and of altruism. This altruism is distinct from the charity of St. Vincent, which sacrificed self in a loving attempt to relieve individual distress. Such pure sacrifice, admirable as it is, is not only narrow in its scope, but because of its austerity must fail to survive in the struggle for existence. Modern altruism aims at removing the main cause of individual distress, and spends itself in educational efforts, in which the well-doer finds happiness in the consciousness of usefulness. It is also unlike the socialism of Condorcet, which reached down in an endeavor to make all institutions subservient to the interests of the poorer and most numerous classes, for it aims at lifting these to the highest possible plane. The mountain summits are not to be lowered, but the valleys are being filled. To raise the people, to build up, not to tear down, is the avowed end of all modern moral effort, and must ever stamp the humanitarian struggles of the present age as distinct from those of the eighteenth and preceding centuries.

With this we may claim an increase in individual freedom, and a perceptible tendency to a logical and ever broadening conception, not only of the rights, but of the duties of citizenship; to a more honest recognition of the place assigned by expediency to evil in the social and business intercourse of a practical life; to a growing scorn of casuistry, and to a stronger faith in the reality of right and of abstract truth as they are revealed in every thinking man’s heart, and the uniformity of which is reflected in the public conscience.

Progress Of Sanitary Science

By CHARLES McINTIRE, A.M., M.D.,
Lecturer on Sanitary Science, Lafayette College, Easton, Pa.

Since blessings brighten as they take their flight, it may be difficult to realize how much of our present happiness and comfort depend upon the constantly abiding benefactions brought about by the progress of Sanitary Science in the present cycle. The proper care of the body and the prevention of disease, rather than its cure, have occupied the minds of men from the dawn of history. Moses is the author of a well-digested code of hygiene, and erudite scholars can find hints of the proper conservation of health in the Egyptian papyri. Hippocrates wrote about the prevention as well as the cure of disease; indeed, all along the course of time the master minds of medicine attempted the solution of many of the problems of Sanitary Science as eagerly as they sought for the *elixir vitæ* or for the universal solvent. Notwithstanding all this, one can truthfully say that sanitation could not be fairly termed Sanitary Science until its rules of procedure began to be formulated with more or less exactness upon careful experiment and accurately recorded observation. Sanitary science, as such, could not begin to be until pathology (a knowledge of the morbid processes of disease) and etiology (a study of the causation of disease) had builded upon a scientific foundation. Before this all deductions were from experience, and had no other reason than the seeming helpfulness of the procedure; after this, as fast as the facts were demonstrated, deductions were made that determined a procedure which would of a certainty accomplish the purpose. In the olden times, during an epidemic of a contagious disease, tar barrels were burned in the streets,—and not without some benefit. At the present, the room, with its contents, can be disinfected with a certainty of destroying every atom of contagion.

This difference must be kept in mind when comparing the old with the new, and the true reason of the great advance be recognized as due to the spirit of scientific investigation, which began in the latter part of the last century with the employment of instruments of precision in research, and which has developed so wonderfully up to the present that the experimental psychologist measures the minute portion of time it takes to form a thought. At the same time, it must be kept in mind that the sciences which furnish sanitary science much of its material are progressing and, because progressing, changing; that the conditions desired to be removed are prevailing, and the necessity of overcoming them urgent. Not in every case has the sanitarian fully demonstrated and laid down scientifically accurate data on which to base his method of procedure. Hence it happens that even now sanitary empiricism must needs be mingled with sanitary science, and the mingling is sometimes as much of a motley as the dress of the court fool of the Middle Ages.

Since sanitary science had its origin during the present century, it will be helpful to assign a definite period for its birth. Not that any one would have the temerity to dogmatically assert that the science came into being at a fixed date, but rather to fix a period of time when the conditions working through the ages were so shaped that, perforce, the problems of sanitation would thereafter be treated more in a scientific and less in an empirical method than before. This time is associated with the beginning of the reign of Queen Victoria of England, since the first Act of Parliament for the registration of births, marriages, and deaths was passed in 1837, and the beginning made of accurately gathering information which is to the sanitarian what the pulse is to the physician. With his fingers on this tell-tale of the flow of the heart-blood of the nation, he is enabled to determine whether disease is above or below the normal, the character of the disease that abounds, and its whereabouts. Knowing where to find any disease in excess, he can study the conditions and surroundings, comparing them with other places, whether afflicted in like manner or, more favored, free from the disease. By means of these vital statistics he can compare year with year, and tell with a degree of exactness heretofore impossible whether any disease is increasing or decreasing; he can lay his returns by the side of the figures of the meteorologist and learn if the weather has any influence on the death-rate; he can follow the results of his efforts to improve the condition of the people and vindicate his expenditure of the public money by pointing to the reduced mortality rate. It may seem to be a gruesome task for every physician in the land to send to the proper official a notice of each death and of each patient suffering from a disease apt to be communicated to some one else; and almost ghoulish for the officer to sit at his desk, day after day, and catalogue and tabulate these returns. But it is only a modern version of the old riddle of Samson, out of the bitter came forth the sweet; for without this, much of the progress of sanitary science would be well-nigh impossible.

The act adopted in Great Britain has been modified and improved upon since then, and in the United States many of our cities and some of our States have been engaged in a similar effort. As yet we have no central bureau or collecting office for the nation; nor is this necessary, if each State would do its duty, or, at least, the general government in that event need only tabulate the returns of each of the States. The effort is now making, under the auspices of the American Public Health Association, to secure a uniform method of registration in all offices collecting vital statistics, by which the same name will be given to the same disease and the same facts recorded in each return made. This will cause a little confusion at first in those offices where statistics have been tabulated for a number of years, but the advantage will be so great as to fully repay any inconvenience at the first. If we desire to obtain the full benefits from the advance of sanitary science, we must see to it that in every State there is an efficient bureau of vital statistics, whether under the supervision of the State Board of Health or some other department of the State. The absence of such a bureau reflects upon the intelligence of the people or the integrity of the law-making power.

Are there tangible results to warrant so sweeping an assertion? is a fair question, since at the time of the preparation of the census of 1890 New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, and Delaware were the only States collecting vital statistics, and since then but Maine and Michigan have been added. Before quoting figures, it must be premised that even now the returns only approximate accuracy; they were much more inaccurate at the first, and before the general registration was undertaken most of the statements are merely estimates, after the fashion of the geographer who gives the number of inhabitants in China, where a census never has been taken. It may happen that the benefits are not as great as the figures seem to show, but after making all allowance there is great improvement.

The “Encyclopædia Britannica” asserts that two centuries ago the mortality of London was 80 per 1000, while now it is but a little over 20. In 1841, out of every 100,000 people in England, 30,000 would have died before reaching the age of 10, and one half would have died before they were 40 years old; in the decennium 1881–90, before 30,000 would have died out of each 100,000 some would have lived to be 17, and some would have lived to be 55 before one half of the number had departed into the unknown and the hereafter.

The figures of the statistician must be quoted again and again in the progress of the article, as no more tangible evidence can be given of the benefits resulting from improved methods of sanitation. Very early a coincidence was observed between the uncleanly and the death-rate. Neighborhoods where little or no care was taken to remove the refuse, where there were foul drains and a deficient water supply, were found to be the abodes of special forms of disease,—so much so, that these diseases soon received the name of "filth diseases." Acting upon the suggestion, the gospel of cleanliness was preached and its practice enforced. There was a "redding up" in its eventuality as thorough as the cleansing of Santiago de Cuba in recent days. It did not take long to discover that decaying organic matter in some way was the offending body, and that this contaminated the water supply. Wells were condemned and public water supplies installed; means were sought to enable the cleansing to be constantly carried on, and sewers for house drainage followed or accompanied the water supply. In proportion as this has been thoroughly done has the death-rate from certain diseases diminished. During the last century the European armies were decimated by fever (typhus or relapsing) to such a degree that the work of the fell destroyer at Santiago was trifling in comparison. On into the present century, the great scourge of Great Britain was these same two fevers; so much so, that "the fever" meant the dread jail or typhus fever. It was imported into this country, and epidemics of "ship fever" were of frequent occurrence. Thus, as late as 1846, it was estimated that in Dublin alone there were 40,000 cases of fever, with a total in Ireland of 1,000,000 cases. There were 10,000 deaths in Liverpool, a city especially prone to the disease; while in Edinburgh one person out of every nine of the population was attacked, and one out of every eight of the sick died. Turning from this account to the medical returns of the war for the Union, there were reported only 1723 cases, with 572 deaths, to the office of the Surgeon General, and even these a very competent authority after careful investigation decided not to be instances of true typhus. Or turn to civil practice: the disease is found so seldom with us that it is not necessary to assign to it a column along with the other diseases in publishing the mortality returns by our health authorities. The deaths from fever in London during October, November, and December, 1898, were but 296. London has an estimated population of 4,504,766, and the "fever" in the report included typhoid, simple and ill-defined forms of fever, as well as typhus. This makes a death-rate of but 0.26 per 1000.

Had sanitary science no other trophy, its votaries could still boast of the great benefits to humanity brought about by their labors. This is but one of many; thus, scurvy, the great bane of the navy, is now a disease that few physicians have the misfortune to see, or patients to endure. Then that disease somewhat akin to typhus, and until within the memory of the fathers confounded with it, hence called typhoid fever, is likewise fast disappearing, more rapidly in cities than in rural communities however. The suppression of typhoid proceeds with equal step with the introduction of a public water supply in our towns, the adoption of the proper means to furnish this water unpolluted, and the proper removal of domestic waste through sewers, whose contents are so treated as to work no harm after they escape. Notwithstanding these great triumphs, if boasting is permissible, the sanitarian's boast is rather that his science, which had its beginning, as we have seen, at the time when there was a great awakening of the national conscience in British politics for "the larger sympathy of man with man," has broadened with the years of its growth; has endeavored to care for one's brother so that his blood would not cry up from the ground; so that, after forty or fifty years had passed, a distinguished sanitarian could write with literal accuracy: "Whatever can cause, or help to cause, discomfort, pain, sickness, death, vice, or crime—and whatever has a tendency to avert or destroy, or diminish such cases—are matters of interest to the sanitarian; and the powers of science and the arts, great as they are, are taxed to the uttermost to afford even an approximate solution of the problems with which he is concerned."[1] And the crowning glory of the science to-day is the care it bestows upon the weak, the ignorant, and the helpless; the efforts it makes to ameliorate every undesirable condition of society.

---

[1] Dr. J. S. Billings in *Ziemssen's Encyclopædia*.

It would be misleading to infer that all of these benefits have been brought about solely through the collection of vital statistics, although much of it would have been difficult without the knowledge furnished by these statistics. Workers in almost every branch of pure science have contributed to the progress,—the physicist, the meteorologist, the chemist, and by no means the least, the biologist. Indeed, with the more recent investigations, the culture tube of the biologist has almost revolutionized medicine and all that pertains to it.

Sanitary science seeks to accomplish two ends; it purposes to *prevent* disease and to *promote* public health. If it seeks to prevent disease, after the fashion of the oft-quoted cook-book, it must first secure the disease, or what is essentially the same thing, know what causes it. If the cause be known, and we can conquer the cause, we can prevent the disease. Thus a disease known as *trichinæ spiralis*, from the name of the parasite invading the body and causing sickness and death, is caused by eating pork infected by the trichinæ. We can certainly prevent trichinæ in persons by forbidding pork; but we also know that the trichinæ do not occur in all pork, and that their presence can be detected by the microscope. If, then, a sample from every slaughtered pig is submitted to the microscopist, the infected pork can be discovered. This is done in our large packing establishments, especially for that pork which is to be exported. Again, a thorough cooking will kill the trichinæ, even if present. Only the grossest carelessness, consequently, can account for a case of trichinæ, and, indeed, it is a very rarely occurring disease. This illustrates the importance of a knowledge of the cause of the disease, to enable one to devise a method for preventing it. In the study of disease causes, the biologist has been very successful during the past few years, and a number of our communicable diseases are demonstrated to be caused by the growth and development of bacteria. From this demonstration in the case of some, a general hypothesis has been formulated, which is useful as a working hypothesis, but by no means safe to call a theory as yet. This hypothesis is that all of our communicable diseases are caused by living organisms originating in one person and conveyed to another, where they begin to grow, to reproduce their kind and to perform their life functions. Hence all communicating diseases are infectious. Some of these infectious diseases, like measles or smallpox, are capable of direct communication from one person to another, rendering them contagious; others, like typhoid fever and cholera, are not contagious in this sense of the word. This is a very excellent distinction to make in the use of these much abused words.

The biologist has rendered sanitary science great service not only in discovering the causes of certain diseases, but also by aiding to determine the nature of the disease in any outbreak. It makes a vast difference if a given case is one of true diphtheria or not, or of Asiatic cholera or not, and often the symptoms alone are not conclusive. Here the biologist comes to our aid, as is seen so often in cases of supposed diphtheria. A portion of the throat secretion is sent him under such precautions that no bacteria from the outside can possibly contaminate. With this secretion he stabs or inoculates a jelly composition which he has placed in a test-tube, stuffs a wad of absorbent cotton in the mouth of his tube and puts it in a warm chamber or incubator. If there are any microbes present, they will begin to grow, and the expert biologist can tell the bacteria from its manner of growth as readily as the gardener can distinguish between his radishes and lettuce when they sprout in the spring, and in this way is able to report the nature of the germs. If he is in doubt, he carries his cultivation further and employs other tests to prove his observation.

The biologist has also rendered great aid to sanitary science in discovering many other species of bacteria that are helpful to man. Our polluted waters could not be purified, our air could not be cleared from foul odors, nor the proper decomposition of organic matters go on, without the aid of bacteria. These little vegetable growths, while working much harm upon humanity, contribute far more to their comfort, well-being, and happiness than they do to their ill. Possibly no better illustrations can be given of the value of bacteriology to sanitary science, and the great progress it has brought about, than to contrast a cholera outbreak of a few years ago with one occurring more recently; or to point to the efficacy of purifying water by the assistance of bacteria. Another disease, pulmonary consumption, may also be noticed, but the triumph here is not so marked as yet.

The first outbreak of cholera in the United States occurred in 1832. In one special hospital in New York city, 2030 patients were received in the nine weeks from July 1 to September 1, and of these 850 died. An eye-witness, who was personally known to the writer, one not given to exaggeration, said that the state of dread and alarm had been increasing until, when the disease first made its appearance in New York, fully one half of the population had left the city, many of the physicians fleeing with the rest. There was no efficient health department, and no organized system for the protection of the public health. This gentleman was a city missionary, and, in the performance of his duties, visited many of the houses. He mentioned visiting one of these on a morning when the fifteenth body had been carried out. It was the time of the rumble of the dead cart and the indiscriminate burial in public trenches. Contrast the horrors of this scene with the last attempt of cholera to invade the United States, in 1893, when, notwithstanding its presence at the quarantine station in New York harbor, and the actual presence of a few well-authenticated cases in the city itself, *not one of these cases proved a focus for the spread of the disease*.

The opinion that water in some way acts as a conveyer of disease can be generalized after a very little observation. To explain how it does this is a problem that was attempted to be solved by the chemist. He added vastly to our knowledge, but it was not until the biologist showed the presence of the disease-producing bacteria in water that a full explanation was possible. But the biologist has done more: it has been found, and notably in the very complete series of experiments carried on by the Massachusetts Board of Health, that even an effluent of a sewer, if filtered through a bed of sand, is purified to such an extent that the filtrate is a perfectly safe water to drink. The dangerous organic matter disappears, and ninety-eight per cent of the bacteria is removed. And it is pleasing to note, when one has so much to say of the dangers of bacteria, that the purification is entirely brought about by the action of bacteria working for the good of man. A sand filter bed does not purify water properly until it has been in operation for a few days, when the top of the bed is covered with a slime in which the bacteria act upon the organic matter in the water and purify it. The fact of the purification was known before the manner in which it was done was understood; and in those cities where the authorities have acted upon this knowledge and have purified their water supply, the influence upon the death-rate of typhoid fever is almost as marked as those already quoted for typhus fever, while the scourge of cholera has been almost entirely removed from their borders, as many an instance during the late outbreak in Europe could illustrate. It does not contribute to our self-esteem to know that most of the water supplies so filtered are to be found abroad. There is not enough of “practical politics” in filter beds to charm the traditional alderman of our cities.

It is now clearly proven that a species of bacteria is uniformly present in pulmonary consumption. This bacillus is to be found in the material coughed up by those who are ill with that disease. It has considerable tenacity of life; the expectorated material can be dried, pulverized into dust, and carried about on the wind; should the bacteria so dried and carried find a proper soil, they can grow and reproduce the disease. Fortunately, a combination of circumstances is required for the contraction of this disease, or it would be far more prevalent than it is. Notwithstanding, it already claims more victims than any other single disease. What has sanitary science done for its repression? It is attempting, in a tentative way, to obtain a registration of those who are consumptives, in order to teach them to avoid being possible sources of infection; to disinfect the discharges carrying the bacteria, and at times the rooms occupied by the consumptives. In Rome, for example, the services of the public disinfectors are asked for as eagerly for the room occupied by a consumptive as for one that had been used by a person suffering from diphtheria. In New York city, where the department of health has been exercising an oversight and care over the consumptives, there has been a constantly diminishing death-rate from all tubercular diseases from 1886, when the rate was 4.42, to 1897, when it was 2.85, with the single exception of 1894, which was lower than 1895. It is too soon to predict the result, but the proper care of consumptives promises much to check the ravages of the disease.

One of the charms connected with the great results indicated is the simplicity of the methods employed to bring them about. While complex schemes and elaborate machinery may be necessary whenever the amount of service to be rendered requires organization and division of labor to properly accomplish the desired results, the principles are such that they can be executed in the smallest hamlet, and with the very crudest paraphernalia. The two great weapons of the sanitarian in fighting disease are isolation and disinfection. Dr. Henry M. Baker, the efficient secretary of the State Board of Health of Michigan, has for years collected and tabulated the results of the observing and non-observing of these precautions in his State. He has a happy faculty for graphically presenting the results. One of his diagrams is presented here and needs no explanation. In very few of these outbreaks could there have been any municipal disinfecting plant or isolating hospital.

Isolation and disinfection—but the old quarantine and fumigation under new names! Who of us has not sympathized with the traveler of the earlier days in the Levant, when he was condemned to days and weeks of detention in the barren lazaretto? And even at so comparatively recent a date as the pilgrimage recorded by Mark Twain in his “Innocents Abroad,” he states that the Italians found it more to their convenience to fumigate travelers than to wash themselves. How very different is a modern quarantine station, such as may be found near any of our more important ports on the Atlantic coast. If the health officer of the port finds a contagious disease upon board, he immediately removes the sick to the hospital, and keeps the well under supervision long enough to see if the disease has been communicated to any. He may keep them on shipboard; but more likely, if the ship must be disinfected, he removes them to the detention station, safely separated from the hospital. The steerage has been crowded, and there is need of disinfection of their persons and clothing. Under proper supervision, each is required to take a bath, for which abundant facilities are furnished; and while this is doing their clothing has been placed in the steam disinfecting apparatus, a partial vacuum secured, superheated steam introduced, the clothing thoroughly disinfected, a partial vacuum again produced, whereby the contents are rapidly dried, and they are ready to be put on again by the time the bath is completed. The luggage is treated in the same way, while the cargo is probably treated to a sulphur fumigation,—the sulphur being burned in furnaces and the fumes carried to all parts of the cargo through lines of hose. In the course of a very few days, at least, all but the sick can proceed on their journey without any risk of conveying the disease.

Everything that has thus far been chronicled regarding the progress of sanitary science has related to the diminution of the death-rate and the prevention of disease. After all, is this worthy the telling? When one learns “how the other half lives,” or, with more restricted knowledge, realizes to a degree the intensity of the remark of a young Hebrew, replying to a command of a police officer to clean up, as related in “The Workers” by Professor Wykoff: “You tell us we’ve got to keep clean,” he answered in broken English, lifting his voice to a shout above the clatter of machines; “what time have we to keep clean, when it’s all we can do to get bread? Don’t talk to us about disease; it’s *bread* we’re after, *bread*!”

Is it worthy of boasting that sanitary science is only increasing the hardships and adding to the number of mouths to be fed, without opening up new ways to earn one's bread? Even if it be so decided, and all the claims of progress thus far made be declared wanting, there still remains much worthy of praise. Sanitary science strives not only to prevent disease, but also to promote health, and its progress is fully as marked in its efforts at promotion as in those of prevention, although we do not possess the cold figures of even imperfect vital statistics to demonstrate the proposition.

It must be kept in mind that sanitary science is wider than sanitation in its technical sense. One would not care to assert that philanthropic effort and sweet charity are resultants of the development of sanitary science,—very few care to assert an evident untruth. But the influence of this study has been widespread and beneficial. The whole round of social science is also permeated with the truths demonstrated by the sanitarian, and is likewise deeply indebted to its teachings. Our field broadens greatly as we view it, just as one who has been traveling through a vale of surpassing grandeur, because of the mountain barriers on either side, finds himself confronted by a park whose beauty is enhanced by its variety as well as its extent, bounded, it is true, by the same mountains, but merely a hazy definition of the distant horizon.

In the construction of dwellings, for example, the small, low ceiled rooms, whose earthen or stone floors were covered with rushes seldom removed, the absorbers of whatever might fall upon the floor; the unpaved, unswept, and unsewered street; the domestic water supply but a well into which filters the water from the adjoining cesspool,—these and many similar destroyers of health and comfort can no longer be found among nations classed as enlightened in our school geographies. Even the improvements of half a century ago—the tenements improvised out of the deserted mansions of the well-to-do, with the additions built on the rear of the lot to increase the density of the population and the rent of the owner (as well as the death-rate), are disappearing, and in their places we find dwellings capable of furnishing air and light to all of the residents.

Then, in the matter of streets, how much more attention is now given to small parks! When about the middle of the century interest in public parks was revived, the efforts of the various cities were directed to the securing of large tracts of ground and beautifying them in every way. They were open to every one, it is true, but too often too far removed to be of use to the submerging tenth. Now, while not adorning these with one garland less, the effort is making to break up the congestion of the crowded districts by breathing spaces, to the comfort and vigor of those who must make the surrounding houses their homes. The streets, too, no longer paved with the unsightly cobble-stones, are made noiseless with the asphalt paving and, what is more to the purpose, can be easily cleansed by flushing. When practical business, and not practical politics, prevails in the municipality, there is no opportunity for the household refuse to accumulate, although no longer rushes are available to receive it, for it is regularly and promptly removed.

The exigencies of trade compelled our government to establish its bureau for the inspection of meat. The necessity of an inspection of foodstuffs for export demonstrates the possibility of adulteration for the home market. While, possibly, the ingenuity of the sophisticator has more than kept pace with the keenness of the inspector, the health of the people has been maintained, their comfort promoted, and their resources husbanded by the inspections carried on by the various city and state boards of health.

The welfare of the people at home, in their dwellings and at their tables, does not limit the efforts of the sanitarian. He takes cognizance of the daily toil, the ceaseless grind, to win one's daily bread. He recognizes that some callings are dangerous or annoying to the people, and devises methods to overcome this, or failing in this, insists that such occupations must be carried on remote from the dwelling-place of man. Others, he finds, bring danger to those who are employed. This may not be an inherent danger, but one acquired by our crowding of operatives, or in other ways not securing to them proper comfort; and factory inspectors are at work to reduce these dangers to a minimum, and to prevent child labor as well—giving to youth, as far as cessation from overmuch toil can give, an opportunity to develop into physical manhood or womanhood. The sanitarian insists upon proper ventilation in mines, and tries to devise the means to remove the danger from those trades that ordinarily are inherently dangerous.

The sanitarian seeks to aid in the amenities and relaxations of life as well. The playgrounds for children, the athletic grounds by the riverside at Boston, recreation piers in New York, are examples of this. And all of these are comparatively recent efforts, adding to the catalogue of achievements during the century. It was the arch-enemy who, in the poem of antiquity, said: "All that a man hath will he give for his life." But he made the remark after much observation, and to Jehovah, unto whom even he would not dare to lie; and the rolling years since the Hebrew epic was first written have only added testimony to the truth of the assertion. In these later days, when the rule and plummet are everywhere applied, where the scientist delves and classifies to seek the cosmos in the apparent chaos, there was evolved out of self-seeking for life a higher and better quest,—a search for those things which make for the health of all. This search has widened, until many a broad savannah has been trodden, many a mountain scaled and wilderness explored. With its ever extending view, new responsibilities and greater cares have been thrust upon those who are endeavoring to rule in this domain. A community, a nation, is but a unit. Let one part suffer, and all are in pain; let one but decay, and rot is imminent everywhere. There can be no true social progress, no real stability of government, no national prosperity worthy the name, unless the environment of each individual permits the enjoyment of personal health, if he individually observes but the ordinary care of self. And whatever else of progress for sanitary science may be granted or denied as belonging to our century, the crowning claim of all, which cannot be taken from her, is that, along with the ideas embodied in commonweal and commonwealth, she has added the other of equal dignity and worth—Public Health.

The Century's Armies And Arms

By LIEUTENANT-COLONEL ARTHUR L. WAGNER,
Assistant Adjutant General, U. S. Army.

A true appreciation of the progress made in the arts and sciences in the nineteenth century can be obtained only by contrasting the conditions found at present with those existing a hundred years ago. The difference between the sperm candle and the electric light; between the stage-coach and the rapid-flying express train; between the flail and the threshing machine; between the hand-loom and the machinery of the modern woollen mill; between the cruel medical operations of five score years ago and the skillful surgery, with the use of anæsthetics, of the present day; or between the mail-carrier with letters in his saddle-bags and the electric telegraph flashing news instantaneously from continent to continent; marks the difference between the beginning of the nineteenth and the opening of the twentieth centuries.

But there is scarcely an agency that has been employed during this wonderful century for the improvement of the condition of man that has not been enlisted for his destruction. Steam, electricity, chemical knowledge, engineering skill, and mechanical invention have all been employed in the science of war, and everything pertaining to the organization, arms, equipment, supply, training, and even the size of armies, has been so revolutionized that there is scarcely anything in common between the forces that fought at Marengo and those employed in recent wars, except the characteristic of being armed and organized bodies of soldiers under military leadership.

The nineteenth century was born in the midst of war. All Europe was an armed camp, and the contest between the principles of the French Revolution and the old feudal system had taken the form of actual strife upon the field of battle. A great alteration was taking place in the methods of war; the old pedantic strategy of the Austrian school had already received a rude shock at the hands of the brilliant young Bonaparte, and the old tactical methods bequeathed by Frederick the Great were, also, soon to be shattered by the genius of the newer and greater warrior. To appreciate the changes that were already being made in military methods, a brief glance at the organization of the armed forces in the latter part of the eighteenth century is necessary. The Prussian army, as organized by the great Frederick, was regarded as the finest of the time. In it the most exact and machine-like methods were observed, the most careful accuracy in marching was required, drill was carried to mechanical perfection, volley firing was conducted with the greatest precision, and no skirmishers were employed. In comparison with later methods, the whole system may be characterized as exact, methodical, and slow. Armies were supplied entirely from magazines, by means of long and cumbrous trains, and the art of moving rapidly and subsisting on the country was still to be discovered.

The French army produced by the Revolution, and led by such men as Dugommier, Hoche, Moreau, and Bonaparte, was trained to operate in column, to deploy quickly into line, and generally to act with celerity; while the impoverished treasury of the republic compelled its armies to live entirely upon the country in which they were operating, as the only alternative to starvation. This entailed serious hardships to the soldiers, and great distress to the population of the country in which they were acting, but it marked distinctly the beginning of a new system of supply, which contributed greatly to the rapid movement of armies. The French army, at the beginning of the century, contained no regiments, but was organized into demi-brigades, each of which consisted of four battalions, each comprising ten companies, two of which were trained to act as skirmishers. These demi-brigades, with one or more batteries of artillery, constituted a division, to which a small force of cavalry was generally added. In 1805 Napoleon, then the supreme ruler of France, made important changes in the organization of the army. The demi-brigade was replaced by the two battalion regiments, each regiment now consisting of eight companies. Two regiments formed a brigade, and two brigades and a regiment of light infantry constituted a division. On the light regiment devolved the duties of skirmishers; namely, to harass and develop the enemy before the main attack. The divisions were grouped into larger organizations known as *corps d'armée*, or army corps, each of which consisted of all arms of the service, and was, in fact, a force capable of operating independently as a small army.[2] A corps of reserve cavalry was also formed. In numbers the cavalry was equal to one fourth, and the artillery one eighth of the strength of the infantry. The infantry was armed with a smooth-bore, muzzle-loading, flint-lock musket, which required some thirty-two distinct motions in loading, and which had an effective range of only two hundred yards, though by giving it a high elevation it could do some damage at twice that distance. This weapon bore about the same relation to the magazine rifle of the present day that the old-fashioned sickle bears to the modern mowing-machine. The artillery consisted of muzzle-loading, smooth-bore guns, which had less than one fourth the range of the modern infantry rifle. Cavalry, being able to form with comparative impunity within close proximity of the opposing infantry, could sweep down upon it in a headlong charge; and the use of the sabre on the field of battle, now so rare, was then an almost invariable feature of every conflict. Under Napoleon the armies continued to "live on the country," but magazines of supplies were carefully prepared to supplement the exhausted resources of the theatre of war.

In besieging a fortified place, the first parallel or line of batteries of the besiegers was habitually established at about six hundred yards from the enemy's works, a distance then at long artillery range, but which would now be under an annihilating fire from infantry rifles. The cannon used solid shot almost exclusively, though early in the present century a projectile, invented by Lieutenant Shrapnel, of the British army, and which now universally bears his name, was introduced. This consisted of a thin cast-iron shell filled with round musket balls, the interstices between which were filled by pouring in melted sulphur or resin, to solidify the mass and prevent it from cracking the shell when the piece was fired. A hole was bored through the mass of sulphur and bullets to receive the bursting charge, which was just sufficient to rupture the shell and release the bullets, which then moved with the velocity that the projectile had at the moment of bursting. Shrapnel has at all times been a destructive missile, though in its early form it was insignificant in comparison with the "man-killing projectile" which now bears the same designation.

In the year 1806, the Congreve rocket was added to the weapons of war. It consisted of a case of wrought iron, filled with a composition of nitre, charcoal, and sulphur, in such proportions as to burn more slowly than gunpowder. The head of the rocket consisted of a solid shot, a shell, or a shrapnel. At the base was fastened a stick, which secured steadiness for the projectile in its flight. The range of the rocket was scarcely more than five hundred yards, though a subsequent improvement, which dispensed with the guide-stick and substituted three tangential vents, increased the range very considerably. Congreve rockets were used with effect in Europe in 1814, and against our raw militia at Bladensburg in the same year. They seem, however, to have depended more upon the moral effect of their hissing rush than upon any really destructive properties, and were effective mainly against raw troops and cavalry. The rocket is now an obsolete weapon, having made its last appearance in war in the Austrian army in 1866.

[2] Brigades and divisions had long existed, but the army corps was a creation of Napoleon.

The infantry of all the armies of Continental Europe, when deployed for battle, was formed in three ranks. On the eve of the battle of Leipsic, Napoleon, finding himself greatly outnumbered by the allies, ordered his infantry to deploy in two ranks, in order that his front might approximate in length to that of the enemy. This formation had, however, been adopted by the British some years before, and had been used with great success against the assaulting French columns, in many of Wellington's battles in Spain, where the steadfast Anglo-Saxon soldiery was able to maintain the "thin red line," and throw the fire of every musket against the denser formation of its foes. It was not until the British troops encountered, upon our own soil, an Anglo-Saxon opponent as steadfast as themselves, and better skilled in marksmanship, that they were unable to achieve a victory over their enemies. True, our raw militia was everywhere beaten when it encountered the disciplined soldiers of Great Britain, but our regular troops at Chippewa and Lundy's Lane gallantly defeated the choice veterans of Wellington's campaigns; and, at New Orleans, an army composed mainly of hardy backwoodsmen, trained in Indian lighting, and expert in the use of the rifle, hurled back, with frightful carnage, experienced British soldiers who had habitually triumphed over the best veterans of the French empire.

The battle of New Orleans marked the introduction of the rifle as a formidable arm for infantry. It was by no means a new weapon, for it had been invented in Germany in 1498; but it had not been used to any extent in military service, mainly because of the slowness of loading. The capabilities of the rifle in the hands of an army of expert marksmen were, however, made so manifest by Jackson's great victory that the attention of military men was turned towards the weapon which had enabled a crude army to overwhelm the choicest troops of Europe.

Yet it was not until 1850 that a practically efficient military rifle appeared. This was the invention of Captain Minié, of the French army, and was the well-known "Minié rifle," long familiar to troops on both continents. The weapon was a muzzle-loader, and its projectile, the "Minié ball," was of a conoidal shape, as shown in the accompanying figure. The ball being slightly smaller in diameter than the bore of the piece, the loading was easily accomplished, and the shock of the explosion against the cavity at the base of the bullet forced the lead into the grooves of the bore and caused the shot to take up a rotary motion on its axis—in other words, "to take the rifling."

Rifles, mostly constructed on principles similar to those on which Minié's weapon was based, were soon in use in the armies of all great nations. The rifle musket, "model of 1855," adopted by the United States, is shown in the accompanying figure.

In 1817 percussion caps were invented in the United States, but some time elapsed before they were introduced into military use; and though the "percussion rifle" was known in 1841, the victorious troops which went with Scott in the brilliant campaign from Vera Cruz to the City of Mexico, six years later, were armed with the flint-lock musket. In 1833, Colonel Colt invented the first practical revolving pistol. This weapon, especially in its present perfected form, is so well known as to need no description. The first pattern of Colt's revolver used paper cartridges and percussion caps.

In the long period of peace which Europe enjoyed after the battle of Waterloo, but little change was made in the organization of the armies of the great powers; and in the Crimean war (1855–56) the composition of the English, French, and Russian armies did not differ materially from the constitution of the forces of the same nations in the Napoleonic wars. Marked changes had, however, been made in the nature of the weapons; most of the English and a part of the French infantry being armed with the rifle, though the Russian infantry, with the exception of a few selected regiments, were still armed with the smooth-bore musket.

Though the extreme range of the rifle at this time did not exceed eight hundred yards, and was inaccurate at half that distance, it was, nevertheless, a formidable weapon in comparison with the infantry musket of Napoleonic times. Rifled siege guns were employed by the British at Sebastopol, but they were not a success, and were soon withdrawn from the batteries. A striking indication of the increased range of artillery was furnished at Sebastopol, when the besiegers established their first parallel at a distance of 1300 yards from the Russian works.

In the Italian war of 1859 rifled cannon appeared for the first time upon the field of battle. They were employed by the French, and to their use was largely due the victories of the French and Sardinians over the Austrians. For many years the attention of artillerists had been devoted to the production of serviceable rifled artillery, and as early as 1846 an iron breech-loading rifled cannon had been invented in France by Major Cavalli. This gun fired a shell not dissimilar in shape to the projectile employed in the Minié rifled musket. In 1854, experiments with a Cavalli gun gave very satisfactory results, both in range and accuracy; but the breech mechanism seemed dangerously weak, and the rifled guns, adopted by the French and used with such effect in Italy, were muzzle-loaders.

In 1854 a breech-loading rifled field-piece was invented by Sir William George Armstrong. It was made of wrought-iron bars coiled into spiral tubes, and welded by forging. The breech was closed with a screw which could be quickly withdrawn for loading and sponging the gun. The projectile was made of cast-iron, thinly coated with lead, and was (with its coating) slightly larger in diameter than the bore. The lead coating was crushed into the grooves by the force of the powder, the necessary rotation being thus given to the projectile. This gun gave excellent results in range and in rapidity and accuracy of fire, but it was not until some years after its invention that it was adopted in the British service. Other breech-loading cannon soon appeared; but in the United States army the 3-inch Rodman muzzle-loading rifled gun was preferred to any breech-loader then devised, and was used with great effect throughout the War of Secession. This gun was made by wrapping boiler plate around an iron bar, so as to form a cylindrical mass, the whole being brought to a welding heat in a furnace and then passed through rollers to unite it solidly. The piece was then bored and turned to the proper shape and dimensions. The projectiles for rifled guns were generally coated with soft metal, or furnished with an expanding base or cup of similar metal or *papier maché*; though in some systems they were furnished with studs or buttons which fitted into the grooves of the bore. In the case of the Whitworth gun, the projectile was made nearly of the exact size and form of the bore, so as to fit accurately into the grooves.

Breech-loading cannon were not, however, quickly adopted, owing, perhaps, to conservatism on the part of artillerists, and partly because the guns first produced did not seem to give appreciably better results in range, accuracy, or even in rapidity of fire than the muzzle-loaders. Not only were breech-loading cannon adopted with seeming reluctance, but rifled cannon generally were looked upon with disfavor by many artillerists of the old school. Hohenlohe tells of an old Prussian general of artillery who was so prejudiced against the rifled innovation that he requested, on his death-bed, that the salute over his grave should be fired with nothing but smooth-bore guns. It must be confessed, however, that the 12-pound smooth-bore Napoleon gun long held its own against the new rifled field-pieces, as many a bloody battle in our Civil War well attested.

In the manufacture of heavy guns the United States for some time led the world. In 1860, General Rodman, of the Ordnance Department, produced the first 15-inch gun ever made. This gun was made of cast-iron, and was cast on a hollow core, cooled by a stream of water passing through it, by which means the metal nearest the bore was made the hardest and most dense, and the tendency towards bursting was thus reduced to a minimum. General Rodman was also the inventor of the hollow cake powder, which consisted of cakes perforated with numerous small holes for the passage of the flame, thus enabling the powder to be progressively consumed, and causing the amount of gas at the last moments of the discharge to be greater than at the instant of ignition. A large-grain powder, known as “mammoth powder,” was afterwards devised by him to produce the same results. It will be seen later that this invention has rendered possible the powerful ordnance of the present day; and it is perhaps not too much to say, that Rodman is really thus the father of the modern high-power guns.

At the beginning of the War of Secession the heaviest gun in the United States was the 15-inch Rodman, the projectile of which weighed 320 lbs., the charge of powder weighing 35 lbs. Next to this was the 10-inch Columbiad, which fired a 100-lb. shell with a charge of 18 lbs. of powder. The effective range of these guns was a little less than three miles. The heaviest mortar was of 13-inch caliber, fired a 200-lb. shell, with a charge of 20 lbs. of powder, and had a range of 4325 yards. This mortar was, like all others then in use, manipulated by means of handspikes, and not only was much less powerful, but was much more clumsy than the admirable mortar of the present day.

The Crimean and Italian wars had foreshadowed the passing away of the old military conditions and the dawning of a new era of warfare. But it was in the gigantic struggle which rocked our own country for four years that the developments of modern warfare really commenced. At the beginning of this great conflict the ranges of 1000 to 1200 yards for field guns, and of 1500 to 2000 yards for heavy guns, were as great as could be secured with any degree of accuracy. The infantry rifle with which the Union and Confederate armies were armed had an extreme range of but 1000 yards, and a really effective range of only half that distance. The rifle was a muzzle-loader, which required nine distinct motions in loading besides those necessary in priming the piece with the percussion cap then used. The tactics employed at first in all arms of the service did not differ materially from the methods employed in the Napoleonic wars; and a line of American infantry deployed for battle in two ranks, shoulder to shoulder, scarcely differed in anything but the color of its uniforms from the “thin red line” of Wellington’s warriors. All this was to be changed; but it was not only in the matter of arms and tactics that a revolution was to be effected, for new forces hitherto untried were to be employed in the art of war.

The War of Secession was not only one of the most gigantic conflicts ever waged on earth, but was one which will always be of interest to the military student because of its remarkable developments in the science of warfare, and one which will ever be a source of pride to Americans because of the grim earnestness and stubborn valor displayed by the contending armies. From first to last, more than two millions of men were enrolled by the United States, and in the final campaign 1,100,000 men were actually bearing arms in the service of the Union. The infantry was organized in companies of one hundred men, ten companies forming a regiment. At first, three or four regiments constituted a brigade, though it was afterwards formed of a greater number when the regiments became depleted by the losses of battle. Three brigades generally composed a division, which also habitually included two batteries of artillery and a small detachment of cavalry for duty as orderlies and messengers. Three or more divisions constituted an army corps. The cavalry was formed into brigades and divisions, which in the later years of the war were combined to form, in each of the large armies, a corps of cavalry. It was in command of such corps of mounted troops that Sheridan, J. E. B. Stuart, Merritt, and Wilson achieved their great fame. The batteries first distributed to divisions, or even brigades, were afterwards assigned to the army corps, and all guns not thus employed were grouped into a corps of reserve artillery.

It is a curious fact that the two factors most important in warfare were found to be two inventions designed primarily for the interests of peace, namely, the railroad and the electric telegraph. Steam and electricity had both been used in the Crimean and Italian wars; but it was in the War of Secession that they received their first great and systematic application. The effect of the use of railroads in war not only enables armies to be more rapidly concentrated than was formerly the case, but renders it possible to supply them to an extent and with a certainty that would otherwise be out of the question. The difference between the supply of an army by wagon and by rail was clearly shown in the siege of Paris, in 1870–71, where six trains a day fed the whole besieging army, while it is estimated that nearly ten thousand wagons would have been required for the same purpose. Moreover, the force of troops necessarily detached to protect a line of railroad communications is not nearly so great as the force that would be necessary to guard the innumerable wagon or pack trains that would otherwise be required. In the opinion of the best military authorities, railroads, had they been in existence, would have enabled Napoleon to conquer Russia, and with it the world; while, without the aid of railroads, the successful invasion of the South by the armies of the Union would have been an impossibility. It is only while it keeps moving that an army can "live on the country." It is like a swarm of locusts, consuming everything within reach; and if it be compelled to halt, whether for battle or from other cause, it must be supplied from bases in the rear, or it will speedily disintegrate from hunger alone. This fact was fully appreciated by General Sherman, when he left Atlanta in his famous "march to the sea;" for though he expected to, and did, live upon the country, he nevertheless took the precaution to carry with him a wagon train containing twenty days' rations for his entire army.

In the War of Secession the electric telegraph first appeared on the field of battle. The telegraph train became a prominent feature of all our armies; and the day's march was hardly ended before the electric wire, rapidly established by an expert corps, connected the headquarters of the army with those of each army corps, division, and brigade. But it was not in its employment on the actual field of battle that the telegraph found its most valuable military use. It enabled generals, separated by hundreds of miles, to be in constant communication with each other, and rendered it possible for Grant to control from his headquarters hut at City Point the movements of the armies of Sherman, Thomas, and Sheridan in combined operations, which enabled each to perform, in harmony with the others, its part in the mighty plan.

It followed as naturally as day follows night that a shrewd and intelligent people, engaged in a desperate struggle for self-preservation, would avail themselves of all means provided by military science for carrying out the contest in which they were engaged. Iron-clad vessels had been devised in both England and France, but they were merely frigates designed on the old lines and partly covered with a sheathing of armor. With characteristic energy and ingenuity the Americans, ignoring old traditions and seeking the shortest road to the fulfillment of a manifest want, produced simultaneously the Merrimac and the Monitor, the former resembling "a gabled house submerged to the eaves," and the latter looking like "a Yankee cheese-box upon a raft." These novel vessels met in their memorable combat at Hampton Roads, and the booming of their guns sounded the death knell of the old wooden navies.

As with war vessels, so with firearms. New conditions were met with inventive genius and mechanical skill. Though the great mass of our troops continued throughout the conflict to use the muzzle-loading rifle, breech-loaders were in the hands of many thousands of our soldiers before the close of the great contest. In 1864 the cavalry of Sheridan and Wilson and many regiments of infantry were armed with breech-loading carbines, which gave them a great advantage over their opponents. The effect of the breech-loaders upon the Confederates was unpleasantly surprising to them, and the Southern soldiers are said to have remarked with dismal humor that “the Yankees loaded all night and fired all day.”

The principal breech-loading arms in use in the Union armies were the Sharps and the Spencer. In the Sharps carbine the barrel was closed by a sliding breech-piece which moved at right angles with the axis of the piece, the breech being opened and closed by pulling down and raising up the trigger-guard. The Spencer carbine was a magazine rifle, and was greatly superior to the Sharps. The magazine of the rifle lay in the butt of the stock, and was capable of holding seven cartridges. As the cartridge was fired and ejected another was pushed forward into the breech by a spiral spring in the butt of the piece. The Spencer carbine used metallic cartridges. The introduction of these cartridges was one of the most remarkable advances in the art of war made during the present century. The cartridge in use in 1864–65 is shown in the accompanying figure; it consisted of a thin copper case firmly attached to the bullet containing the powder, and having at its base a small metallic anvil, in a cavity of which was placed the fulminate, which was exploded by means of a firing pin, driven in by a blow of the hammer. The advantages of the metallic cartridge can scarcely be overestimated; it rendered obsolete the percussion cap, and being water-proof it did away with the ever-present bugbear of damp ammunition. The old injunction, “Put your trust in God and keep your powder dry,” has consequently lost much of its force; for while it is to be hoped that the soldier will continue to place his reliance upon Providence, the latter part of the advice can now be safely ignored.

Among the many advantages possessed by the breech-loader over the muzzle-loader, the principal ones are greater rapidity of fire, ease of loading in any position, diminished danger of accidents in loading, and the impossibility of putting more than one charge in the piece at the same time. This last advantage is by no means slight. Among 27,000 muzzle-loading muskets picked up on the battlefield of Gettysburg, at least 24,000 were loaded. Of these about half contained two charges, one fourth held from three to ten charges, and one musket contained twenty-three cartridges.

The failure of the Americans to produce during the great war a practical breech-loading field-gun is doubtless due to the fact that the field artillery in use at that time answered fully all the requirements then existing. Owing to the nature of the country in which the armies were operating, the range of the 3-inch rifled gun was fully as great as could have been desired; and on the broken and wooded ground which generally formed our field of battle, the smooth-bore Napoleon gun, firing shrapnel and canister, seemed to have reached almost the acme of destructiveness. Moreover, the muzzle-loading cannon, both rifled and smooth-bore, were served with such celerity as to make it a matter of doubt for some years after whether the introduction of breech-loading field-guns would materially increase the rapidity of fire. It was not until infantry fire had greatly increased in range and rapidity that a further improvement in field artillery became necessary. In siege artillery, heavy rifled guns of the Rodman and the Parrott type appeared. The Parrott gun was of cast iron, strengthened by shrinking a coiled band of wrought iron over the portion of the piece surrounding the charge. The famous “Swamp Angel,” used in the siege of Charleston, was a Parrott gun. The sea-coast artillery consisted mainly of smooth-bores of large calibre, which were able to contend successfully with any armor then afloat. It is a curious fact that the war, so to speak, between guns and armor has been incessantly waged since the introduction of the latter, every advance of armor towards the degree of invulnerability being met with the production of a gun capable of piercing it. The sea-coast artillery of the United States in the Civil War met fully every demand to which it was subjected.

The War of Secession produced the first practical machine-gun,—the Gatling,—though such guns were not used to any extent. The machine-gun has, in fact, passed through a long period of gestation, and it is only in recent years that it can be said to have attained its full birth. Our great war was also noted for the introduction of torpedoes. These peculiar weapons had, it is true, been devised may years before; and Robert Fulton had, in the early part of the century, devoted his inventive genius to the production of a submarine torpedo, which, however, was never practically tested in war. It was not until the contest of 1861–65 that torpedoes were of any practical use. The high explosives of the present day being then unknown, these torpedoes depended for their destructive force upon gunpowder alone. Yet crude and insignificant though they were in comparison with the mighty engines of destruction now known by the same name, they accomplished great results in more than one instance. The destruction of the Housatonic off Charleston, the sinking of the Tecumseh in Mobile Bay, and Cushing's daring destruction of the Albemarle, gave notice to the world that a new and terrible engine of warfare had made its appearance.

But it was not merely by the production of new weapons that the great American war was characterized. It marked the turning-point in tactics as well. The first efforts of our great armies of raw volunteers were as crude as the warfare of untrained troops always is, and it was fortunate that we were opposed to a foe as unpracticed as ourselves; but as the troops gained experience in war, acquired the necessary military instruction,—in brief, learned their trade and became regulars in all but name,—they displayed not only a steadfast prowess, but a military skill that placed the veteran American soldier at the head of the warriors of the world. The art of constructing hasty intrenchments on the field of battle grew out of the quickness of the American soldier to appreciate the necessity of providing defensive means to neutralize, in some degree, the greatly increased destructive effect of improved arms. In this respect he was thirteen years in advance of the European soldier, for hasty intrenchments did not appear in Europe until the Turco-Russian War. True, intrenchment on the field of battle was as old as war itself; but the American armies were the first that developed a system of quickly covering the entire front of an army with earthworks hastily thrown up in the presence of the enemy, and often actually under fire. Skirmishers were no longer used merely to feel and develop the enemy; but in many of our battles, notably in Sherman's campaign in Georgia, the engagement was begun, and fought to the end, by strong skirmish lines successively reinforced from the main body, which they gradually absorbed in the course of the action. Here, too, the American soldier was fully six years in advance of the European warrior; for it was not until the Germans had been warned by the terrific losses incurred in their earlier battles with the French, in 1870, that they evolved from their own experience a system of tactics, the essential principles of which had already been demonstrated on the Western Continent.

The increased range of artillery again received a practical illustration; for at the siege of Fort Pulaski the Union batteries first opened fire at ranges varying from 1650 to 3400 yards from the Confederate fort. At the siege of Charleston shells were thrown into the city from a battery nearly five miles distant.

In 1866, the brief but bloody war between Austria and Prussia suddenly raised the latter nation from a comparatively subordinate position to the front rank of military powers. The greatness of Prussia was born in the sackcloth and ashes of national humiliation. Forbidden by Napoleon, after her crushing defeat in 1806–7, to maintain an army of more than 40,000 men, her great war minister, Scharnhorst, conceived the plan of discharging the soldiers from military service as soon as they had received the requisite instruction, and filling their places with recruits. In this way, though the standing army never exceeded the stipulated number, many thousands of Prussians received military training; and when Prussia declared war against Napoleon, after his disastrous Russian campaign, the discharged men were called back into the ranks, and there arose as if by magic a formidable Prussian army of trained soldiers. The principle of universal military service, thus called into existence in Prussia in time of war, had been continued through fifty years of peace, and enabled Prussia, with a population scarcely more than half as numerous as that of Austria, to place upon the decisive field of Königgrätz a larger army than that of her opponent.

The Prussian system, which has since been copied by all the great military nations of Europe, is, in its essential features, as follows: Every able-bodied man in the kingdom, upon reaching the age of twenty years, is available for military service; and each year there are chosen by lot sufficient recruits to maintain the army at its authorized strength. The great body of the male population is thus brought into military service. There are a few exceptions, such as the only sons of indigent parents, and a small number of men who are in excess of the force required. Any man who escapes the draft for three successive years, and all able-bodied men exempted for any cause from service in the regular army, are incorporated in the reserve. The term of service in the regular army is two years for the infantry and three for the artillery and cavalry. After being discharged from the regular army the soldier passes into the reserve, where he serves for four years. While in the reserve, he is called out for two field exercises of eight weeks' duration each, and the rest of his time is available for his civil vocation. At the end of four years in the reserve he passes into the Landwehr, in which he is required to participate in only two field exercises of two weeks' duration each. After five years in the Landwehr proper, he passes into the second levy of the Landwehr, where he is free from all military duty in time of peace, though still liable to be called to arms in case of war. From the second levy of the Landwehr he passes, at the age of thirty-nine years, into the Landsturm, where he remains until he reaches his forty-fifth year, when he is finally discharged from military duty. The soldier in the Landsturm is practically free from all military duty, for that body is never called out except in case of dire national emergency. By this system Prussia became not only a military power but "a nation in arms," in the blaze of whose might the military glory of Austria and of France successively melted away in humiliating defeat.

The careful military preparation of Prussia in time of peace was by no means limited to measures for providing an army strong in numbers. Every year her troops were assembled in large bodies for practice in the manœuvres of the battlefield. This mimicry of war, at first lightly regarded by the military leaders of the other European nations, produced such wonderful effects in promoting the efficiency of the army that it has since been copied in all the armies of Europe, and is now regarded as the most important of all instruction for war.

Though breech-loading rifles were, as we have seen, used in the War of Secession, the Prussian army was the first that ever took the field completely armed with such weapons. The Prussian rifle was not new, for it had been invented by a Thuringian gunsmith, named Dreyse, about the time that the Minié rifle appeared. Dreyse's arm was known as the "zundnadelgewehr," or needle-gun, and its effect in the Austro-Prussian war was so decisive and startling as to cause muzzle-loading rifles everywhere to be relegated to the limbo of obsolete weapons. Yet the needle-gun was but a sorry weapon in comparison to those now in use, and was distinctly inferior to the Spencer carbine. Its breech mechanism was clumsy, it used a paper cartridge, it was not accurate beyond a range of three hundred yards, and its effective range was scarcely more than twice that distance. The German infantry fought in three ranks, and its tactics was not equal to that employed by the American infantry in the War of Secession. The Prussian field artillery was the most formidable that had yet appeared, and consisted mainly of steel breech-loading rifled guns, which were classed as 6-pounders and 4-pounders, though the larger piece fired a shell weighing fifteen pounds, and the smaller projectile used a shell weighing nine pounds. In the Austrian army the infantry was armed with a muzzle-loading rifle, and the artillery consisted entirely of muzzle-loading rifled guns.

The exalted military prestige gained by Prussia rendered it certain that she must soon enter the lists in a contest with France, whose commanding position in Europe was so seriously menaced by the rise of the new power. Foreseeing the inevitable conflict, Napoleon III. endeavored to prepare for a serious struggle. The French infantry was armed with the Chassepôt rifle, which had an effective range nearly double that of the needle-gun. A machine gun, known as the *mitrailleuse*, was also introduced into the French army. Much was expected of these new arms; but so superior was the organization, readiness, generalship, and tactical skill of the Prussians that the war was a practically unbroken series of victories for Prussia and the allied German States. Profiting by their experience in the course of the conflict, the Prussians formed their infantry for attack in three lines; the first consisting of skirmishers, the second of supports, either deployed or in small columns, and the third of a reserve, generally held in column until it came under such fire as to render deployment necessary. The skirmishers were constantly reinforced from the supports, and finally from the reserve as the attack progressed, the whole force being united in a heavy line, and opening the hottest possible fire when close enough to the enemy for the final charge. In its essential principles this attack formation is in use at the present day in the armies of all civilized nations. The Prussian artillery was handled with terrible effect both in battle and siege. A new demonstration of the increased power of artillery was given in the siege of Paris, in which shells were thrown from the heights of Clamart to the Panthéon, a distance of five miles.

The next European war was the contest between Russia and Turkey, in 1877. In this conflict the American system of hasty intrenchments was used with success by the Turks, who were also armed with an American rifle, the Peabody, which enabled them to inflict serious losses upon the Russians at a range of a mile and a quarter. Owing to the Turkish intrenchments and the inferiority of their own arms, the Russians won their victories over much smaller armies only with a gruesome loss of life. A further impetus was given to the development of the infantry rifle, and the German tactical experience was confirmed by the Russian General Skobeleff in the declaration that infantry can successfully assault only in a succession of skirmish lines.

The war in Turkey was the last great European conflict. Subsequent campaigns of the Russians in Central Asia, of the English in Egypt, the Soudan, and India, of the Japanese in China, of the Turks in Greece, and the Americans in Cuba, have emphasized the lessons already taught, and demonstrated the increased power of new weapons.

Having taken a retrospective view of the military forces and weapons employed in the wars of the nineteenth century, let us now turn to a consideration of the armies and arms of the present day. The adoption of the system of universal military service has increased the size of the standing armies of the nations of Europe far beyond the proportionate increase of their respective populations. In round numbers, the strength of the armies of the great powers is as follows: Russia, 869,000; Germany, 585,000; France, 618,000; Austria, 306,000; Italy, 231,000; Great Britain, 222,000.[3] Not only are the standing armies greater than in the early days of the century, but, owing to the improved methods of transportation and supply, the forces now brought upon the field of battle are vastly larger than in the days of Napoleon. The French army at Marengo was less than 30,000 strong. At Austerlitz it was only 70,000, which was its strength also at Waterloo. In only two battles, Wagram and Leipsic, was Napoleon able to place 150,000 men on the field; and in the latter battle the armies of all Europe opposed to him numbered only 280,000. In more recent times Prussia alone placed

[3] These numbers give the *peace* strength of the armies. In time of war they can easily be quadrupled.

upon the field of Königgrätz 223,000 men with which to oppose the Austrian army of 206,000; and at Gravelotte the great French army of 180,000 men was outnumbered by the German host of 270,000. It is probable that in the next great European war more than a million men will be found contending on a single battlefield. A detailed description of the armies of all the great powers would prove wearisome to the reader, for their points of resemblance are many and their general characteristics are the same. The German army may be taken as the most perfect specimen of a highly organized military force, and a description of its organization would answer with slight modification for the other armies of Continental Europe.

The infantry of the German army is organized in companies of 250 men each. Four companies constitute a battalion, and three battalions compose a regiment. The brigade consists of two regiments, and the division is composed of two brigades of infantry, four batteries of artillery, and a regiment of cavalry. The army corps consists of two divisions, a body of corps artillery composed of twelve batteries, a battalion of engineers, and a supply train. In round numbers, the fighting strength of the army corps consists of 30,000 men and 120 guns. The cavalry is organized in squadrons of 150 sabres each, five squadrons forming a regiment, only four of which are employed in the field, the fifth remaining at the regimental depot. The cavalry brigade consists of three regiments; and the cavalry division, which is composed of two brigades, aggregates 3600 sabres. Thus a small part of the cavalry force is attached to the infantry divisions, while the bulk of it is organized into divisions composed of mounted troops alone, two batteries of horse artillery being attached to each cavalry division. The entire military force is divided into “armies,” each consisting of from three to six army corps and two or more cavalry divisions. The cavalry has about one sixth and the artillery about one seventh of the numerical strength of the infantry. The German cavalry is armed with sabre, carbine, and lance. The officers carry the sabre and revolver.

In the army of the United States the organization differs in many respects from that of the German army. The infantry companies each consist of 106 men, including officers. Twelve companies form a regiment, and three regiments constitute a brigade. A division is composed of three brigades, and the army corps is made up of three divisions. The number of batteries assigned to the divisions varies, as also the amount of corps artillery. In the army operating in Cuba, the artillery was all in a separate organization, and was distributed to the divisions only on the eve of battle. Experience and theory alike suggest four batteries for each division and eight batteries for the corps artillery. No cavalry is assigned to the divisions, but a regiment is supposed to be assigned to each army corps. The main force of the cavalry is grouped together into cavalry divisions. The cavalry is organized into troops of 100 sabres, four troops forming a squadron, and three squadrons constituting a regiment. Three regiments form a brigade, and three brigades a division. The American cavalry brigade is thus of the same size as a Prussian cavalry division. The cavalry is armed with the sabre, carbine, and revolver. The lance is unknown in the American army.

Having viewed the composition of modern armies, let us now see how they are armed. A consideration of the powder now in use is a necessary preface to a description of the weapons employed in the warfare of the present day. The old fine-grained black powder familiar to every boy who has ever handled a shotgun has passed completely out of military use. The powders now employed usually have guncotton or nitroglycerine and guncotton for a base. They are practically smokeless, the product of their combustion is almost entirely gaseous, they leave no solid residuum, and are of the quality known as “slow-burning,” giving a constantly increasing pressure on the projectile from the moment of ignition to the time when it leaves the muzzle of the piece. These powders are manufactured in thin sheets or small tubes or cords, which, for small arms, are broken up into grains. They vary in color from light yellow to black.

Before the adoption of smokeless powder, the cake powder invented by General Rodman had been highly developed and improved in the form of “cocoa powder.” This was made in hexagonal prisms, each perforated longitudinally, so as to have a hollow core. These grains were carefully arranged in the cartridges so as to have this core continuous from one grain to another, in order that upon ignition the combustion would begin in the interior and produce a constantly increasing volume of gas as the exterior surface of the grain was reached. Though the time of combustion was too rapid to be appreciated by the ordinary senses, it was, nevertheless, quite different from the practically instantaneous combustion of the old small-grain powder, and was susceptible of accurate measurement. Much difficulty was experienced in overcoming the detonating tendencies of the smokeless powders, but at last the requisite slow-burning properties were obtained. The smokeless powder for large guns is made in cartridges composed of bundles of strips or cords, or in the same prismatic form as the cocoa powder, and the process of combustion is the same.

The form of the gun is dependent entirely upon the nature of the powder used. As the pressure of the gas constantly increases with the burning of the powder, the maximum force will be reached at the moment the combustion is complete. The length of the bore should, therefore, be just sufficient to enable the powder to be entirely consumed at the exact instant the projectile leaves the muzzle of the piece. A shorter bore would cause much of the powder to be thrown out unconsumed, while a much greater length would retard the projectile by subjecting it to the friction of the bore after the maximum force of the powder had been reached. This accounts for the greatly increased length of the modern cannon. A change in the method of gun construction has accordingly become necessary. Guns are no longer made of cast iron, but are “built up” of steel. The explosion of the powder is, of course, exerted in every direction, against the bore and sides of the piece as well as against the base of the projectile. This produces two strains; a longitudinal strain which is exerted in the direction of the axis of the piece, and a transverse strain which tends to burst the gun. It is necessary, therefore, to have the piece so strong, especially at the points of first explosion, as to counteract these strains, and thus cause the entire force to be exerted upon the projectile in the direction of the “least resistance.” This strength, or “initial tension,” is obtained by shrinking cylinders of steel over the original cylinder of the piece, each outer cylinder or jacket being a few thousandths of an inch smaller in its interior diameter than the outer diameter of the cylinder which it incloses, and being expanded by heating to a sufficient degree to enable it to be slipped over the latter. Upon cooling, the jacket exerts a constant and powerful force of compression, which counteracts the outward pressure of the force of explosion. The longitudinal strain is less dangerous than the other, and is usually counteracted by an interlocking of some of the cylinders or hoops, to which the strain is transmitted from the breech-plug. The art of building up guns has been of slow growth, the first efforts in this direction having been made by Sir W. G. Armstrong nearly half a century ago. The weight of the projectile of the present 16-inch gun in the United States service is 2370 pounds; the charge of powder weighs 1060 pounds, and the extreme range is more than 14 miles. The cost of each shot is $450, and when we consider that this does not include the wear and tear of the gun, it is evident that money has become more than ever before “the sinews of war.”

Not less remarkable than the improvement in cannon is the improvement in mortars. These mortars are very unlike the clumsy weapons of that name manipulated by hand-spikes, which were known in our great war. They are now mounted on a platform which turns on rollers. They are elevated or depressed by a mechanical appliance, are loaded at the breech, are accurately rifled, and can drop their projectiles on the decks of hostile vessels at a range of six miles. They are placed in groups of four, each in a separate pit, some batteries containing as many as four groups, or sixteen mortars. In all important sea-coast batteries both guns and mortars are so arranged as to be fired by electricity, either singly or in volleys.

A dynamite gun has been devised by Captain Zalinsky for the purpose, as the name implies, of throwing a projectile containing dynamite. Attempts to fire dynamite projectiles by means of powder have thus far failed. In the Zalinsky gun the propelling power is compressed air. The projectile contains from fifty to sixty pounds of gelatine dynamite, the explosion of which is terrific. Excellent results have been obtained with Zalinsky's gun up to a range of 2000 yards, but as this is insignificant in comparison with the enormous range of high-power cannon using powder as a charge, the dynamite gun is still a weapon of limited usefulness. Although the dynamite gun has not as yet fulfilled the desired requirements as to range, promising experiments have been made in firing shells charged with high explosives from mortars using charges of powder, and it is probably a question of only a short time before means will be found for successfully firing dynamite in a similar manner.

The great improvements in field artillery make the cannon of the early battlefields of the century seem, in comparison, almost like harmless toys. The modern field gun is made of steel, is rifled, loads at the breech, and has great rapidity and accuracy of fire. The extreme range of the 3.2-inch field gun in the United States service is about four miles. This, in fact, is beyond the ordinary range of human vision, and it is but rarely that the ground for so great a distance is free from features that obstruct the view. For these reasons the fire of field guns can seldom be utilized beyond a range of two miles. The projectile of the 3.2-inch field gun weighs 13½ pounds, and the charge of powder 3½ pounds. The 3.6-inch gun is a still more powerful weapon, the weight of the projectile and charge being 20 and 4½ pounds respectively. Shells are used against inanimate objects, such as earthworks or buildings; but the great artillery projectile for the battlefield is shrapnel. It is now very different from the crude projectile known by the same name in the early years of the century. The bullets are assembled in circular layers and held in position by "separators," which are short cast-iron cylinders with hemispherical cavities into which the bullets fit. The bottom separator fits by means of lugs into recesses at the base of the shrapnel, and prevents independent rotation of the charge of bullets. The top separator is smooth on its upper side, and is kept firmly in place by the head of the projectile, which screws against it. The separators prevent movement or deformation of the bullets under shock of discharge, and being weakened by radial cuts, increase the effect by furnishing additional fragments of effective weight. The shrapnel for the 3.2-inch gun contains 162 bullets one half inch in diameter and weighing 41 to the pound. The total number of bullets and individual pieces in the shrapnel is 201.

The heavy sea-coast guns are now mounted either in armored turrets, *en barbette*, or on disappearing gun-carriages. The first system is very costly and is not generally used in the United States. The second system, in which the guns are fired over a parapet and are constantly exposed, is used only in rare cases. The third has been perfected in the United States in the Buffington-Crozier and the Gordon disappearing gun-carriages. These carriages enable the gun to be loaded in safety under cover of the carriage pit, and then to be raised by means of counterweights or compressed air to a position from which it can fire over the parapet. With trained cannoneers, the gun can be raised and fired in twenty seconds, and this brief period of exposure, especially when smokeless powder is used, renders it almost impossible for the enemy to locate the gun with any degree of accuracy. The shock of the recoil, taken up by pneumatic or hydraulic cylinders, brings the piece back, quickly but gently, to the loading position, whence it is again raised for firing.

The siege artillery of the United States army consists of the 5-inch gun, the 7-inch howitzer, and the 7-inch mortar. They all use shell, and their effective range is from three to four miles.

When the enemy is sheltered behind entrenchments it is difficult to reach him with shrapnel fired from field guns. Field mortars have accordingly been devised for this purpose and have given excellent results. The United States 3.6-inch field mortar is rifled, and carries a shrapnel weighing twenty pounds. The weight of the field mortar is only 500 pounds, and it can be easily carried in a cart drawn by a single mule.

But great as the improvements have been in artillery, they are less important than the changes effected in the infantry rifle; for upon the quality of the infantry depends, more than upon anything else, the efficiency of an army. There are many kinds of rifles now in use in the different armies of the world, but in their essential principles they are very similar. All use smokeless powder, and all are provided with a magazine which admits of firing a number of shots without reloading. The Springfield rifle formerly in use in the United States army has been replaced by the Krag-Jorgensen, which has a magazine holding live cartridges, and is provided with a cut-off which enables the piece to be used as a single-shooter. When an emergency demands rapid fire, the opening of the cut-off enables the cartridges in the magazine to be fired in rapid succession. The range of the Krag-Jorgensen is 4066 yards, being practically equal to that of the Mauser, which, in the hands of the Spaniards, inflicted casualties upon our men when they were more than two miles from the hostile position. The difference in the penetrating power of the Krag-Jorgensen and the Springfield is shown in the accompanying illustration, taken from the report of the chief of ordnance for 1893. The Springfield lead bullet was fired with 69 grains of black powder, and penetrated 3.3 inches of poorly seasoned oak, the bullet being badly deformed. With a bullet covered with a German silver jacket the penetration was 5.3 inches, the bullet being again deformed. The Krag-Jorgensen used a bullet consisting of a lead core and a cupronickeled jacket, which was fired with 37 grains of smokeless powder. The bullet penetrated well-seasoned oak to a distance of 24.2 inches and was taken out in perfect condition. The new rifle, at short ranges, has an almost explosive effect and produces a shocking wound; but at ordinary ranges the wounds inflicted by it may be almost characterized as merciful, for the bullet makes a clean puncture, and unless a vital organ is struck the wound heals easily and quickly. The old expression of "forty rounds," so familiar to veterans of the Civil War, is now obsolete; for no soldier now thinks of going into action with less than 150 cartridges on his person. Not only is the firing more rapid than was formerly the case, but the lighter weight of the cartridge enables a greater number to be carried.

From the rifle to the Gatling gun is only a step, for the latter is essentially a collection of rifle barrels fired by machinery. It consists of a number—generally ten—of rifle barrels grouped around, and parallel to, a central shaft, each barrel being provided with a lock. By turning a crank at the breech, the barrels and locks are made to revolve together around the shaft, the locks having also a forward and backward motion, the first of which inserts the cartridge into the barrel and closes the breech at the time of the discharge, while the latter extracts the cartridge after firing. Upon the gun, near the breech, is a hopper which receives the cartridges from the feed case. The cartridge falls from the hopper into the breech-block of the uppermost barrel, and in the course of the first half-revolution of the barrel it is inserted, the hammer is drawn back, and at the lowest point of the revolution the breech is closed and the cartridge is fired. As the barrel comes up in the second half-revolution the cartridge shell is extracted, and when the barrel reaches the top it receives another cartridge. The Gatling gun can be fired at the rate of 1000 to 1500 shots a minute. It generally uses the same cartridge as the infantry rifle; but some patterns of the gun fire a projectile an inch in diameter, and approximate closely in their effect to a field gun. The gun is mounted either on a carriage similar to that of a field-piece or on a tripod. Gatling guns were very successfully used by the British in the Zulu War and in the Soudan, and by our own troops in the battles around Santiago.

The Gardner is a lighter machine gun than the Gatling. It consists of two parallel rifle barrels, and is operated by means of mechanism at the breech, which, as in the case of the Gatling, is worked with a crank. It can fire 500 shots a minute without danger of overheating, as the breeches are enclosed in a metallic water-jacket. Its extreme portability makes it a most valuable weapon, though its firing capacity is not equal to that of the Gatling.

There are several other types of machine guns, but the most ingenious, and perhaps the most effective, is the Maxim automatic gun. This has a single barrel, about two thirds of which, from the muzzle towards the breech, is surrounded by a water-jacket into which water is automatically injected at each discharge, thus rendering overheating impossible. The mechanism for operating the gun is at the breech, covering the remaining third of the barrel. All that is necessary is to draw back the trigger to fire the first shot; the recoil of the piece again cocks it, and the gun is then automatically fired, the process being kept up until the cartridges in the feed-belt are all expended. The cartridges are fed to the piece by means of belts holding 333 rounds, two or more of the belts being joined together if desired. The Maxim gun can easily fire ten shots a second, and if every man at the piece were killed the moment the first shot was fired the gun would keep on until it fired at least 332 more shots.

The Gatling, Gardner, Maxim, and similar guns are known as machine guns. Of the same general family, so to speak, are rapid-fire guns, which are, however, distinguished from machine guns by having a larger calibre, loading by hand, having only one barrel, and being provided with artificial means of checking recoil and returning the piece to the firing position. They use metallic ammunition, and have a breech mechanism which cocks the firing pin and extracts the empty case by the same motion which opens the breech for reloading.

Rapid-firing guns were first designed as a means of naval defense against torpedo boats. They deliver a rapid and easily aimed fire, and use projectiles of sufficient power to penetrate the plates of the boats. In the naval service the gun is mounted on a spring return carriage fixed to the vessel, so that the piece, when discharged, is brought back to the firing position without any derangement of aim. On land a rigid carriage is used. This carriage has a spade at the end of the trail, which is forced into the ground by the recoil and holds the gun and carriage in place. The principal rapid-fire guns are the Hotchkiss, Driggs-Schroeder, Nordenfelt, Krupp, Canet, and Armstrong, which fire from five to ten shots a minute, and use either shell or shrapnel. Experiments are now being made in different armies with a view to adopting rapid-fire guns for field artillery.

The principle of rapid fire, or "quick fire," has been successfully applied to guns having a caliber as great as six inches. The metallic cartridge used in rapid-fire guns is, in appearance, simply a "big brother" of the cartridge used in the infantry rifle.

Closely allied with guns, both in coast defense and in naval warfare, are torpedoes. The crude weapons of this type, used in the War of Secession, have been developed into formidable engines of war, before whose destructive power the strongest vessels are helpless. For their classification and description *see* "The Century's Naval Progress," pages 84, 85.

The destructive power of torpedoes is so well known as to give them a great moral weight as a means of defense. The fact that the German harbors on the Baltic were known to be protected by torpedoes saved them from an attack by the French navy in 1870–71, and Cervera's fleet in the harbor of Santiago, in 1898, was safe from our squadron so long as the mouth of the channel was closed with Spanish torpedoes.

Though necessarily brief, the foregoing sketch will show that in the course of the nineteenth century armies have increased enormously in size, and in the power of rapid movement and certainty of supply. Infantry has increased in relative numbers and in importance. Extended order fighting, in which the individuality of the soldier comes into play, has taken the place of the old rigid shoulder-to-shoulder line of battle. The private soldier's vocation has risen, in many branches of the military service, from a trade to a profession, and now, more than ever before, is extensive training and a high order of intellect necessary for the command of armies. Wars have become shorter, sharper, more decisive and more terrible; and increased emphasis has been placed upon the warning, "In time of peace prepare for war."

The Century's Progress In Agriculture

By WALDO F. BROWN,
Agricultural Editor "Cincinnati Gazette."

I. VICISSITUDES OF EARLY FARMING.

If the thought enters the mind of the reader that a youth (?) of sixty-seven is not competent to write upon agricultural improvement for the entire century, the answer is that such improvement can scarcely be said to have begun until near the middle of the century; that the early forties saw the writer at work on a farm; that he has ever since lived on a farm; and that he, therefore, writes from personal experience of the improvements which have transformed agriculture from a simple art to a profound science.

To realize the progress agriculture has made, we must understand its condition in the first half of the century, and the causes which prevented improvement at that time. The soil was rich with the accumulations of centuries, and the farmer was at no expense to either maintain or restore fertility, for with but indifferent cultivation large crops could be raised. When a field became impoverished, with axe and torch a new field was soon cleared from the forest. The implements in use were of the crudest and mostly manufactured by the nearest blacksmith, and it cost but a few dollars to equip a farm; still they were sufficient for the wants of the farmer of that date. So it will be seen that the difficulty was not in the farm nor with the farmer; for he could grow not only all that was necessary for family use, but more than enough to supply the demand for such market as he had. Perhaps the greatest difficulty in the way of agricultural progress was the want of transportation facilities; for a market was of little use to a farmer if he was separated from it by a hundred miles or more of roads which, through almost the entire winter, were so deep with mud that modern farmers would think them utterly impassable, with streams unbridged and hills ungraded. The first step toward relieving the farmer of this trouble was John Quincy Adams' message to Congress in 1827, when he recommended the construction of the National Road, the eastern terminus of which was to be in Maryland and the western at St. Louis, Mo. This road was constructed within a few years. It was the first outlet for the crops of the great West, and over it, across the Alleghany Mountains, a procession of covered wagons passed during the entire year, carrying the products of the farms to the Eastern markets and bringing back manufactured goods. One other avenue was opened for the interchange of products between these two sections, the Erie Canal being completed in 1825, and enlarged and improved many years later.

During the thirties, just preceding the era of railroads, there was almost a craze on the subject of canal building, and scores of miles of canals were begun which were never completed, as with the beginning of the fourth decade of the century the railroad idea had taken possession of the minds of the people. In some cases the tow-path of the canal formed the roadbed for the railroad which superseded it, and probably more lines of canal were abandoned than were completed. The era of railroads—that wonderful factor which was to revolutionize farming—dates from about 1830. The first locomotive in the United States was imported from England and placed upon the rails in 1829, and in 1830 the first American locomotive was built. It was, however, very near the middle of the century before the system of railroads had been completed so as to materially improve the condition of agriculture; and although the fact may sound strange to some, the first railroad train ran into Chicago in 1852. During these years of depressed agriculture, however, the population of the country was rapidly increasing.

While the railroad system of the country was developing, turnpikes were being built radiating from the principal markets and railroad stations. With the beginning of the second half of the century the farmers awoke to the fact that the United States was a large and populous nation, requiring an immense amount of supplies, and that improvements for transportation had been furnished so that the markets were easily accessible. Before passing, however, from the discouragements and difficulties of agriculture in the early days, some practical illustrations of the difficulties met with seem necessary to give a clear understanding of the condition. What would the farmer of to-day think were he obliged to start with a load of wheat in midwinter over roads which crossed unbridged streams and wound over clay hills, not a rod of which was macadamized and all of which were poorly graded, spending ten days with a four-horse team to make a round trip of one hundred miles with thirty-five bushels of wheat, and sell it in the market for 35 cents a bushel? Yet such was the fact which the writer had from the lips of a farmer who had been through this experience. Two thoughts may occur to the reader—first, that thirty-five bushels was a light load for a four-horse team, and, second, that hotel bills would more than absorb the money received from such a load of wheat. But both of these are explained by saying that one cause of the lightness of the load was that the farmer must carry feed for his team for the entire trip, and another, the uncertainty of the condition of the roads; for though he might start with the roads frozen solid and possibly worn smooth by the teams which had preceded him, he was liable on the trip to meet with a sudden thaw which reduced the roadbed to mortar, so that the wheels would sink almost to the axle, and in many cases the load would be found too heavy for his team. It was no uncommon sight to see a score of places to the mile where the fences had been torn down and rails carried into the middle of the road to be used in prying the wagons out of the mud when hopelessly mired. The reason the hotel bills did not consume the proceeds of the load was that there were none; for the farmer carried his camp kettle, bedding, and provisions with him, and slept in the wagon during his entire trip. The same farmer referred to, in telling his story, said that all the money spent on the ten days' trip was three "fips" (18¾ cents), and that, presumably, was for three "nips" of whiskey.

An interesting personal experience in the winter of 1846–47 was in driving hogs from Anderson, Ind., to Cincinnati, Ohio, a distance of about 150 miles. The drove was started with the mercury at zero, and the first difficulty met was in getting them across White River, as there was no bridge and the stream must be forded. The hogs absolutely refused to enter the icy water, but the pioneer of that day was equal to any emergency. The drove was soon huddled on the bank, rails were carried from an adjoining field, and a close pen was built around them; then two plucky frontiersmen, with thick leggings reaching from ankle to hips, towed them by the ears to frozen shoal water in the centre of the river, and pushed them across the ice, when they were obliged to go ashore on the other side. Two days later a sudden and unexpected thaw set in, when for one hundred weary miles the drivers urged the hogs through mud which reached from fence to fence, and which was so fluid that not a trace was left behind, as it flowed in to fill not only the track of the hogs but the footsteps of the drivers. When after days of urging the hogs began to lose strength and fall by the way, they settled down into the ooze, from which the men must lift them into wagons which accompanied the drove or were hired from farmers along the road. When Cincinnati was reached it seemed that the worst trouble of the journey was over; but not so, for the climax of disaster with this drove was reached at the slaughter-house, when for two weeks the weather was so warm that no slaughtering could be done, and the price of pork declined day by day, until the entire drove was finally sold at one and three quarters cents per pound dressed weight—and during the entire time, both on the road and in the pens, the hogs had been losing rapidly in weight every day. This was the lowest price recalled for hogs; but it was very common to have a glut in the market of some staple which reduced the price so low that it scarcely paid for transportation, and in some cases made it actually unsalable.

A neighbor relates that when he was a boy, needing some money, his father made him the offer that he might have all the corn that he would shell, take to mill, and market the meal in Cincinnati, forty miles distant. He went to work with a will, prepared a two-horse load, and reached Cincinnati with it safely, only to find the market glutted so that he could not get an offer on it. A part of it was finally sold at 10 cents per bushel, and the remainder was taken home.

During the closing years of the fifth decade the prices of stock were at the lowest, good dairy cows bringing from $7 to $9 per head; yearling calves from $1 to $2; the very best horses, $40, and stock hogs selling for $1 or $2 each. At the same time many of the necessities of life were sold at exorbitant prices, and an examination of an old account book shows the following figures: Salt, $4 per barrel; nails, 6 to 8 cents per pound; calico, 12½ cents per yard; drilling, 25 cents per yard; clocks, $40 each (the value of the best horses!).

Some other facts must be taken into consideration to understand why the farmers did not attempt improved methods. One was the condition of the currency. The United States Bank, which it would seem should have afforded security and stability to the currency, had been wrecked by the action of Andrew Jackson in vetoing its rechartering and withdrawing the United States funds (at that date about $43,000,000) from it; and private banks had been established over the entire west and south, a system of what was then known as “wild cat” banks supplying the people with currency. The man who was trading needed to carry in his pocket at all times a “bank detector,” to which he might refer to ascertain how many cents on the dollar the issue of each bank was worth.

Looking back at the condition of affairs as described, remembering how few the markets, how easily glutted, how unstable the currency, and all the uncertainties connected with the disposal of the farmer’s products, what was there to stimulate him to improve his methods or increase his products? If, as was occasionally the case, the farmer determined to improve his stock, he must import from England or buy at high prices from an importer, and there being no express companies to deliver his stock, he must either go in person or trust to private individuals to drive them over the mountains or, if small stock, to bring them in wagons the entire distance.

He could not afford to carry on a wide correspondence, for each individual letter cost twenty-five cents postage, if the distance was over three hundred miles. It was not until 1845 that postage was reduced to ten cents, and ten years later it was reduced to three cents for letters of half an ounce.

If any one is inclined to throw the blame upon the farmers for not having done their part to improve agriculture and bring prosperity, he should consider the conditions under which they had lived for a generation; the uncertain markets; the low prices of products; that they must construct roads and bridges, build schoolhouses and churches, clear the farms, nearly all of which were covered with heavy timber; and the fact that all this work was done with the crudest implements. It will be seen that the farmers had been accomplishing wonders and were worthy of the highest praise rather than blame.

With the beginning of the last half of the century, the farmers suddenly awoke to the fact that the conditions had become wonderfully favorable. Towns and cities were growing up on every hand, offering new markets. Railroads and other means of transportation were opening to them. Inventive genius had taken up the improvement of implements of agriculture, and, best of all, prices had advanced greatly for all the leading products. The improvements of methods in farming, which have not been less than those in manufacturing and other callings, date from this time, and will be described under the following heads: Improvements in implements; in stock; in drainage and tillage; in the maintaining and increasing of fertility; in care and feeding of stock; in and around the farmer's home; and education, which includes agricultural literature, farmer's organizations, and schools.

II. IMPROVEMENTS IN FARM IMPLEMENTS AND MACHINERY.

In writing on the improvements in agriculture one can scarcely fail to be impressed with the fact that whenever the human race comes to the point that it must have help and make a demand upon nature, she always honors the draft; and as the steps are portrayed by which the agricultural products of this continent have been increased a hundred fold, while the power of the individual worker has increased wonderfully, and the labor has been lightened by machinery, we can see that these inventions and improvements came just as fast as they were needed, and no faster. God has given to the human mind such power, and to the hands such skill, that whatever is necessary is soon provided when the want is made known. Perhaps there is no better way in which this can be traced than in the appliances by which the farmer feeds the world. It is an interesting study to note the successive steps in the improvement of implements for the work of the farm. In the beginning of the century the sickle and flail were all that were needed to cut and thresh the grain; and it was by a series of steps that the steam thresher and the combined mower and binder were evolved. The sickle was all that was needed until population increased and markets were made accessible; then the cradle was invented. With the former, an expert could cut an acre a day, and with the latter four or more acres; but all the work was done by human muscle. The man using a sickle must work with bended back all day. The cradle enabled him to work erect, and lightened the labor; but when the "Reaper sickle" was invented the labor was transferred to brute muscle. The first machines were clumsy and heavy to draw, requiring as much, or more, power to cut the grain as to cut and bind it with the light running modern binder. Now, the man who sweltered with bended back ten or twelve hours to cut an acre of grain with the sickle "drives his team afield," and by simply guiding it cuts and binds ten or fifteen acres a day, and carries the bundles to the shock row.

The improvement in threshing machinery has been as marked as in that for harvesting the grain. In the first part of the century all the work was done with the flail, and on farms where a large amount of grain was grown it kept a man busy a good part of the winter to thresh it. The first improvement was in threshing the grain by tramping it out with horses, and with two men and four horses, under the most favorable conditions, from fifty to one hundred bushels could be threshed in a day. But by both these methods there was the disadvantage that in all damp weather the work must be stopped, as the grain would become so tough that it could not be threshed. Another disadvantage of these methods was that it took a long time to prepare the crop for market, and in case of a sudden rise in price the farmer could not take advantage of it as he now can when his grain is all threshed in a single day and held in the granary for sale. In the thirties, the first threshing machines were put in use, and were but little improvement over the method of tramping with horses. The machines were of small capacity, and simply threshed the grain, but did not separate it from the straw and chaff, both of which operations had to be done by hand; and if the straw was to be saved, either in the barn or in a stack, it had to be all handled with rakes and forks. The first threshing machine that the writer ever saw was one that was called "The Traveller." This was followed by machines run by stationary horse-power. These were called "chaff pilers," from the fact that they threshed the wheat but did not separate it from the straw or chaff. The first horse-powers were inclined planes, or endless chain powers, as they were called, and were run by the weight of the horses, the floor revolving under their weight as they attempted to go up the grade. These were soon superseded by lever powers, made at first for two or four horses, but afterward increased in size and power until ten or twelve horses were used; and about this time the machinery for separating the grain and chaff was added to the machine. It almost seemed to the farmers at this time that perfection had been reached when two or three hundred bushels could be threshed in a day and also cleaned; but the feeding of this large number of horses was a heavy tax upon the farmers, particularly when a rainy day would intervene before the job was finished, and they were obliged to keep the horses two or three days. The invention and introduction of the mounted steam-engine not only saved the farmer from this expense, but also increased the power and doubled the daily capacity of the machine. For a short time the farmers were satisfied with this; but the engine was heavy, and often the farmers' teams were light, and as it was the rule that each man must draw the engine from his farm to where the next job was to be done, and often the distance was great and the roads bad, it was not long until he tired of this. Then came the traction engine, which not only transported itself but also drew the thresher and separator. About this time another difficulty arose; for now that the machine had been improved and the power increased so that under favorable conditions a thousand bushels could be threshed in a day, the handling of the straw became a serious problem, for it was impossible to build it in a stack suitable for keeping as fast as the machine would deliver it. The first step to lighten and expedite this labor was in adding a straw carrier, a kind of revolving platform, which was attached to the separator and would lift the straw some twelve or fifteen feet. For a year or two the farmers were satisfied with this help, but soon found that it was inadequate for the work. Then the stacker was invented, a separate machine which was backed under the straw carrier to receive the straw, and which had, mounted on wheels, an elevator which would carry the straw to a height of twenty-five or thirty feet; and not only could it do this, but it was the work of a moment, with a crank at its base, to raise it, and it could be run at any angle. When the machine first started, the straw carrier was placed horizontally, and as the stack grew in height, it was raised until in the finishing out of the stack it stood at an angle of forty-five degrees or more. The straw carrier could not only be raised, but by an ingenious arrangement of small wheels, it could be moved from side to side by a light pressure with one hand, or by a man on the stack pushing it with his fork. With this admirable machine for handling the straw, it seemed as though perfection had been reached, and that there was now practically nothing more to be desired. But it was not long until the farmer found that with the delivery of six tons of straw per hour it was heavy work for six men to build the stack, and that it was the most disagreeable work about the machine because of the dust. About 1890, some inventive genius produced the "blower" to take the place of the stacker. This is a long jointed tube, some sixteen or eighteen inches in diameter, mounted at the rear of the cylinder through which the straw is forced by compressed air which is furnished by the machine. It can be raised or lowered, turned to the right or to the left, so as to deliver the straw at any desired point on the stack. It is managed by a man standing on top of the separator near the rear end, does away entirely with any hands on the stack, and thus reduces the force about six men. Some other improvements which have been added are the putting of knives in the cylinder to cut the bands, thus saving one or two hands, for often it was necessary to have a man on each side for cutting the bands when the wheat was dry and the work was done with the greatest rapidity. Then a revolving platform, called a self-feeder, was added in front of the cylinder, on which platform the bundles could be thrown from a wagon standing on each side, and be carried automatically and dumped into the cylinder, doing away with the man who formerly fed the bundles to the machine. To some machines an automatic weigher has been attached, which does away with a man for measuring and keeping tally of the wheat. Compare for a moment this modern machinery which, with a force of twelve or fourteen men, will thresh and clean for market from 1200 to 1600 bushels of wheat per day, with the man with the flail laboriously pounding out ten bushels, and you will get a vivid idea of the progress in agricultural machinery. One somewhat curious fact must be taken into account in this, which is, that with some of these most wonderful machines the cost of labor is about the same it formerly was. But the advantage is that the work can be done in a few hours, and the farmer's crop be ready for market to take advantage of increased prices, while by the old plan the work would reach almost through the winter.

In the cutting and handling of hay there has been as great improvement as in any portion of the farm. A first-class mowing machine, new from the shop, can now be bought for $40 or less, and with it the farmer can drive to the field after supper, in the cool of the day, and in an hour cut more grass, and do it better, than a man could with a scythe by working hard all day.

Instead of shaking out the swaths slowly with a fork, with a single horse hitched to a hay tedder about two acres an hour can be shaken up and left in such shape that both sun and wind have perfect access to it and cause it to cure rapidly.

Instead of raking the hay laboriously by hand, a steel sulky rake does the work easily and quickly, doing more in an hour than was possible in a day with the hand rake. On farms where the acreage of hay is large, a self-loader attached to the rear of the wagon gathers the hay from the windrow and delivers it on the wagon. At the barn, instead of the slow and wearisome hand pitching, the hay fork and hay carrier deliver it in the top of the highest barns.

The invention of the hay baler enables the farmer now to condense his crop, so that one third of the room for storage formerly required for hay will answer; and it also enables him to ship it to market by rail, where formerly it was necessary that it should be taken in wagons.

While the plough has not been improved to the extent that many of our farm implements have been, it is vastly superior to those used by the pioneers, and modifies somewhat the adage of "Poor Richard," who wrote:—

"He who by the plough would thrive,
Himself must either hold or drive;"

for the modern ploughman must not only hold and drive, but drive three horses at that, and turn as many acres in a day. Another adage attributed to "Poor Richard" was—

"Plough deep while sluggards sleep,
And you shall have corn to sell and keep."

But the modern farmer has learned that the depth to which he ploughs must be governed by the nature of his soil, and that deep ploughing on heavy clay lands, or lands with a crude subsoil, is often the cause of short crops and permanent injury to the soil.

It is doubtful if in any line of farm implements there has been more improvement than in that of harrows; and yet this improvement dates back but about a quarter of a century, as previous to that time the old "A" harrow or drag, which was hard on the team and did indifferent work, was the only one found on most farms. More recently the cutting and slicing harrows have been largely introduced, and many other forms of improved harrows have been put on the market. For the preparation of hard land for a seed bed, especially for small grain, the disk harrow cannot be excelled.

But for garden use, or for pulverizing sod land which has not been too much compacted, the slicing Acme harrow is the most perfect implement in use, it being of light draft, easily transferred from field to field, and capable of making the finest and best seed-bed.

The cultivators in use have been greatly improved. It is necessary to describe but two of them. The two-horse cultivator with fenders, which enables the farmer to cultivate both sides of the row at once, driving two horses in the field instead of one, as by the old method, has more than doubled the capacity of the individual; as by its use he is able not only to cultivate both sides of the row at once, but to dispense entirely with the man who, under the old rule, was obliged to follow the cultivator and uncover the corn. This "fender" is exceedingly simple, and the only wonder is that it took the farmer so long to find out its value. Costing but a few cents, it has saved the farmers millions of dollars, as previous to its adoption it was necessary to have one man follow each one-horse plow to uncover the corn. There are two forms of this "fender," the simplest being a light piece of galvanized sheet iron attached to the cultivator or plow so as to come just between it and the row of corn; the other is in the form of a rolling cutter, and attached in the same way. With either of these the farmer goes into the field as soon as the young plants can be seen in the row, drives his team astride the row, and stirs every inch of the soil, putting a little fresh earth around each hill of corn or potatoes without covering a single plant. As a single State grows some millions of acres of corn, it can be seen that the saving from this little invention to the farmers amounts to millions of dollars in a single year.

The old idea of deep cultivation of most crops has been proven to be wrong, and modern implements are made to cultivate the surface to a depth of two or three inches rather than to tear up the roots of the plants; and one of the most perfect of all implements for this purpose is the "Planet Junior one-horse cultivator."

Perhaps no other class of machines has relieved the farmer more than the ones for planting the grain; and with a modern two-horse corn planter two rows can be planted at a time in checkered rows, so that it can be cultivated both ways and with more precision, both as to alignment and as to the number of plants in a hill, than by the old hand method of planting. The small grain is sown by a two-horse drill arranged for not only the grain, but at the same time to deposit commercial fertilizer along the rows of grain, and with a grass seed sower attached. In the garden a hand drill is used. It is easily adjustable to any sized seed, from that of the turnip up to beans and peas, and the seed is perfectly distributed in straight rows, while the garden hand cultivator does away largely with the use of the hoe.

One other modern implement, which promises to be very useful, is "the weeder," and its value rests on two facts which it required the farmer many years to discover. The first is that the thorough pulverizing of the surface, even to the depth of an inch, breaks the capillaries and checks the evaporation of moisture; but to do this it is necessary that the work be done just as soon after a rain as the land will crumble, and since often if a drying wind blows the land gets dry in a few hours, a machine is needed that will enable the farmer to thus stir a large surface in a short time; and this the weeder does, as it is made to cover the width of three rows at once, and more than two acres an hour can be stirred with a single machine. The other fact which makes this implement of great value is that all weeds are easily exterminated when in embryo, and this stirring of the soil kills every one that is starting.

One other machine which has been greatly improved is the clover huller. Previous to its invention, most of the clover seed was sown in the chaff, and when clean seed was required it took several days' work with four horses to tramp out three or four bushels, and then much of the seed was left in the chaff.

The modern huller is equipped with the blower and self-feeder, and with it from twenty to fifty bushels can be hulled and cleaned in a day, the amount depending on how well filled the heads are with seed.

It is quite recently that machinery has been invented that relieves the farmer of the hard work of planting potatoes by hand, and at the same time does the work better than the old way, as the machine drops the seed at a uniform distance apart and covers it perfectly. A man with this machine will do the work of eight or ten men dropping by hand. Several potato diggers, operated by horse power, have also come into recent use. They greatly lighten and accelerate the work, and the cost of growing potatoes has been reduced several cents a bushel by these inventions.

III. IMPROVEMENT OF STOCK.

Perhaps it would be well in beginning to write on this subject to ask, what is “pedigreed stock”? Many people have the idea that pedigreeing is an arbitrary rule adopted by stock growers to mystify the buyer and secure larger prices for their stock. The fact is that it is intended as a protection to the purchaser, and is, or should be, a guarantee that the stock has been bred along certain lines for a sufficient period to establish the desirable qualities which it is wished to perpetuate. A rigid censorship is exercised over the record books, and it makes every one recording stock, in a certain sense, a detective to see that the records are truthful and represent the animals just as they are.

It is doubtful if along any line of farm operations there has been greater improvement than in the breeding and care of stock; yet there were greater difficulties to overcome in doing this than in improving the implements. These difficulties may be classed as follows: First, the one already alluded to in the opening chapter, to wit, the expense of importing and the consequent high price of thoroughbred animals; and when we recall that this was at a time when the farmers were hewing out their homes from the forest, and could not obtain large prices for their products, it will be seen that few farmers could afford to improve their stock. Second, as to cattle and hogs, it was almost impossible to breed pure stock; for all animals were allowed to run at large, and the woods were full of “tramp males,” which would break through the fences and invade the fields where the improved stock was kept. Third, those engaged in breeding stock found that there was a limit which when reached brought barrenness to high-bred animals, and in many other cases reduced the vitality so as to invite disease. That this evil was a real and serious one is shown from the fact that large numbers of high-priced animals failed to produce young among cattle, and that many herds of pedigreed swine were carried off by epidemic diseases. Fourth, and perhaps the most serious hindrance to improvement, was the indifference of farmers and the want of appreciation of good stock, and of course the farmer who did not want it would not coöperate in producing it.

The difference between the improvement of implements and stock consisted largely in the fact that trained mechanics were responsible for the former, and they would perfect the implements until the farmers could not afford to do without them; while the slipshod farmer would be satisfied with his common stock, and would fail to accept the help of the men who were trying to improve it. Another thing which farmers learned slowly was that good stock requires good care, which not only means shelter and liberal feeding, but also that the food be adapted to the wants of the animal. More fine animals were ruined by over-feeding with corn—a heating and fattening diet—than by insufficient food and exposure to cold and storm. It took many years to teach the farmer what a balanced ration was, and why it was necessary.

It would be interesting to take up each separate breed of cattle and trace its source, giving credit to the men who improved and developed it, and the date of each importation; but the limitations of this article forbid anything more than brief mention of the more prominent breeds, and many which possess great merit cannot be even mentioned. The improved cattle of the United States may be grouped under three heads—beef, dairy, and general purpose. Of the first the Short-horn holds, perhaps, the highest place, or certainly did for a long series of years. These for many years were bred under the name of "Durham," but about a generation ago the name began to undergo a change to Short-horn.

These animals, while especially adapted to the block, are fairly good milkers, and some strains of them are superior dairy cows. They have the quality of early maturity and produce a larger per cent of fine cuts of meat than most, if not any, other breeds. These cattle were first imported into America in 1797, and many other importations were made during the first half of the present century.

Another breed which closely resembles the Short-horn is the Hereford. These cattle are usually of a uniform color—a pale red—with white face, breast, and flanks, and drooping horns. They were first introduced by Henry Clay in 1817. Another importation was made in 1840, but it was not until 1860 and subsequently that they were imported largely and a "herd book" established for them. Since that time they have multiplied largely.

The last of the three distinctly beef breeds is a hornless race originating in Scotland, and known by the name of Aberdeen Angus, Galloway, or Polled cattle. These cattle have the distinctive quality of hardiness, and as they have very thick, close hair they are able to subsist on the range without shelter better than perhaps any other breed. The males have a remarkable prepotency, and the cross-bred animals very rarely show horns. Like the Herefords, they are poor milkers; for while their milk is rich, the quantity is small, and they usually go dry for several months of the year. They were first imported into this country about 1850, and in 1883 nine hundred were imported and distributed among the cattle breeders of the plains. Polled cattle are becoming more popular every year, and many farmers now dehorn the cattle of other breeds; and the time is not far distant when horned cattle will be the exception and not the rule.

The Channel Island group—the Jerseys, Alderneys, and Guernseys—embraces unquestionably the best butter animals of the world; and if we are to judge by their wide distribution and great popularity, the Jerseys lead the list. They were first introduced into the United States in 1820, and in 1850 large importations were made; but it was during the decade from 1870 to 1880 that greatest interest in the breed was awakened and large and frequent importations were made. There has been a strong and bitter opposition to these cattle by many farmers on account of their small size, but they have won their way until they are more universally distributed, and are to be found on more farms than any other breed. Remarkable yields of butter from the individual have been recorded, many of them running from 12 to 18 pounds per week under high feeding and extra care.

While the Ayrshire possesses great merit, so few of them have been imported into this country that it seems scarcely worth while to more than mention them.

Under the head of general-purpose animals come the Holsteins, Devon, and Red Polls. All of these breeds possess fine qualities. The Holsteins were probably not introduced into this country until the last half of the century, and the "Holstein Herd-Book," published in 1882, shows that about 5000 registered animals were in this country at that date. While fair beef cattle, the Holsteins are deep milkers, and show a record of the largest quantity of milk of any breed in America,—some cows giving over 12,000 pounds of milk in a year. The milk, however, is not as rich in butter fat as that of the Jersey, but probably they are the best breed of dairy cows for the cheese factory in the United States.

The Devons are beautiful red cattle. They do not rank as large milkers, but produce a superior quality of milk, and are unexcelled in this respect by any breed but the Jersey. One peculiarity about the breed is the comparative smallness of the cow; for while the steer will weigh from 1400 to 1600 pounds, the cows will average only from 800 to 1000 pounds each.

The importation of Red Polls from England is comparatively recent, and they come nearer filling the idea of a general purpose animal than any other breed in America. The first importation was made in 1873, and consisted of only four animals. Two years later four more were imported, and in 1882 twenty-five. Other importations soon followed. They are of a uniformly cherry-red color, with occasionally the tip of the tail white or a little white about the udder. Ninety per cent of the grades are hornless. They are of large size, mature bulls weighing from 1800 to 2200 pounds, and occasionally one will exceed 2500 pounds. Cows weigh from 1100 to 1600 pounds, and will average 1200. That they mature early the following weights, copied from the report of the Smithfield Club, of England, will show:—

Steer, twenty-two and one half months old, weighed 1390 lbs.
Heifer, twenty-one and three quarters months old, weighed 1258 lbs.
Steer, twenty-three and one half months old, weighed 1500 lbs.
Steer, twenty-two months old, weighed 1336 lbs.

At the same show a mature cow was exhibited that weighed 1903 pounds. As dairy cattle they show good records, giving an average of 5500 pounds of milk per year, and some have exceeded 500 pounds of butter in a year, milking over 300 days.

While the United States can show as good horses as any other country in the world, they are not as generally distributed among the farmers as are animals of other breeds of stock. This perhaps can be accounted for, first, from the fact that a horse must be mature, and not less than six years old, before it can be put on the market; and that the low price of the service—fee of grades and scrub stallions—is too great a temptation to the farmer who is in debt and short of money. Still, our standard has been advancing, and there is a sure but slow bettering of the working stock of the country.

In the draft class we have the Norman, Percheron, Clydesdale, and Belgian, and possibly some others, while the Cleveland Bay comes as near the general-purpose horse as any other breed. The importations that have given us the magnificent horses which are being used in this country have been made chiefly from France, England, Belgium, and Germany. The blood of the English thoroughbred and of the Arab has also contributed to the development of the qualities desired.

In no other class of stock produced in this country has the improvement been more marked than in the swine, and while there are probably half a score of breeds in the country, a look through the markets shows that probably 90 per cent of them are of the three following breeds: Poland-China (formerly called Magie), Berkshire, and Duroc or Jersey Red; although it is quite possible that the Chester White might take the third place. With the exception of the Berkshire, these may be called distinctively American breeds, and even the Berkshire has been so modified and improved as to almost lay claim to American origin. A few other breeds are kept pure in this country, particularly the Essex, Yorkshire, and Victorias; but they are bred to but a limited extent and then for a special purpose. One thing that makes it easy and rapid to improve swine is the fact that they mature so early, and that a new cross may be made every year if desired. The writer, living in that part of Miami Valley, in Ohio, where the Poland-China swine originated, has seen, in a quarter of a century, these hogs change in form and color and general characteristics, and these fixed so thoroughly that they could be depended on to reproduce them. As this breed existed in the fifties, they were coarse in form, mongrel in color, and slow in maturing, requiring from eighteen months to two years to be made ready for market. But to-day they are early maturing, can be put on the market at six months of age, weighing from 200 to 250 pounds, and are of uniform shape and color. They are still the leading breed throughout the great corn belt of the United States, and the herd-books have registered breeding stock to the number of many thousand.

The Berkshire hog was first introduced into this country in 1823, and a second importation was made in 1832, but there was no systematic breeding and care to preserve their purity, and grades were sold for pure-bred until the breed fell into disrepute; but in 1865 new importations were made of the finest animals to be found in England, and the merits of the breed became universally known. Though called a small breed, they are but little below the Poland-China in weight, and grades from Berkshire males on large rangey sows will give the finest possible hogs for the block; but these grades must not be used for breeding, or the stock will deteriorate.

The American Chester White hog originated in Chester County, Pennsylvania; but it is believed that there was an importation of white hogs from England in 1818. The breed, until within less than a quarter of a century, was coarse, large of bone, and slow of maturity, and sometimes would attain enormous weight, nearly 1000 pounds; but in the last quarter of a century they have been improved until they are a close rival of the best breeds we have.

The Duroc-Jersey Red seems to be a distinctly American breed, having a history dating back to 1824, but it is less than a half century since they came into prominence, and the improvement made in them in that time has put them near the front rank. One thing which caused their rapid increase was the belief that they were proof against swine-plague and hog-cholera, and they were boomed on that idea. But this did not prove true, and our intelligent farmers have learned that it is not in the breed but in the food and care that immunity from disease will be found. These hogs are of a beautiful red color, and of good form. The mothers are prolific and good nursers, and they mature early, making the choicest of pig pork at an early age.

No other class of animals has been subject to so much foreign competition or has figured to such an extent as a political factor as the sheep, and this, for more than a generation past, has kept the sheep industry fluctuating between a depression which destroyed all profit and a boom which placed fictitious values on them, and both extremes have worked harm to the industry. Yet through all these changes, those who have recognized the intrinsic value of the sheep and stuck to the work of improvement, have not only found the business profitable but have prevented the deterioration of the animals which threatened.

While swine are of no value until killed, the sheep gives two coupons in a year, one in the fleece and the other in the increase, and the breeder always has two distinct objects before him,—the production of wool and mutton. The breeds of sheep are almost as dissimilar as are horses from cattle, and some are suited for hot arid lands, while others are adapted to the rich lowlands with their abundant and succulent herbage. The most ancient of all breeds is the Merino; and those who have studied this question trace its descent back in direct line, probably, to the flocks of the patriarchs. For ages they have been the clothers of mankind, first with the skin and later with the fleece, and still they maintain a high, if not first, place among different breeds. They have been wonderfully improved, but the improvement has been along the line of increasing the value of the fleece rather than the carcass, and it has been changed from an animal that would produce two or three pounds of wool, and one which had bare belly and legs, to one which produces a fleece from the hoofs to very near the nose. It is within bounds to say the weight of the fleece has been doubled.

With the long-wool breeds the improvement has been designed to develop the carcass and mutton qualities rather than the wool, and of these the two typical breeds are the Shropshire and Cotswold. Probably the best mutton lambs that are produced in this country are from the Shropshire rams and Merino ewes. The representative Cotswold is of majestic port and large size. The wool is curly, long, and lustrous; not dry and harsh to the touch, and has but a slight amount of yolk; at maturity it ought to be eight inches long. The fleece averages six or seven pounds.

IV. IMPROVEMENT IN FARMING METHODS.

The improvement of methods on the farm has been discussed to some extent in speaking of implements and stock, as their use involves better methods; but there are other points worthy of notice. One of the most important of these is drainage. The first attempts to remove surface water from farm-land were by the construction of open ditches; but as these had to follow the natural water-courses which often zigzagged through the fields, they were objectionable, not only because of making bad shaped lands to plow and cultivate, but also because they caused a waste of land, and usually had to be bridged to be crossed with the wagons. Other objections to them were that they produced crops of weeds to give trouble in the fields, and there was a constant tendency to fill up, which soon impaired their usefulness; or, if kept cleaned out, it had to be done at heavy expense. The first attempt at underdrains, or “blind ditches,” as they were called, was by making an underground water-way with stone or timber; but both these materials were found objectionable, because such drains were easily damaged by the action of craw-fish and rarely continued to do good work for more than a few years. It was after the middle of the century that drain tiles made of burnt clay were introduced, resembling good hard brick in material; but the first drains laid were usually with tiles of too small caliber, two-inch being largely used, which were not only easily choked but failed to carry the water off rapidly enough in a wet time. Large sections of many of our States were originally swampy and so nearly level as to make it necessary to construct open ditches, almost like canals, as an outlet for the water flowing into them from the drains. These could not, of course, be constructed by individuals, as no man had a right to go on his neighbor’s land to open a ditch for this purpose; so, in many cases, this was made a matter of legislation, and the large open ditches were built by taxation equitably levied on the lands. By this means the farmers were enabled to thoroughly drain large areas of country which otherwise would have been nearly worthless for agricultural purposes. In some instances the earth taken from these large ditches was graded up several feet high at the side, and on the top of this levee a turnpike road was constructed, thus giving a double benefit from a single operation. The first draining of farms was in the wet spots where, usually, a single line of tiles, laid for a moderate distance, would bring the parts of the field under cultivation that otherwise would be waste; but gradually the farmers learned that there were other valuable effects from drainage, and that most heavy clay lands would be benefited by it sufficiently to justify the expense. The following incidental advantages have been learned: first, drainage deepens the soil; second, it prevents the killing out of grass and grains during a wet season; third, it makes the land warmer; fourth, it improves the texture of the soil and makes it possible to work and plant it earlier in the spring; fifth, it prevents washing and waste of manure; sixth, it often prevents failure of crops in excessively wet seasons, and enables them to endure drought better in dry seasons. Although drainage is expensive it is a permanent improvement, and in many cases the increase of the wheat crop in a single year has defrayed the expense of tilling the land.

Another improvement, which seems to be the opposite of this, is the irrigation of arid lands in those parts of the country where the annual rainfall is small and every summer brings a drought. In these cases, water stored in large natural or artificial reservoirs, or that furnished by snow melting on the mountains, is utilized to carry the crops through the dry season and to enable the farmer to grow large crops where nothing could be produced without this aid.

Perhaps in no other line have the methods changed for the better more than in the care of domestic animals, and this includes both shelter and feeding. In the first half of the century, cattle and hogs were usually exposed to the severe weather of the winter with no other shelter than that afforded by a straw-stack, and this often was found leveled to the ground by the first of March, leaving them entirely without shelter at that changeable season of the year. They were allowed at all seasons to roam over the farm and gather their own living, and were turned into the cornfields as soon as the ears were removed, where they lived well as long as the stalk pasture lasted, after which they depended on straw for food until spring; and it was common to have the cattle so poor, as spring approached, that many died of actual starvation, while others became so feeble that they would have to be lifted to help them on their feet. Then the stables for horses were constructed apparently with the idea that ventilation was the chief thing, and the horses stood and shivered in their stalls from the drafts that blew through the sides of the barn and up through the floors of their stalls. Gradually these things have changed, until the larger part of farm stock is warmly sheltered, and well fed with a variety of food. Succulent food is now largely furnished from ensilage preserved in silos, from beets and other roots grown and stored for winter use, and, more recently, from sorghum, which has been found to retain its succulence and sweetness during the entire winter. Farmers have learned what is meant by a balanced ration, which is a combination of foods that will give the proper proportion of heat and fat producers with those which make bone and muscle, and that it means both health and economy to substitute to a certain extent bran and oil meal for corn, and clover hay for hay made from the grasses, and straw.

Another great improvement has been along the line of fencing; and, in this respect, the most economical step of all has been in reducing the amount of division fence on the farm, keeping only a portion of it divided into fields for pasture, and leaving half or more of the best parts to be cultivated in a single inclosure on which stock is never turned. In most States, laws have been passed obliging each farmer to fence in his own stock, and no one is compelled to fence out his neighbor's. The substitution of wire for wood as a fencing material has reduced the cost of fence construction about one half, and the waste of land occupied by fences is reduced in about the same proportion.

V. IMPROVEMENT IN AND AROUND THE HOME.

The change in this direction in a single generation has been most marked, and is one of the surest signs of prosperity. The log cabin has given place to a substantial and, in many cases, an elegant home. The irregular and ill-shaped yards, fenced with rails, which surrounded both house and barn, and in which hogs and cattle were kept, with no shelter but a rail pen with straw roof, have disappeared, and rectangular lots enclosed with neat fences and good barns and piggeries have taken their place. The wood-pile has retired from the front yard, and is now sheltered in a woodshed adjoining the kitchen; and a neat lawn with flowers and shrubbery is no longer the exception, but the rule. A good garden, in which the newer and improved vegetables have taken the place of the old sorts, and a berry patch, well cared for, afford the luxuries which they alone can give for a period of many weeks each season. The water is no longer carried from a remote spring, but good wells and cisterns are placed conveniently, many of them so that the pump is in the kitchen or under a porch attached to the house. The cellar is usually floored with cement, and the stairs leading to it are of easy grade; while good walks of plank or cement make it a pleasure to pass from the house to the surrounding outbuildings.

Another line in which very great improvement is shown is in maintaining the fertility of the soil. The old method was to exhaust the fertility of a field and then clear a new one; and it is doubtful if one farmer in a hundred could have answered the question, "Why does land become sterile after long cultivation?" for they had no conception of what the chemical elements of the soil were which are necessary to its fertility. There are two theories of fertilizing and fertility: one, that the soil is a mine to be worked out, and which will inevitably become unproductive in the process; the other, that it is a laboratory in which, under the intelligent management of man, forces can be set at work which will maintain and develop a perpetual fertility. Malthus, more than a century ago, announced that the time would come before long when the people of the earth would starve because they had outgrown the fertility of the soil and its productive capacity; but after long cultivation, we find it possible to produce on less than half the cultivatable land enough not only to feed our own nation, but the world at large, and there is no questioning the accurateness of the laboratory theory as opposed to the mine theory.

The first improvement along this line was in the better saving and utilizing of animal manures; but when it was found that these were insufficient, science came to the help of the farmer. The chemist analyzed both crop and soils, ascertaining what was needed, and then the world was searched for the materials necessary. The elements which formed our plants were found to be fifteen in number, but of these it was found that it was necessary to furnish only three,—nitrogen, phosphoric acid, and potash. Nitrogen was known to exist in inexhaustible quantities in the atmosphere, forming seventy-six per cent of its composition; but the question was long unsolved: "Can growing plants appropriate atmospheric nitrogen?" Finally, it was discovered that plants of the Leguminosæ family—of which clover is the best type and of greatest value for this purpose to the farmer—could appropriate nitrogen from the atmosphere; and after careful research, with the aid of the microscope, it was discovered that this appropriation came about through the agency of bacteria in the roots. This fact connected with the clover plant is one of immense importance to the farmer, because nitrogen is not only the most expensive element of fertility to purchase, but is likely to be lost both through evaporation and leaching. So it can be seen that clover is one of the most valuable plants which can be grown on the farm, for the reason that the crop can be utilized as food for stock, while still great benefit inures to the soil, as the fertility is largely stored in the roots, which cannot be used for any other purpose, and as by the action of these roots the mechanical condition of the soil is greatly improved. Further, the dense shade the plant affords induces chemical action in the soil, which makes plant food available that would otherwise remain inert. One of the most wonderful things connected with fertility is that God has so locked it up in the earth that no greedy generation can exhaust it, and that the greatest source of fertility is the atmosphere, whose secrets are just being discovered.

An English scientist has recently announced that by the aid of electricity, furnished by cheap water-power, nitrates can be manufactured directly from the atmosphere so as to reduce their cost to less than one fourth what it has heretofore been. Again, the intelligent use of clover will enable the farmer to produce his own nitrogen and reduce the cost of chemical fertilizers to one half what it usually is when containing nitrogen. This brings us to the question of commercial fertilizers. With the single exception of guano, they are a product of the last third of the century. The first step toward the use of commercial fertilizers was by analyzing our barnyard manures. When the chemist discovered that a ton or more which the farmer drew out laboriously with two horses to the field contained but twenty or thirty pounds of actual plant food,—the remainder being water, sand, and other dead matter,—the next step was to combine the three elements essential to a perfect fertilizer in such proportions that a single sack would hold enough manure for an acre of ground; and in tens of thousands of cases, the application of this amount of fertilizer has increased the wheat crop from five to fifteen bushels per acre, doubling the grass crop which followed, which in turn, and through the influence of the fertilizer, formed a sward which, by its decay, fertilized a third crop when it was turned under in the rotation.

The element in fertilizers of next importance to nitrogen is phosphoric acid, and the first source from which this was obtained was the bones of animals. But the supply from animals slaughtered was entirely insufficient; and so the great plains of the West were gleaned, and tens of thousands of tons of buffalo bones were gathered and shipped East to fertilize our farms. But soon this source began to wane; then two other sources, practically inexhaustible, of this indispensable element were discovered,—the phosphate rocks of the South and the iron slag from furnaces, each of which is found to contain a large per cent of phosphoric acid; and when the rock is dissolved by acids and the slag ground to an impalpable powder by machinery, the fertilizing elements in both are found to be as available and valuable as that from bones. The supply of potash was obtained at first from wood ashes, which the clearing of the farms and the universal use of wood as fuel made abundant. But later, when these sources were no longer sufficient, potash salts were found in large quantities where they could be mined from the earth, so that now there seems to be in sight an inexhaustible supply of the elements needed for plant food. Like almost every reform, the use of commercial fertilizers was opposed bitterly by many farmers, and statements were made by them that their effects on the soil were like those of whiskey or other stimulants on the body, and that the ultimate result of their use would be that the soil would become barren. Many refused, to use them at all; others, after a single trial made without intelligence, denounced them as humbugs. But as they saw on the farms of their neighbors the wonderful results from their use, they have been gradually led to adopt them, until now, with most farmers, the question no longer is, “Can I afford to use commercial fertilizers?” but rather, “Can I afford to do without them?”

VI. IMPROVEMENT IN AGRICULTURAL EDUCATION.

To one who has followed the writer to this point, it must be apparent that the farmer of to-day has made progress in the knowledge of his calling to at least as great an extent as he has improved in his methods, and that the terms “farm drudge” and “clodhopper” are misapplied and should be obsolete. There is no other industrial calling in which one touches nature and science at so many points, or which gives such good opportunities to develop the perfect man,—“the sound mind in the sound body,”—as that of the farmer. Admitting that not all farmers understand this and live up to their privileges, does not alter the fact that the farm offers a great opportunity to develop and broaden the mind; that the last quarter of the century has brought into active operation forces which have touched and influenced a large per cent of the tillers of the soil; and that the leaven of education is working mightily. The intelligent, studious farmer becomes a practical botanist as he studies the growth and habits of plants. As he is dependent more than any other man upon the weather and must change his plans frequently to correspond with climatic changes, he becomes a meteorologist. Myriads of insects, which include both enemies and friends, make him a student of entomology; and the wonderful alchemy of the soil by which offensive and poisonous matters are transmuted into golden grain, luscious fruits, vegetables, and flowers, calls for a knowledge of chemistry. The use of modern machinery develops his mechanical powers; and the man on the farm develops in more directions and has an opportunity to acquire a broader education than any other man who earns his living by his own labor. To sustain this statement, it is only necessary to enumerate the educational opportunities and privileges now open to the farmer and which are, to a great extent, utilized by him. First, what the government is doing for him. No other calling is represented in the cabinet of the President, and time and experience have demonstrated the wisdom of a Secretary of Agriculture. Not only are we distinctively an agricultural people, but the prosperity of the nation depends on the intelligence and prosperity of the farmer more than on all other classes combined. Not only must the food supply of our people be furnished, but the foreign demand must be met; and this gives to the farmers money to spend, so that the industries which contribute to their wants shall share in the general prosperity. While there are many honorable and useful callings, agriculture seems to be the only one which touches and affects all others. The financial importance of agriculture is shown by the fact that, after the wants of the nation were supplied, in the year 1897 we exported in round numbers $690,000,000 worth of agricultural products, or nearly 67 per cent of the entire exports; and notwithstanding an enormous increase of imports of wool and sugar, in anticipation of increased duties, the balance of trade on agricultural products for the year was $289,000,000, and the export of agricultural products for the current fiscal year would show still larger figures.

Considering the specific educational influences which are elevating the farmer and his calling, we enumerate the following: Agricultural literature, farmers' organizations,—including farmers' clubs, farmers' institutes, and the Grange,—agricultural experiment stations, and agricultural colleges, all of which have contributed their share to the intelligence and prosperity of the farmer, and all are products of the last half of the century. To give an intelligent idea of the help which these influences have brought to the farmer, it is necessary to treat them to some extent in detail. First, agricultural literature. All that is necessary to an understanding of the progress in this direction is to get one of the very few so-called agricultural papers of fifty years ago and compare it with those of to-day. Not only have they multiplied a hundredfold, but while the former largely contained stilted articles written by theorists, to-day every page is full of practical instruction written by farmers, and often by specialists who have spent years in improving some line of farming or stock breeding. Most of our agricultural papers have a staff of paid contributors, nearly all of whom have made a success in some branch of farming; and so anxious are the publishers of these papers to give their readers all the help possible, that they search out the men who are prospering on the farm and engage their services as instructors for their readers. The journals devoted to agriculture are numbered by hundreds, some of them devoted to a single line,—such as sheep, poultry, or gardening,—and others with well classified departments which give instruction on all points. In addition to this, nearly all of the weeklies have a page of agriculture, usually conducted by a farmer or some one with practical knowledge of farm work. There are no secrets in agriculture, and every farmer is ready to impart to all any valuable information he acquires. Farmers appreciate the value of these helps and make large use of them, and the circulation of these papers is enormous.

By Farmers' Clubs we mean those organizations of farmers, governed by constitutions and by-laws, who meet at stated times for the discussion of topics connected with the improvement of their calling. There are no statistics available from which can be gathered the extent of this movement, but Ohio reports fifty clubs and has formed a state organization. In Michigan, where the clubs are organized on a different basis, 30,000 members are reported; they have also formed a state organization, which was attended by 200 delegates at the last meeting. Indiana is but little, if any, behind these two States, and the club idea is rapidly spreading through the Northern States. There are two forms of these clubs, one of which limits the membership to twelve families, and the meetings are all held at the homes of the members, one each month. The advantages of this plan are several. First, with the club thus limited, the horses can be stabled and cared for during inclement weather of winter. Second, the wives need prepare but one meal in the year for the club; while with the large club it is necessary that each should contribute to a basket dinner for every meeting, which often causes as much trouble as to prepare the meal for the entire club once a year. Third, the attendance is sure to be more regular in the small club, and one condition of membership is that every member shall be present at each meeting unless providentially detained. Fourth, with a club of this size every member can take part in the discussion, and there will be less danger of a few "talkers" monopolizing the time. Fifth, the social features in the small club are very much better than in the large. Most of the clubs in Ohio and Indiana are organized on this basis, while in Michigan it is probable that most of the clubs have an unlimited membership. The objection is sometimes urged that the small club seems selfish, but as any twelve or even six families are at liberty to organize a club this objection is not valid.

As many farmers who would like to organize may not be able to find a form of constitution and by-laws, it seems proper to give one here.

Preamble.

Recognizing the fact that farmers need an opportunity to compare methods and to cultivate their social qualities, and considering that "As iron sharpeneth iron, so a man sharpeneth the countenance of his friend," in order that we may be mutually helpful to each other in matters relating to husbandry, home comfort, and economy, we do form ourselves into an association known as the —— Farmers' Club [fill the blank with the name you wish to use for your club], and adopt for our government the following:—

Constitution.

Article 1. The officers shall be President, Vice-President, Secretary, Treasurer, and Librarian, who shall be elected annually in November, and assume their duties in January of the following year.

Article 2. The duties of these officers shall be such as pertain to the offices in other organizations and are indicated by the name of the office.

Article 3. The active members of this club shall be engaged in agricultural pursuits, but honorary members may be elected by unanimous vote. Honorary members are not obliged to attend all the meetings, but will be welcomed to any.

Article 4. Application for membership must be submitted at the meeting previous to their being balloted for, and members will be admitted on receiving a two-thirds vote by ballot; but the membership shall be limited to twelve families.

Article 5. Amendments may be made at any regular meeting by a two-thirds vote of the active members.

By-laws.

1. The club shall meet at the residence of one of the members on the third Thursday of each month, at ten o'clock, invitations to which shall be limited to the hostess of the day.

2. The club shall be called to order by the president, after an hour spent in social intercourse, and the order of exercises shall be as follows:—

a. Reading and approving minutes of last meeting.

b. Monthly record of current events.

c. Selections, recitations, essays.

d. Adjournment for dinner and social intercourse until two o'clock.

e. Discussion; so conducted as to avoid all questions of politics and theology.

f. Question drawer.

g. Miscellaneous business.

In order that the work of the club may be systematic and the time fully occupied, a programme covering the entire year is prepared and printed so as to be ready for distribution at the December meeting of each year. That the reader may understand the working of this plan, a few topics will be given, taken from the programme of the club of which the writer is a member:—

January.

The club will meet at the home of Mr. ....

Thursday, the 19th.

Selection .... Mrs. ....

Paper .... Mr. ....

Topic: A review of the previous year.

Each member will give in writing a statement of profits and losses for the year under the following heads:—

1. General crops grown and acreage and yield thereof.
2. What special crops have been raised.
3. Stock raised or handled.
4. What experiments have been made on the farm.
5. What losses of stock, or crops, and the cause thereof.

June.

The club will meet at the home of Mr. ....

Thursday, the 15th.

Selection .... Mrs. ....

Paper: “Hindrances to sheep raising and how to avoid them.” Mr. ....

Topic: The Farmer’s Barn.

1. Relative size to farm.
2. Location and ground plan.
3. Arrangement of stabling, feeding, and water conveniences.
4. Plan for saving manure.

Either a gentleman or a lady is appointed to open each topic, after which the subject is opened for question or discussion by any member of the club. During one month of the summer, usually July or August, a picnic takes the place of the regular meeting, at which a basket dinner is served.

Farmers’ institutes are, in the best sense of the word, a farmers’ school, and while it is less than twenty years since their first organization, nearly all of the States, at least in the North, are conducting them to a greater or less extent. As Ohio claims the honor of inaugurating this movement, and the writer is more familiar with the plan of organization and the work of institutes in that State than any other, some facts concerning them will be given. The first attempt to teach the farmers by lecture courses was made late in the seventies at the Ohio State Agricultural College, when a course of eighty lectures on subjects connected with farm interests were given, all of them by professors of the college. This first course occupied five weeks; and as it was found that but a limited number of farmers could be induced to leave their homes and care of their stock in the winter, and that the attendance was only about forty, the next two years the course was shortened in hopes that a larger attendance might result, but such was not the case. Then some one suggested, “If the farmers will not come to the lectures, why not take the lectures to the farmers?” and the outcome of this suggestion has been a wonderful success; the State holding three hundred institutes in the winter of 1897 and 1898, under a law providing a fund for that purpose, and over a hundred independent institutes in addition, by which is meant institutes in which the local organization pays its own expenses and chooses its own lecturers and subjects.

The work in most of our States is thoroughly organized, a fund provided to meet the expenses of the work, placed in some States under the charge of the Secretary of Agriculture, and in others in charge of a superintendent of institutes. The farmers have met this effort for their improvement with great enthusiasm, and the attendance is usually limited by the size of the hall provided. All partisan and sectarian questions are rigorously excluded from the discussions. A bulletin is issued in the fall, which gives the names of a large corps of lecturers and a list of subjects, and these are sent to the officers of the local organizations, from which they can select such topics as they wish discussed. Half of the time of each session is allotted to the state lecturers, while local talent is expected to fill the other half. The greatest possible freedom is allowed in asking questions and discussing the work of the speakers, and no other educational influence which has come to the farmer has equaled that offered by these meetings. At the close of each year the best papers and discussions are printed in a bulletin for free distribution among the farmers, and are given out at the meeting the ensuing year, or are mailed from the office of the Secretary of the State Board of Agriculture on application.

The Grange was organized at Washington, D. C., in 1807, but existed only on paper until January, 1873, when the first meeting of the National Grange convened at Georgetown, D. C., with delegates from ten States. It was started as a secret society, with a ritual and degrees, and seemed to catch the popular fancy among the farmers. At the meeting of the National Grange in 1874, thirty-two States were represented.

Probably no other organization has made so rapid a growth as this. A large element, however, of the membership was attracted to it by the rallying cry of “Down with the middleman!” and had little or no conception of its educational possibilities. Little country stores with very small capital, and managed by men with no business training, sprang up at every cross-road, which, contrary to the expectation of their founders, did not save money, but resulted in some valuable business education for which a good tuition fee was paid. The reaction which set in made it seem for a time as though the entire order would disintegrate; but fortunately there were wise leaders who had caught the true idea, that the organization must be kept on an educational basis to save it from extinction, and through their efforts it has become a power for good in most localities, and has been of great service to the farmers. County, state, and national societies have been organized, and no other large bodies of farmers can so quickly and thoroughly coöperate in measures pertaining to the interests of the farmer as those belonging to this order.

Another educational force of immense value to the farmers is found in the experiment stations, which are established in every State of the Union. This work was started by an act of Congress, approved March 2, 1887, and known as the “Hatch Act.” By this act the sum of $15,000 per annum was appropriated for each State in the Union, to be specially provided by Congress in the appropriations from year to year. In addition to this sum, most of the States have made large appropriations for the purchase of suitable grounds and the erection of buildings, and to cover the expense of printing the reports and pamphlets which are sent out free to the farmers who apply for them.

To go a little farther, the questions requiring investigation by the agricultural experiment stations may be divided into three principal groups, according as they are related to the soil, to the growth of crops and vegetation, or to domestic animals and their products.

I. The soil is studied—

(1) In its varieties, as found in different parts of the farm and of the State.

(2) In its physical properties, as affected by tillage, drainage, irrigation, etc.

(3) In its chemical properties, as related to the maintenance of fertility by the use of fertilizers and otherwise.

II. In vegetation and crop production some of the objects of study are:—

(1) Varieties, including the selection and dissemination of new sorts; the elimination of synonyms; the comparison of strains of varieties; the production of improved varieties, etc., etc.

(2) Vegetable pathology, including studies of rusts, smuts, blights, rots, mildews, etc.

(3) Control of injurious insects.

(4) Forestry, embracing the culture of forest trees for wind-breaks, for timber, for nuts and incidental products.

III. In the study of animals some of the problems are:—

(1) Breeds and their comparative values for different purposes.

(2) Foods and feeding, for growth, for meat, for milk and wool.

(3) The diseases of animals, especially those of contagious, epizootic, or parasitic nature.

The stations have done most valuable work along these different lines, and have contributed in a large measure to the introduction of improved varieties of cereals, forage crops, and fruits. In the case of wheat especially, there can be no doubt that the work of the stations has been a factor of great importance in producing large yields, by stimulating the farmers to a more careful comparison of varieties and of methods of culture.

A plan of purchasing and testing most of the so-called new varieties of fruits and grains has been followed by some of the stations, thus enabling the farmers and fruit growers to judge whether such varieties are likely to be superior to sorts already cultivated. It has been part of the work of the stations to expose fraudulent sales of fruit, stock, and fertilizers. Much other work has been and is being done, but the instances given show the value of the investigations made. As has already been stated under another heading, the officers of the experiment stations take an active part in the work of the institutes, and by the frequent issuing of bulletins and their annual reports convey valuable information to the farmer in every department of his work. In many States they have established reading courses for the study of Nature, which are conducted similarly to those in the Chautauqua courses.

In the same connection the work of the Bureau of Animal Industry should be noticed. Possibly no other organization of the government is doing so much to save farmers from loss through disease of stock and educating them to the same extent as this. The organization is made up of men of the highest scientific training, whose lives are devoted to the study of diseases of domestic animals and whose work extends to the testing of remedies, the inspection of meats, the study of foreign markets, and everything that pertains to the interest of the stock growers. No disease can break out in the herds of live stock in any part of the country without this bureau being at once notified of it, and trained officials are sent to study all the circumstances connected with it and to prevent, if possible, such disease from becoming epidemic. Some years ago, when contagious pleuro-pneumonia had secured a foothold in this country, the Bureau of Animal Industry set to work to stamp it out. The Old World was paralyzed by the enormity of the undertaking. Veterinarians in England and Continental Europe laughed at us and considered us fit subjects for lunatic asylums. "Hadn't *they* always had it? It cost them millions of dollars annually in cattle, yet they had been unable to stamp it out, and most assuredly we could not do what European veterinarians could not." They forgot that we were Yankees. It cost us many good hard dollars that were represented by large figures; but we stamped it out, and it has now been years since "Uncle Sam" officially declared the country free from it.

Another work which this bureau undertook was the regulation of vessels in which cattle were exported, and they reduced the losses so as to save from two to three million dollars annually in the insurance of export cattle. The greatest possible care is taken to disinfect vessels in which cattle have been shipped, and strict regulations are established regulating the size of stalls, ventilation, the number of cattle to be carried on any single vessel, and every point which has a bearing on the health and comfort of the animals.

It was not until after the Civil War that such a thing as an agricultural college was known in this country, but through the action of Congress very liberal appropriations were made, which in most States were supplemented by the action of the State Legislatures, and an agricultural college was started in every State of the Union. In the beginning there was much criticism, and without doubt many mistakes were made by those to whom the work was assigned; but now that a generation has passed, the farmers have come to understand better the objects of these schools, and scientific men have been trained to do the work; and these men have gone out into other departments, such as those already described, and have made possible the splendid achievements which have already been hinted at in what has been written. The teachers and officials of these colleges have been exceedingly friendly to everything that could help the farmers, and are in close touch with them; aiding in the work of local, state, and national organizations, and, in most States, carrying on the work of the experiment stations through their professors and graduates; and in many of them courses of lectures by practical farmers have been established. Without question they are becoming more and more helpful as the years go by, and their power for good is constantly increasing.

A SUMMING UP.

What has agriculture gained, or rather along what lines, in the century's progress? A brief summary would seem a fitting close of this chapter:—

(1) The marvelous advance in methods and means of transportation, and the consequent opening of the markets of the world.

(2) The knowledge of the chemical constituents of the soil and its management in the line of maintaining fertility.

(3) The appliances to lighten labor and shorten processes in the production and harvesting of crops.

(4) Increased knowledge of plants, as to their growth and cultivation, their feeding qualities, and the combination of these qualities in feeding our domestic animals, by which we are able to reduce the cost of production through the early maturity of the animals and the maintaining of vigorous health.

(5) Increased knowledge of the value and power of organization and of agricultural literature in helping to a practical education for the duties of the farm.

(6) In an increase of home comforts and a higher ideal of living, and an appreciation of the fact that the work of the farm should be subservient to the life on the farm, as “The life is more than meat, and the body than raiment.”

(7) In no other country on the globe are there so many tillers of the soil who own their homes, and, as a consequence, there is no country where there is so much of patriotism. When Matthew Arnold visited the United States, nothing that he saw delighted him more than the beautiful farms, with their comfortable dwellings and outbuildings and the evidences of high cultivation and fertility. But one thing puzzled him, and that was the absence of tenant houses, and he asked, “Where do the men live who cultivate these farms?” When told that in most cases the farmers were their own tenants, he could scarcely express his astonishment.

Prince Kropotkin, of Russia, who has traveled in this country and paid particular attention to the condition of agriculture, says in his summing up: “American agriculture offers an imposing sight; not in the wheat fields of the far West, which will soon become a thing of the past, but by the development of rational agriculture and of the forces which promote it. Read the description of an agricultural exhibition in a small town in Iowa, with 70,000 farmers camping with their families in tents during the fair week, studying, learning, buying and selling, and enjoying life. You see a national fête, and you feel that you deal with a nation in which agriculture is held in respect. Or read the publications of the scores of experiment stations, whose reports are published by thousands and scattered broadcast over the country, and are read by the farmers and discussed at countless farmers’ meetings, and you will feel that American agriculture is a real force, imbued with life, which no longer fears mammoth farms, and needs not, like a child, cry for protection.”

The future of agriculture in this country seems safe, and no class of men can look the future in the face with more of confidence than those who till the soil.

Progress In Civil Engineering

By WALTER LORING WEBB, C.E.,
Assistant Prof. of Civil Engineering, University of Pennsylvania.

I. AN INTRODUCTORY VIEW.

If we broadly define civil engineering as the art of construction, then the birth of the art is as old as the emergence of man from savagery. The savage who hollows out a log of wood in order to construct a canoe has taken the first step in the art of shipbuilding; and when he has constructed a hut, however rude, to take the place, as an abode, of the cave hollowed out by nature, he has moved one step nearer to those triumphs of building construction which satisfy man's necessities, comforts, and æsthetic desires. From this standpoint civil engineering is as old as the oldest of the arts and sciences. Not only is civil engineering an ancient art, but when the archæologist points to some of the masterpieces of building construction which have been literally hidden from view by the débris of centuries, and describes the old roads which the disintegrating forces of nature, working for centuries, have not been able to destroy, it is natural to assume that in many features the civil engineering of the present day is but a copy of ancient work, or, at least, that there has been comparatively little real progress. It may be claimed that bridges are very old, that canals, lighthouses, and roads antedate the Christian era, and that even the ancient Egyptians knew that the earth is round, and had made a rough computation of its diameter. But it will be shown that even in these cases there has been an enormous advance, not only in the character and magnitude of the work done, but also in another feature of civil engineering which is frequently overlooked, namely, the *economy* of labor and material. Civil engineering has been defined as the art of doing well with one dollar what any bungler can do somehow with two dollars. This definition, although very loose and one-sided, nevertheless contains a very important truth. If by improved methods a canal or a bridge can be constructed for one half to one third of what it would have cost by older methods, then the world has advanced, in that it may have two or three canals or bridges at the same cost of labor as would have been previously required for the construction of one. When we add to this a vast improvement in quality, an improvement that would have been previously impossible at any cost, the world's advance is hardly measurable by any standard. It is a well-known fact that many engineering works, justly considered masterpieces at the time of their construction, could now be replaced by a much better structure for a comparatively small part of their original cost. This statement not only applies to very old constructions, but even to some of the great engineering works of the latter half of this century. Some of these reconstructions have actually occurred, as is illustrated in the Victoria tubular bridge at Montreal, or the Roebling suspension bridge at Niagara Falls,—described later. In fact, the progress in civil engineering during the nineteenth century is chiefly made up of the enormous advances which have been made during the latter half of the century. It should not be argued that these recent constructions are cheaper, because "everything is cheaper now." The general scale of wages has advanced, and the total cost of construction is cheaper, only because improved methods of work have reduced the labor required to produce finished building material from the raw product and to erect that material into a structure. Therefore in considering in detail the construction of the great masterpieces of this century, we should not lose sight of the enormous advance in general methods of work, which has rendered it possible to have all of these structures which so minister to the prosperity of the world, at such a reduced cost in labor.

A complete discussion of the century's progress in civil engineering would require a treatise on all modern practice as well as a description of nearly all of the great engineering masterpieces in existence, but the limitations of this article utterly preclude the possibility of even a short discussion of all the branches of the science, to say nothing of a detailed description of all of the examples. The following discussion will therefore be confined to those branches in which the advance has been most notable, even to the unscientific reader, the progress being illustrated by brief statements regarding the most typical constructions.

II. BRIDGES.

Not only is there evidence that bridges of the simplest forms have been used from prehistoric times, but the engineering world has been frequently surprised at the discovery, in semi-barbarous lands where there was evidently no scientific knowledge of bridge construction, of a bridge which, in its mechanical analysis, is a rude example of some one of the more complicated types now in use. But these bridges are always small, and are constructed with an utter disregard of that economy of construction which is one of the great triumphs of modern bridge engineering, being uselessly strong in some parts, considering their weakness in others. At the beginning of this century there was not a wrought-iron or steel bridge in existence. Disregarding stone arches for the present, all other bridges were made of wood—with the exception of a few bridges of cast iron, which were constructed during the latter part of the eighteenth century. But cast-iron is unsuitable for pieces requiring tensile strength; it is also difficult to cast very large pieces with any assurance of uniformity. The best existing examples of cast-iron bridges are, therefore, those of the arch type; but these are very heavy in proportion to their real strength, and would now be much more costly than, as well as inferior to, steel bridges of equal strength. Therefore the great advance in bridge work during this century consists in the development of steel bridge construction, and a brief description will be given of a few bridges which represent the chief types.

Brooklyn Bridge.—The suspension bridge between New York and Brooklyn is the largest bridge of its kind in existence, and, until the construction of the "Forth" bridge, was the longest clear span ever built. Every one is so familiar with this stupendous structure that only a few statements will be made, which may give a better idea of the unprecedented problem which confronted the great engineer, John A. Roebling. When looking at the exceedingly graceful design of the towers, one is apt to forget that a large part of the structure of each tower is hidden from view. The bottom of the foundation of the pier, on the New York side, is 78 feet below mean high tide, and spreads over an area 172 feet long and 102 feet wide. The pressure exerted by the caisson on its base is about 114,000 tons, or 6½ tons per square foot. This great area, 354 feet below the parapet of the towers, is a surface consisting partly of bed-rock and partly of a material so compact that it was found, to be almost impossible to drive an iron bar into it. Down below the mud, below all danger of scour, far below the depth where the dreaded *teredo navalis* can destroy the timber in the caissons, these piers rest on an immovable foundation, and are an imperishable monument of man's skill. The floor of the bridge is supported by four cables, each containing 6300 wires. Each wire is supposed to be subjected to a stress of about 570 pounds, and to have an ultimate strength of 3400 pounds. To say that each cable is pulled by a force of 3,591,000 pounds conveys but little real impression to the mind—as little as to say that it would require a pull of over 21,000,000 pounds to break it. And there are four such cables! The main span, including the weight of the cables, weighs about 5000 tons. Some interesting facts concerning the caissons under the piers of this bridge will be given under the heading of "Caissons."

Niagara Railway Arch.—The railway suspension bridge, constructed by Mr. John A. Roebling across the Niagara gorge in 1853–55, was justly considered a monument to the skill of a great engineer, a monument of the world's progress; and yet so rapid has been the advance in the art of bridge engineering, that this great structure is already a thing of the past, and has now been replaced by another bridge which better fulfills the increased requirements. It was not that Roebling's bridge was an engineering failure, but that the large increase in the weight and length of trains now requires a much stronger bridge. There were several formidable conditions confronting the engineer who designed the steel arch which has now replaced the suspension bridge. For one thing, a heavy railroad traffic was using the old bridge. The interruption of railroad traffic for even a few day's is a serious matter. Extend the time to several months, and the consequences are too serious for toleration. And thus it became necessary to so plan and construct the arch that both structures would occupy the same site, not interfere with each other, and not interfere with the running of trains. It is an amazing, almost inconceivable, triumph of constructive skill that this was accomplished so that "*not a single train was delayed*, and traffic on the highway floor was suspended only for about two hours each day, while the upper floor system was being put in." The second rigid requirement was the necessity for constructing the arch without any "false works" underneath. Of course it was not practicable to suspend the various members of the arch during construction, from the old bridge, as it was not designed for such a load. Nor would it have been possible to plant false works in the deep and swift current of the Niagara River. And so it became necessary to make each half of the bridge self-supporting, as it hung out over the raging torrent a distance of about 275 feet from the abutments, until the two projecting arms could be joined in the centre. The illustration does not show the independence of the arch from the old bridge. If the old bridge had not been there (as was virtually the case, so far as support given by it is concerned), the independence of those arms reaching out over the river would have been more apparent. Add to all these rigorous conditions the marvelous fact that the erection of this great arch was begun on September 17, 1896, and that the bridge was tested on July 29, 1897 (only 315 days afterward), and we have here one of the greatest triumphs of engineering which could be imagined.

Pecos River Viaduct.—The original location of the Galveston, Harrisburg, and San Antonio Railway included a section of about 25 miles which was very difficult to operate, on account of its very heavy grades and sharp curvature. After some years of study and surveying, a line was found which would save 11.2 miles in distance, 378 feet of rise and fall, and 1933 degrees of curvature, besides being free from land slides which threatened the old line at many points. But the great economic advantages in the expenses of operating could only be obtained at the cost of an almost unprecedented structure,—a viaduct 2180 feet long, which should cross the Pecos River at an elevation of 320 feet 10½ inches above the water surface. There are two bridges in Europe which span very deep gorges by *arches*, which are higher above the water than this viaduct, but in such cases the depth of gorge is of no engineering importance. There is also a viaduct, for a narrow-gauge railway in Bolivia, 800 feet long and with a height of 336 feet from the rails to the water. But the Pecos viaduct is built to carry standard-gauge railway traffic over a valley nearly half a mile wide, and at such a height that a train moving over it appears diminutive. The stone towers in the illustration appear small, but they are constructed to a height of over 50 feet above the ordinary level of the water, to allow for possible floods. The longest "bents" have a height of 241 feet 0¾ inches. No "false works" were used in erecting the bridge. The "traveler," shown in the illustration, had an arm 124 feet 6 inches long. After completing the construction on one side of the river (including one half of the "suspended" span immediately over the river), the traveler was taken apart, loaded on cars and transported by rail a distance of nearly 40 miles, in order to reach the other side of the valley. Then the construction was carried on as before, until the two halves of the suspended span met in the centre. The work of erection began November 3, 1891, and on February 20, 1892 (only 108 days later), the two halves of the suspended span were connected. A portion even of this time was lost by inclement weather and unavoidable delays. This light “spider-web” method of construction for crossing very high valleys was originated by American engineers, the first notable instance of it being the construction of the “Kinzua” viaduct, on the N. Y. L. E. & W. R. R., which has a length of 2050 feet and a height of 302 feet above the water—figures which are only slightly less than the above.

Forth Bridge.—The next type of bridge to be considered has for its example the largest bridge in the world—the “cantilever” crossing the Firth of Forth, in Scotland. The economic design of bridges of this type, on the basis of the mechanical principles involved, is not only an achievement of this century, but of the latter part of the century. Nevertheless, we may find illustrations of the fundamental principle in the stone lintels in an Egyptian temple; in a rough wooden bridge erected by Indians in Canada, near the line of the Canadian Pacific Railroad; and in a bridge erected over two hundred years ago in Thibet, and discovered in 1783 by Lieutenant Davis, of the English embassy to the court of the Teshoo Lama. The principle of these bridges is very graphically shown by a photograph made at the time of the construction of the Forth bridge.

This bridge joins two sections of Scotland which had been previously separated by an arm of the sea, which could only be crossed by a tedious ferry. Even this ferry was frequently tied up by fog or by the strong gales which so often blow up the channel. The prevalence of heavy wind pressure demanded that special attention should be given to this feature, and the most elaborate tests ever made of the effect of wind on a bridge structure formed a part of the preliminary work. The estuary, for a distance of nearly fifty miles, is never less than two miles wide, except at this one place, where it is but little more than one mile wide, with the added advantage of having the island of Inchgarvie nearly in the centre of the channel. The channel on both sides is about two hundred feet deep, which would forbid the location of a pier at any place except on this island, which, being composed of basaltic trap rock, furnished a sufficient foundation at a comparatively slight depth below the surface. To secure the maximum rigidity consistent with economy in weight, the “vertical columns” of the towers were spaced 120 feet apart at the base, but only 33 feet apart at the top. The towers are 330 feet high. As shown in the illustration, the cross-sectional dimensions of the cantilevers diminish rapidly both in width and height, so that although the weight of the steel per running foot at the towers is 23 tons, it becomes only a little over two tons per foot at the centre. The structure is exceptionally rigid.

The picture of any gigantic structure, especially when well proportioned, utterly fails to give an adequate idea of the size of its component parts. It is difficult to realize from the illustration that the four tubular “vertical columns” on each main pier are twelve feet each in diameter at the base—large enough for “a coach and four” to drive into, if they were laid horizontally. Over 50,000 tons of steel were used in the main spans. The total cost of the whole structure was over £3,200,000 ($16,000,000).

Stone Arches.—The nineteenth century has but little to claim as to the development of stone arches. The mechanical theory of their stresses is perhaps better understood now than ever, and the largest masonry arch in existence (the Cabin John arch, having a span of 220 feet, carrying the Washington aqueduct over a creek) is a piece of American work of this century. But it should not be forgotten that more than five hundred years ago there was constructed at Trezzo, Italy, a granite arch of 251 feet span. This arch was unfortunately destroyed in 1427. One of the most remarkable arches in existence was designed and built by an “uneducated” stone-mason at Pont-y-Prydd, Wales, in 1750. A rigorous analysis of its strains—of which the designer probably knew nothing—shows that the “line of resistance” passes almost exactly through the centre of the arch ring. The most highly educated engineer of the present day could do no better. On the other hand, the development of the theory has been shown by the successful construction of an exceedingly bold design for a bridge on the Bourbonnais Railway, in France. The span is 124 feet, and the rise only 6.92 feet. The design was considered so very bold that a model of the arch was first constructed and tested before the design was finally adopted. The extension of the use of stone arches, especially those of very large size, is doubtless prevented by their excessive initial cost over the cost of a steel structure of equal span and strength. Since a stone arch is generally considered more beautiful than a steel bridge, the æsthetical element often demands the construction of stone arches in public parks in situations where a metal structure would be more economical. The great reduction in the cost of steel during the past few years, due to improved processes of manufacture, generally renders the cost of a steel bridge, even with a proper allowance for maintenance, repairs, and renewals, cheaper than a stone arch, unless the span is short.

III. CAISSONS.

The use of compressed air to keep back the water that would naturally flow through the soil into a deep excavation is a comparatively recent idea. In 1839 M. Triger, a French engineer, conceived the idea of sinking an iron cylinder through twenty metres of quicksand in the valley of the Loire River, in order to reach a valuable coal deposit which was known to be located beneath the river. A chamber with doors, such as is now called an air-lock, was constructed at the top of the cylinder. To pass into the cylinder the lower door, opening downward, was closed, and when the air in the chamber was at atmospheric pressure, the upper door, also opening downward, was opened. Upon entering the chamber the upper door was shut, and air was pumped in until the pressure equaled the pressure in the cylinder underneath, which was also the pressure necessary to keep back the water from the excavation. The lower door could then be opened and the working chamber entered. To pass out, the reverse process in inverse order was necessary. This was the first pneumatic caisson ever sunk, although such plans had been proposed and even patented in England several years before. The idea was essentially the present plan, but the process has been improved and enlarged. The required pressure is substantially that due to the weight of a column of water as high as the depth of the base of the caisson below the water surface. In the case of the St. Louis bridge, the bottom of the caisson was sunk to 109 feet 8½ inches below the water surface, which required an air pressure of about 47 pounds per square inch in the working chamber. Such a pressure is dangerous to those working in it. The men literally “live fast.” Great exertion is easily made, but is followed by corresponding exhaustion after leaving the caisson. Those having heart disease, or who have been debilitated by previous excesses, are liable to be seriously affected—generally by a form of paralysis which has been specifically named by physicians the “caisson disease.” At the St. Louis bridge, when working at the greatest depths, the men were only worked four hours per day, in two-hour shifts. Facilities were likewise provided to have them bathe, rest, and take hot coffee on coming out of the working chamber. Healthy men, who observed these and similar precautions, were not permanently affected by the work.

The caissons of the New York and Brooklyn suspension bridge are the largest ever constructed, and a bald account of some of the experiences encountered is fairly dramatic. Under such air pressures the flame of a candle will return when blown out, and so the danger of fire inside the wooden caissons became very serious. One evening a fire was discovered in one of the caissons, caused presumably by a workman holding a candle temporarily against the wooden roof while searching for his dinner pail. When discovered it was apparent that the fire had burned out a cavity in the solid timber roof, and the supply of compressed air was fast turning those timbers into a mass of living coal. Two pipes capable of throwing one and one half inch streams had been provided for this express contingency, and the two streams were turned on as quickly as possible. All night the fight went on. At 4 A. M., when the water was pouring out of the orifice of the cavity as fast as it was sent in by the hose, it seemed as if the cavity must have been thoroughly flooded and the fire out. To make sure of the absolute extinction of the fire, borings were made, which showed that the fire had worked its way along individual timbers, especially those which were "fat" with resin, and that the fourth roof course was still a mass of burning timber. It was then decided that the caisson must be flooded, which was done by pumping in 1,350,000 gallons of water. After flooding the caisson for two and one half days, it was pumped out and the work examined. It required the services of eighteen carpenters, working day and night for two months, to repair the damage caused by that fire.

When the Brooklyn caisson was twenty-five feet below the water level, the boulders encountered became so large that blasting became necessary. But blasting inside of a caisson was hitherto an untried experiment. It was feared that the men would be injured; that their ear-drums would break by a sudden explosion in that confined space under heavy air pressure; that a "blow out" might occur, i. e., that the compressed air might suddenly escape past the edges, and that an inflow of water would then drown the men. At first a pistol was fired, gradually using heavier charges; then a small blast was set off. Encouraged by their freedom from resulting complications, the blasts were gradually increased, until they finally used as heavy blasts as was desired, the men simply stepping into an adjoining chamber to avoid flying fragments; and an increase in the rate of progress was at once apparent, the caisson being lowered from twelve to eighteen inches, rather than only six inches, per week.

The caissons of the bridge across the Firth of Forth, Scotland, are examples of the great development of the caisson idea. The pneumatic caisson of Triger, in 1839, had but one air lock, through which must pass men, excavated material, and constructive material for linings, etc. This plan meant slow and expensive work. The caissons of the Brooklyn bridge were a vast improvement over this plan, both on the score of economy and safety. In the Forth bridge the caissons were made almost wholly of iron, thus avoiding the danger of the fire which so nearly wrecked the caisson of the Brooklyn bridge. The careless or premature opening of the doors of air locks, which once nearly caused a serious accident on the Brooklyn caisson, was rendered impossible by a very elaborate system of interlocking. The efficiency of the apparatus for removing excavated material from the compressed air chamber was also greatly increased. Electric lights were used instead of gas or candles.

"Freezing Process."—This process is mentioned here on account of the analogy of its object to that of pneumatic caissons—sinking a shaft through excessively soft wet soil. The process is very recent, it having been invented by Dr. F. H. Poetsch, of Prussia, in 1883. It has been used only in a very few cases up to the present time, but where it has been used it has accomplished results which were practically unattainable by ordinary methods. A very brief description of one instance of its use will explain the general idea. For many years engineers had been baffled in their attempts to sink a shaft through 107 feet of quicksand at the Centrum mine, near Berlin, Germany. Dr. Poetsch sunk sixteen pipes in a circle around the proposed location of the shaft, and in thirty-three days had succeeded in producing a frozen circular wall six feet thick, within which the excavation was readily made and the shaft suitably lined. The freezing is accomplished by circulating a freezing liquid (chloride of calcium) through the tubes. After the shaft is completed the pipes can be thawed loose from the wall of ice by simply circulating a hot liquid instead of a cold one. The pipes can then be redrawn uninjured, and used over again—a consideration of no small advantage. The process is not cheap. It would seldom, if ever, be used where the more common methods are practicable; but for passing through very soft and wet soils it is frequently the only possible method.

History records the construction of a ship canal across the Suez Isthmus as early as 600 B. C.; that it continued in use for about 1400 years and was then abandoned. It was very small; all traces of it are now utterly lost. The authentic records of it are very meagre, and they serve only to show the great antiquity of the canal idea. The nineteenth-century progress on this line, therefore, consists in the enormously greater magnitude of the works accomplished in the solution of the great subsidiary problems involved, and in the improvement in methods of work which has rendered these great structures possible. The limitations of this article utterly forbid even a brief description of all the great canals which have been constructed during this century, and it must therefore be confined to a few statements regarding the more important and typical constructions. It might be thought that no discussion of nineteenth-century canals would be complete without a mention of the Nicaragua and Panama canal projects. But these stupendous works, which will eclipse anything of the kind which the world has ever seen, are not yet accomplished facts. The twentieth century will be well under way before a trip “around the Horn” will become unnecessary. The successful completion of one of these canals will, very probably, so reduce the demand for the other that its construction will be indefinitely postponed. These canals will not be further considered.

Suez Canal.—This great work permits a reduction of about 3750 miles in the length of a voyage from Western Europe to India. Compared with some of the other great canals of the world, its construction was easy. The total length between termini is about 101 statute miles, of which about nine miles required no excavation; sixteen miles more required only a slight excavation to make the channel of sufficient depth through existing dry depressions, called “lakes;” and the remaining seventy-six miles of excavation were cut chiefly through a soft alluvial soil. At only one point did the excavation reach fifty or sixty feet in depth, and here also was found the only instance of rock excavation. Even this rock (gypsum) was so soft that part of it was excavated by the steam shovels. About 80,000,000 cubic yards of material were removed. If this material had been loaded on to cars carrying twenty-five cubic yards per car, made up into trains of twenty cars per train, and the trains were strung along at the rate of five per mile, it would have required 32,000 miles of such trains to transport the material that was excavated. Work was actually begun in 1800. The Viceroy of Egypt originally agreed to furnish the laborers required, and at one time about 30,000 laborers were thus employed. On a change of administration in Egypt, the new Viceroy refused to furnish the native labor, and it then became necessary to import labor from Europe, and to supplement this insufficient and high-priced supply of labor by very large dredging machines, or steam shovels, of which about sixty were employed. The task of supplying water for the vast army of workmen was an engineering feat of no mean character and cost, as the entire route lies through an arid desert. A system of waterworks, having its source at Cairo, on the Nile, and distributing the water throughout the length of the canal, was therefore constructed. In the latter part of 1869, the waters of the Red and Mediterranean seas were joined, large arid depressions had been transformed into great lakes, and ocean-going vessels were sailing through what had been a desert. The canal is 26 feet deep, 72 feet wide at the bottom, the sides sloping variably, according to the nature of the material, the resulting width at the top varying from 190 to 328 feet. Although not deep enough for the very largest vessels afloat, it will accommodate the great bulk of ocean travel, including war vessels. The total cost of this work, including the breakwaters, lighthouses, etc., at each terminus, was, approximately, £20,000,000, or $100,000,000.

Unlike most canals, the Suez canal has no locks. The original plan of the Panama canal did not include locks, but the revised plan provided for them, in order to save excessive cutting. The Nicaragua canal scheme necessarily includes locks. The water for the Suez canal comes directly from the seas which are connected. A canal with locks necessarily requires an ample water supply from some river or fresh-water lake. If the Suez canal had been constructed at a higher level than the Mediterranean and Red seas, had been supplied with water from the Nile, and had, therefore, been constructed with suitable locks at each end (as was actually recommended by some engineers), the cost of construction, as well as the perpetual expense of maintenance, would have been greatly in excess of its actual cost. And so the fact that it was possible to construct the canal without locks, and without providing for a supply of water, was a great advantage that facilitated the promotion of the enterprise.

Manchester Canal.—This canal, having a total length of only thirty-five and one half miles, has transformed the city of Manchester, England, from an inland city to a seaport. Actual excavation was begun in November, 1887, and just six years afterwards the whole canal was filled with water. It has a depth of 26 feet, and a width at the bottom of from 120 to 170 feet, thus giving a greater capacity than the Suez canal or the proposed Panama canal. Some of the greatest difficulties involved arose from the necessity of providing for the existing canals and railroads with which that busy portion of England is so crowded. Perhaps the most interesting feat of engineering was the drawbridge carrying the Duke of Bridgewater’s canal at Barton. This small canal, having originally a depth of only four and one half feet, here crosses the River Irwell. It was justly considered a great feat of engineering when James Brindley constructed the canal, during the eighteenth century, so that it crossed the river on a viaduct. A waterway crossing a waterway on a viaduct was then a new idea. But this old canal was constructed considerably above the desired level of the Manchester canal, and yet, of course, not so high that a masted ship might pass under it. Therefore a draw became necessary. To add to the complication, the water supply of the small canal being somewhat limited, it was considered very undesirable to lose a troughful of water (roughly, 200,000 gallons) each time the draw was opened. To allow this water to flow into a tank and then pump it back would consume too much time, to say nothing of the expense. Therefore the bridge must swing with the trough full of water. That required gates at each end of the draw, as well as at the ends of the canal on each abutment. These gates were comparatively simple; but the difficult problem was to ensure a water-tight joint between the ends of the draw trough and the corresponding ends of the canal. Temperature changes, as well as many other considerations, would preclude the possibility of making even a fairly tight joint by swinging the draw to a close fit with the abutments. The desired result was accomplished by placing at each end of the draw a very short U-shaped structure, having the same cross section as the cross section of the trough, and having beveled ends fitting corresponding bevels on the ends of the trough. These beveled ends are faced with rubber. To open the draw the gates are closed, the water between the gates at each end (a comparatively small amount) is drained off and wasted, the U-shaped wedges are raised, and the draw is then free to turn. The wedges are operated by hydraulic rams.

Chicago Drainage Canal.—It will probably be a surprise to many people to learn that this “drainage” canal has a greater cross section throughout the “earth-work” sections than any ship canal in existence, and is only exceeded through the rock sections by the Manchester canal. The city of Chicago obtains its water supply from Lake Michigan. The “intake” pipe was at first located comparatively near the shore. As the population of the city grew and the volume of its sewage increased, it was observed that the water supply was becoming contaminated. The Chicago River, into which the sewage was emptied, became so foul that the odor was intolerable. The very evident fact of this odor probably had more to do with the promotion and accomplishment of the means of relief adopted than the far less evident but very dangerous pollution of the water supply. An extension of the intake pipe to a point several miles from shore by means of a tunnel (which was in itself a notable feat of engineering) only deferred the time when the water supply would again be fatally contaminated if the sewage continued to flow into the lake. It was accordingly determined to dispose of the sewage by discharging it into an artificial channel where it might become diluted with water from Lake Michigan, and thence pass from the watershed of the Great Lakes to the watershed of the Mississippi. The level of Lake Michigan is so high that there was no trouble about obtaining the requisite grade, and the divide between the watersheds is so low that the depth of the required cutting at the summit was not forbidding. But why have such a large canal? It was required that the sewage should be diluted, so as not to become offensive to the inhabitants of the region through which the canal must pass. The law under which the work was authorized required that the flow should be 600,000 cubic feet per minute, and that the minimum width at the bottom of the channel must be 160 feet. According to the well-known laws of hydraulics, it was seen that a deep canal would have a greater capacity per unit of excavation than a very wide shallow canal. This is especially true through the sections of deepest cut, since excavation *above* the water line adds nothing whatever to the capacity for flow. The sections adopted called for a depth of water of 22 feet. The side walls in rock are practically vertical, the width of channel being 160 feet at the bottom and 162 feet at the top. In earthwork the cross section is larger than in rock, thus reducing the velocity of flow and danger of scouring the banks. The width of channel at the bottom is 202 feet, the width at the water surface being 290 feet, and the side slopes 2 horizontal to 1 vertical.

A very expensive feature of this great work was the necessity for constructing a diversion channel for the Desplaines River throughout that portion of the river valley occupied by the canal. Lack of space forbids a further discussion of this feature. The canal drains into the Desplaines River at a point where the slope of the river is so great that there will never be danger that a strong west wind or an unusual lowering of the level of Lake Michigan can possibly cause the current to flow eastward.

Work on the canal was commenced only after many years of discussion, planning, legislation, litigation, and bitter opposition by the varied interests which considered themselves more or less injured. But the work was actually commenced in July, 1892. The estimated excavation was approximately 40,000,000 cubic yards—about one half that of the Suez canal; but the length is only 29 miles, compared with 101 miles for the Suez canal. The total cost was estimated at something over $27,000,000. On August 22, 1900, the Congressional River and Harbor Committee approved the work as far as completed.

V. GEODESY.

It may be that many, who have read of the incredulity of all Europe when the voyages of navigators during the fifteenth and sixteenth centuries first demonstrated the sphericity of the earth, will be surprised to learn that this knowledge had been acquired almost two thousand years before, and had since then been *forgotten*. To Eratosthenes, a Grecian, belongs the honor of first making a measurement (about the year 230 B. C.) of the size of the earth, which, while very rude and inaccurate, used the same fundamental principle as is now employed by geodesists. But the appliances of those ancient Grecians and of the Arabians, who later carried on the work, were exceedingly crude. Even during the sixteenth and seventeenth centuries, when the French, English, and Dutch were working very hard on the problem, and were gradually obtaining results which came closer and closer to those now known to be correct, the appliances for measuring angles were so rough and inaccurate that it was only possible to assert that the earth is spherical, with a diameter of about 7900 miles. The seventeenth century was nearly past when Picard first used spider lines to determine the "line of collimation," or the true line of sight, in a telescope. This marked a new era in methods of work, but the eighteenth century was about half gone when it was first authoritatively proven that the earth is not a sphere, but is more truly an “oblate spheroid,”—such a figure as would be obtained by flattening a sphere at the poles. Some idea of the accuracy of the work done, even at this stage, may be obtained by considering that the computed flattening is so slight that if we had a perfect reproduction of the earth, reduced to a diameter of 12 inches, the flattening would be less than 1/25 of an inch—almost imperceptible even to a trained eye. The very highest mountain would be considerably less than 1/100 of an inch in height on such a sphere.

The present marvelous state of the science is due to the great improvements which have been made in the construction and use of angle-measuring instruments and of “base bars;” also to the development of the mathematical theory and processes involved, notably that of the “method of least squares.” As an illustration of the accuracy attainable in the construction of theodolites, the writer recently made an elaborate test of the error of the centering of one of these angle-measuring instruments. Of course no *direct* measurement is possible. The result is based on a long series of observations, which, when combined according to certain mathematical principles, will give the desired result. The error was thus computed to be *forty-two millionths* of an inch. To realize what is meant when an angle is measured with a “probable error” of a few hundredths of a second of arc, it should be remembered that one second of arc on a circle 10 inches in diameter is less than 1/40000 of an inch. The accuracy which has been attained in the measurement of base lines is not easily realized by a layman. An engineer realizes the practical impossibility of measuring a line twice and obtaining *precisely* the same result to the finest unit of measurement. The initiated are therefore able to appreciate the achievement of measuring a base line having a length of over nine miles, with a “probable error” of less than one five-millionth of its length. The words “probable error,” as used above, have a scientifically exact meaning, but they may be taken by the uninitiated as representing a measure of the precision obtained.

At about the close of the last century the great mathematician, Laplace, had declared that the results of the surveys which had then been made were inconsistent with the theory that the form of the earth is exactly that of an oblate spheroid. That form would require that the equator and all parallels of latitude shall be true circles, and that all meridian sections shall be equal ellipses. Laplace showed that the discrepancies between the actual results obtained and the results which the theory would call for are too great to be considered as mere inaccuracies in the work done. With the extension, during this century, of the great geodetic surveys, carried on by the various governments of the world, more and more evidence has developed that the meridian sections of the earth are not equal, which is equivalent to saying that the equator is not a perfect circle. This has led to the next stage, which has been to prove that the form of the earth may be more closely represented by an “ellipsoid” than by a spheroid, that is, that *every* section of the earth is an ellipse. Several calculations have been made to determine the length and location of the principal axes of such a figure. But these calculations are considered unsatisfactory, because evidence has developed that the true form of the earth cannot be represented even by an ellipsoid. This figure is symmetrical above and below the equator. There are reasons for believing that the southern hemisphere of the earth is slightly larger than the northern, and that the form of the earth is more nearly that of an “ovaloid,”—a figure of which the ordinary hen’s egg is an exaggerated example.

All the above forms, the sphere, spheroid, ellipsoid, and ovaloid are geometrical forms which represent with more and more exactness the true form of the earth, but even this increasing exactness will not account for the discrepancies and irregularities which have been found at various places, and which cannot be explained on the ground of inaccurate work. Geodesists have been forced to the conclusion that the true form of the earth is not a regular geometrical form, but is a “geoid,” that is, like the earth and like nothing else, unless we admit the exaggerated comparison that it is “like a potato.” It should be understood that the words “form of the earth” do not refer to the actual surface of mountain, valley, or ocean bottom, but to the actual ocean surface, and to the surface which the free ocean would assume if it could penetrate into the heart of the continents. The astounding accuracy of the work done may be appreciated when we consider that the differences between the “geoid” and the more accurate mathematical forms are distances which should be measured in feet rather than in miles. For many purposes, it is sufficiently exact to consider the earth as a sphere. For some very precise work it is necessary to consider it as a spheroid. The more exact forms have little or no utilitarian value, and the vast amount of work that has been spent on these researches has been due to man’s thirst for knowledge as such,—due to the same enthusiasm which advances the sciences in fields which only broaden man’s knowledge of the world in which we live.

VI. RAILROADS.

The achievements of engineering skill on the line of bridges, canals, tunnels, etc., have been great, but their effect is insignificant compared with the social revolution that was created by the invention and development of railroads. The railroads of this country represent a value of about $12,000,000,000—one sixth of the national wealth. Their pay-rolls include about 850,000 employees—1/28 of the working population. They support, directly or indirectly, about 5,000,000 people. They collect an annual revenue of about $1,200,000,000, which is greater than the value of the combined products of gold, silver, iron, coal, and other minerals, wheat, rye, oats, barley, potatoes, and tobacco, produced by the entire nation. Such a stupendous social institution requires special discussion, and it will be found treated separately under the heading of “Evolution of the Railway.”

VII. TUNNELS.

Tunnels are of exceedingly ancient origin, if by tunnels we include all artificial underground excavations. From prehistoric times natural caves have been used as burial places, and, following this practice, tunnels and artificial rock chambers have been cut out by kings and rulers in Thebes, Nubia, and India during periods so ancient that we call the study of their history archæology. Nor were the ancient tunnels confined to tombs. The Babylonians constructed tunnels through material so soft that a lining of brick masonry had to be used to sustain the work. The Romans constructed a tunnel over three and one half miles long to drain the waters of Lake Fucino. About 30,000 laborers were occupied on this work for eleven years. The nineteenth century can hardly boast of works that represent a greater amount of labor (measured in mere days of work) than some of these ancient monuments of constructive skill, but the masterpieces of this century are works which have been greatly aided and even rendered possible by three modern inventions,—compressed-air drilling machines, modern explosives, and the compressed-air process used in subaqueous work. The advance in methods of tunnel surveying is as great and nearly as important. Progress in excavating tunnels is necessarily slow, because the working face is so small that only a few men can work there at a time, and the rate of advance depends upon them. As an illustration: although the Mont Cenis tunnel belongs to the latter half of this century, the first blast being made in 1857, yet for the first four years hand drilling was employed, when the average progress was about nine inches per day. Then machine drilling with compressed air was adopted, when the rate of advance was multiplied five times. The invention of compressed-air drills simultaneously solved two difficulties: (1) The compressed air furnishes an extremely convenient and safe form of power, which enables holes to be drilled much more rapidly than it is possible to drill them by hand. (2) The compressed air, after doing its work, is exhausted into the tunnel, and thus furnishes a continuous supply of fresh air. The necessity for ventilation has often required the construction and operation of expensive ventilating plants. Add to these improvements the lighting of the tunnel, even during construction, by electric lights which consume no oxygen, and the comparison between ancient and modern methods becomes especially marked. Before the invention of explosives, hard rock was sometimes broken by building wood fires next to the rock, and then, when the rock had become very hot, cooling it suddenly with water. The sudden contraction would split the rock. Ventilation was attempted by waving fans at the tunnel entrances. With torches and fires to consume the precious oxygen, and no effective ventilation, it is a wonder how those earlier tunnels were constructed. The compressed air methods for subaqueous work will be referred to under a special case. The essential principles have already been described under caissons.

Tunnel Surveying.—The tunnel surveying developed during this century is one of the marvels of surveying work. If a tunnel is to be several miles in length, not only is the excavation commenced at each end, but one or more intermediate shafts are frequently sunk to the level of the tunnel, and excavation is extended in each direction from the shafts. It is extremely important that these sections of the tunnel should "meet" exactly. If they should fail to do so by any appreciable amount, the necessary modifications are frequently costly and therefore justify the most elaborate precautions in the surveying work, especially since the surveying costs much less than the consequences of such a blunder. The Hoosac tunnel is over 25,000 feet long. The heading from the east end met the heading from the central shaft at a point 11,274 feet from the east end and 1563 feet from the shaft. The error in alignment was five sixteenths of an inch, that of levels "a few hundredths," error of distance "trifling." The corrected alignment was then carried on toward the heading from the west end, which it met at a point 10,138 feet (nearly two miles) from the west end and 2056 feet from the shaft. Here the error of alignment was 9/16 of an inch and that of levels about 1-5/8 inches. The surveying work of the spiral tunnels on the St. Gothard Railway (to be described later) is another example of marvelously accurate work under peculiarly unfavorable circumstances.

St. Gothard Tunnel.—To appreciate the magnitude of the problem involved, of which this great tunnel is the crowning feature, some idea should be obtained of the Alpine topography lying between Silenen, in Switzerland, and Bodio, in Italy, less than forty miles apart. The idea of connecting Switzerland and Italy by a railroad passing over or through the Alps, by utilizing the St. Gothard Pass as far as possible, dates back to 1850, or even earlier. An enterprise of such magnitude could be consummated only after years of discussion, planning, surveying, negotiations, and even international agreements. In 1871 a treaty was finally ratified between Germany, Italy, and Switzerland, by which the construction and financiering was duly authorized. On August 7, 1872, the contract for the construction was signed, with a proviso that the work must be completed within eight years. On April 30, 1880, the advance headings met, and soon thereafter the mails were regularly carried through, although the tunnel was not actually completed in the specified time.

The route adopted was bold enough to stagger the financier, if not the engineer. Starting from Silenen, Switzerland, it required a climb of nearly 2000 feet to reach Göschenen, the adopted northern portal of the tunnel. This would require an *average* grade of 200 feet per mile in the ten miles of distance, or an actual grade of 370 feet per mile in the upper part of the line, if the river valley were followed. The line was therefore "developed," that is, the distance was purposely increased by adopting an indirect line, in order that the grade might be less. It was found possible to run the line from Silenen to Pfaffensprung, a distance of about six miles, on the comparatively low grade of 137 feet per mile. At this point the line suddenly plunges into the mountain, and curves around in a circle, which is, roughly, 2000 feet in diameter, while it continues an upward grade of 121½ feet per mile. After traversing 4845 feet of such tunnel, the line again emerges into the open air, having turned nearly three fourths of a circle in the solid rock. About 2000 feet farther on the line actually crosses itself, the upper line there being 167½ feet higher than the lower line, which is at that point within the tunnel. By this device, which is called a spiral, the line is run at a practicable grade, and an elevation of 167½ feet is surmounted by introducing 6986 feet of "development." Near the entrance of the Leggistein tunnel, the line is less than 500 feet away (horizontally) from a lower part of the line, which is about 350 feet lower in elevation. Space forbids a further description of this climb of 2000 feet to Göschenen, where the line plunges into the bowels of the earth, and does not again emerge until it has traversed *nine and one quarter miles*, and has reached the southern slope of the Alps. Even here the portal is 3755 feet above sea level, and the valley down to Bodio is steeper in places than the valley of the Reuss. Four spirals are used in descending about 2650 feet in an air line distance of less than 19 miles. In one place even the upper line, where it crosses the lower line, is in solid rock. Imagine standing in the gloom of a tunnel and considering that vertically beneath your feet—more than 100 feet further down in the bowels of the earth—there is another tunnel belonging to the same line of road. The great majority of tunnels are straight. A few have curves at one or both ends, but nowhere else in the world can be found such examples of spiral tunnels carved out of the living rock.

St. Clair Tunnel.—A glance at a map of lower Canada and Michigan will show that all the rail traffic of lower Canada, and even that from Montreal and Quebec, that passes as far west as Chicago, must either cross the Detroit River at Detroit or the St. Clair River, at or near Port Huron. Plans for bridging the river have been frequently made, but the Canadian government has steadily refused permission. The traffic along the river in 1896 amounted to over 35,000,000 tons, or more than was shipped at the ports of either New York, London, or Liverpool, and greatly in excess of that which passed through the Suez canal. Such traffic must not be impeded even by a drawbridge; and therefore a tunnel was the only alternative. The problem was in many respects unique. Borings showed that the tunnel must pass through clay and occasional pockets of quicksand, and therefore it would be necessary to employ a pneumatic method. Brunel had used a "shield" on the Thames tunnel half a century before; but all of the earlier tunnels constructed by this method were much smaller, and the difficulty and danger increase very rapidly as the size increases.

In 1886 the "St. Clair Tunnel Company," virtually a creature of the Grand Trunk Railway Company, was organized, and in 1888 work was begun. After a false start, made by sinking shafts which were afterwards abandoned, open cuttings were commenced at each end, which were extended to points 6000 feet apart, between which the tunnel was excavated and lined. The circular lining, having an outside diameter of 21 feet, is of cast iron, made in segments which are bolted together, having strips of wood three sixteenths of an inch thick placed in the joints. Liquid asphalt was freely used as a preservative and to make tight joints. The tunnel was excavated for nearly 2000 feet on each side as an ordinary open tunnel until the excavation was actually under the river; then a diaphragm with air locks was built on each side, and that part of the tunnel lying under the river—2290 feet in length—was constructed under air pressure. Several curious facts were developed during the construction. The material excavated outside of the shields was thrown inside, loaded on to cars, and hauled by mules to the diaphragm. It was found that horses could not work in compressed air. Mules could do so, but even they were sometimes affected by "the bends," a disease akin to paralysis, which frequently occurred among the men. The shields were forced forward by twenty-four hydraulic rams, each having a capacity of 125 tons, or 3000 tons for each shield. Usually a force of 1200 to 1500 tons was sufficient. Much gas was encountered, which, on account of its explosiveness, prevented the employment of blasting to break up the boulders which were frequently found. The advantages of electric lighting in compressed air work were exemplified in this tunnel. In August, 1890, about one year after the shields were placed on each side of the river, they met near the centre. The progress of each shield averaged nearly ten feet per day. Considering the frequency with which the cost of great engineering work exceeds the original estimate, it is remarkable to note that in this case the actual cost ($2,700,000) was less than the original estimate, which was about $3,000,000.

The Century’s Progress In The Animal World

By D. E. SALMON, M.D.,
Chief of Bureau of Animal Industry, U. S. Agricultural Department.

I. OF ANIMAL DISEASES.

The wars of Napoleon, which in the early years of the nineteenth century so seriously affected the governments and institutions of Europe, had an equally marked influence upon the development of the animal industry in the countries that were brought within the sphere of the military operations. This chapter of the history of that period appears to have been neglected by writers who have industriously delved into details of subjects of far less interest and importance. Enough has been chronicled by various historians, however, to show that in many cases those engaged in successful operations for improving the breeds of domesticated animals were forced to abandon the work to which they had devoted their lives, and for which long study and experience had specially fitted them, and to become units in the vast armies which were organized only to melt away in the bloody and disastrous campaigns of that epoch. But it was not the men alone that were taken. The best horses were seized for the use of the officers and the cavalry, for the artillery and the transportation trains. The sheep and swine were slaughtered for the subsistence of the armies, and the cattle were driven off for the same purpose. Neither the choicest flocks and herds nor the most magnificent individuals produced by the breeder’s art escaped. The fruits of many years of patient effort in selection and in guiding the forces of heredity were blotted out; the animals left were few and inferior. To crown all these disasters, the most deadly forms of contagion were gathered from their hiding places with the animals that were seized, the plagues which these caused were propagated among the vast aggregation of beasts that were required for the service of the armies, and, finally, they were disseminated throughout all sections to which these armies penetrated.

The agriculturists of Great Britain, thanks to the isolation due to the considerable expanse of water which separates their territory from the mainland, escaped not only the invasions of armed and destructive hosts, but also the pestilences which accompanied them. While, therefore, the farmers of the continent were struggling to save a few of their remaining animals from the ravages of glanders, rinderpest, foot-and-mouth disease, pleuro-pneumonia, and other plagues, those of the British Isles were perfecting the work of their ancestors without molestation. These circumstances, lost sight of by many, explain to a certain extent the apparently marvelous success of the British husbandmen in developing so many breeds of horses, cattle, sheep, and swine to the wonderful perfection which we see at the end of the nineteenth century. The favorable climate, together with the abundant and nutritious herbage, have undoubtedly been factors in the production of the British breeds, but the power and opportunity to select the best animals and retain these for breeding purposes must also have had great influence.

The effect of contagious diseases in retarding the development of animal life may be appreciated from the estimate, carefully made, that in the closing years of the eighteenth century the cattle plague (rinderpest) alone destroyed in Europe two hundred million head of cattle, valued at seven billions of dollars. During the first half of the nineteenth century, cattle plague, pleuro-pneumonia, and foot-and-mouth disease were particularly disastrous to the animal industry of the Continent of Europe, and unquestionably, also, throughout Asia, which appears to have been the original habitat of these plagues. During the last third of this century the development of veterinary science, together with the enactment of sanitary legislation and the enforcement of intelligent measures of repression, have practically eradicated the cattle plague from the countries of Europe, and we have only to note, as important, its invasion of Great Britain in 1865, which led to the adoption of the present most excellent sanitary organization, and the extensive outbreak on the continent following the Franco-Prussian war. During the last six years this plague has swept over large sections of the African continent, destroying nearly every bovine animal in the regions first invaded, and had it not been for the fortunate and timely discovery of a successful method of preventive inoculation, the cattle industry would have been absolutely annihilated.

Pleuro-pneumonia, almost equally destructive with cattle plague and much more persistent, was widely disseminated over the continent of Europe during the seventeenth century, and reached England about 1840. Many years were lost in futile contentions over the subject of contagion, and it was not until the last twenty years that vigorous measures for its extermination were enforced. In the meantime the contagion had been carried to Australia and South Africa, where it has since remained domiciled, a constant source of loss to the cattle growers. The losses from this disease in Europe are now comparatively unimportant, but in the countries of Asia and Africa, and in Australia, it is still a great incubus. Foot-and-mouth disease, less fatal in its effects than the other maladies mentioned, appears to be more difficult to control, and, in the closing years of the century, we find it prevailing extensively over the principal countries of Continental Europe.

The diseases which have most seriously affected the development of other species of animals are the glanders of horses, the variola of sheep (sheep-pox), and the three diseases of swine known in Europe as erysipelas, swine pest, and swine plague. These have been extremely prevalent and fatal in many parts of Europe. Glanders, swine pest, and swine plague have been brought to the American continent, and have been even more destructive here than in their ancient habitat.

The diseases which at present are regarded as most serious attracted but little attention at the beginning of the century, or were unknown. Tuberculosis has now become the great scourge of dairy cows and other highly bred cattle, ruining many of the best herds and threatening the health of the consumers of milk, if not also of beef. Texas fever, a disease of cattle first studied in the United States, but now known to be widely disseminated over the South American, African, and Australian continents, has during late years retarded operations for improving and increasing the stock of cattle, and has seriously restricted the marketing of animals from the infected districts.

This brief summary relative to contagious diseases and their effects is all the attention that can be given in this article to conditions which through all historic times have been important, and, in many cases, have been supreme in their influence upon the tendencies and development of the animal population. As the twentieth century approaches, however, the influence of the animal plagues is on the wane, and with a few more years of active scientific investigations they will all be so thoroughly controlled that the disastrous visitations of the past can never be repeated, and they will not even be a hindrance or menace to the stock grower.

II. INCREASE IN NUMBERS.

As might be expected, there has been an increase in the numbers of the domesticated animals held in the various countries of the world, but this increase has been far from uniform, and cannot be measured either by the growth of the population or the degree of prosperity.

Evidently the density of population, the development of manufactures, and the fertility of the soil have had much influence.

In the United Kingdom there were 1,500,000 horses in 1800, and but 2,000,000 in 1898. During this time the cattle had increased from 5,000,000 to 11,000,000; the sheep from 25,000,000 to 31,000,000; and the swine from 3,000,000 to 3,700,000. Thus, while the cattle doubled in numbers during the century, the horses increased but one third, the sheep one fourth, and the swine one fourth. As in the same period the population of the country was augmented from 16,200,000 to 40,000,000, or two and one half times, it is not difficult to see why England has become the world's greatest market for animals and animal products.

It is important to note the increase in animals in a few of the principal countries of Europe. In France there were 1,800,000 horses at the beginning of the century, and there were 3,418,000 in 1896. The cattle increased from 6,000,000 to 13,334,000; the swine from 4,500,000 to 6,400,000; the goats from 800,000 to 1,500,000; while the sheep decreased from 30,000,000 to 21,200,000. That is, in round numbers, the horses, cattle, and goats doubled, the swine increased nearly 50 per cent, but the sheep were diminished one fourth. The population advanced from 27,350,000 to 38,500,000, or about 40 per cent.

In Germany, from 1828 to 1892, the horses increased from 2,500,000 to 3,836,000; the cattle from 9,770,000 to 17,500,000; the goats from 700,000 to 3,000,000; the swine from 4,500,000 to 12,174,000; and the sheep decreased from 17,300,000 to 13,600,000. The population increased during the same time from 29,700,000 to 49,500,000.

In European Russia, from 1828 to 1888, the horses were increased from 12,000,000 to 20,000,000; the cattle from 19,000,000 to 23,840,000; the sheep from 36,000,000 to 47,500,000; while the swine decreased from 15,800,000 to 9,200,000. The population during this period increased from 45,000,000 to 90,000,000.

These are the countries in which there is most interest on account of their influence upon the markets of the world. In regard to Europe as a whole, owing to the lack of statistics, we can only estimate approximately as to the condition at the beginning of the century. From such data as are available it appears that there were about 20,600,000 horses, 61,800,000 cattle, 157,500,000 sheep, and 36,600,000 swine. The population of Europe at that time is placed at 175,000,000. In the year 1900 there will be in Europe not far from 44,250,000 horses, 108,000,000 cattle, 180,575,000 sheep, and 56,800,000 swine. The population will reach about 380,000,000.

From these figures it would appear that, taking all of Europe, the human population has increased more rapidly than have any of these species of domesticated animals. In other words, the population is 2.17 times what it was at the beginning of the century, while there are but 2.14 times as many horses, 1.75 times as many cattle, 1.55 times as many swine, and 1.14 times as many sheep.

This growing deficiency in the stock of animals, coupled with an increasing consumption of meat per capita, has led to the importation of great numbers of animals and large quantities of meats and other animal products. The resulting trade has stimulated the production of animals in other parts of the world, particularly in the United States of America, Australia, and Argentina, in all of which there has been a marvelous development.

There are no reliable statistics as to the number of animals in the United States at the beginning of the century. Some have estimated that there were only 300,000 horses, 600,000 cattle, and 600,000 sheep; but the writer is of the opinion that there were from 500,000 to 1,000,000 horses, at least 3,000,000 head of cattle, and from 2,000,000 to 3,000,000 sheep. In 1840, with a population of 17,063,000, there were 4,300,000 horses, 14,900,000 cattle, 19,300,000 sheep, and 26,300,000 swine; while in 1899 the number is placed at 15,800,000 horses and mules, 44,000,000 cattle, 39,000,000 sheep, and 38,600,000 swine.

In 1888 the horses of Canada numbered 1,100,000, the cattle 3,790,000, the sheep 2,600,000, and the swine 1,205,000. In the same year Mexico was credited with 2,000,000 horses, 3,000,000 cattle, 2,000,000 sheep, and 5,000,000 goats. Taking the whole of North America, and making allowances for the increase since 1888 in Canada and Mexico, it may be fairly assumed that at the close of the century there will be about 19,000,000 horses and mules, 55,000,000 cattle, 50,000,000 sheep, and 40,000,000 swine.

In South America, Argentina far outstrips all other countries in animal production. The horses, which in 1864 numbered 3,875,000, had increased by 1895 to 4,447,000; the cattle increased in the same period from 10,215,000 to 21,702,000; the sheep, from 23,110,000 to 74,380,000. The population in 1895 was only 3,964,000. In Uruguay there were, in 1895, 402,348 horses, 5,248,000 cattle, and 14,333,000 sheep. In Paraguay there were, in 1896, 246,000 horses and 2,100,000 cattle. The last returns from Chili (1882?) give 450,000 horses, 1,530,000 cattle, and 2,500,000 sheep. As to the condition in Brazil, we have no reliable statistics.

The animal industries of Australasia have shown the most wonderful development during the century. In 1800, there were but 200 horses, 1040 cattle, and 6100 sheep. In 1810, there were 1130 horses, 12,440 cattle, 25,900 sheep, and 9540 swine. In 1896, there were 1,923,554 horses, 12,701,600 cattle, 110,524,000 sheep, and 1,000,000 swine.

In Asia there are large numbers of animals, but it is impossible to give statistics, except for British India, where, in 1895, there were 1,152,000 horses, 49,000,000 cattle, and 17,200,000 sheep.

Mr. Simonds endeavored to ascertain the number of each class of live stock in the world in 1890, and his conclusions may be accepted as approximately correct. He placed the total number of horses in all countries at 63,469,000, the asses and mules at 10,318,000, the cattle at 309,807,000, the sheep at 588,935,000, the swine at 102,526,000, and the goats at 59,971,000.

III. IMPROVEMENT OF BREEDS OF ANIMALS.

The increased number of animals now held in various parts of the world does not give an adequate idea of the enlarged production of animal food products, as compared with one hundred years ago. During the last century there has been constant improvement in the various breeds of animals, with a view to perfect their form and shorten the time required for their growth. The breeder has learned how to stimulate development, and has fixed the quality of early maturity, through hereditary influence, until it is now transmitted with the same regularity as are other characteristics.

Cattle are no longer fed until they are three or four years old before being sent to the butcher, and it has been found that they can be made to yield an equal quantity of beef of better quality at eighteen months to two years. It is the flesh of such young animals which has been much discussed under the title of “baby beef.” Not only is this beef commended on account of its tenderness, its high nutritive value, and the more even distribution of fat through the muscular tissue, but because this shortening of the feeding period enables the farmer to produce a greatly increased quantity of human food from the same number of acres. That is, by reducing the age at which bullocks are marketed from three and one half years, as was formerly the rule, to twenty months, it is possible for the same farm to produce one third more animals in a given series of years.

It may be admitted that not all of the stock of beef-producing animals, nor even the greater part of it, has acquired this extreme degree of early maturity, but most of it has developed somewhat in this direction. The large-boned, gaunt, and long-horned cattle of Texas have nearly disappeared, and even in Mexico they are being rapidly replaced by others of better quality. The most important fact is that breeds exist which can be depended upon for the speedy transformation of the entire stock of cattle when the necessity arises.

A similar hastening of maturing has been accomplished with the mutton breeds of sheep, with numerous varieties of swine, and to a considerable extent with poultry.

The development of the dairy breeds of cattle has also been remarkable. It can be best appreciated by contrasting the half wild cows of our Western plains, which yield but two or three quarts of milk a day at their best, and none for half of the year, with the highly specialized types which produce twenty to thirty quarts daily when in full flow, and with which the milk secretion continues from year to year without interruption.

The yield of butter has been increased equally with that of milk, and among the dairy breeds there are some which are specially valued because of their aptitude for butter production. While the unimproved cow yields but one fourth to one half pound of butter a day, good specimens of the best breeds produce from one and one half to three pounds, and in numerous instances still greater quantities.

In the production of wool there has also been a wonderful advance. The fibre has been increased in length, the fleece has been distributed more uniformly over the surface of the body, and the quality of the fibre has been modified to conform to the requirements for manufacturing the infinite varieties of fabrics demanded by modern civilization. The fleece of to-day is probably three times as heavy as that of a century ago.

The improvement in the Merino type has been truly wonderful. Not only have the beautiful long and silky wools of the Rambouillet and Saxony breeds been developed by persistent selection, but the body of the Merino, formerly small and almost useless for its flesh, has been brought to a standard closely approaching that of the best mutton breeds.

It is unfortunate that the changes of fashion have, during the latter part of the century, made the production of the extra fine wools less profitable than the coarse varieties, and that, as a consequence, many flocks which had been bred to the very highest degree of perfection in this direction have gone to the shambles, and their peculiar points of excellence have been lost.

With poultry, a vast number of varieties and strains have been developed, among which the most fastidious taste may readily find its ideal. Some of these have been perfected from the standpoint of utility, while with others the guiding principle has been purely æsthetic. Thus there are breeds which are characterized by their size, rapid growth, and excellence of flesh; others which have been developed simply as egg-producing machines and which have even lost the maternal instinct for incubation; and still others in which the beauty, the complication, and the perfection of the feathering constitute the principal claims to attention.

The standard weights of the heavy varieties, such as Brahmas and Cochins, is now 11 lbs. to 12 lbs. for cocks, and 8½ lbs. to 9½ lbs. for hens. In the United States, there has been developed a distinct American class of medium weight fowls, of which the Plymouth Rocks and Wyandottes are the most popular varieties. The cocks of these varieties weigh from 8½ lbs. to 9½ lbs., and the hens 6½ lbs. to 7½ lbs. They are valued both for their flesh and for egg production. The rapid multiplication of varieties by modern breeders is illustrated by the Wyandottes, which came into existence during the last third of the century, and of which there are now five distinct varieties: the Silver, Golden, White, Buff, and Black.

The breeder's art has been most successfully brought to bear in stimulating the function of egg production. Not many years ago, an average yield of 125 to 150 eggs annually from the hens of even a small flock was considered all that it was possible to obtain, but at present there are varieties which may be relied upon to produce more than 200 eggs annually. In some instances, it is alleged that an average of nearly 300 eggs a year has been reached in small flocks which have been given special care.

It should not be forgotten that there has also been great improvement in the various breeds of horses. The heavy draught horses have been bred into a more compact form, with better legs and feet and less sluggish disposition. The most noticeable advance has, however, been in the lighter grades of horses, and this has largely been accomplished by infusing the blood of the English thoroughbred. The French, by systematically breeding the heavy mares of the country to thoroughbred stallions with careful selection of the offspring, produced an extremely valuable breed of carriage-horses, known there as the *demi-sang*, and which have been imported into the United States as French coach-horses. These animals, beautiful in form and action, have been brought to a high degree of perfection, and the breed is so well established that its good qualities are reliably transmitted from generation to generation.

There are also German coach-horses and similar breeds in several other countries, which have been established by following the same general plan as that adopted by the French. These breeds are peculiarly the product of the nineteenth century, and are in their most valuable condition as the century closes.

The American trotting horse has without doubt been one of the most remarkable triumphs of the breeder's art which the century has seen. Originating in considerable obscurity, but undoubtedly owing much of its excellence to the thoroughbred, the trotter was born with the century, and has continually increased its speed until the very end. It now gives promise of continuing its evolution through at least a considerable part of the twentieth century. In the decade from 1800 to 1810, the best recorded speed at this gait was 2:59; from 1810 to 1820, the time was lowered to 2:48½; from 1830 to 1840, it reached 2:31½; from 1840 to 1850, the limit was 2:28; from 1850 to 1860, 2:19¼; from 1860 to 1870, 2:17¼; from 1870 to 1880, 2:12¾; from 1880 to 1890, 2:08¾; and from 1890 to 1898, 2:03¾.

This extraordinary and constantly progressing increase in speed during the century has excited the interest and admiration of the world. It is, however, quite generally admitted that too much attention has been given to speed and not enough to disposition, size, conformation, and soundness, to bring the animals to their highest value for other than racing purposes.

Owing to the relatively small extent of agricultural territory and the great development of manufactures, Great Britain has become the best market in the world for animals and animal products. The purchases of cattle, sheep, beef, and mutton have been particularly large. Considering, first, the importations of cattle, it is found that during the five years from 1861 to 1865 inclusive, the average number was 174,177; from 1866 to 1870, the average was 194,947; from 1871 to 1875, 215,990; from 1876 to 1880, 272,745; from 1881 to 1885, 387,282; from 1886 to 1890, 438,098; from 1891 to 1895, 448,139; and for the two years 1896 and 1897, 590,437.

This unparalleled growth in the consumption of foreign cattle has had a marked influence in encouraging the development of the cattle industry of some other parts of the world, particularly in the United States, Canada, and Argentina. The export trade of the United States has developed even more rapidly than the import trade of Great Britain. In 1871 this traffic was in its infancy, and but 20,530 head of cattle were exported, valued at $400,000. By 1879 the number had increased to 136,720, valued at $8,300,000. Then came the British restrictions prohibiting American cattle from leaving the docks where landed, and requiring their slaughter on these docks within ten days from their arrival. These regulations were a rude shock to the American cattle grower, and led to measures here for the control and eradication of the cattle diseases which were cited by the English authorities as the cause of their unfavorable action.

Although the pleuro-pneumonia, about which most apprehension was expressed, has long since been extirpated, and an elaborate inspection service has been organized to prevent any affected animals from leaving our shores, the restrictions have been continued. Fortunately, the trade was only temporarily embarrassed, and has continued its growth notwithstanding this obstruction. In 1889 these exports first exceeded 200,000, and the following year reached 394,836. Since that time the number has fluctuated between 287,000 and 392,000, until 1898, when it reached the enormous aggregate of 439,255, valued at $37,800,000. Not quite all of these cattle have gone to Great Britain, but that has been the destination of by far the greater part.

The exports of sheep have varied widely, according to the fluctuations of the markets at home and abroad. From 1870 to 1873 the number varied from 39,000 to 66,000; from 1874 to 1889, it varied from 110,000 to 337,000. In 1890 the exports were but 67,500; in 1891, 60,900; in 1892, 46,900; and in 1893, 37,200. Beginning with 1894, the exports of sheep again increased, reaching in that year 132,000; in 1895 they were 405,000; and in 1896, 491,000. In 1897 there was a decrease to 244,000, and in 1898 a further decrease to 200,000, valued at $1,213,000.

The export trade in horses and mules was inconsiderable, varying from 2000 to 8000 a year until 1895, when 14,000 horses and 4800 mules were shipped to foreign ports. This trade increased in 1896 to 25,126 horses and 6534 mules, together valued at about $4,000,000. In 1897 a further increase was made to 39,532 horses and 7753 mules, the value being $5,400,000. And, finally, in 1898 there were exported the largest number ever sent from this country, amounting to 51,150 horses and 6996 mules, valued at $6,691,000.

Swine are not exported in very large numbers, as they do not stand shipping well. The largest number sent abroad was 158,581, in 1874, the value of which was $1,625,837. In 1897 and 1898 there were only 16,800 exported each year. Very few of these cross the ocean.

This resumé of the development of the international traffic in live animals and the status of the animal industry would not be complete without some reference to the markets for animal products. The quantity of foreign meat consumed in Great Britain is most remarkable. The imports of fresh beef, which from 1861 to 1865 averaged but 15,772 cwts., had increased in the years 1891 to 1895 to an average of 2,020,668 cwts., and in 1897 exceeded 3,000,000 cwts. The proportion of this supplied by the United States is indicated by the returns for 1896, giving a total of 2,659,700 cwts. of imported beef, of which this country furnished 2,074,644 cwts.

Great Britain also imported 3,193,276 cwts. of fresh mutton in 1897, more than nine tenths of it being frozen carcasses from Argentina and Australasia. Of fresh and salted pork, the United States supplied 4,183,800 cwts. out of a total of 6,563,688 cwts. The principal other animal products imported by that country are, 1,750,000 cwts. of lard, 276,458 cwts. of rabbits, and 1,683,810,000 eggs.

The continent of Europe consumes considerable quantities of lard and salted pork, which are largely furnished by the United States, notwithstanding the unfavorable attitude of the governments towards such traffic and the existence of many annoying and injurious regulations. Fresh meats from America have been practically excluded.

The British markets for dairy products and wool have also had considerable influence upon the prosperity of the animal industries in various parts of the world. The rapidly increasing demand for dairy products is worthy of attention. In 1877 there were imported into the United Kingdom 1,637,403 cwts. of butter and margarine. In 1897 the imports had been raised to 3,217,801 cwts. of butter and 936,543 cwts. of margarine, or a total of 4,154,344 cwts., being two and one half times the quantity imported in 1877.

The quantity of cheese imported in 1877 was 1,653,920 cwts., and had increased to 2,603,608 cwts. in 1897.

The country supplying the largest quantity of butter in 1896 was Denmark, with France second, Sweden third, Holland fourth, and Australasia fifth. Nearly all of the margarine came from Holland. The largest quantity of cheese came from Canada, the United States being second, with less than half the quantity furnished by her neighbor to the north, and Holland third.

The quantity of wool imported by the United Kingdom, France, Germany, Austria, Belgium, United States, and other consuming countries, increased from 200,000 tons, in the decade 1821–1830, to 3,300,000 tons in 1871–1880. This wool came principally from Australia, River Plate, South Africa, Russia, and Spain.

The excess of imports of wool into the United Kingdom over the exports were, in 1892, 312,217,111 lbs., and in 1896, 383,845,450 lbs. Of the total quantity imported by the United Kingdom in 1896, the United States supplied but 4,500,000 lbs., while Australasia furnished 477,600,000 lbs.; Cape of Good Hope, 70,000,000 lbs.; British East Indies, 43,000,000 lbs.; Natal, 21,000,000 lbs.; France, 20,000,000 lbs.; Turkey, 16,500,000 lbs.; and Belgium, 11,400,000 lbs.

The tendency of the last decade of the nineteenth century has been to displace horses and adopt mechanical motors. The great increase of steam railroads, cable cars, electric cars, bicycles, and automobile vehicles has so reduced the demand for these animals that their value has decreased over fifty per cent. While there is still a good market for horses suitable for carriage use, for drays, for army service, and for agricultural purposes, buyers are becoming more critical and the future is uncertain. As it is five or six years after a breeding establishment is started before any of the horses produced can be placed upon the market, the effect of this uncertainty is to discourage would-be horse breeders and influence them toward other enterprises.

The end of the century also finds the sheep industry in a depressed condition on account of over-production. The vast quantities of wool grown in Australasia and South Africa have clogged the markets to such an extent that Australian wool in the London market has dropped from 15d. per pound in 1877 to 8¼d. in 1897, and South African wool from 15¾d. to 7½d. during the same period. Other wools have fallen in about the same proportion. Although sheep are raised for the production of mutton as well as wool, and the tendency in the United States has been towards the breeding of mutton sheep, the value of these animals has been reduced about one half.

There have been periods of depression with the cattle and swine industries, but prices have been well sustained. The European markets are yearly requiring larger supplies, and the stock of beef-producing cattle in the United States, in proportion to the population, is rapidly diminishing. The decreased number is in a slight degree counterbalanced by earlier maturity; but when due allowance is made for this, it is plain that the United States has not the surplus of beef which it boasted a few years ago. At the same time, our meat trade in the markets of the world is threatened with more serious competition from South America, Australasia, and even Russia.

The century closes in a period of wonderful achievements in the extension of transportation facilities and in the education of the masses in all parts of the world. The producer in South America, Africa, and Australasia keeps abreast with the most enlightened stock-growers of Europe and America in his knowledge of the best breeds, the most economical methods of feeding, and the most desirable handling of his products. There is no animal product so perishable but that it can now be sent from the antipodes to London in good condition. All of this has brought surprising changes in the traffic between different countries and in the modification of industries to meet new conditions. The producers of the most distant parts of the world are aggressively entering our nearest markets. Competition is becoming more intense, and commercial rivalry is assuming more the appearance of warfare than heretofore. The nations of the world are actively engaged in assisting their people in this struggle. They diffuse information as to the best and most economical methods of production, they seek out new markets, they subsidize transportation lines, they assist in the introduction of new kinds of goods, they sustain their subjects in the most aggressive practices, they exclude the products of competing countries by tariffs and hostile sentiment, by discriminations, by unpacking, delaying, or damaging goods, under the pretext of inspection, and by burdensome charges and regulations. Some countries have gone so far as to absolutely prohibit competing products for comprehensive but indefinite sanitary reasons.

The outcome of this commercial warfare cannot be foreseen. The struggle has been, and is, fiercest over the international traffic in animals and animal products. The greatest forces of the world are to-day contending as to what the future shall be. The United States has only recently begun to realize that it also must take part in this commercial struggle, if it would retain markets for its products and secure prosperity for its people. Its trade has been unjustly prohibited and discriminated against, its merchants have been unfairly treated and insulted, and its protests have been treated with ill-disguised contempt. Notwithstanding all these efforts at repression, American trade has gone on increasing at an amazing rate, the forbearance of the government having been far overbalanced by the energy of the people. Having grown to be one of the greatest powers of the world, with magnificent resources yet undeveloped, the United States will no doubt maintain its position and continue to supply the markets of the world with the best animals, the best meats, and probably with the best dairy products.

Leading Wars Of The Century

By MAJOR GENERAL JOSEPH WHEELER, U. S. ARMY.

I. WARS OF THE UNITED STATES.

The progress of the nineteenth century, in everything that pertains to civilization, arts, and sciences, has been greater than the total progress in any decade of centuries in the history of the world, and this is equally true in regard to the art and science of WAR; for the expenditure of blood and treasure in the prosecution of the wars and the fighting of the battles of this century far exceeds that of any other like period.

The first year of the nineteenth century dawned upon the United States at peace with the world. In September, 1800, Napoleon, finding that he could not coerce the young nation into "an entangling alliance," and fearing lest the United States should join England in opposing him, found it his best policy to conclude a peace. The brilliant achievements of the newly organized navy, under Commodore Truxton, not only illuminated these early pages of our history, but established a prestige never yet forfeited; for the history of this branch of our service is unparalleled from the first effort, during the Revolution, of Esek Hopkins, to that of George Dewey at Manila, and Sampson and Schley at Santiago.

War with Barbary States.—In 1803 the United States determined to end the piracy of the Barbary States, and an expedition under Commodore Preble was sent to the Mediterranean. The Philadelphia, while pursuing a pirate, was grounded off the coast of Tripoli, and captured by the Tripolitans, who made slaves of the crew and prisoners of the officers. In February, 1804, Captain Decatur, with seventy-six men from his ship, the Intrepid, boarded the Philadelphia, killed or drove off the Moors, fired the vessel, and returned without the loss of a man, although fiercely attacked by the shore batteries. In July, Commodore Preble, with his squadron, laid siege to Tripoli, but his bombardment was ineffective. General Eaton, consul to Tunis, induced Hamet, the brother of Yusef, who had usurped the sovereignty of Tripoli, to furnish him a troop of Arab cavalry and a company of Greeks. With these, and a band of Tripolitan rebels and a force of American sailors, he crossed the Barcan Desert, stormed and captured Derne, an eastern seaport of Yusef. The latter was glad to make peace, and a treaty was signed June 4, 1805.

Indian Wars.—From 1809 to 1811 fighting with the Indians in the South and Northwest was constant. General Harrison and the celebrated Indian chief Tecumseh were the principal actors.

War of 1812.—The contest between England and France for the dominion of the seas was the cause of the war of 1812. England declared the German and French coast to be in a state of blockade. Napoleon, in 1806, made the same declaration regarding British ports. In 1807, England prohibited trade with the coast of France. American commerce was injured and almost destroyed by the combined action of the two powers. Four years were consumed in negotiations, with constant aggressions on the part of England, and on June 19, 1812, Congress declared war. The great error of the campaign was the attempted invasion of Canada. Had the war been made entirely upon the seas, an early peace might have ensued.

The war began on the Lakes, and, repulsed in the effort to make a stand on the Canada shore, and falling back, Hull surrendered Detroit, August 5. Again, at Queenstown, October 13, the

Americans were defeated with the loss of a thousand men. Altogether the first year of the war was a disastrous one on land.

At sea, the navy, consisting of not more than a half-dozen frigates, with its magnificently disciplined officers, had been eminently successful. On August 13, the Essex, Captain Porter, captured the British sloop Alert; on August 19, Captain Hull, commanding the Constitution, destroyed the Guerriere off the Gulf of St. Lawrence; October 18, the Wasp, Captain Jones, captured the Frolic, but later in the day both the Frolic and the Wasp fell into the hands of the British ship Poictiers. October 25, Captain Decatur, with the frigate United States, captured the Macedonian off the Azores; on December 29, after a desperate fight in the South Atlantic, Captain Bainbridge, commanding the Constitution, defeated the British ship Java.

The campaign of 1813 opened on the Canadian frontier with the several divisions in command of Generals Harrison, Dearborn, and Hampton. On June 8, General Winchester, with eight hundred Kentuckians, drove the British and Indians, under Proctor, from Frenchtown, on the River Raisin, but returning with a force of fifteen hundred, they obliged Winchester to surrender, which he only consented to do under Proctor's promise to protect the Americans from the Indians; which promise Proctor treacherously disregarded, and marched away, leaving the sick and wounded Kentuckians to be massacred. Henceforth the Kentucky war cry was, "Remember the River Raisin," and many were the British and Indians who had cause to dread that slogan. May 5, General Harrison, reinforced by General Green Clay and his Kentucky troops, repulsed the British and their dusky allies under Tecumseh. July 21, they returned four thousand strong, but were again repulsed.

The Americans, by wonderful exertion and hard work, built and equipped, at Erie, a squadron of nine ships with fifty-five guns, the command of which was given to Commodore Perry. September 10, Perry won his grand victory on Lake Erie, over the English squadron of six ships and sixty-three guns. This was the turning point of the war, and Perry's name goes down to posterity with the immortal names that never die. On October 5, General Harrison, conveyed by Perry's ships, landed his forces in Canada and completely destroyed Proctor's army, Tecumseh being among the slain. So ended the war in the Northwest.

In the meantime, General Dearborn was fighting with varying success in Upper Canada. Jackson, in the South, was avenging the Fort Mimms massacre, finally crushing the Creeks early in the next year. The British, under the odious Admiral Cochrane, plundered and ravaged and burned everything in reach, from Lewistown to the Carolina coast, seizing the negroes and selling them in the West Indies. During this year the American navy continued to be successful, meeting few losses, though the fighting was even more desperate.

July 5, 1814, the Americans defeated the British at Chippewa; and on the 25th was fought the battle of Lundy's Lane, where Generals Brown and Scott were wounded. In this desperate battle, eight hundred men were lost on either side; and though the battle was undecisive, it had the effect of a victory for the Americans. August 14, five thousand troops, under General Ross, were landed on the Patuxent, and, defeating General Winder, who made a stand with a handful of men near Bladensburg, proceeded to the city of Washington. After burning the capitol and White House, and other buildings, they hastily withdrew. The attempt to take Baltimore proved abortive, and on September 14 the British reëmbarked. It was at this time that Key wrote the "Star Spangled Banner." August 15, the enemy were repulsed at Fort Erie with the loss of one thousand men, and a month later were finally driven back. The whole British squadron on Lake Champlain surrendered to Commodore MacDonough after a terrific fight for several hours, on September 17, and on the same day the British army of twelve thousand was forced to retreat from Plattsburg by General Macomb's force of forty-five hundred.

In Florida the Spaniards had allowed, if not encouraged, the English to use their territory to fit out expeditions against the United States. Jackson, with two thousand men, took possession of Pensacola on the 7th of November, driving out the British.

December the 28th the British opened fire on New Orleans; again, on January 1, 1815; and on January 8 Packenham, with twelve thousand men, made his supreme effort. Jackson's force was now about six thousand. The British were driven to their ships after losing two thousand killed and wounded, their general being among the slain. The American loss was seven killed and six wounded. The war was kept up on the ocean until March, the last capture being that of the British brig Penguin by the American sloop-of-war Hornet, in the South Atlantic.

The treaty of Ghent had been signed on the 24th of September, 1814, and the news of the glorious victory at New Orleans reached Washington simultaneously with that of the signing of the treaty. The war had been so distasteful to the people of New England that Massachusetts and Connecticut had passed laws directly antagonistic to those of the United States, and hostilities between the Federal and State governments were feared, which, perhaps, were only averted by the ending of the war. The issues leading to the war of 1812 were left unsettled by the treaty, but England never again attempted to interfere with American shipping.

Second War with Barbary States.—Immediately on the close of the war of 1812, the Algerians, supposing that the American navy was badly crippled, began again their depredations on American commerce. Commodore Decatur was sent to the Mediterranean with a squadron, and once more gave them an American drubbing. June 17, 1815, he destroyed two Algerine vessels; June 28, in front of the city of Algiers, he demanded the release of all American prisoners, indemnification for all property destroyed, and a relinquishment of all claims for tribute from the United States. The Dey quickly assented to the terms, and signed a treaty of peace. Tunis, Tripoli, and Morocco were likewise brought to terms, the United States thus taking the lead of all the other powers in its determination to break up the piracy of the Barbary States.

Mexican War.—The Republic of Texas became, by its own request and by Act of Congress, one of the United States July 4, 1845. Mexico prepared for war; the United States took measures to protect the new State. March 8, 1846, General Zachary Taylor marched with fifteen hundred men to a point on the Rio Grande opposite Matamoras, where he erected Fort Brown.

To the secretary of war, William L. Marcy, and to General Winfield Scott was due the plan of campaign, the battles of which, like instantaneous flashes of victory from the beginning of the war until its close, illumine the pages of American history. Then, as now, Congress was slow to respond to the needs of the military branch of the government.

April 24, 1846, hostilities began. General Taylor advanced into Mexico and, May 8, won the brilliant victory of Palo Alto, and again, the next day, the battle of Resaca de la Palma. Taylor's force was less than one third the number of the enemy, whose loss was one thousand. These two battles crushed the flower of Santa Anna's army. Taylor returned to the relief of Fort Brown, where the brave garrison had sustained a cannonade for 168 hours. September 24, Monterey and its garrison of nine thousand men were taken by General Taylor with six thousand.

February 23, 1847, Taylor gained the glorious victory of Buena Vista, in which the Mexican loss was 2000, the American, 714. At times the Mexicans were within a few yards of Bragg's guns. "A little more grape, Captain Bragg," was Taylor's celebrated order, the execution of which decided the day. The American loss was severe in officers. Taylor's force, depleted by more than two thirds, which had been sent to reinforce General Scott, was barely forty-five hundred; the Mexican troops numbered twenty thousand. Captain Fremont, assisted by Commodores Sloat and Stockton, had subjugated California; General Kearney and Colonel Doniphan, Northern Mexico. Doniphan defeated the Mexicans at Bracito, December 25, 1846, and at Sacramento, February 8, 1847, and took possession of Chihuahua, a city of forty thousand inhabitants, and marched to join General Wool at Saltillo, March 22.

Early in January, 1847, General Scott reached the mouth of the Rio Grande, where he awaited the eight thousand troops sent by General Taylor. This raised his force to twelve thousand. These were landed at Sacrificios. The Americans debarked just below Vera Cruz between sunset and ten o'clock on the night of March 8 without a single accident. With wonderful skill the investiture of Vera Cruz and the castle of St. John de Ulloa was completed. On March 22 the Governor of Vera Cruz was summoned to surrender. Day and night the mortar batteries played upon the city, the fleet ably assisting; and on the 29th the stars and stripes floated above the walls of city and fortress. The Americans lost but two officers and a few soldiers. April 18, the magnificent victory at Cerro Gordo, where three thousand Mexicans were captured, was won; April 19, Jalapa was taken; April 22, Pecote, the strongest of Mexican forts, was captured; and May 15, Puebla surrendered to General Worth. Ten thousand prisoners, seven hundred cannon, ten thousand stands of arms, and thirty thousand shot and shells were captured within two months. When the army entered Puebla it numbered but forty-five hundred.

Reinforcements reaching him, Scott set out from Puebla to the valley of Mexico on August 7. August 20, the heights of Contreras were assailed and taken, and the battle of Churubusco—with nine thousand Americans against thirty thousand Mexicans—was fought and won. September 8, Molino del Rey was taken; September 13, the heights of Chapultepec. The Mexicans fled from the capital, and the victorious American army marched in and took possession of the city, September 14, 1847. Here Scott and his noble warriors rested until the treaty was concluded at Guadalupe Hidalgo, February 2, 1848, and peace was proclaimed, July 4, by President Polk. Guadalupe Hidalgo, New Mexico, and California were ceded to the United States, $15,000,000 paid to Mexico, and the debts due from Mexico to American citizens were assumed by the United States.

The Civil War.—It is not here the place to rehearse or to discuss the causes which led to America's Civil War, a war perhaps the most stupendous recorded in history. Looking backward, after the bloody foot-prints have been well nigh obliterated by the growth of a generation, we can see that the trend of human progress, the political problems confronting the federated States, in the solution of which were evolved elements of discord, the inherited antagonism between the Puritans of the North and the Cavaliers of the South, all combined to make the conflict inevitable. For more than a decade of years grievances had been growing and rumblings were heard, like the imprisoned fires beneath the surface of the earth, until the election of Abraham Lincoln as President, pledged to a policy believed to be inimical to the South, caused the outburst of the volcano, whose fierce fires and molten lava for four years spread desolation over the land.

Time and milder judgment have very nearly smoothed away the wrinkles of discord, and the close of the century finds the nation a reunited people, whose new compact is written in the life-blood of her sons on the battlefields of the recent war with Spain.

December 20, 1860, South Carolina; January 9, 1861, Mississippi; January 10, Florida; January 11, Alabama; January 18, Georgia; January 23, Louisiana, and February 1, Texas, one by one asserted their supposed right to withdraw from the federal compact, and enacted ordinances of secession in their several state conventions. Each State, as it took action, claimed and possessed itself of all government property, forts, guns, ammunition, within its borders, and armed its militia for garrison duty. A convention of delegates from the seceded States, held February 4, 1861, at Montgomery, Alabama, organized a new federation, to be known as the Confederate States of America, chose Jefferson Davis President and Alexander Stephens Vice-President, and set the whole machinery of a provisional government in working order. July 20, Richmond became the capital of the Southern Confederacy. Virginia seceded April 17; Arkansas, May 6; North Carolina, May 20, and Tennessee, June 8. Kentucky declared neutrality.

Lincoln, upon assuming the executive chair, March 4, 1861, found the treasury depleted, the army of only sixteen thousand men scattered in the West, and many of its best officers already with the Confederacy. The navy had been sadly neglected by Congress, partly because this branch of the service had been steadily antagonized by the West, so that at the beginning of the war, both as to vessels and armament, it was by no means in a condition for active service. As in the army, some of its most valuable officers had espoused the cause of their native States, and the South Atlantic and Gulf ports, being in possession of the new federation, left the United States vessels no place of refuge. With unlimited means at command, the Union navy increased the number of its vessels to 588—75 of them ironclads—with 4443 guns and 30,000 men, before the end of 1862. Torpedoes and steel rams were first used during this war, and monitors, just invented, were used by the United States. With a nucleus of 10 vessels, around which to build its navy, the Confederacy had, by November, raised the number to 34. Until the blockade became effective, "cotton was king;" for, in October, 1861, the Nashville, running out with a heavy consignment, brought back into Charleston in exchange a cargo worth $3,000,000. Vessel after vessel was bought from English shipbuilders, among them the celebrated Alabama, which, in the fourteen months of her service, captured sixty-nine prizes, and destroyed ten million dollars' worth of merchandise. The armored ram Stonewall was bought in France.

April 12, 1861, Fort Sumter, in Charleston harbor, was forced to surrender to the Confederates, and the first shot at the old flag ushered in the long, bitter struggle.

Troops were called for by Lincoln. Lieutenant-General Scott, the veteran hero of Mexico, was in command of the army. In three months, three hundred thousand men were in the field. One hundred thousand had swarmed to the Confederate ranks. General McClellan was sent to the front and, after the resignation of Scott in the latter part of the year, was made commander of the army.

July 21, the battle of Bull Run was fought. The Union troops were disastrously routed and retreated in confusion to Washington. The army did little more during this year.

April 21, after setting fire to and destroying the Navy Yard and ships, Norfolk was evacuated by the Union forces. The frigate Merrimac, which had been sunk, was raised by the Confederates, plated with iron, renamed "Virginia," and became the scourge of the shipping off the Virginia coast.

The navy, as is usual, and because of its very organization, got in its effective work much earlier than did the army, and the seizure of the forts and ports on the coast of the seceded States began at once. Fort Hatteras was taken August 29; Port Royal, in South Carolina, November 7. November 7 a naval officer, by overhauling an English mail steamer and taking off Messrs. Mason and Slidell, who had been appointed commissioners of the Confederate States to France and England, very nearly caused a complication with the latter power. Mr. Seward's diplomacy settled the incident amicably, and the commissioners were allowed to proceed upon their mission, which, however, proved futile. By the close of the year, Maryland, Kentucky, and Missouri, at first doubtful, were securely in the Union, though many of their citizens were in the Southern army.

1862.—February 6, General Grant, commanding the army of the Tennessee, with the assistance of Commodore Foote and his gunboats, captured Fort Henry, on the Tennessee River, and, on the 16th, Fort Donelson on the Cumberland. The Federal forces had reached the number of four hundred and fifty thousand, of which McClellan had two hundred thousand.

May 23, at Front Royal, and May 25, at Winchester, "Stonewall" Jackson defeated the Union troops and forced them across the Potomac. Banks, Fremont, and McDowell, concentrating their forces, bore down on Jackson, who slipped through their lines, and, on June 9, defeated Shields at Fort Republic.

The cry of the Northern press was, "On to Richmond," and McClellan endeavored to obey the command. He had arrived not far from the city, between the York and James rivers, when he was defeated in the bloody battle of Seven Pines, May 31 and June 1. The Confederate General Johnston was wounded, and General Lee was assigned to the command of the army of Northern Virginia, which he retained until the end.

The Seven Days' battles, from June 25 to July 1, were fought at fearful cost to the Confederates; nevertheless, "it was a glorious victory," and the siege of Richmond was raised. Lee advanced toward Washington, met the armies of Banks and Pope, and defeated them in the second battle of Bull Run, August 29 and 30, and at Chantilly, September 1 and 2, forcing Pope's army to retreat to Washington. The clamor in the South had been, "On to Washington." Lee crossed the Potomac at Harper's Ferry and took twelve thousand prisoners. McClellan, who had been recalled, met the Confederates at Sharpsburg (Antietam), September 17, and fought a battle with undecisive results. Each side lost about ten thousand men, and Lee returned.

The Union army under Burnside, who had superseded McClellan, met a fearful repulse at Fredericksburg, December 13, with a loss of fourteen thousand. The Confederate loss was five thousand.

December 31, January 1 and 2, was fought the terrible battle of Murfreesboro, Tennessee, where Bragg's force was 35,000, and his loss in killed, wounded, and missing, 10,466. Rosecrans's force was 43,400, and his loss 12,595.

March 8, the Virginia attacked the Union fleet at Fortress Monroe and destroyed the Cumberland and the Congress. The next day, the Monitor attacked the Virginia, and, after five hours' fighting, succeeded in disabling her so that she returned to Norfolk. The Virginia was destroyed by the Confederates before evacuating Norfolk, May 10.

Admiral Farragut, with a fleet of 45 vessels, entered the Mississippi and bombarded the forts of St. Philip and Jackson. Despising the fear of mines and torpedoes, he continued on his course, defeating the Confederate fleet, and, together with General Butler, entered New Orleans April 25. During this year the navy, with the assistance of land forces, had retaken all important ports on the Virginia, North Carolina, and Georgia coasts, seriously interfering with the blockade running, upon which the Confederacy depended for its foreign supplies. The year 1862 closed with no advantage having been gained on either side.

1863.—On January 1, Lincoln issued the threatened Emancipation Proclamation. This destroyed the last hope of the Confederacy for recognition by England. No event of importance occurred before the middle of spring, when Hooker, who had relieved Burnside, made another advance upon Richmond, and was routed by Lee and Jackson at

Chancellorsville, May 2, and on the 5th was forced across the Rapidan with a loss of seventeen thousand. The Confederate loss was less than five thousand. In Jackson's death the Confederacy received a blow, the consequences of which may never be estimated.

Lee's army again crossed the Potomac for an invasion of the North. The Union forces, under Meade, marched in an almost parallel line with Lee's through Maryland into Pennsylvania. They met and fought at Gettysburg, July 1, 2, and 3, one of the decisive battles of the world's history. Lee was forced to again retire beyond the river. The Union could well afford the loss of twenty-three thousand men, but Lee's loss of twenty thousand of the choice troops of his army was irreparable.

In the meantime, Grant had been sent to open the Mississippi, and after a six weeks' siege, on July 4, Vicksburg, with nearly thirty thousand prisoners and vast quantities of stores, fell into his hands. These two almost simultaneous victories greatly encouraged the North, and formed the turning point in the history of the war. July 9, Banks's victory at Port Hudson accomplished the desired possession of the Mississippi River.

Bragg, who had been sorely pressed by Rosecrans, made a stand at Chickamauga, defeating the Union General Rosecrans, September 19 and 20, and forcing him to retreat to Chattanooga, where he was besieged by Bragg. Grant, with Sherman, coming to his aid, the battles of Lookout Mountain and Missionary Ridge were fought, November 23 and 25, and Bragg was driven back into Georgia.

The Federal navy was gradually taking possession of the whole coast, and Charleston was tightly blockaded. In March the Confederate ship Nashville was sunk in the entrance of the Savannah River.

During this year both governments were forced to resort to conscription. Lincoln ordered a draft, and, in July, a three days' riot in consequence prevailed in New York, during which two million dollars' worth of property was destroyed.

1864.—In March, Grant was put in command of the whole Union army, the grade of lieutenant-general having been revived in his behalf. He left Sherman in command, repaired to Washington, and, May 3, started on the third campaign against Richmond, with a force of one hundred and forty thousand. Sherman, with one hundred thousand, was to march to Atlanta. The whole strength of the Union army at this time was about seven hundred thousand. Grant had spent some weeks in formulating his plans of campaigns, from the main features of which he never deviated. The Union had at last found the man, and at the same time had acquired the wisdom to leave the conduct of the war to his judgment; proving, also, that "there is no war on record that has not given its man to the world or shaped the destiny of some other."

Crossing the Rapidan, Grant encountered the Confederates, and the fighting, on the 5th, 6th, and 7th, of the battles of the Wilderness, was terrific, but the result undecisive. At Spottsylvania he fought from the 8th to the 18th with fearful loss. June 1, he was repulsed at Cold Harbor, and again on the 3d, and fighting, more or less desultory, continued in that vicinity until the 12th. Since the opening of the campaign, the Union army had lost sixty thousand men; the Confederate thirty thousand. Grant moved on Petersburg and began the siege which lasted from June until the next April. The western part of Virginia had seceded from the eastern portion, and, June 20, was admitted into the United States.

To divert Grant, and, if possible, to raise the siege of Petersburg, in July, Lee sent General Early to threaten Washington and Baltimore, which he accomplished without, however, affecting Grant's position. Returning laden with spoils, Early turned, and driving back the Federal troops invaded Pennsylvania, burning Chambersburg, and came back again bringing vast quantities of supplies. Sheridan was sent to dispose of Early and to ravage the valley. At Winchester, he met and defeated Early in a very severe fight on October 20, almost destroying the force under that general's command. Sherman set out for Chattanooga on May 7, marching towards Atlanta. At Dalton he met General Johnston's army of fifty thousand men. Johnston's masterly retreat from Dalton to Atlanta is unrivaled in military history. He made a stand from May 25 to June 4 at Dallas, but, being outflanked, was obliged to fall back. The next stand was made at Great Kenesaw, on June 22, when he repulsed the Federals. On the 27th, Sherman made a powerful assault, but was again repulsed with a loss of four thousand, Johnston's loss being four hundred; but, again outflanked. Johnston was forced across the Chattahoochie, and July 10 found the Confederate army entrenched in Atlanta.

Johnston's retreating tactics caused the people to clamor for a "fighting leader," and Davis, in transferring the command from Johnston at such a crucial time, committed a grave error. Johnston was superseded by General Hood, whose chief ambition was to fight, which, in this case, was a great mistake in judgment. On the 20th, 22d, and 28th of July, Hood assaulted the lines of the besiegers, only to be repulsed again and again. In these fights more men were lost than during Johnston's long, skillful retreat. An injudicious movement by Hood separated his command, obliging him to evacuate Atlanta, of which Sherman, on September 2, took possession. In its advance on Atlanta, the Union army had lost thirty thousand men. Hood saved his army and made his way towards Nashville, hoping to divert Sherman from Georgia. At Franklin, November 30, he met General Schofield, and drove him back to Nashville, from whence General Thomas made a sortie, and fell upon Hood's troops, December 15, completely routing them. In the two fights, Hood lost in killed, wounded, and captured over eleven thousand. With the remnant he escaped into Alabama, and these finally reached Johnston, participated in his last fight with Sherman, and were surrendered at Raleigh with the troops of their old commander.

November 14, Sherman burned Atlanta, cut all telegraph lines and began his "March to the Sea," ravaging, devastating, and utterly destroying everything in his reach. He was opposed by the Confederate cavalry, which successfully defended the cities of Macon and Augusta, upon which the Confederacy mainly depended for the manufacture of munitions of war. Sherman entered Savannah on December 22, the advance having cost him only 567 men killed and wounded.

On June 19, the celebrated sea fight between the Kearsarge and the Alabama took place off Cherbourg, France. The Alabama was sunk after a five hours' fight. Admiral Semmes was rescued by the Deerhound, belonging to an English gentleman, and thus saved from capture. August 5, Commodore Farragut, overcoming the Confederate ram Tennessee and the gunboats, sailed into Mobile Bay, commanding his fleet from the maintop of his flagship.

1865.—The opening of the campaign of 1865 found Grant's army still before Petersburg. On April 2, he ordered an attack along his whole line, which had been so lengthened that the lines of Lee's depleted army were very thin. The Confederates were driven back with heavy loss. Lee telegraphed to Davis: "My lines are broken in three places; we can hold Petersburg no longer. Richmond must be evacuated this evening." That night Admiral Semmes, in obedience to orders, destroyed the Confederate fleet in the James River. Richmond was in the possession of the Union forces the next day, and on April 4 Lincoln held a reception in Davis's vacated mansion. Lee attempted to break through Grant's lines at Appomattox, but closely pursued by Sheridan, and finding further retreat impossible, he surrendered with about twenty-six thousand men on the 9th of April.

Grant's magnanimous terms were worthy of his fame. The troops were paroled on condition of promise not to take up arms until exchanged. The officers were permitted to keep baggage and side arms, and all were to retain their horses, as, Grant said, "they would be needed in the crops."

Turning northward from Savannah, Sherman continued his march and reached Fayetteville, North Carolina. Wilmington had been captured early in the year by a land and naval force. Johnston had been reinforced by the garrison which had been forced to evacuate Charleston and the remnant of Hood's army, and had several severe fights, with no decisive results, with Sherman, who entered Raleigh; and here, on April 26, Johnston's army surrendered on the same terms given by Grant.

December 31 and January 1 Fort Fisher was captured, and on January 12 Wilmington was entered by the Federals; February 18, Charleston was captured.

The regular battles during the Civil War numbered 892. Lincoln called in all for 2,690,000 men. There were actually in service 1,490,000. There were 400,000 disabled; 304,369 perished; 220,000 were captured, and 26,000 died in captivity. The expenses of the war were $3,500,000 per day. The national debt was $2,700,000,000.

This great American War was fought on both sides with a courage and fortitude never before experienced in the annals of warfare. As compared with the statements of forces and losses in battles of European armies, the casualties in the battles of the Civil War were three and four times as great. And this proves that in the American War each side met "foe-men worthy of their steel." These overwhelmingly fearful casualties are not to be explained otherwise. And each section respects the other more than before the war—a war in which the conquered felt not, nor said, *peccavi*, and in which surrender to greater numbers and heavier artillery involved no sacrifice of belief in the truth and justice of their cause. Was there ever an armed strife that brought forth greater generals or more knightly valor, undiminished courage and unflinching fortitude on the part of combatants? Together must the names of Grant and Lee go down to posterity as great types of the American soldier,—the one, noble and generous in victory; the other, though a hero uncrowned by success, a warrior still more heroic in defeat.

The Spanish-American War.—The proximate causes of the war with Spain are tersely set forth in the Joint Resolution declaring the independence of Cuba and demanding the withdrawal of Spanish sovereignty therefrom, which says:—

"*Whereas*, The abhorrent conditions which have existed for more than three years in the island of Cuba, so near our own borders, have shocked the moral sense of the people of the United States, have been a disgrace to Christian civilization, culminating as they have in the destruction of a United States' battleship, with 266 of its officers and crew, while on a friendly visit in the harbor of Havana, and cannot longer be endured, as has been set forth by the President of the United States in his message to Congress of April 11, 1898, upon which the action of Congress was invited; therefore,

"*Resolved*, by the Senate and House of Representatives of the United States of America in Congress assembled:

"*First*, That the people of the island of Cuba are, and of right ought to be, free and independent.

"*Second*, That it is the duty of the United States to demand, and the Government of the United States does hereby demand, that the Government of Spain at once relinquish its authority and government in the island of Cuba, and withdraw its land and naval forces from Cuba and Cuban waters.

"*Third*, That the President of the United States be, and he hereby is, directed and empowered to use the entire land and naval forces of the United States, and to call into the actual service of the United States the militia of the several States to such extent as may be necessary to carry these resolutions into effect.

"*Fourth*, That the United States hereby disclaims any disposition or intention to exercise sovereignty, jurisdiction, or control over said Island, except for the pacification thereof, and asserts its determination when that is completed to leave the government and control of the Island to its people."

This resolution was signed by the President at 11.24 o'clock A. M., April 20, 1898.

It was on February 15, 1898, that the catastrophe referred to—the blowing up of the Maine—occurred. On April 25, the formal declaration of war was made.

Spain had three fleets,—Admiral Cervera's flying squadron, the Asiatic fleet under Admiral Montejo, and Admiral Camara's fleet of heavy armored vessels.

The American navy is always ready for emergencies, and even with the grudging appropriations made by Congress, the "new navy," while not possessing vessels of such large size as those of some other nations, was much more formidable than was generally supposed. Congress, apprehending the outcome, had given the President $50,000,000 to put the country on a war footing. In reply to the call for 125,000 volunteers, five times that number offered themselves.

It had been more than fifty years since the United States had encountered a foreign foe, and since the close of the Civil War, for a third of a century, peace had reigned.

April 25, by cable to Hong Kong, Commodore Dewey was ordered to find and destroy the Spanish Asiatic fleet, which he proceeded to do on May 1st, without the loss of a single man. Entering Manila Bay, scorning torpedoes and mines, his wonderful battle at Cavite is the admiration of the world.

Schley, with his flying squadron, watched in Hampton Roads for an attack by the enemy on the Atlantic coast. Havana was blockaded by Sampson's squadron April 22, and his searchlights seen from the Cuban capital were as the handwriting on the sky, foredooming Spanish rule. His tactics were to take no risk with his vessels while awaiting the appearance of the Spanish ships, so he failed to return the greeting of the shore batteries.

The first casualties of the war were in Cardenas harbor May 11, when upon the Winslow, while chasing a decoy gunboat too far under the fire of the land batteries, Ensign Bagley and four sailors were the first men of the navy to lay down their lives.

It was known that Cervera had sailed from Cadiz toward the West Indies. Sampson made a tour of Porto Rico to hunt the Spaniard, who mysteriously eluded the sight of the Americans. San Juan was bombarded on May 12. On May 30 Schley, who in the meantime had arrived off Santiago, dispatched: "I have seen the enemy's ships with my own eyes." Cervera had then been in the harbor ten days. On the 31st, Schley commenced a bombardment, and the forts at the mouth of Santiago harbor and the vessels within replied for an hour. June 1 Sampson came, and all hope of escape for Cervera was cut off. On that night Lieutenant Hobson executed his bold, heroic plan of sinking the Merrimac in the channel of the harbor, which was accomplished without the loss of one of his seven co-heroes, although subjected to a deadly fire from forts and vessels.

The first troops landed on Cuban soil were the marines, 650 in number, under Lieutenant-Colonel Huntington. This battalion had been on board the Panther since May 22, and the men were eager to land. After Sampson had shelled the shore and adjacent hills and woods, on the afternoon of June 10 the landing was made and the American flag raised for the first time on

Spanish territory in the west. No Spaniards were seen until after the tents had been erected and the evening shadows were falling. Then for five nights and days there was no sleep for these men, than whom there were no greater heroes in this short, sharp war. With few exceptions they received their “baptism of fire,” and nobly did they acquit themselves.

I am told that when almost utterly exhausted the first platoon reached the summit of Cusco hill, so exactly in unison was their fire that the Spanish, believing that machine guns were opening upon them, turned and ran, never again making a stand. The first to consecrate the soil with his life’s blood was Dr. John Blair Gibbs, who left a $10,000 practice in New York to go as surgeon of the battalion, and who had greatly endeared himself to both officers and men. Sergeant Goode, one of the finest subalterns in the corps, and four men were killed. The good condition and health of this battalion during the whole campaign were due to the fine organization of the commissariat and the strict discipline maintained in this corps.

General Shafter arrived off Santiago, June 20, with a force of 773 officers and 14,564 men. General Garcia, the Cuban commander, with four thousand insurgents, was at Assuadero, eighteen miles west. There he, Shafter, and Sampson held a consultation. On the 22d, the disembarkment of troops was begun. On the morning of the 23d, General Lawton with his division advanced to Juragua. Major-General Wheeler, after landing 964 of his force, pursuant to General Shafter’s orders, moved rapidly to the front, and, passing through Lawton’s lines, pushed on to Las Guasimas, attacking and defeating General Linares on the morning of June 24.

The entire American force was pressed forward under General Wheeler, General Shafter being detained on the ships to attend to the landing of the armament and supplies. On the 29th, the commanding general left his ships and pitched his camp on the Santiago road, and on the next day orders were given for an attack along the whole line. In carrying out these orders, General Lawton with about six thousand men attacked El Caney, a small town about five miles north of Santiago. The garrison consisted of 520 men, the defenses being one block-house and a shore fortification. It was not until four o’clock that General Lawton’s success was complete. His loss was 437 killed and wounded, and but 30 of the enemy succeeded in escaping and reaching the Spanish lines. While Lawton was moving on El Caney, the cavalry division, unmounted, and Kent’s infantry division were ordered to move forward. Crossing San Juan River at a point about five hundred yards from the enemy’s fortifications on San Juan ridge, the left of the cavalry rested on the main Santiago road and the infantry formed to the left of the cavalry. These troops were subjected to a very heavy fire in advancing from El Pozo, in crossing the river and in forming on the other side; they, however, most bravely charged the enemy in their strong position on Kettle Hill and San Juan ridge, and drove them precipitately from their strong fortifications; the American loss being 154 killed and 997 wounded. This placed the Americans in a position commanding the fortifications around the city of Santiago.

The Spanish fleet, consisting of five armored cruisers of 7,000 tons and 2 torpedo-boat destroyers, attempted to escape from Santiago at 9.30 o’clock on Sunday morning, July 3, just nine weeks after the destruction of Montejo’s fleet. Schley and Sampson destroyed the vessels and made prisoners of 70 officers and 1600 men; 350 were killed and 160 wounded.

Fighting more or less severe occurred until the 10th, when negotiations for surrender were inaugurated, resulting in the capitulation of Santiago, July 16, the Spanish fortifications, twenty-four thousand prisoners, and a large amount of arms and ammunition. At noon on Sunday, July 17, 1898, the American flag was hoisted over the headquarters at Santiago.

General Miles started on the invasion of Porto Rico, July 25, and reached Guanica at daylight next morning. He landed with three thousand five hundred men, marched toward Yauco, five miles distant, which he entered after a skirmish, and was received enthusiastically by the citizens, as he also was at Ponce, where he was joined by General Wilson, who had come with the war ships, and who was made governor. The army continued on to San Juan along the military road, meeting very little opposition.

July 26, the French ambassador, M. Jules Cambon, acting for Spain, made overtures for peace. The protocol was signed on April 21, by M. Cambon and Secretary of State Day. A cessation of hostilities was proclaimed. At the very moment of the signing of the protocol, the last naval battle took place at Manzanilla, Cuba, and an artillery engagement at Aybonito in Porto Rico.

The one-hundred-days Spanish-American war was concluded by the treaty of Paris.

It will be only in the retrospect that we may tell the results of this conflict. As the future unfolds them to our view, it may be that it will have been more momentous in its consequences than we can now determine. One thing it has proved, that is, that this nation is really *reunited*; for, from all sections and from all grades of life, men flocked together to fight and conquer under the old Stars and Stripes.

II. FOREIGN WARS.

Napoleonic Wars.—The long contest between France and Austria began when the Girondist ministry of France declared war, April 20, 1792. By the execution of Louis XVI., January 21, 1793, the Revolution threw down the gauntlet to all ancient Europe. England, whose sympathies had hitherto been more or less with France, began to take measures to bring about more cordial relations with the other powers of Europe. Spain, Portugal, Austria, Prussia, and Russia, for the time seemed to forget their several grievances as they found themselves confronted with a totally new move on the chessboard of European autonomy. The year 1794 saw the French Revolution progressing triumphantly, and all Europe, except England and Austria, appeared acquiescent in apathetic indifference. In 1795 the royalists made a supreme effort to recover power, but were crushed by the “Man of Destiny,” and the Directory, consisting of five members, of whom Carnot was one, came into power. Dominated by the martial genius of Carnot, “the organizer of victory,” the Directory won the confidence of the army. Scherer, the commander, lacked the qualifications to undertake a successful campaign against Austria, and Bonaparte, succeeding him, soon infused his own spirit into the army and bound it to himself with a devotion that never failed.

Early in the year 1800, Napoleon, having been made first consul, took up his abode in the old palace of the kings of France, the Tuileries. The history of Napoleon for the ensuing fifteen years is the history of Europe. It is, therefore, best to begin with the close of the eighteenth century, in order to appreciate the situation at the dawn of the nineteenth.

Austria and England, with several small German principalities, were still in arms against France. The plans and movements of the armies under Napoleon showed him to be verily a master in military skill. Opening this campaign, he left Massena with about eight thousand soldiers to hold the territory from Nice to Genoa, so as to keep the Austrian army in Italy busy. He sent the Rhine army, under Moreau, to threaten Bavaria and to secure the most important position between the Rhine and the Danube. Moreau drove the Austrians to Ulm, and disposed his left flank to support Napoleon. Meantime, he himself was recruiting another army for operations on the Po. Baron de Melas, commanding the Austrian troops in Northern Italy, besieged Massena in Genoa, which, after severe suffering, surrendered, leaving De Melas free to join the army of the Po. Napoleon was between de Melas and Austria. General

Ott, with eighteen thousand men, attempted to reach Placentia, but Lannes, with twelve thousand, defeated him at Montebello, forcing him back to Allesandria. Napoleon hastened across the Po to Stradella to intercept De Melas and prevent his breaking through the French lines to Placentia.

The night of June 13, 1800, the French army was scattered, watching along the Po and the Tessino for the Austrians, while their army, forty thousand strong, with ten thousand more not far distant, was ready at daybreak of the 14th to cut its way through the armies of France, and reach Placentia. The French force was but eighteen thousand, but Victor with his division held his position firmly, and the great leader, Kellerman, was in command of the cavalry. Backward and forward surged the battle with varying fortune, and at noon victory seemed perched upon the banners of Austria. De Melas was so certain that the battle was won that he galloped back to Allesandria and sent dispatches to that effect to the governments of Europe. General de Zach was left in command to conduct the pursuit and to drive the French across the Scrivia. Napoleon, dismayed, hoping against hope that Desaix, whom he had sent towards Novi the day before to look out in that quarter for De Melas, might hear the thunders of the battle and return, saw him in the distance, hurrying with his troops, who, though worn and tired, were eager for the fight, and Napoleon saw already the tide of battle turned.

Desaix had found no trace of the Austrians, but he had heard the sound of battle at day dawn, and he knew that De Melas was there, and that there he was needed, and not at Novi. He roused his division, and hastened back to Napoleon. A short conference with his chief, to whose questioning he answered, “The battle is lost, but it is only three o’clock, there is yet time to win another,” and the battle of Marengo, glorious in its consequences to Napoleon, stupendous in its carnage, was won; but Desaix, the brave paladin, lay dead upon the field. De Melas returned from Allesandria to meet the victorious army he had left—flying in disorder—thoroughly routed. On December 2, Moreau and Ney won the field of Hohenlinden, and the “peace of Luneville” was concluded, February 9, 1801.

The result of this campaign was the cession of Austria’s strongholds in the Tyrol and Bavaria to France, as also a number of important holdings in Italy. France secured the left bank of the Rhine, the Belgian provinces and Tuscany, and the king of Naples closed his harbors to England. In March, 1802, by the “treaty of Amiens,” peace was concluded with England.

The coalition of Denmark, Sweden, Russia, and Prussia, with France against England, in 1800, fomented by Napoleon, broke down in 1801, after Nelson’s battle of Copenhagen.

England had secured the supremacy of the sea and dominion over India, rescued Portugal, Naples, and the States of the Church from France, and restored the Sublime Porte to Turkey. Finding Napoleon again militating against her interests, and resenting his encroachments, England declared war against France in the spring of 1803. Russia espoused the cause of England, Prussia held off, and Austria was friendly, though not in fighting trim. The third coalition comprised England, Russia, and Austria.

Powerless to hurt England on the seas, Napoleon, who had the year previous been proclaimed emperor, attacked Austria, invaded her territory, captured her army at Ulm, proceeded to Vienna, and occupied a great part of the valley of the Danube. On December 2, 1805, the “Battle of the Three Emperors” (the battle of Austerlitz) was fought. The “Peace of Pressburg,” concluded December 26, left Austria shorn of her ancient prestige, her title of German Empire, and of a great part of her possessions. The “Sun of Austerlitz” melted the third coalition. In the meantime the battle of Trafalgar, won by the immortal Nelson, crushed the naval power of both France and Spain.

In September, 1806, Prussia declared war against France, and, to the amazement of Europe, alone undertook to engage armies flushed from their recent victories and still in Germany. October 14, Napoleon utterly defeated the Prussians at Jena and Auerstadt, and entered Berlin a conquerer, the king having fled to Königsberg. Russia came to the aid of Prussia, but arrived too late to accomplish anything except to check the advance of the French, whose armies wintered on the Vistula. The next summer, however, the Russians met their final defeat in this campaign at Friedland, and Königsberg was taken. The "Treaty of Tilsit" ended the operations of this fourth coalition July 7, 1807.

The fifth coalition against Napoleon comprised England, Austria, Spain, and Portugal. The decisive battle of this campaign was at Wagram, July 5 and 6, 1809, and terrible as were the consequences of his defeat to Austria, so crippled was Napoleon that he willingly granted the armistice of Znaim and concluded the "Peace of Vienna." When the fifth coalition ended, Napoleon had acquired the Illyrian provinces and part of the Tyrol for France, and eventually the Emperor's daughter, Maria Louisa, for his wife.

In 1812 came war with Russia, and that most disastrous campaign which cost France more than three hundred thousand soldiers and Napoleon his empire. Russia, England, Prussia, and Sweden formed the coalition now, and Turkey had made peace with Russia. Napoleon crossed the Niemen in June, halted at Wilna to put his new conscripts in better order, addressed words of sympathy to Poland, and took measures to keep Austria conciliated. The Russians retreated before him. He met and fought and defeated them at Smolensk, August 17; they retreated in good order, burning and destroying all in their reach. The terrible battle of Borodino was fought September 7; the defeated Russians again retreated in good order, pursuing the same tactics. Napoleon reached Moscow September 15, but the heroic measure of Russia in destroying that city was equal in its results to several victories. October 15, the French troops commenced their fearful retreat. The Russian armies grew bold, they harassed the French troops, weak from hunger and cold, and from Moscow to Wilna their progress was one continual guerilla warfare. From Wilna, their flight to France, December 5, was even more disastrous. Of the grand army that set out in the spring not one fourth ever returned.

Affairs in Spain had fared badly for France. Wellington defeated the French army in Spain, and finally expelled it. France, though sometimes shaken in her devotion by the conscription that was draining her children's blood, still had faith in Napoleon, and in 1813, having raised another grand army, he undertook to subjugate Prussia. His first victory was on the plain of Lutzen. The Prussians and Russians retreated in good order through Dresden. Napoleon pursued and drove them from Bauken, on May 20 and 21, and established his headquarters at Dresden. Austria now joined the allies. In their attack upon Dresden, August 26 and 27, they were defeated, but Russian troops and the King of Bavaria coming up made Napoleon's position untenable. The allies were awaiting him at Leipsic. The battle raged for three days, and Napoleon withdrew on October 19, utterly defeated.

January 23, 1814, Napoleon, having raised another army, left Paris to assume command. The allies—England, Austria, Prussia, and Russia—were more determined than ever to crush him. Many battles were fought, and the fortunes of war varied. Blucher defeated him at La Pothiers on the 1st of February. Napoleon was the victor at Montenau; unsuccessful at Soissons, March 3; victorious at Cravonne, March 7; and defeated by Blucher at Laon, March 9. With more than half his army lost, Napoleon worried the allies in their rear; but Blucher marched on Paris. The prestige of Napoleon and France in Europe was at an end.

The Empress and the regency retired to Blois. On March 31 Paris surrendered, and the Emperor of Russia and the King of Prussia entered the city. A provisional government, with Talleyrand at its head, deposed Napoleon on April 2, and on April 6 he abdicated. May 30, the First Peace of Paris was concluded between France and the allies. France was to have her boundaries as they were in 1792, and also her foreign possessions, except Tobago, St. Lucia, and Mauritius, which, with Malta, were ceded to England. The Bourbons, in the person of Louis XVIII., were restored; but the French people were not content, so that when Napoleon appeared at Cannes on March 1, 1815, he was greeted with joy, even by the troops sent out to oppose him. This astonishing news was communicated to the Congress of the Allies assembled at Vienna. The allied armies at once gathered on the borders of France, Wellington landed in Flanders, and Blucher's Prussians joined him. Wellington, finding Napoleon in front of him, fell back to Waterloo, lest the approach of the Prussians should be cut off. Napoleon hurled his force on Blucher at Fluores, and victoriously drove him from the field on the 15th. Ney, who had been sent to confront Wellington, fought at Quatre Bras, and the following day joined Napoleon. On the 18th of June, 1815, Napoleon made his supreme and final effort to recuperate his lost fortunes and to reestablish his empire.

The story of the battle of Waterloo, than which none ever fought was more decisive in its consequences, has been told and retold. The battle was at first undecided, victory seeming to incline to Napoleon, though the English and Germans with unflinching heroism still held the field until the afternoon, when Blucher, with his Prussians, at last arrived. Napoleon perceived that the supreme moment was at hand, and that his only hope was to crush Wellington before Blucher's advancing columns could be thrown into line of battle. He sent forward his magnificent Imperial Guard. They charged with chivalric splendor, fought with heroic desperation, were repulsed,—and the star of Napoleon set to rise no more.

Finding his cause irretrievably lost, leaving the remnant of his army in command of Marshal Soult, Napoleon fled and, failing to find a passage to America, surrendered. This battle, magnificent in its results, ensured to England a long peace, and raised her to the first rank, for military prowess, among the nations of the world.

Napoleon's skill at Waterloo was up to the highest standard of his most glorious work; but he was overwhelmed by preponderance in numbers. His entire force with which he conducted this campaign was barely 104,000, while the combined armies of Wellington and Blucher numbered 220,000.

The Congress of Vienna restored the *ancien régime*, replacing dethroned monarchs upon their hereditary domains, but the parceling out of the smaller territories showed the Powers to be quite as arbitrary as Napoleon himself. The semi-decade of passive submission to the "policies of princes" was broken in 1820 by general revolts in Europe. Spanish-American colonies, indignant at French interference in Spanish matters, began their struggles for independence.

Greek War for Independence.—Since the capture of Constantinople by the Turks, in 1453, Greece had been subject to Turkey. Out of the defeats of several rebellions against the greed, tyranny, and brutality of the Moslem,—particularly from the revolutions of 1770 and 1790,—grew the secret society of the Hetæria, cementing the union of the Greeks for the struggle beginning in 1821. It is claimed that ten thousand Greeks were slaughtered within a few days, and thirty thousand in less than three months.

Mahmoud, having failed in 1825 to crush the rebellion, called Mehemet Ali, the Pasha of Egypt, to his aid. Mehemet sent Ibrahim, his son, with his army and navy, trained in the tactics of European warfare, into the Peloponnesus. Victory and devastation marked his course. Never was grander courage nor loftier bravery displayed than by the Greeks. The siege of Missolonghi lasted from April 27, 1825, until April 22, 1826. Athens was captured, June 2, 1827. The fleets of England, France, and Russia were cruising on the coasts to prevent attacks by the Turks on the islands. Approaching the bay of Navarino, they were attacked by the Turks and Egyptians, whose combined fleets were thereupon annihilated on October 20, 1827. The Sultan was forced by the powers to consent to the establishment of the kingdom of Greece, and his delay to do so was punished by Czar Nicholas, who declared war, crossed the Balkans, and at Adrianople in 1829 compelled the Sultan to recognize her independence, grant Christian governors to Servia, Moldavia, and Wallachia, and to yield Bessarabia to Russia.

Minor European Wars.—The French Revolution of 1830, placing Louis Philippe on the throne of France, brought about Belgium's independence.

The Polish insurrection of 1831–32 lost Poland her last vestige of liberty, enchaining her irretrievably under the tyranny of Russia.

From 1840 to 1852 England was engaged in quelling periodic wars in her Indian possessions. In 1841, her army, numbering seventeen thousand men, perished in their retreat from Afghanistan. So with France in Algiers and Morocco. And revolts in Spain were more or less successful.

In 1842, England's war with China, caused by seizure of opium, resulted in the cession by China of Hong Kong, the freedom of five other ports, and $21,000,000 indemnity.

In 1848, the revolutionary spirit broke out fiercely, and the people made strong leaps for liberty and constitutional government. In France, it overthrew Louis Philippe, establishing a republic, with Louis Napoleon President. In all Europe its echo resounded. Riots in Vienna forced Metternich to flee to England; Ferdinand, to take refuge in the Tyrol and to abdicate in favor of his son, Francis Joseph. Frederick William was compelled by the conditions in Berlin to promise a constitution. The Frankfort Assembly, in 1849, offered Frederick William the title and prerogative of Emperor of Germany, and though, because of his respect for the Hapsburgs, he declined the honor, he still took advantage of the sentiment that prompted the offer to so strengthen the dynasty that later it might be held.

Hungary rose against Austria in 1848, and almost won independence. Kossuth proclaimed Hungary a republic, and Nicholas immediately sent aid to Austria. The Russian army, 130,000 strong, joined the Austrians. The Hungarians retreated to Temesvar, where they were defeated with great slaughter, and Georgy surrendered, August 9, 1849. The name of Haynau, the Austrian commander, is held in execration for his awful cruelty to the conquered.

In the meantime Italy rose. Lombardy drove out the Austrians. Charles Albert, king of Sardinia, had declared war on Austria and crossed the Mincio, April 8, 1848. Radetsky, commanding the Austrians, lost Gorto and yielded Peschiera in May, but in June he forced the Papal troops, who were assisting Charles Albert, to surrender, and completely routed the Italians at Custozza, July 25, and entered Milan. Charles Albert was again defeated by Radetsky at Novari, March 23, 1849, and Venice was captured August 23. Charles Albert resigned his crown to his son, Victor Emmanuel, and died shortly after.

Pope Pius IX. was forced to flee from Rome. Mazzini established the Roman republic in November. Austria, by the close of the summer of 1849, had regained control of her disputed possessions. Louis Napoleon, taking part against Italy, occupied Rome with his troops, July 2, 1849, and drove out Mazzini and Garibaldi.

The Crimean War.—In 1853, Louis Napoleon wanted war. He fomented trouble between the Porte and Nicholas, which ended by a declaration of war by Russia. The Czar claimed and demanded the protectorate of Christians in Turkey. Austria, France, and England opposed the demand. Nicholas had intimated to the British minister at St. Petersburg that England and

Russia should share the partition of Turkey,—showing that he was ready to carry out the will and aims of Peter the Great and Catherine. The Russian army was thrown across the Pruth into Moldavia, and was at first worsted by the Turks. In deference to the wishes of Austria and Prussia, Nicholas withdrew his army from the Danubian provinces, and so secured their neutrality. He dislodged the Turkish fleet at Sinope, November 4, 1853.

England and France allied with Turkey and declared war against Russia, March 28, 1854. The allied fleets and troops proceeded to the Black Sea. Sebastopol was the great arsenal of Russia. Twenty-seven thousand English, thirty thousand French, and seven thousand Turks were landed in the Bay of Eupatoria, thirty miles above Sebastopol, September 14, 1854, towards which, five days later, the southerly march began. The allies waded the river Alma under terrific fire from the large Russian army, and won a brilliant victory. The attack was remarkable in that it won victory over superior numbers in seemingly impregnable positions, and in spite of official blunders. Mentschikoff, the Russian general, withdrew the crews from the ships in the harbor and put them, eighteen thousand strong, in command of the batteries. With his own army he marched out of Sebastopol, leaving twenty-five thousand defenders to the city. Admiral Korniloff and his able assistant, Colonel Von Todleben, undertook to strengthen the defenses and to inspire the troops. On October 17, the siege guns of the allies were in position. The English stormed the suburbs of the city, the Malakoff and the Redan; the French stormed the city. Both were unsuccessful. Russian troops poured into Sebastopol, and invited battle outside of the fortifications. At the harbor of Balaklava, Turkish troops recoiled from the Russian advance, and Sir Colin Campbell, with the Highland Brigade, saved the shipping and stores by timely check to the Russians. The battle of Balaklava, October 25, gave the town to the British after stubborn fighting, more than two thirds of the Light Brigade having been sacrificed to Lord Lucan's misconstruction of orders.

At Inkerman, on November 5, sixty thousand Russians, in fog and rain, surprised the British Household Guards, and for six hours vainly strove to crush them. General Bosquet, with the genius of the soldier, guessed the point of severest attack, and sent reinforcements to the Guards. The Russians were finally driven back. Little good resulted from these two stubborn battles. Winter put an end to active operations. Rain, hurricanes, insufficient shelter, lack of supplies, and extreme cold produced fearful misery among the soldiers. Russia suffered as severely as did the allies, besides having had her fleet on the Black Sea destroyed and her army beaten.

In April, 1855, the bombardment began again. In May the allies captured Kertch and Yenikale, thus cutting off Russian supplies from the Caucasian provinces. In June, Marshal Pelissier succeeded Canrobert and successfully stormed Manelon; and, after the abortive attacks, June 18, of the French on the Malakoff and the English on the Redan, General Simpson succeeded Lord Raglan. August 16, the Russians crossed Tchernaya, but were repulsed by the French. On September 8 the French carried the Malakoff; the British failed to carry the Redan. The Russians set fire to the city and ships and retired to the northern part of the harbor, where they held strongly intrenched positions opposite the allied armies and beyond the reach of the allied fleets. Russia was driven from the Black Sea, had lost her prestige in the Baltic Sea, Bomarsund, on the Aland islands, and the arsenal of Sweaborg, in the Gulf of Finland. She had saved Cronstadt, and, at terrible sacrifice, had captured Kars from the English General Williams with his army of Turks. Her vast territory was comparatively intact. The nations were not satisfied. The Peace of Paris increased the prestige of Louis Napoleon; it postponed the Eastern Question by putting the Christian subjects under the nominal protection of the Powers, but virtually under that of the Sultan. The treaty of peace was signed March 30, 1856.

Wars in the East.—In 1857, the Indian Mutiny was caused by the introduction of Enfield rifles. Delhi was taken after desperate fighting, September 20. Cawnpore and Lucknow were the theatre of horrible scenes. The rebellion was finally crushed in 1859.

In the meantime war with Persia was begun and ended by the recapture of Herat, in Afghanistan. In December, 1857, England and France made war on China and captured Canton. They secured many concessions by the Treaty of Tien Tsin, and $2,000,000 indemnity.

War between Austria, France, and Sardinia.—In 1859, Louis Napoleon made a secret alliance with Italy. General disarmament was proposed. Sardinia agreed to it; Austria stood aloof. On April 25, 1859, Austria ordered the disarmament of Piedmont. On the 27th, King Victor Emmanuel proclaimed war. On the 30th, French troops were in Turin. On May 13, Louis Napoleon himself disembarked at Genoa, where he was met by Victor Emmanuel. The Austrian forces crossed the Ticino, *en route* for Milan, but hesitated, because of the French advance. The opening battles at Montebello and Balestro, May 20, 30, and 31, were favorable to the allies.

At Magenta, June 4, the Austrians met with terrible defeat. The forces of the allies numbered 55,000, and their loss was 4000; the Austrian army of 75,000 lost 10,000 killed and wounded and 7000 prisoners. The conquerors entered Milan on June 8. Francis Joseph fell back to the line of the Mincio, and at Solferino the decisive battle of the campaign was fought on June 24. Napoleon commanded the allied armies, which numbered about 150,000; they fought for sixteen hours against the Austrian force of 170,000, gaining a fearful victory. This battle cost Austria 20,000 men; the French lost in killed and wounded 12,000 and the Sardinians 5000 men.

The allies crossed the Mincio and laid siege to Peschiera, but while all Europe expected another fight, an armistice of five weeks was agreed to, and Napoleon, unknown to his ally, met Francis at Villafranca and made a peace, upon which was based the Treaty of Zurich, signed November 10. Austria gave Lombardy to Napoleon for the king of Sardinia, as also the fortresses of Mantua and Peschiera. Italy was to become a confederation, with the Pope as president, of which Austria was to be a member, because of her holdings in Venetia. Tuscany and Modena were to be restored to their princes. Garibaldi’s brilliant conquest of Sicily and Naples, in 1860, and Sardinia’s growing power, startled Europe, but the nations dared not interfere. The general parliament of Italy met in 1861, at Turin, and made Victor Emmanuel king of Italy. Rome, under the Pope, and Venetia, under Austria, were as yet dismembered from “Young Italy.”

War with Denmark.—Christian IX. succeeded to the throne of Denmark November 15, 1863. He endeavored to incorporate Schleswig with Denmark; the German population repudiated him and appealed to the Confederacy. The Diet sent troops into Holstein. Bismarck induced Austria to join Prussia in setting aside the London treaty of 1853, and the allied troops forced the Danes back to the intrenchments of Duppel. The capture of Duppel by the Prussians, April 18, proved the efficiency of needle guns and rifled cannon. June 22, the allies crossed the channel to the Island of Alsen and, on the 28th, captured the Danish stronghold Dennewerke, hitherto considered impregnable. The Treaty of Vienna, October 30, 1864, closed the war. Prussia and Austria together were to control the duchies.

The Seven Weeks’ War.—The arrangement between Prussia and Austria respecting the Danish duchies caused the “Seven Weeks’ War” of 1866. Bismarck induced Victor Emmanuel to form an alliance against Austria, March 27. The Prussians, on June 7, without a blow forced the Austrians to retire from Holstein, ignoring the protest of the Federal Diet.

Austria was not prepared for war. Her army, together with that of Saxony, amounted to two hundred and seventy-one thousand. With Prussia, fully equipped and on a war footing with three armies, besides the reserves, the grand total estimated at three hundred thousand, the result was a foregone conclusion. Prussia declared war, June 15, 1866, against Hanover, Hesse, and Saxony, and next day threw her armies into the hostile states. On the 17th Francis Joseph published his war manifesto. Italy declared war, on the 20th, against Austria and Bavaria. In fourteen days Prussia's immense army was mobilized. In five days the northern states to the Main were disarmed, and the Saxon army was forced to retreat toward Bohemia.

General Benedek was commander of the Austrians. Upon news of Prussian victories, he advised Francis Joseph to make terms of peace with William. Prussia fought for German unification; Austria to protect her pride. It was supposed the Austrians would first enter Saxony and dispute the Prussian advance, but Bismarck had determined the war should be brief, for Prussia was now master of the situation. On June 23, the Prussian army marched from three points towards Josephstadt, where Benedek was preparing to fight. On the 27th the Austrians were driven back at Soor, next day at Skalitz, and on the 29th at Gitschen. Archduke Leopold, on the 28th, and Count Clam Gallas, at Gitschen, both attacked the enemy in disobedience of orders, and thus forced Benedek to fall back from his strongest position towards Königgratz. The Austrians were also defeated, on the 28th, at Königinhof and Schweinschadel, and their loss by this time numbered over thirty-five thousand. Benedek asked permission to retreat into Moravia and await reinforcements, but news of the Austrian victory over the Italians at Custozza reached Vienna, and immediately battle was enjoined upon Benedek. Benedek placed five hundred guns in position, spanning a league between the Elbe and Bistritz.

On July 2, the king of Prussia assumed command of the Prussian hosts and ordered attack for the next day. The Crown Prince, several miles away with his army, received orders at four o'clock in the morning of the 3d to advance his Silesian army from Königinhof. At eight o'clock, Prince Frederick Charles, with a hundred thousand, attacked the Austrian centre lying against Sadowa. General Herwarth, with four hundred thousand men, attacked the Austrian right. The whole Austrian army was hurled against these two commands for five hours. Prince Frederick Charles forced passage through the Bistritz and took Sadowa, but could not take the heights. At one o'clock retreat was being considered, but the Crown Prince coming up with his troops the heights were taken at four o'clock. The fighting on both sides in this battle was determined and heroic. The Prussian loss was over ten thousand, and the Austrians lost twenty-seven thousand killed and wounded, nineteen thousand prisoners, with 174 cannon and 11 colors. At Lissa, on July 20, the Austrian navy destroyed the Italian fleet. July 22, an armistice of four weeks was granted. The Peace of Prague was concluded August 23. Her defeat cost Austria Venetia and the quadrilateral, namely, the fortresses of Peschiera, Mantua, Verona, and Legnano, deprived her of any part in Germany or German affairs, and Holstein and Schleswig, and obliged her to pay 40,000,000 thalers, one half of which she was to retain in lieu of the duchies.

Austria emerged from the "Seven Weeks' War" with her ideas somewhat liberalized, and though her territory was diminished her progress and prosperity increased. The dual-Austro-Hungarian empire was formed by Francis Joseph, he ruling at Vienna as Emperor of Austria and at Buda Pesth as king of Hungary. This war also ended the Germanic confederation of 1815, and the North German Confederation under Prussia arose.

At the peace of Vienna, October 3, Austria recognized the kingdom of Italy, and with the acquisition of Venetia and the quadrilateral fortresses the "Seven Weeks' War" had greatly helped on the cause of "United Italy."

In April, 1864, Louis Napoleon sent an army of twenty-five thousand to sustain the Austrian Archduke Maximilian on the throne of Mexico. At that time the United States was occupied with the Civil War. This ended, Napoleon was summarily required to withdraw his forces from the American continent, which he did. Maximilian was thus left to his fate, and, after being condemned by court martial, was shot at Querétaro, June 19, 1867.

The Franco-Prussian War.—Prince Leopold, of Hohenzollern, was offered the throne of Spain after Isabella had fled from Madrid. Leopold declined, but Napoleon demanded that the Emperor William should guarantee never to permit Leopold to accept. William refused to accede to the demand, and Napoleon, urged by the war party, declared war July 19, 1870. On the same day the Confederation placed its forces in the hands of William, as did the South Germans. This spontaneous uprising of all Germany was unlooked for. Napoleon's army numbered three hundred and ten thousand men. In ten days William had nearly half a million soldiers ready to march against the enemy. August 2, the first fight took place at Saarbrücken, a little town over the German frontier. Napoleon and the young Prince Imperial were present, and the force of Uhlans was driven back. August 4, the Crown Prince of Prussia drove the right wing of MacMahon's army back at Weissenburg, and on the 6th, again was MacMahon defeated at Wörth. The Germans, having separated MacMahon's army, advanced into Alsace. In the meantime General Steinmetz carried Spicheren by storm, and the whole German army went forward. Together with the Crown Prince, Steinmetz, on the 14th of August, defeated Marshal Bazaine, at Courcelles, who retreated to Metz, and then endeavored to push on with his hundred thousand men to Chalons. Von Moltke hurried on the Crown Prince to intercept Bazaine, and at Mars la Tour was fought the fiercest battle, so far, of the war. On either side the losses amounted to seventeen thousand. Gravelotte was fought, on August 18, between the armies of Steinmetz and the Crown Prince, King William commanding in person. The battle lasted all day between two hundred thousand Germans and one hundred and eighty thousand French. The Germans lost twenty thousand men, and succeeded in forcing Bazaine into Metz. Although, in one sort, an undecisive battle, Gravelotte perhaps settled the fate of the Empire. MacMahon's plan was, with his one hundred and twenty-five thousand men reorganized at Chalons, to prevent the German advance on Paris. He was overruled and sent to the relief of Bazaine. Defeated in several small fights, MacMahon was obliged to fall back on Sedan. The heights and ridges above Sedan once occupied by hostile troops, surrender or annihilation was the outcome. MacMahon was wounded, then Ducrot, and the command fell to Wimpffen. Sedan was forced to surrender, September 1, and Napoleon himself gave his sword to King William. Paris was maddened. The Empress escaped to England. Napoleon was taken to the castle of Wilhelmshöhe.

A month had hardly passed since the outbreak of the war, and one of the two great French armies with the Emperor had been captured; the other was besieged in Metz. Gambetta and other prominent men in Paris set up the government of the national defense. A republic was proclaimed. The defense of Paris was zealously undertaken. Large supplies of provisions were gathered. Fortifications were strengthened. The siege began September 19, 1870, and ended January 28, 1871. The direst famine attended it. Gambetta left Paris in a balloon, and at Tours succeeded in forming the army of the Loire and the army of the North. Both were defeated. Strasbourg was captured, and Metz surrendered with a hundred and seventy-three thousand men, among them three marshals of France. The entire German loss in this war was 129,700 men.

January 17, 1871, Thiers was elected President of the Third Republic. Knowing the impossibility of further resistance, with half a million German soldiers, flushed and inspired by constant success, on the soil of France, and Paris in their anaconda coils, he counseled that peace be asked. Thiers, Favre, and Picard negotiated with William and Bismarck. An armistice of twenty days was permitted, that the National Convention then at Bordeaux might ratify terms. In the meantime the house of Hohenzollern reached the summit of its gratified ambition, when, on March 18, William was crowned at Versailles, Emperor of Germany. The cession of Alsace and Lorraine, and $1,000,000,000 indemnity, was the price of peace.

No patriot name in all history deserves more reverence than that of Louis Adolphe Thiers. Upon him devolved the task of making peace with the German foe, of quelling the civil war, and of so managing the finances of France, that her people within two years were enabled, to the astonishment of the world, to pay the enormous indemnity extorted by the Germans, and, by September, 1873, the last franc was paid and the last German sentinel removed from the soil of France.

The civil war between the Republic and the Commune settled the question once for all, that *Paris*, accountable for all the errors and vicissitudes of the country, is not *France*, and there is every reason to hope that out of the unequaled horrors of those awful days of carnage the republican government of France arose to remain in perpetuity.

Garibaldi, taking advantage of the fall of Louis Napoleon, and caring not for the king's promises, took possession with his troops of the city of Rome, September 20, 1870, and on July 2 of the next year Victor Emmanuel erected his throne in the Quirinal.

Turco-Russian War.—In 1875, the Bosnians, Turkish subjects, revolted. They maintained their struggle, and the enraged Turks sent Mohammedan troops among the defenseless Bulgarians, destroying unnumbered thousands of men, women, and children. Czar Alexander declared war April 1, 1877. His army crossed the Balkans and occupied Shipka Pass. Osman Pasha developed unexpected military genius and skill. For five months he checked the onward march of the Russians and won world-wide admiration by his defense of Plevna. By the first of December Plevna was invested completely by the Russians. Driven back whenever attempting to make a sortie, starvation compelled Osman to surrender with forty-four thousand troops. Adrianople was occupied. The Treaty of San Stefano was wrested in sight of Constantinople. It greatly reduced Turkish power in Europe, and constituted Russia heir to Turkey in Europe. Bulgaria was to be protected by fifty thousand Russian troops for two years and to have a Christian governor.

Three months later, England formed a secret treaty with Turkey, securing Cyprus and agreeing to protect Turkey in Asia. Austria, too, was dissatisfied, and the treaty of Berlin was made in 1878, to rectify the balances of the nations. Russia was by this treaty damaged in prestige and, shorn of triumphs, was given only Asiatic provinces. Turkey was stripped of all real power in Europe.

Chino-Japanese War.—In Japan's declaration of war against China, August 1, 1894, she set forth succinctly the provocation forcing her to this action. She said that Korea had been brought into the notice of the nations of the world by her efforts; that China constantly had interfered with Korea's government, insistently posing as her suzerain; that when an insurrection in Korea broke out China sent troops into Korea, and that when Japan, under the treaty of 1885, also sent troops to assist Korea to quell the rebels, asking China's coöperation in the effort, China refused her rightful demand; that China's course tended to keep up the trouble indefinitely, so that the only course left for Japan was to declare war.

As with Germany a score of years previously, when the time came Japan was ready, not only with munitions of war, but with better topographical knowledge of the enemy's country than they themselves possessed. The Emperor, whose dynasty antedates the Christian era, gave his people a constitution, and stretching his hand towards Korea he helped her in the same direction. He had Japan's army and her navy drilled by expert European officers. Arsenals and extensive manufactories for the implements of war were started, with European superintendents. The latest and best of ships were both bought at foreign marts and made at home. Her students were to be found in the universities of the world. Her agents were sent to study in their capitals the economy of every government and the machinery of their executive departments. To find the best and assimilate it seemed the principle of her progression, so that both in military skill and the knowledge of diplomacy she acquired the ability to hold her place among the nations of the civilized world. A war alone was needed to prove that this was a fact.

Japan's navy consisted of four armored cruisers and eight vessels of 3000 tons each. This was a much lighter fleet than that of China, but swifter. China's navy had been trained by an able English naval chief, Captain Lang. Her outfit of ships was, perhaps, superior to that of Japan, consisting of five armored vessels, nine protected cruisers, and torpedo boats besides. The principal battle of this Chino-Japanese war was fought on September 15 at Ping Yang, an old capital of Korea, situated at the meeting of several roads. The Japanese landed troops at Gensan, on the northeast, and at Hwang-jo, on the northwest, coast of Korea. These formed the right and left wings of the army whose centre, under General Nodju, advanced from Seoul, about one hundred miles to the south, of which the Japanese were already in possession. Only one wing of the army met opposition in its march, a small battle having been fought. The forces, so far as we can learn, were between twenty and thirty thousand of Chinese and between thirty and forty thousand of Japanese. Japan's twenty-four years of scientific preparation, her study of the art of war, the practicability of her strategic movements,—admired by the soldiers of the world,—left China, with her old semi-barbarian methods, no chance for victory.

The battle was a bloody one; the defeated Chinese fled until they were on the other side of the Yalu River, in Manchooria. Seven hundred (some accounts say fourteen thousand) Chinese were captured, two thousand killed and wounded. The army continued fighting and conquering until practically the province of Manchooria was in Japan's possession, as well as the peninsula of Liaotung, terminating with Port Arthur.

The battle of Yalu, or Hai Yun Tao, afforded the first practical test of modern vessels, guns, and projectiles in Asiatic waters. Ping Yang has been called China's Sedan, and Yalu, Japan's Trafalgar. Japan had nine cruisers and two converted cruisers wherewith to fight twelve Chinese warships and four torpedo boats. It is said that Japan used melanite shells. The fleet of Chinese warships, convoying transports with ten thousand troops, entered the Yalu River. The next day, September 17, the Japanese fleet, under Admiral Ito, went out to meet them. A European officer on a Chinese vessel says: "Passing along the Chinese line, the Japanese poured as heavy a fire as they could bring to bear upon each ship in succession, and, while they had sea-room, circled round their opponents. The Japanese state that no Japanese war-ship was lost and only three seriously injured." A Chinese officer says: "As soon as the Chinese on the port side had brought their guns to bear and had obtained range accurately, the Japanese would work around and attack the starboard side." Four ships were destroyed and two badly injured. One of the Chinese ships was said to have been hit two hundred times. The Chinese ironclads that escaped were later sunk off Wei Hai Wei. Port Arthur, captured October 21, was filled to overflowing with ammunition, grain, and other supplies.

China made three informal overtures for peace. Finally, Li Hung Chang went from Tientsin to Shimonoseki, to make terms, on the 19th of March, 1895. By the treaty there made, May 17, China recognized the independence and autonomy of Korea, ceded certain territory in Manchooria, all the islands in the eastern part of the bay of Liaotung and the northern part of the Yellow Sea, Formosa, and all islands belonging to it, and the Pescadores group. Two hundred million Kuping taels were exacted as indemnity, to be paid in eight installments, one every six months. The inhabitants were to sell out and leave, or in two years to be Japanese subjects. Russia, Germany, and France recommended that Japan should not permanently possess the peninsula of Feng Tan, and Japan agreed to their suggestions.

Formosa, as a strategetical post, is of the greatest value. Korea and Japan now control absolutely the Japan Sea. It was only after four months of fighting that Japan completely conquered the Formosans and had all her new possessions under her control.

China paid Japan an additional $30,000,000 for the release of Port Arthur and Liaotung peninsula. China was well pleased. But in April, 1897, Russia herself had obtained possession of Port Arthur and Talien Wan, and in December the Germans received Kaio Chao, the finest naval station of the province of Shantung. France subsequently obtained Kwang-Chau, the best port of Wangsi; and England, though not joining these powers in the demand in favor of China in 1895, obtained Wei Hai Wei in 1897.

Greco-Turkish War.—In 1895, the fearful atrocities committed by the "unspeakable" Turk began to assume appalling proportions. During three years one hundred thousand Cretans were murdered. February 8, 1897, the Cretans proclaimed union with Greece. The Greeks, unable longer to endure the sufferings of their kindred, determined to help them.

Prince George left for Crete with a torpedo flotilla February 10; Colonel Vassos, aide-de-camp to the king, followed with fifteen hundred men and two batteries on the 13th. Prince Nicholas led a regiment of artillery to the Thessalian frontiers. The powers sent a collective note of protest to Greece, but it was not heeded. Colonel Vassos landed in Crete on the 14th. Sailors from the fleet of the powers occupied the coast towns of Crete. Pasha Berovitch resigned and returned to Constantinople. Greek reserves rallied promptly. Volunteers offered. Colonel Vassos established headquarters in the mountainous interior at Sphakia.

March 18, the powers blockaded Crete. On the 27th, Crown Prince Constantine proceeded to the Turkish frontier. On April 5, the powers declared no gain should accrue to the combatant who approached Thessalian borders. April 8, three thousand Greeks crossed near Krania, began fighting, and were driven back. On April 17 Turkey declared war. On the 18th, a battle of twenty-four hours, in Milouna Pass, crowned Turkish arms with victory. Another hard fought battle, at Reveni, discomfited the Greeks. Greeks passed the Arta River and Greek ironclads bombarded Prevessa. On the 19th, the Turks were in Thessaly and the Greeks in retreat to Larissa. After terrific battles Tornavo and Larissa, on the 25th, fell into the hands of the Turks. Colonel Smolenski fought desperately at Valestino, but had to yield; and Volo also fell to the Turks. The Turks occupied Pharsaos on May 6. Greece asked the powers for peace, May 8; Cretan autonomy was agreed to, and Turkey permitted armistice on the 15th. The war closed. Turkey was forced to yield all Thessalian territory, and Crete was relieved of Turkish oppression. Greece was forced to withdraw all support from Crete and pay $20,000,000 indemnity.

The remarkable feature of this war was the intensely hard fighting from start to close, and the disposition of the powers to assist Turkey by interfering with the Grecian navy. Frequently the Austrians helped the Turks by placing their guns in position. It was only when the Sultan conquered Thessaly and threatened to keep it that the powers interposed.

The crime committed by the powers against civilization and Christianity by their action seems incredible, even though the peace of Europe was thereby secured.

England's Wars in the Soudan.—The Khedive of Egypt had obtained great loans from Europe. England and France took financial control of the country. Arabi Pasha inaugurated a rebellion and fortified Alexandria. Many Europeans were murdered, and England bombarded the city, taking possession July 12, 1882. General Wolseley, at Tel el Kebir, September 13, fought and defeated Arabi, who fled leaving two thousand dead. France withdrew from the financial arrangement. The English remained to put the Egyptians in condition for self-government. England has remained ever since.

Mohammed Ahmed arose in the Soudan, proclaiming himself El Mahdi, the Mussulman Messiah. The barbarian hordes flocked to his banner. He defeated the Egyptians in four engagements, October, 1883. The Anglo-Egyptian force of ten thousand men, under General Hicks, was destroyed, only two escaping. General Gordon was sent to the relief of the Egyptian army. He reached Khartoum, February 18, 1884. The Mahdists besieged the city. Gordon sent for reinforcements. England was so slow in sending them that they arrived two days too late. Khartoum was captured through treachery, and Gordon, the most beloved of English soldiers for his saintly and heroic character, was put to death on January 27, 1885.

General Sir Horatio Herbert Kitchener was made Sirdar in 1890. He started from Cairo with one thousand British and fifteen thousand Egyptians, black and fellah troops, building a road across the desert as he advanced, and engineering his gunboats up the Nile. The distance from his base, at Cairo, to his first storehouse, at Wady Halfa, is eight hundred miles. April 8, 1898, was fought the battle of Atbara, a fort at the point where the Atbara River enters the Nile. Here Mahmud, the commander of the barbarians, was captured and his army of twelve thousand infantry destroyed. Osman Digna got away with the greater part of the cavalry, numbering four thousand.

The force was about a month reaching Wady Hamed, and, September 1, was in sight of Omdurman. The Sirdar's line was drawn up in crescent form, with Omdurman and Khartoum for its centre. In this position was fought the first battle of Egeda, in which twenty-two thousand of the Dervishes fell. The Khalifa and Osman Digna fled with a scant handful of followers, and are now said to be bandits in the Kordofan. The number of the annihilated army of the Mahdists will never be known. The British loss of whites was less than two hundred, and the native loss less than three hundred. The fire of the barbarians was generally too high to effect great injury. September 2 will be a marked day in England's calendar. The Sirdar marched into Khartoum, the Union Jack was raised, and beneath its floating crosses his chaplains performed Gordon's funeral ceremonies on the spot where he was slain nearly fourteen years before.

The Boer War.—By the treaty of 1881 Great Britain claimed suzerainty over the South African (Transvaal) Republic and Orange Free State. These Republics claimed that by the treaty of 1884 Great Britain gave up her claim of suzerainty. Here arose an issue which was aggravated by the discovery of diamonds at Kimberley and of gold at Johannesburg, followed by the Jameson raid, which, shorn of its disguise, was notice to the Boers that Great Britain desired and designed to occupy and absorb their two Republics. The diplomatic war went on for years between President Kruger, of the Transvaal, and Mr. Chamberlain, Great Britain's Colonial Secretary. It culminated in an ultimatum on the part of Kruger, on October 9, 1899, which Chamberlain rejected. Both sides had been preparing for this, and on October 11, the outbreak of the war, Great Britain had already an army of 25,000 men in South Africa, while the Boers had mobilized an equal, if not superior, army of effectives. The Boers immediately invaded Natal and Cape Colony, shutting up General White and his army in Ladysmith, and Colonel Powell and his forces in Mafeking. Kimberley was also besieged. The initial battles were numerous, fierce, and generally favorable to the Boers. Great Britain's eyes were speedily opened to the gravity of the situation. She hurried large reinforcements to the scene till her armies far outnumbered those of the Boers. Yet her best generals, as Buller at Tugela River, and Methuen, at Magersfontein, continued to meet with disastrous defeats. Lord

Roberts, in connection with General Kitchener, was sent, January 10, 1900, to supersede the blundering generals, and to organize a new campaign. It was seen that direct battle against the Boers was bound to end in defeat. So Roberts was provided with an overwhelming army, estimated at 225,000, and he at once entered upon a war of strategy. His northward advance was general along his lines, thus keeping the Boers divided. He flanked them out of their strongholds. By February he had invaded the Orange Free State, and raised the siege of Kimberley. On February 27 he captured General Cronje and his force of 4000 men, and on March 13 took possession of Bloemfontein, the Free State capital, whence he issued a proclamation annexing the republic under the name of Orange River Colony. On February 28 the siege of Ladysmith was raised, and shortly after that of Mafeking. The Boers continued to fight doggedly, all the while inflicting heavy losses on their enemy, but resistance was futile against such overwhelming odds. They were gradually forced from one position to another in the direction of Pretoria, the Transvaal capital. On March 5 Presidents Kruger and Steyn joined in peace proposals, which were rejected. On March 12 they made an appeal to the nations for mediation. All refused to mediate. On March 27 the Boers lost their ablest general in the person of General Joubert, who died at Pretoria. By May 12 Kroonstad, the second Free State capital, had fallen into Lord Roberts' hands. The Vaal River was then crossed and the Transvaal invaded. On May 31 the British army entered the important town of Johannesburg, and hastened toward Pretoria, which was captured on June 5, 1900. President Kruger and General Botha had left a few days before, the former in the direction of the Portuguese port of Lorenzo Marques, the latter with the remnant of the Boer army to the mountains beyond Pretoria. On September 3 Lord Roberts declared the Transvaal annexed to Great Britain under the name of the Vaal River Colony. Generals Botha and De Wet continued a guerrilla warfare far past the end of the century. President Kruger accepted the protection of Holland, and sailed thither on October 20, 1900. Lord Roberts arrived in England in December, 1900, to receive his honors. At the turn of the century the South African problem was a most wearying one for Great Britain.

The Boxer Uprising.—The defeat of China by Japan in 1894, the ambition of European powers to occupy her ports and enlarge their "spheres of influence," the ominous threats to partition her territory, soured the Manchu dynasty and the people of northern China against foreigners. The Empress Dowager deposed the young Emperor, seized the reins of government, and catered to that reactionary and hostile spirit which culminated in the "Boxer" uprising. These mobs began the destruction of missions, the murder and expulsion of missionaries, and concerted attack against everything that savored of foreign direction and influence. The Chinese regular soldiers were either helpless before them or in sympathy with them. By May, 1900, all the powers represented at Peking stood aghast at the startling fact that their respective legations were beleaguered in Peking, and liable to be murdered. Warships were instantly ordered to Taku. By June 1, 1900, twenty-three vessels had reported,—nine Russian, three British, three German, three French, two American, two Japanese, one Italian. A force of 2000 soldiers was landed from these, and immediately started for Peking, under command of the British Rear-Admiral Seymour, for the rescue of the legations. This force was defeated by the "Boxers," and compelled to retreat to Tien-Tsin with heavy loss. An attempt to torpedo the Taku harbor was resented by the warships. They bombarded and blew up the Taku forts. In this action the American warships did not participate. The "Boxers" swarmed in Tien-Tsin, and an allied force of 4000 men was sent thither to capture it. In their first attack, on July 9, they were repulsed with heavy loss. Being reinforced up to 7000 men, their second attack, on July 13, was successful. The city was taken, and made the base of further operations against Peking, 80 miles up the Pei-ho. The allies were further reinforced, and started for Peking with an army of 16,000 men. They met the Chinese army of 30,000 men at Pei-Tsang, and after a severe battle on August 5, drove them from their fortifications with great loss. The Chinese rallied at Yang-Tsun, but were again defeated by the allies on August 6. They offered no further serious resistance to the allies, who moved swiftly on Pekin, invested it, and, on August 14, breached its walls and entered it in triumph. The legations were relieved after an imprisonment of nearly three months. Two ministers, one of Japan, the other of Germany, had been murdered. The others had escaped death only by concentrating and defending themselves in the English compound. The allied forces occupied the city for a time, and then those of Russia and the United States withdrew, leaving a strong legation guard. The Chinese government appointed Li-Hung-Chang and Prince Ching ministers to meet ministers of the powers to arrange terms of settlement. After months of conference a protocol was signed in January, 1901, which was supposed to contain the germs of future settlement. But there was that in the Chinese situation which was bound to tax the diplomacy of the world during many years of the twentieth century.

A Review of Martial Results.—The history of the world shows that successful war adds to the glory and prestige of the victorious nation, and this is particularly exemplified by the wars of the nineteenth century. France, so long victorious, dazzled the world. At Waterloo, her glory was clouded. Napier, in his closing words of the history of these events of the twenty years of war and turmoil, showed how thoroughly the English people appreciated that their greatness and power were due to the glory achieved by the arms of Britain's chivalrous sons.

While England was covering herself with glory, her offspring, the United States, was teaching her, in the war of 1812, that being now of age his pockets were not again to be turned inside out, a lesson which thereafter she heeded.

Greece, throbbing with the impulse of freedom, achieved her independence, displaying all the heroism of her Hellenic ancestry.

The Mexican war added greatly to the glory of American arms and resulted in the acquisition of a vast territory, whose inhabitants quickly assimilated themselves to the requirements of American citizenship.

The Revolution of '48 but served to consolidate the power of Prussia, laying the foundation for the Imperial crown to rest upon the head of her king, while fitting France for her future solid republican career.

The Crimean war, except that it checked the policy of Russia, produced few results in comparison with the vast amount of blood and treasure so lavishly spent.

The victories of Magenta and Solferino illumined again the eagles of France. The "Seven Weeks' War," while still further consolidating Germany under Prussia, was not without its blessings for Austria, and advanced "Young Italy" greatly toward the goal of her ambition.

In America, the appeal to arms was made to decide the questions mooted since the nation's birth. One effect of this war was to show the wonderful prowess and soldierly qualities of the American citizen.

The Franco-Prussian war lifted the dignity of Hohenzollern to its height, ended forever the Empire of France in a crushing fall, and taught the lesson of scientific preparation for war, than which no science is more worthy of intense study and application in all its branches.

The Chino-Japanese war was a triumph of a growing civilization over semi-barbarism, and foreshadows the prominent rôle that Japan may be called upon to play in the twentieth century. The enlargement of her territory was a fitting reward for her unselfish championing of her weaker sister, Korea.

The Greco-Cretan-Turkish war shed no glory on the Turkish nor on the so-called Christian nations, and will stand on history's page as a crowning shame to European civilization.

The opening of Africa by General Kitchener and his great achievements read like old-time stories, and the twentieth century may see great results in Africa from this wonderful campaign.

The war of the United States with Spain, fought because it was impossible longer to allow the atrocities of her rule on this hemisphere at our very doors, has brought conditions not dreamed of, and which, under the providence of God, may lead to greater results in the development of Christian civilization than we now may comprehend.

The Boer war had little instigation on the part of Great Britain, except greed. Its management reflected no credit on her military genius, weakened her in the eyes of nations, and entailed a loss of life and money from which she will not recover in generations.

The Chinese disturbance did not rise to the dignity of war, but opened problems of startling intricacy and moment for all the powers.

The Century’s Fairs And Expositions

By GEORGE J. HAGAR,
Editor of Appendix to Encyclopædia Britannica.

Dr. Alfred Russell Wallace, in a recent work, argues that the nineteenth century is altogether unique in that it inaugurated a new era. To grasp its marvelous achievements, he tells us, it should be compared with a long historical period, rather than with another century, however happily selected. The progress it environs is set down as almost wholly material and intellectual, and the palm for completeness is given to the material. Debatable as his conclusion may be, there can be no dispute either as to the qualitative or quantitative progress in the material advancement of mankind in the century now closing. In the present retrospect the broader view becomes apparent,—that the material and the intellectual have been allied forces that have constantly pushed forward side by side, one devising in the solitude that genius needs for expansion, the other showing to the world the realizations of thought that in practical application benefit all.

The evolution of the international exposition of to-day is a conspicuous result of this material and intellectual wedlock. It seems a long time between the fair that was held to allow people not closely settled to purchase the ordinary commodities of life, food, clothing, and household belongings, and the great expositions to which the nations of the world bring the surpassing embodiments of native thought. Measured by years, the time is really beyond computation; but measured by results, mere time is annihilated, and the progress that the evolution illustrates is found to have kept a steady pace with man’s physical necessities and intellectual growth. The moment Necessity has shown that mankind needed something to make life brighter, happier, or more comfortable to pass through, Intellect has undertaken the task of creating it and has fashioned out the Material.

In the great expositions of to-day are seen the effects of the marvelous influence which sprang from the fair as a market, instituted so long ago that no call for the records is answerable. Of this kind, only a very few remain. Then came the fair designed to promote the useful arts and manufactures; the fair to advance agriculture and allied industries; and the fair to show special articles, to commemorate historical events, and to aid interests of large public concern. Under an ever-increasing expansion, stimulated by popular favor, the fair, with the commercial feature abandoned or having it only as a restricted branch, became the exhibition to show a larger development of the arts, sciences, and mechanical trades; to celebrate great public occurrences on a grander scale than earlier fairs had done; to promote special industries, local or national; to aid education by permanent displays of natural or manufactured products; and to promote the commercial intercourse of the world. From the first of this class of exhibitions came the international undertakings, first known as world’s fairs, and afterward as international exhibitions and expositions. In some one of these classes may be found every kind of a display of products, irrespective of its purpose or individual name.

The development of the modern exhibition from the early fair has been confined to no one country nor people. Everywhere the purpose and process have been the same. A few years changed the old-time mart, where people went to buy what they knew they would find, to the convenient place where tradesmen placed on view the things they knew people would need and buy, as well as articles offered at a venture that people who really didn’t need them might be tempted to purchase because of novelty or other quality. Thus, the bargain counter and the department store are several hundred years older than the thrifty housewife of to-day reckons.

Trade competition, then as now, led to a broadening of plans, rival efforts, and special attractions. People began to attend fairs to see what was new, as well as to buy; and soon, lest they should tire of sightseeing, it became necessary to provide means for entertaining them. Punch and Judy came on the scene with perennial popularity. Jugglery astounded the young and fascinated their elders. Dancing and wrestling rings proved sportive magnets of annually increasing strength. The fair now began to change from a strictly commercial undertaking to an occasion for holiday hilarity, and soon trade and amusement were struggling for the mastery. In many places, hilarity led to excesses, and excesses to crime. Public opinion demanded the forceful intervention of the law, and one by one the most demoralizing fairs were suppressed, the notorious Donnybrook closing its long career of debauchery and lighting in 1855.

The display of merchandise and the gathering of customers at the most noted fairs in time became really enormous, and for many years the great fairs of the day were held on open and extensive plains. Then, too, the fair assumed an importance that led first the local authorities, and after them higher dignitaries, to seek to turn it to their individual advantage. For a time no fair could be held in Great Britain without a special grant from the crown, and it was a widely observed custom for royal or ecclesiastical authorities to give permission to a town or village that had suffered some misfortune to hold a fair as a means of reestablishing itself. The famous fair of St. Giles's Hill, near Manchester, England, was instituted as a revenue to the bishop by William the Conqueror. That it was a valuable monopoly is shown by the facts that its jurisdiction extended seven miles around the city, and that all merchants who sold wares within that circuit, unless at the fair, forfeited them to the bishop.

A curious evidence of early international interest in the fair, as well as of its importance and influence, is found in the records of 1314, when King Philip of France sent a formal complaint to King Edward II. of England, to the effect that the merchants of England had ceased frequenting the fairs in his dominions with their wood and other goods, to the great loss of his subjects. Philip entreated Edward to persuade, and, if necessary, to compel, English people to frequent the fairs of France as formerly, promising them all possible security and encouragement.

As a purely commercial institution, the fair had its best day when people were widely separated. The increase of population, the development of new life and activity by growing communities, the opening of means of travel between distant points, and the establishment of stores and markets, were all fatal to the commercial fair. To-day, in all Europe, only three really great annual fairs of this character remain,—those of Nijni-Novgorod, in Russia; Beaucaire, in France; and Leipsic, in Germany. The same conditions that brought the popular usefulness of the commercial fair to an end were the forces from which the fair as an exponent of industrial achievement has been developed, and the material progress of the nineteenth century is to be traced.

For the modern fair in all of its forms the world is indebted to the Society of Arts, of London, an organization whose fame in America was so great that Benjamin Franklin, in soliciting corresponding membership, declared that he would esteem it a great honor to be admitted and also to be permitted to contribute twenty guineas to be expended in premiums. What this Society in its early days did for Great Britain it did also for civilization. It organized the first exhibition of specimens of improvements in the useful arts and manufactures in 1760; stimulated native ingenuity by judicious awards of prizes and premiums for exhibits of exceptional merit; and extended its powerful influence to foster art, science, mechanical and agricultural industry, and the fishery trade and colonial commerce of the country.

Of the many influences of this Society that came to the United States, it may be questioned if any had a more lasting benefit for both people and country than that which gave birth to the mechanics' institutes. There are people still living who are able to recall how the large cities in the Eastern and Middle States vied with each other in the establishment of two great and kindred institutions—the mechanics' institute and the apprentices' library. Philadelphia led the cities in the matter of time, her Franklin Institute being founded in 1824. Four years afterward the American Institute was chartered in New York City. After these came the Massachusetts Charitable Mechanics' Association in Boston, the Maryland Institute in Baltimore, and numerous others,—those mentioned being the principal ones that still maintain annual or other exhibitions. At first, the exhibitions of these institutes, like the first one ever held under the patronage of a national government,—that in Paris in 1798,—were composed of various articles loaned by their owners. Soon, however, the popularity of the institutes and the awarding of prizes and diplomas brought to the exhibitions specimens of the handicraft of members and friends, and the rising lights in the arts and manufactures became eager to secure the recognition of their genius that such awards established. Thus, the influence of the principal surviving institutes has spread far beyond local limits.

Purely national exhibitions have never found much popular favor in the United States. When as a whole people we decide to hold one for a purpose of general interest, we prefer to set a large table and invite the universe to help us celebrate. In France, the first national exhibition was a loan exhibition. Its effect, however, was so immediate that the government repeated it the same year, organized more elaborate ones in 1801 and 1802, and decided to hold them triennially thereafter—a course that has since been interrupted by political exigencies. These exhibitions were projected to illustrate the progress of France only. In the United States there have been no State exhibitions, excepting agricultural fairs, for which outside coöperation has not been invited.

The life of the American agricultural fair is almost measurable by the full century. This, too, had its origin in England. The father of the American system of combined agricultural fairs and cattle shows was Elkanah Watson, a native of Plymouth, Mass., who spent the greater part of his life in promoting large public measures besides agriculture and education. In 1807 he removed from Albany, N. Y., to Pittsfield, Mass., where he engaged in general and experimental agriculture and cattle-raising. His efforts to improve local farming conditions and to raise a superior breed of cattle attracted widespread interest, and this suggested to him that an annual exhibition of cattle and of farm products, resulting from a more painstaking system of cultivation than was commonly followed, would prove of material advantage to the farmer, the breeder, and the general public. Accordingly, he induced his farming friends in the country to contribute specimens of improved breeds of cattle and of superior products of the soil; and the first exhibition or fair was held in 1810. This, with modest prizes for the best exhibits, proved a complete success.

Encouraged by the results of his initial efforts, he went to Boston to solicit pecuniary aid for a second and much larger exhibition. Although he was at that time widely known for his public-spirited philanthropy, and also as the founder of the influential Berkshire Agricultural Society, his appeals for aid brought him little save derision. To show how small concern was felt by business and public men toward the farming industry, a sentence in a letter from ex-President John Adams to Mr. Watson is sufficient:—

"You will get no aid from Boston; commerce, literature, theology, medicine, the university, and universal politics are against you."

The ex-President was correct in his judgment. Mr. Watson did not receive a single favorable response to his appeals; yet he lost not a particle of faith in the wisdom of his undertaking. With the coöperation only of the farmers in his county, Mr. Watson succeeded in arranging annual exhibitions until 1816, when he returned to Albany. The same year he organized the first agricultural society in the State of New York, and began establishing fairs and cattle shows in the near-by counties. In 1819 he secured the passage of an Act by the Legislature appropriating $10,000 annually for six years for the promotion of agriculture and domestic manufactures, conditional on a like amount being raised by the agricultural societies in the different counties. A State Society was incorporated in 1832, to which county societies were directed to report, while it, in turn, had to render a combined report to the Legislature annually.

Since then an agricultural department has become an indispensable part of the government of the various States and Territories, even of those that are popularly believed to be only metallic producers. The character of the state and county agricultural fair has been undergoing a radical change for many years, especially in sections thickly settled or near large cities, and the chief attractions have passed from the exhibition of sleek domestic animals and choice fruits of the soil to horse-racing and bicycle contests. Innovations foreign to the spirit and intention of the fair have already wrought its ruin in many places and are threatening it generally.

Of American fairs in the original commercial sense, those held during the Civil War, to aid the work of the United States Sanitary Commission on the battlefield and in the camp and hospital, will always be historically conspicuous. During those memorable four years it is doubtful if there was a single city, town, or village in the Northern States that did not put forth a special effort to provide necessities and conveniences for the soldiers and sailors that were not supplied by the government, and the fair was the most popular form of raising the needful money.

Exhibitions of special articles, possessing the features of state, national, and international combinations, and independent of any locality, event, or period of time, are growing in frequency. Many of these have a predominating technical interest,—as the international exhibitions of fisheries and fishery methods, of life-saving methods and apparatus, of forestry products and systems of forest preservation, and of railway appliances; while others combine the technical and popular features, as the exhibitions of electrical apparatus, of improved food preparations, of bicycles, of automobile vehicles, and of wood-working and labor-saving machinery.

Special exhibitions in the United States that possess a large popular interest include the annual showing of the art associations and leagues in the principal cities, and the annual horse, dog, and sportsmen’s shows in New York city. Among them also are to be noted the permanent expositions in Philadelphia and Chicago—both reminders of the greatest international expositions that had been held up to their day. The Philadelphia exposition is held in Memorial Hall, the building erected in Fairmount Park by the State of Pennsylvania at a cost of $1,500,000, and used for the Art Gallery of the Centennial Exposition in 1876. It now contains an art and industrial collection similar to the famous South Kensington Museum in London. The Chicago exposition is in the former Art Palace of the World’s Columbian Exposition in 1893, and, having been endowed by Marshall Field with $1,000,000, is now known as the Field Columbian Museum. Its most conspicuous feature is a collection showing the development of the railway, and the next, its forestry exhibits. In the line of permanent expositions, Philadelphia is to be credited with two commercial museums of far-reaching influence that will be considered further on.

The first exhibition of the industries of all nations was that held in Hyde Park, London, in 1851. It was an outgrowth of the annual exhibitions of the Society of Arts, before mentioned, and was at first designed to be only a national enterprise, but on a more extended scale than the former exhibitions of the Society. The late Prince Albert, husband of Queen Victoria, however, conceived the idea of throwing this particular exhibition open to the industry of the world. His suggestion at once met the favor of the Council of the Society, as well as of the leading manufacturers of England and the general public. A royal warrant was procured appointing a commission to "manage an exhibition of the works of industry of all nations," and of this body Prince Albert became president.

On February 21, 1850, the commissioners felt justified in making a public announcement that the building would cover an area of from sixteen to twenty acres; that it would be ready for the reception of goods by January 1, 1851; and that the exhibition would be opened to the public on May 1, following. The plans for a building submitted by Sir Joseph Paxton were accepted after a large number had been considered. They called for a vast structure of iron and glass, somewhat similar to the great conservatory he had erected for the Duke of Devonshire at Chatsworth. A contract was signed with Messrs. Fox and Henderson for the construction of the building, under which they were to receive £79,800, and the materials of the building were to remain their property. On February 3, the completed structure was formally delivered to the commissioners. It had an extreme length of 1851 feet and an extreme breadth of 408 feet, with an additional projection on the north side, 936 feet long by 48 feet wide.

While the erection of the building was in progress, Dr. Lyon Playfair was chosen to decide and classify the wide range of articles that was sought to be brought together under the general title of "Objects of Industrial and Productive Art." He arranged these under four great sections: Raw Materials, Machinery, Manufactures, and Fine Arts, and they in turn were divided and subdivided into a vast number of classes and smaller divisions. The collecting of national exhibits was placed in the hands of district committees in all the principal towns and manufacturing localities, and in response to invitations extended to all the British colonies and the various foreign governments, nearly every country in Europe, almost every State in the North American Union, the South American republics, India, Egypt, Persia, and the far-off islands of the seas, sent objects that swelled the total estimated value of exhibits—excluding the renowned Koh-i-noor diamond—to £1,781,929.

The exhibition was opened by Queen Victoria on the appointed day, and was continued till October 11. The total number of exhibitors was about 15,000. During the 114 days the exhibition was open a total of 6,063,986 persons visited it, a daily average of 42,111. The largest number in a single day was on Tuesday of the closing week, 109,915. An attempt to ascertain the number of foreign visitors developed the unexpected result that not much more than 40,000 foreigners visited London beyond the annual average of 15,000. The financial result of the exhibition was really remarkable. The total receipts from all sources amounted to £506,000, and the total expenditures to about £330,000, leaving a surplus of £176,000, which was subsequently increased to £186,436.

The distinctions of all kinds that were awarded, Council and prize medals and "honourable mentions," aggregated 5084. It is here interesting to note, as showing the truly international character of the first world's exhibition, that foreign guests occupied two-fifths of the exhibition space and received three-fifths of the honors. British exhibitors of machinery, manufactures in metal, and manufactures in glass and porcelain, took more prizes than all the foreigners combined. Foreigners led in the number of prizes for textile fabrics, fine arts, and miscellaneous manufactures; and in the section of raw materials for food and manufactures the foreign exhibitors gained nearly four times as many prizes as the British.

This exhibition developed a number of features that should be borne in mind when considering those that came after it. It was an experiment in an untried field; it was comprised in a single building; and it was self-supporting. In all respects it was a marvelous achievement. It made the late Prince Consort the “father,” and the Society of Arts the pioneer promoters, of the international exposition.

The beneficial influence of the first world’s exhibition began to be felt immediately. An exhibition of the arts and manufactures of Ireland was held in Cork in the following year, and the Royal Dublin Society, which had been holding similar exhibitions triennially, got up a much larger one than usual, through the generous pecuniary aid of William Dargan, in 1853. The Dublin exhibition, unlike that of Cork, was international in scope.

American visitors to the London exhibition brought home with them a pretty large inspiration for a similar effort, and before the close of 1851 a number of citizens of New York had associated themselves for that purpose. In January, 1852, the corporation of the city of New York granted a lease for five years of Reservoir Square, on the conditions that a building of iron, glass, and wood should be erected thereon, and that the entrance fee to the proposed exhibition should not exceed fifty cents. In March, the Legislature incorporated the Association for the Exhibition of the Industries of all Nations, with a capital of $200,000 that might be increased to $300,000. Subsequently, the Federal Government constituted the building a bonded warehouse and exempted foreign exhibits from the payment of duties.

This exhibition was therefore a private enterprise, having no other official recognition than that mentioned. It was also an unfortunate affair from beginning to end. The location was then three or four miles from the heart of the city; the area was entirely inadequate for the purpose; the day of opening had to be postponed, because of the incomplete condition of the building; and financially the enterprise was a huge failure.

The exhibition was opened July 14, 1853, with much ceremony, although still scarcely half ready for exhibits or visitors, and was continued for 119 days. There were about 4800 exhibitors, somewhat more than one-half being foreign. The total cost of the exhibition was nearly $1,000,000, and the receipts were $340,000. Although a financial failure, and a disappointment in many ways, this first international exhibition in the United States was productive of much good.

The success of the London exhibition also aroused the French to depart from the exclusively national character of their former exhibitions and to inaugurate one open to the world. This was done under the direct auspices of the Imperial Government, which undertook to combine certain features of both the London and the New York enterprises; hence, the first international exhibition held in Paris was practically a private scheme supported by official guarantees. A further departure was here made in the matter of building, and, instead of the single great structure, there were the Palais de l’Industrie, the Palais des Beaux Arts, the Panorama, and three smaller buildings for agricultural implements, carriages, and a variety of less costly articles. Another innovation was here introduced, a partial return to the methods of the commercial fair, in the setting apart of exhibiting spaces on the open ground.

The main building, the Palais de l’Industrie, was erected by a joint-stock company on the Champs Elysées, and provided a floor space of 1,770,000 square feet. It was built of glass, stone, and brick, and was 800 feet long by 350 feet wide. The various buildings cost about $5,000,000, and the Palais de l’Industrie was erected for a permanent structure.

This exhibition was opened on May 15, 1855, and closed on November 15, following. It was visited by 4,533,464 persons. Besides France and her colonies, fifty-three foreign states and twenty-two colonies belonging to them sent exhibits. In all there were 20,839 exhibitors, those of France and her colonies predominating by only about 500. The exhibits were classified on the London plan, there being in each case thirty classes altogether. Excluding the main building, which the Imperial Government acquired, the exhibition cost about $2,250,000.

Between the first and second London exhibitions there were many industrial and art displays in the United Kingdom and colonies and on the Continent, among which should be noted those of New Brunswick and Madras in 1853, Munich in 1854, and Edinburgh and Manchester in 1857.

The second London exhibition was undertaken by a commission headed, as the first, by the Prince Consort, under a guarantee fund of $2,250,000. While it was in course of preparation the Prince Consort died, and for a while a heavy pall hung over the scheme. The commission here introduced the French idea of separate buildings. The site was at South Kensington, and the main structure was built of brick, glass, and iron, was nearly rectangular in shape, and covered an area of about seven acres. With the annexes the total area under roof was about twenty-three acres.

This exhibition was opened by the Duke of Cambridge on May 1, 1862, and remained open for 177 days. It was visited by 6,211,103 persons, a daily average of 36,329, its receipts were wholly absorbed by expenses, and a slight deficit was left. Foreign exhibitors numbered 17,861, and received more than 9000 prizes.

In 1863 the French Government announced that an exhibition would be held in Paris in 1867, that was intended to be more completely universal in character and more comprehensive in plan than any that had ever been held. The Champ de Mars, the great parade-ground on which the Ecole Militaire faced, containing about 111 acres, was placed at the disposal of the commissioners by the Government. In the centre of this space was erected the principal building, an oval structure mainly of iron, 1607 feet long and 1246 feet wide, that cost $2,357,000.

In planning this building the convenience of exhibitors and visitors in ready access to the exhibits of any desired country or class was given the preference over architectural effect. Here, again, was a diffusion of exhibits in detached buildings, and a noteworthy novelty was the reservation of ground on the park surrounding the main building for the erection by foreign exhibitors of special buildings for the display of articles that could not be accommodated in the main structure. This feature became the most popular one of the entire exhibition, for it gave a most graphic illustration of the architecture, manners, customs, and countless peculiarities of the peoples of the world.

The exhibition was opened by the Emperor on April 1, 1867, and was closed on October 31, following. The number of visitors was upward of 15,000,000, a daily average of nearly 70,000, and of exhibitors, 51,819. In all, 12,944 medals and grand prizes of honorable mention were awarded. From beginning to end the expenses were $4,596,764, and the receipts aggregated $2,822,000. The national and municipal governments contributed $1,200,000 each, which added to the receipts of the exhibition proper created a surplus over expenditure of $626,000.

London’s third exhibition, from May 1 till September 30, 1871, was projected as the first of an annual series that should separately promote a distinct branch of industrial effort. Thirty-three foreign countries were represented; there were approximately 4000 art and 7000 industrial exhibitors; and the visitors numbered 1,142,000. The second in the series, in 1872, was confined to printing, paper, music, musical instruments, jewelry, cotton goods, and fine arts; and the third, in 1873, was devoted to the general subject of cookery.

Great as was the universal exposition of Paris in 1867, that at Vienna in 1873 far surpassed it in extent and grandeur, although its pecuniary success was severely affected by an epidemic of cholera, a financial crisis, and local extortions. As each of the preceding international exhibitions had developed a distinctive feature, so this of Vienna introduced the custom of holding world's congresses for the discussion of great problems of universal application.

The exhibition was opened on May 1 and closed on November 3, following. Turnstiles recorded the entrance of 7,254,687 visitors. There were about 70,000 exhibitors, whose display, in extent and costliness, exceeded that of Paris in 1867. The gross receipts were about $2,000,000, and expenditures about $9,850,000, making a deficiency of some $7,850,000, which the Government liquidated. The United States was represented by 643 exhibitors, more than half of whom were awarded prizes.

This brings the record up to the Centennial Exposition, at Philadelphia, in 1876, and covers the third quarter of the century. The actual work of making the Centennial Exhibition began on March 3, 1871, when Congress passed an Act creating the United States Centennial Commission. This authorized the President to appoint a commissioner and an alternate from each State and Territory, on the nomination of the respective governors. The appointments were promptly made, and from the whole body of commissioners the following were chosen for the principal executive officers: President, Joseph R. Hawley, of Connecticut; Vice-Presidents, Alfred T. Goshorn, of Ohio, Orestes Cleveland, of New Jersey, John D. Creigh, of California, Robert Lowry, of Iowa, and Robert Mallory, of Kentucky; Director-General, Alfred T. Goshorn; Secretary, John L. Campbell, of Indiana; Assistant Secretary, Dorsey Gardner; Counselor and Solicitor, John L. Shoemaker.

Details of organization and management were vested in an Executive Committee. On June 1, 1872, Congress passed an Act creating the Centennial Board of Finance, with large powers. This Board estimated that the cost of the exhibition would be $10,000,000, and apportioned shares of capital stock for this amount among the several States and Territories, on the basis of population. Subsequently, a Board of Revenue was appointed and vested with authority to collect subscriptions and other funds.

Despite the financial panic of the summer of 1873, preparations progressed so favorably that on July 3 President Grant issued a proclamation reciting that the one-hundredth anniversary of the independence of the United States would be celebrated by holding an international exhibition of arts, manufactures, and the products of the soil and mine, in Philadelphia, in 1876, opening April 19 and closing October 19, and inviting the nations of the world to take part in both the celebration and the exhibition. In response to a formal invitation issued by the Secretary of State, thirty-two foreign governments sent favorable replies for themselves and their colonies.

The city of Philadelphia placed at the disposal of the commissioners a tract in Fairmount Park, aggregating 236 acres, for the principal buildings, and also made proportionately large allotments for the exhibition of livestock and agricultural implements.

Five principal buildings were erected. The Main Exhibition Building was in the form of a parallelogram, 1880 feet long and 464 feet wide, with projections at the centre of the longest sides 416 feet long, and at the centre of the short ones 216 feet long. The building was erected on piers of masonry, wrought-iron columns supporting wrought-iron roof trusses forming the superstructure, the sides of which for some distance above the ground were finished between the columns with paneled brick work. This building covered 21.47 acres, had a floor space of 936,008 square feet, and cost $1,600,000.

The Art Gallery and Memorial Hall, designed to be a permanent structure, was erected on an eminence in the Lansdowne Plateau. It is built of granite, glass, and iron, in the modern Renaissance style of architecture, on a terrace several feet above the level of the Plateau, and cost $1,500,000. The dimensions are: length, 365 feet; width, 210 feet; height, 59 feet. From the centre of the structure rises a dome of iron and glass, 150 feet in height, surmounted by a figure of Columbia with outstretched hands. This building was erected by the State of Pennsylvania, and is now used as a permanent art and industrial museum.

Machinery Hall was 1402 feet long and 360 feet wide, with an annex on the south side 210 by 208 feet, and the main building and annex had together a floor space of 558,440 square feet, or nearly thirteen acres. The total cost was $792,000. Horticultural Hall, near the Art Gallery, was built by the city of Philadelphia for permanent uses. It exhibits the Moorish architecture of the twelfth century, is 383 feet long by 193 feet wide, and is 72 feet high to the top of the lantern. Its cost was $251,937. The Agricultural Building was erected of wood and glass, the ground plan showing a parallelogram 630 feet long by 465 feet wide, and a nave 826 feet long and 100 feet wide crossed by three transepts, and cost about $356,000.

Other noteworthy edifices were the United States Government Building, 504 feet long by 300 feet wide, prepared to exhibit the various functions of the public service; the Women's Pavilion, covering an area of an acre, and with its exhibits of woman's handiwork from the fifteen leading nations of the world constituting the first display of the kind ever attempted on a large scale; twenty-six buildings erected by State and Territorial governments; and many others put up by foreign governments or exhibitors. Before the exhibition closed there were more than two hundred buildings on the ground.

An interesting feature of this exhibition was the observance of State Days, when the governors of the States, with their official staffs and a large following of citizens, made ceremonial visits and held receptions in the several State buildings. There were also numerous other special days, when hosts of people united in a common interest, religious, fraternal, social, military, aquatic, or educational, added thousands to the ordinary attendance.

During the exhibition 9,910,966 persons entered the grounds, of whom 7,250,620 paid the full rate of fifty cents, 753,634 paid twenty-five cents each, and 1,906,692 had free entry. The exhibition represented an outlay of all kinds and by all interests of about $20,000,000. The United States Government aided it with a loan of $1,500,000, which was repaid; the State of Pennsylvania appropriated $1,000,000, and the city of Philadelphia gave $1,500,000. From every point of view it was an unqualified success.

Two years after the Centennial Exposition another one was held in Paris, which not only exceeded all previous ones in that city in size and magnificence, but made an unprecedented display of works of art and literature. On this occasion about one hundred acres were set apart for the various buildings, the exhibitors numbered some eighty thousand, the gross receipts were upward of $2,500,000, and 16,032,725 visitors were registered.

The third world's exhibition in the United States was held in New Orleans during the winter of 1884–85, and was planned to commemorate the centennial of the first export of cotton from America. The conception was an outgrowth of the exposition in Philadelphia, and was first carried out on a limited scale in Atlanta in 1881, and on a larger one in Louisville in 1883. Under the belief that the cotton centennial should be celebrated in the chief city of the cotton belt, the National Cotton Planters' Association joined heartily in the scheme suggested by Major E. A. Burke, of New Orleans, for a universal exhibition in that city, in which the great industry of the Southern States should play the most prominent part. Congress aided the movement by an Act incorporating the World's Industrial and Cotton Centennial Exposition, and, further, made a loan of $1,000,000 and appropriated $300,000 for a Federal Building. Railroad and other corporations subscribed for $500,000 in stock, the State of Louisiana appropriated $100,000, and the city of New Orleans contributed a similar sum for the erection of a permanent Horticultural Hall.

Formal invitations were sent out to all foreign governments by the State Department at Washington, commissioners were appointed for the several States and Territories, and the time of the exposition was fixed for December 1, 1884, to May 31, 1885. The site selected was the Upper City Park, an unimproved tract of 245 acres, and in its centre was erected the Main Building, a structure built wholly of wood, 1378 feet long and 905 feet wide, and with a continuous roof principally of glass. The entire building covered a space of thirty-three acres. A Music Hall capable of seating 11,000 persons was constructed in the centre of this building, and a Machinery Hall in the rear. An extension at the southern end, 570 by 120 feet, was devoted to mills and factories in operation, and at right angles with this extension was a building given up to sawmills.

The Federal Building, planned for the exhibits of the United States Government and of the States, was 885 feet long by 565 feet wide, and in general style and construction conformed to the Main Building. Horticultural Hall, built of iron and glass, is 600 feet long, 100 feet wide in main structure, and has a central transept carrying out the extreme width to 194 feet. The Art Building, of corrugated iron and glass, stood nearly in front of the Main Building, and was 250 long by 100 feet wide, with a rotunda 50 feet square in the centre. Two other noteworthy buildings were erected by the Mexican Government, one in the style of a native hacienda, with an interior gallery for the display of horticulture and bird-life; the other for native minerals. Excluding those of Mexico, the various buildings covered an area of 2,673,588 square feet, or sixty-two acres, and all buildings covered about seventy-six acres.

Among the special features of this exposition were the display of woman's work, under charge of Mrs. Julia Ward Howe; of the work of the colored race, under charge of the late Blanche K. Bruce; of the cultivation of cotton and manufacture of the fibre; and of the cultivation, harvesting, and preparation for market of rice and sugar.

On May 5, 1889, another universal exposition was opened in Paris. This was also a commemorative one, marking the centennial of the French Revolution, and because of its political character only the United States and Switzerland accorded it official recognition, although most of the European governments encouraged individual participation. The exposition, despite this feature, was a grand success because of its unusual extent and comprehensiveness and its distinctive features. This exposition cost $8,600,000, and had about 60,000 exhibitors and more than 28,000,000 reported visitors, the greater number, of course, being French.

The making of the World's Columbian Exposition, to commemorate the discovery of America by Columbus, began soon after the close of the Centennial Exposition in Philadelphia. It was at first proposed to create a permanent exposition, to be held in Washington in 1892, to illustrate the progress of North, Central, and South America, and a board of promotion was organized. By 1889, however, a strong popular sentiment had been aroused for a more comprehensive display, and citizens of Washington, New York, Chicago, and St. Louis vied with each other in pressing on a special committee of the United States Senate the advantages of their respective cities. A certificate to the effect that subscriptions to the amount of $5,000,000 had been made in Chicago decided the controversy in favor of that city.

On April 25, 1890, Congress passed an Act giving a legal status to a World's Columbian Exposition, to be held under the auspices and supervision of the United States Government, the organizing corporation to guarantee the subscription of $10,000,000 and the payment of $500,000 before the national commissioners should officially recognize the site offered by the corporation for the exposition. On December 24, following, President Harrison announced the forthcoming exposition, to be opened on May 1, 1893, and invited the nations of the world to participate in it. Congress appropriated in various sums a total of $3,238,250 in money and authorized the coining of 5,000,000 souvenir fifty-cent pieces in silver to be sold for the benefit of the exposition.

The management was vested in a National Commission of two representatives of each State and Territory and of the District of Columbia, and eight from the country at large. The site was Jackson Park, on the shore of Lake Michigan, to which was added the Midway Plaisance tract of 80 acres, making an aggregate ground area of 633 acres. On the main ground more than 150 noteworthy buildings were erected. The Midway Plaisance was devoted to amusements and the illustration of the manners and customs of the world. Here, the most conspicuous of a multitude of great and curious objects was the gigantic revolving and passenger-carrying Ferris Wheel. All of the exposition buildings proper were constructed of wood, iron, and glass, in combination with a material known as "staff," made by uniting plaster and jute fibre in water, in the form of a paste. As all exterior surfaces were painted white, the exposition grounds became popularly known as the White City.

The principal buildings, with their cost, were those of Manufactures and Liberal Arts, the largest of all, 1687 by 787 feet, $1,500,000; Machinery, $1,285,000; Fine Arts, $670,000; Agriculture, $618,000; Administration, $435,000; Electricity, $401,000; United States Government, $400,000; Live Stock, $385,000; Transportation, $370,000; Horticulture, $300,000; Mines, $265,000; Fisheries, $224,000; Woman's, $138,000; Forestry, $100,000; and a brick imitation of a modern United States battleship, with complete armament and equipment, $100,000. Foreign governments appropriated a total of $6,571,520 for their respective buildings and exhibits, France leading with $650,000, and being followed by Japan, $630,000; Brazil, $600,000; Germany, $214,200; and Austria, $149,100; and the States and Territories, a total of $6,020,850. The entire cost of construction was $18,322,622.

According to the original Act of Congress, the buildings then completed were dedicated on Columbus Day, October 21, 1892, with prayer, music, and an oration by Chauncey M. Depew, and during that week a number of State buildings were also dedicated. The exposition was formally opened with exceedingly brilliant ceremonies on May 1, 1893, and was closed with an entire lack of formality on October 30, following, in consequence of the assassination of Carter Harrison, mayor of Chicago, two days before. Up to November 12, the receipts from all sources aggregated $33,290,065, and the expenditures, $31,117,353. The total number of paid admissions, excluding those prior to the opening and after the closing, was 21,477,218, and of all, 27,529,400; smallest single-day number, 10,791; largest, on "Chicago Day," 729,203. In all there were 65,422 exhibitors, and medals were awarded to 23,757 of them, the jury examining and reporting on more than 250,000 separate exhibits.

Present space will only permit the briefest summarizing of this greatest of all international expositions hitherto held,—matchless in extent, in completeness of composition, in grandeur of setting. A pleasing evidence of the influence the undertaking was expected to yield is found in the remarkably large number of international congresses that were held during its progress. This feature alone called for 1245 separate sessions, at which there were 5974 speakers and a special attendance of more than 700,000 persons, chiefly adults. Almost every conceivable branch of human thought and effort had its individual congress. Particularly noticeable among these formal gatherings was the Parliament of Religions, in which Christian, Protestant, Catholic, Jew, and Buddhist expounded their doctrinal beliefs and narrated the story of their sectarian progress and hopes.

The Cotton States' and International Exposition, opened in Atlanta on September 18, 1895, had its origin in two purposes: the first, to give the industrial conditions of the Southern States a more adequate display than they had at Chicago, owing to the constitutional inability of their Legislatures to appropriate public money for such a purpose; the second, to promote larger trade relations between the South and the Latin-American republics and with Europe. It was set on foot by private enterprise, and received its largest official aid from the city council of Atlanta, which appropriated $75,000.

Piedmont Park, a tract of 189 acres, two miles from the centre of the city, and memorable because traversed by the rifle-pits over which General Sherman threw shells into the city thirty-one years before, was selected as the site. In a natural dip of the ground an artificial lake was constructed, covering thirteen acres, and around it the principal buildings were erected. Not only the Southern, but many of the Northern and Western States aided the enterprise with special buildings and exhibits.

Of the thirteen large buildings, that of the United States Government occupied the most conspicuous site. The Administration Building was a reproduction of portions of Blarney Castle, the Tower of London, Warwick Castle, the Rheinstein in Germany, and St. Michael's, on the coast of Brittany. On a considerable elevation was the Auditorium, a four-story building with a dome surmounted by a statue of Music. The largest building was that devoted to Manufactures and Liberal Arts, and the most original of all in design was the one set apart for Minerals and Forestry, which was constructed entirely of wood from the different Southern States in its natural condition, with the bark on. The Fine Arts and the Woman's Buildings were the showiest, and the Negro Building was made attractive by specimens of the industry of negroes in fourteen States. The exposition was closed December 31, and cost about $2,000,000.

The international exposition at Nashville, open from May 1 to October 30, 1897, was a commemoration of the one-hundredth anniversary of the admission of Tennessee into the Union, and had for its special attraction a reproduction of a number of notable buildings of antiquity. The original plan provided for an exposition in 1896, the true centennial year, but the projectors encountered unusual opposition in their efforts to procure the necessary funds, and it was not till early in 1897 that the incorporators were able to begin the creation of the Centennial City.

West Side Park, a former race-course in the suburbs of Nashville, with many natural attractions in running water and forest growths, was selected as the site, and Centennial City was made for the brief time of the exposition a full-fledged municipality, with a mayor, board of aldermen, and a combined police and fire department. The reproduction of notable buildings showed on a reduced scale the Parthenon, the Pyramid of Cheops, the Alamo of Texas, the Blue Grotto of Capri, a glimpse of the Rialto of Venice, and, in the beautiful main entrance, a type of early Egyptian architecture. A flagstaff 250 feet high, cotton and tobacco fields, Venetian gondolas, Vanity Fair, a typical Chinese farm, an abundance of statues of classical and mythological subjects, waterfall and old-time wheel at work, Lake Katherine, Ellen Island, the umbrella fountain, and a large field for athletic sports, were among the pleasurable features. The State made a strong showing of its industrial development and of its riches yet in reserve.

In all 190 acres of ground were occupied. The total receipts were $1,087,227, and the expenditures balanced to a cent. A unique expense feature was that, excluding the preliminary work, the women raised the money and paid the entire running cost of the Woman's Department. The turnstiles registered 1,886,714 entrances.

This exposition was succeeded in 1898 by the Trans-Mississippi and International Exposition at Omaha, an undertaking designed to show what had been accomplished by the pioneers and their children in the great Trans-Mississippi Valley, and especially in a State that forty-three years before was an unorganized territory in the vast tract known as the Louisiana Purchase. The site was a plateau just north of the city, and in planning the display every consideration was given to originality. Excepting that the grounds constituted a second White City, from the use of "staff," as at Chicago, every feature of design and construction possessed striking elements of difference from all similar efforts in the past.

The management was under the presidency of Gurdon W. Wattles, and the exposition was formally opened by President McKinley, who, in the White House at Washington, pressed an electric button that started the great engine. The United States Government erected a building of the classic style, following the Ionic order. It was surmounted by a colossal dome supporting a copy of Bartholdi's statue of "Liberty Enlightening the World," and had a floor space for exhibits of about 50,000 square feet. The Government also recognized the importance of the event by issuing a special set of commemorative postage stamps. Fine arts was exhibited in a twin-domed building, a structure in two parts, with an elaborate peristyle between them, and all under one great roof.

What afforded the masses the greatest delight were the ethnological exhibits and the instructive and amusing scenes on the Midway Reserve. These included an Indian village, with representatives from every tribe between Alaska and Florida, a Chinese village, an Arabian encampment, a Moorish town, a Swiss village, a Cairo street, the entertaining Egyptian Pyramid, and the gigantic passenger-carrying Sherman Umbrella—a mechanical marvel operated by electricity, and one hundred feet higher than the Ferris Wheel of Chicago. There was also a picturesque lagoon or canal, half a mile long and 150 feet wide at its narrowest part, terminating in an artificial lake trefoil in shape and 400 feet across.

The exposition was opened on June 1 and was closed on October 31. In that time it was visited by more than 2,600,000 people, the largest single-day attendance being 98,785. The total receipts were not quite $2,000,000, and the expenditures were about $1,500,000.

This completes the record of the most notable expositions and the incidental history of their development, from the commercial fair of the previous century up to near the close of 1899.

There remains to note a form of permanent exhibition that has been purposely reserved for this point. The Commercial Museum, of which Philadelphia has the two most effective examples in existence, is a purely commercial development, yet an educational text-book of unique and extraordinary compass. Though the Philadelphia Commercial Museum and the similar department of the Philadelphia Bourse were both projected before the foreign trade of the United States had reached the enormous volume that caused wonder and alarm alike all over the world, both have had a powerful, direct, and immediate influence in bringing about a greater appreciation abroad of American products.

The commercial museums stand between the American producer and the foreign factor. They inform the former where special articles are needed and the latter of reputable firms who can supply their needs. By a large corps of traveling agents, an enormous correspondence, and a direct coöperation with the State Department and its representatives, these museums keep in the closest possible touch with the commercial interests of the world. All this is independent of the exhibition feature, a vast department in which the principal economic productions, first of the United States and then correspondingly of the world, are spread before the eye of the visitor. In this connection should also be noted the fact that many of our commercial representatives abroad have established at their headquarters collections of American products that are particularly needed in their respective localities.

In all of the foregoing a single text has been kept in mind: What has been the influence of the fair, the exhibition, the international exposition? Ready answers have been suggested by the several items of cost and attendance. Another answer may be divined in their frequency and universality. And at the close of this survey of more than a hundred years, probably the best answer of all is to be found in the efforts in this line with which one century is closed and another opened.

These include the Greater American Exposition at Omaha, July-November, 1899, a commercial success, and a revelation of trans-Mississippi pioneering enterprise. This was supplemented by the Export Exposition and World's Commercial Congress, the first of the kind ever held under the joint auspices of the Commercial Museum and the Franklin Institute of Philadelphia, in that city, in September-November, 1899. Then followed the Universal Exposition in Paris, in 1900. It was regarded as especially elaborate and successful. It beautified the Champ de Mars and Place des Invalides with handsome industrial palaces, brought into permanent existence the two Palaces of Fine Arts and the Alexander III. Bridge, lined the banks of the Seine with the "Street of Nations," and swarmed the Trocadero with the world's colonization. Over 50,000,000 witnessed its panoramic scenes. Its expense was largely provided for by prior sales of tickets on a bonded plan. The century turned with a prospective of the Pan American Exposition at Buffalo and International at Glasgow in 1901; the Ohio Centennial and International at Toledo in 1902; the International at Liege, Belgium, in 1903; and the Louisiana Purchase Centennial at St. Louis in 1904.

The Century’s Progress In Coinage, Currency, And Banking

By HON. BRADFORD RHODES,
Editor of “Banker’s Magazine.”

I. BANKS AND BANKING RESOURCES.

The history of nation building contains no parallel to the progress and development of the United States in the past one hundred years, and the most accurate and striking indication of this remarkable growth may be seen in the evolution of our currency and banking systems. As the variations in temperature and the changes in atmospheric pressure are measured by the thermometer and barometer, so are the fluctuations in a country’s wealth gauged by the banks and other financial institutions. Likewise the degree of civilization to which a country has attained is reflected by the perfection of its monetary machinery. After having tried nearly every unwise experiment condemned by the teachings of history, the United States has finally reached a position where its currency meets the two fundamental requirements of sound finance, namely, (1) the standard of value is that in use among the great commercial states of the world; (2) all of the currency is either directly or indirectly convertible into the standard coin.

Despite some minor faults in our financial system which make the maintenance of the parity of the several kinds of currency a cumbersome and expensive operation, and prevent the banks from rendering that full degree of assistance to commerce and industry which they would afford under laws that did not unnecessarily restrict their rightful functions, all our money responds to the two essential tests—safety and convertibility; while the banks have been among the most powerful factors in placing the United States in the front rank of the nations of the earth.

Our finances may be likened to a triangle, of which the base—the gold standard—has been in actual existence since 1879 (much longer than that in law), and the other side—safety—also assured, wanting but another addition—elasticity—to complete the symmetrical and perfect figure. That this last requisite of a sound currency will be supplied by the wisdom and ingenuity of our people, is not to be doubted.

There are two respects in which the financial policy of the United States is unique in comparison with most other great commercial countries; first, its gold reserve is unprotected by the devices in use elsewhere, as it does not charge a premium on gold as the Bank of France does when gold is wanted for export, nor can it protect the gold reserve by raising the rate of discount as the great banks of Europe may do; second, banking is practically free and anti-monopolistic. Under these conditions we have reached a place that may well excite the astonishment of the old-world countries. Our stock of metallic money, as estimated by the Director of the Mint, in 1898, was $925,000,000 in gold and $638,000,000 in silver. No other nation owned so much gold. Only one—China—owned as much silver, but it had no gold, and the per capita of silver in China is only $1.96 against $8.56 in the United States. Our stock of gold is more than double that of Great Britain, greater by a hundred millions than that of France, and also exceeds that of Germany and Russia. Of our silver stock, $561,500,000 is a full legal tender, and $76,700,000 a limited legal tender, the latter sum representing the subsidiary coins.

In our banking power the situation is equally fortunate. Mulhall defines banking power as the paid-up capital of banks, the deposits exclusive of savings banks, and the amount of convertible paper money.

In the two great essentials of financial strength—the quantity of metallic money and banking power—we have far outstripped every other nation. This is an unfailing sign of our advance toward a position of commercial and industrial supremacy. The sceptre of financial power has crossed the Atlantic from Europe to the New World. We are gradually acquiring command of the world's markets, and in time we shall see our banks—ever the handmaids of commerce—extending their operations to the most distant quarters of the earth and carrying everywhere the beneficent influences of modern civilization.

New York as a financial centre has been growing with astonishing rapidity in recent years. From 1879 to 1899 the banks belonging to the New York Clearing-House Association increased their deposits from $254,700,000 to $910,500,000, and their specie—chiefly gold—from $54,700,000 to $202,600,000, the latter item having about doubled in the past two years, being $104,700,000 in 1897, and $202,600,000, as above stated, in 1899. The aggregate of banking institutions in the city—national banks, state banks, trust companies, and savings banks, exclusive of private banking firms—had, about January 1, 1899, capital, surplus, and profits amounting to $311,600,000; deposits of $2,047,800,000; and total resources of nearly $2,500,000,000. One bank—the National City—with over $144,000,000 of deposits, is the largest in the United States; while the Bowery Savings Bank, with 121,000 depositors and $67,000,000 of deposits, is the largest of its kind in the country.

There were 3582 national banks that reported, and 5903 other banks, a total of 9485. The total banking funds, that is, capital, surplus and profits, and individual deposits, of all banks reporting, amounted to $7,416,355,568.

We cannot get a correct understanding of these figures without going back to earlier dates and making comparisons. In 1798 there were twenty-five state banks in the country, against 3965 reporting to the Comptroller of the Currency in 1898, which is perhaps about 90 per cent of the total of such institutions now existing.

A hundred years ago the capital of the state banks was less than twenty millions, compared with $233,971,643 now reported. They had, all told, but $14,000,000 of specie—half as much as is now held by one New York city bank alone. Their circulation was only $9,000,000, compared with more than $200,000,000 of national bank circulation now outstanding.

The national banks also show a remarkable growth. In 1869 there were 1620 banks in operation, reporting $420,800,000 capital, $547,900,000 individual deposits, $17,500,000 specie, and $1,517,700,000 total resources. Thirty years later the number of banks had increased to 3590, while the capital was $608,300,000, the individual deposits $2,232,100,000, and specie $371,843,400, while the total resources had increased to $4,403,800,000.

The total wealth of the United States in 1895 was estimated at more than $80,000,000,000,—far exceeding in the aggregate that of any other country in the world. It is expected that the census of 1900 will show our total wealth to be more than $100,000,000,000, or probably double that of Great Britain, the next richest nation.

But while the nation is piling up wealth at an unexampled rate, it cannot be said that this is a land "where wealth accumulates and men decay." Great in its material resources, the country was never before stronger in those elements which constitute the chief reliance of national power. A united citizenship, possessing an honesty that adversity cannot sully and an intelligence that when once aroused penetrates the most cunningly concealed economic sophistries, working out the problems of the future under laws and conditions assuring to the individual the largest opportunities, points to a development in the twentieth century in no wise inferior to that of the hundred years preceding.

II. COINAGE AND PRODUCTION OF PRECIOUS METALS.

The prevailing systems of coinage in this country and among all great commercial nations are the result of development and growth. Gold and silver have become the principal money metals by a process of natural selection, which has chosen the instruments best suited to the purpose. In recent years, and under the laws of development, nearly all the great trading countries of the world have selected gold as the standard of value. In the future, gold itself may give way to something better, for it only relatively meets the essentials of a perfect standard.

Among Greeks, Romans, and Oriental peoples, cattle were generally used as a standard of value. The modern rupee of India is the old Sanscrit word *roupa*, a herd. Capital is but the estimate of Roman riches in cattle. The Latin *pecus*, cattle, is the root of *pecunia*, riches, and the origin of our word pecuniary. The Icelanders measured values in dried fish; the Hudson Bay country in skins; the early Virginians in tobacco; the Indians of the United States and Canada in wampum; the Chinese, even in recent times, in squares of pressed tea; the Africans in bars of salt and slaves.

These primitive devices gradually gave way, under the demands of international trade, to the use of metals as standards of value. Tin, copper, gold, silver, and iron all were used, and, at first, passed by weight. Government coinage of money is thought to date from the seventh century B. C., and is credited to the Lydians and to Pheidon of Argos, the official stamp being a guarantee of the honesty, weight, and purity of the coins.

Modern coinage dates from the reformation of the coinage of Rome under Constantine, who introduced the gold *solidus* of $3.02 in value, and a silver coin of like weight but of relative value. After the time of Julian, this silver piece, called *siliqua*, was given such value as that twenty-four of them equaled a gold *solidus*. In the Frankish Empire, under the Merovingian kings, the relative values of the *solidus* and *siliqua* fluctuated greatly. In the eighth century, on account of the scarcity of gold, there was a gradual transition to the silver standard, and a silver unit, also called a *solidus*, was substituted for the gold *solidus*, the former being divided into twelve pence. This silver *solidus* afterwards became the shilling of England and Germany. At first 300 pence were coined out of a pound of silver; but under Pepin the number was reduced to twenty-two *solidi* of twelve pence each—264 pence—out of a pound of silver. Under Charlemagne it was provided that only 240 pence, or twenty *solidi* of account, should be stamped out of a pound of silver, and this system was introduced, with more or less success, in what is now France and Germany. As to form, it has remained, up to the most recent period, the basis not only of the countries of Charlemagne's Empire but of England.

After the time of Henry VIII. came a period of coinage debasement which culminated in 1551. A thorough coinage reform was effected under Elizabeth in 1560. The first large coinages of gold in England were made under James I. These continued until the death of William III., in 1701. Still, silver continued to be the standard metal, and in 1695 another attempt was made to reform the currency by a recoinage of the silver pieces, most of which had been clipped or worn, into a new full-weight silver coin. These, however, were soon exported, in spite of a reduction of the current value of the guinea, in 1717. The gold standard in England gained a nearly complete victory by act of Parliament in 1774, which provided that silver coins not of full weight (there were hardly any others) need not be accepted in payments of more than twenty-five pounds, except by weight. This provision, after several renewals, became permanent in 1798. In 1797 coinage of silver was suspended, and the single gold standard practically introduced, though its operation was somewhat interfered with by the existence of a paper currency. In 1816 the present English monetary system was introduced. It held fast to the gold standard, by the provision that silver pieces should be used only as divisional coins, and with a legal-tender power limited to forty shillings.

Properly speaking, there was no coinage in the United States during the colonial period. Maryland had a mint at one time, and one or two of the other States, but they practically amounted to nothing. In the early colonial period the substitutes for coins were wampum and bullets, as in Massachusetts; skins and furs, as in New York; tobacco, as in Maryland and Virginia. The coins in use before the Revolution were, to some extent, those of England, but more largely those of Spain, circulated in South America and traveling up to the United States. The unit of account was the Spanish milled dollar or piece-of-eight, though, up to 1775, accounts were kept in pounds, shillings, and pence, a pound consisting, then as now, of twenty shillings, and a shilling of twelve pence “colonial” or “pound” currency. Four pounds of this “colonial currency” were reckoned as equal to three pounds sterling.

This colonial composite system of current coins was regulated by coinage tariffs. Such a tariff, issued in 1750, valued one ounce of silver at six shillings and eightpence, the Spanish milled dollar at six shillings, the guinea at twenty-eight shillings, and the English crown at six shillings and eightpence. All foreign coins were valued in proportion to the value of the Spanish piece-of-eight. Some of the colonies stamped the shilling, which constituted a large part of the money in circulation. It, however, varied greatly in value in the different colonies. Thus, the Spanish dollar equaled five shillings in Georgia; eight in North Carolina and New York; six in Virginia, Connecticut, New Hampshire, Massachusetts, and Rhode Island; seven and sixpence in Maryland, Delaware, Pennsylvania, and New Jersey; thirty-two and sixpence in South Carolina. The Spanish dollar itself, with which these comparisons were made, was frequently below legal weight, and, therefore, varied in value. Where the pieces mentioned in the tariff of 1776 were of full weight, the ratio there established was the English ratio of one to 15.21, the ratio for bullion being nearly the same.

After the tariff of 1776 had been in operation for six years, the colonies began to feel keenly the difficulties caused by the variety of coins constituting their metallic circulating medium, and the need of a special American coinage was frequently expressed. In 1782, Robert Morris, superintendent of finance, submitted to the Congress of the Confederation a scheme for a national coinage and the establishment of an American mint, which met with approval. Jefferson recommended the decimal system, with the dollar as the unit. Neither of these proposals was carried into effect till, in 1786, the Congress of the Confederation chose as the monetary unit of the United States the dollar of 375.64 grains of pure silver, which unit had its origin in the Spanish piaster or milled dollar, then the basis of the metallic circulation of the English colonies in America. This American dollar was never coined, there not being at the time a mint in the United States.

The Act of April 2, 1792, established the first monetary system of the United States. The bases of the system were: The gold dollar, containing 24.75 grains of pure gold, and stamped in pieces of $10, $5, and $2.50, denominated respectively eagles, half-eagles, and quarter-eagles; the silver dollar, containing 371.25 grains of pure silver. A mint was established. The coinage was unlimited, and there was no mint charge. The ratio of gold to silver in coinage was 1:15. Both gold and silver were legal tender. The standard was double.[4] The Act of 1792

[4] This was true so far as the law was concerned, but not actually, as may be seen by reading the sentences immediately following the above statement.

undervalued gold, which was therefore exported. The Act of June 28, 1834, was passed to remedy this by changing the mint ratio between the metals to 1:16.002. The latter act fixed the weight of the gold dollar at 25.8 grains, but lowered the fineness from 0.916⅔ to 0.899225. The fine weight of the gold dollar was thus reduced to 23.2 grains. The Act of 1834 undervalued silver as that of 1792 had undervalued gold, and silver was attracted to Europe by the more favorable ratio of 1:15½. The Act of January 18, 1837, was passed to make the fineness of the gold and silver coins uniform. The legal weight of the gold dollar was fixed at 25.8 grains, and its fine weight at 23.22 grains. The fineness was therefore changed by this act to 0.900 and the ratio to 1:15.988+. Silver continued to be exported. The Act of February 21, 1853, reduced the weight of the silver coins of a denomination less than $1, which the Acts of 1792, 1834, and 1837 had made exactly proportional to the weight of the silver dollar, and provided that they should be legal tender to the amount of only $5. Under the Acts of 1792, 1834, and 1837 they had been full legal tender. By the Act of 1853 the legal weight of the half dollar was reduced to 192 grains, and other fractions of the dollar in proportion. The coinage of the fractional parts of the dollar was reserved to the government.

The Act of February 12, 1873, provided that the unit of value of the United States should be the gold dollar of the standard weight of 25.8 grains, and that there should be coined besides the following gold coins: A quarter-eagle, or two and-a-half dollar gold piece; a three-dollar gold piece; a half-eagle, or five-dollar piece; an eagle, or ten-dollar piece; and a double eagle, or twenty-dollar piece, all of a standard weight proportional to that of the dollar piece. These coins were made legal tender in all payments at their nominal value when not below the standard weight and limit of tolerance provided in the act for the single piece, and when reduced in weight they should be legal tender at a valuation in proportion to their actual weight. The silver coins provided for by the Act were a trade dollar, a half-dollar or fifty-cent piece, a quarter-dollar, and a ten-cent piece, the weight of the trade dollar to be 420 grains troy; the half-dollar, twelve and a half grams; the quarter-dollar and dime, respectively, one half and one fifth of the weight of the half-dollar. The silver coins were made legal tender at their nominal value for any amount not exceeding $5 in any one payment. Owners of silver bullion were allowed to deposit it at any mint of the United States to be formed into bars or into trade dollars, and no deposit of silver for other coinage was to be received. Section 2 of the joint resolution of July 22, 1876, recited that the trade dollar should not thereafter be legal tender, and that the Secretary of the Treasury should be authorized to limit the coinage of the same to an amount sufficient to meet the export demand for it.

The Act of March 3, 1887, retired the trade dollar and prohibited its coinage. That of September 26, 1890, discontinued the coinage of the one-dollar and three-dollar gold pieces. The Act of February 28, 1878, directed the coinage of silver dollars of the weight of 412½ grains troy, of standard silver, as provided in the Act of January 18, 1837, and that such coins, with all silver dollars theretofore coined, should be legal tender at their nominal value for all debts and dues, public and private, except where otherwise expressly stipulated in the contract. The Secretary of the Treasury was authorized and directed by the first section of the act to purchase from time to time silver bullion at the market price thereof, not less than $2,000,000 worth nor more than $4,000,000 worth per month, and to cause the same to be coined monthly, as fast as purchased, into such dollars. A subsequent act, that of July 14, 1890, enacted that the Secretary of the Treasury should purchase silver bullion to the aggregate amount of 4,500,000 ounces, or so much thereof as might be offered, each month, at the market price thereof, not exceeding $1.00 for 371.25 grains of pure silver, and to issue in payment thereof Treasury notes of the United States, such notes to be redeemable by the government, on demand, in coin, and to be legal tender in payment of all debts, public and private, except where otherwise expressly stipulated in the contract. The act directed the Secretary of the Treasury to coin each month 2,000,000 ounces of the silver bullion purchased under the provisions of the act into standard silver dollars until July 1, 1891, and thereafter as much as might be necessary, to provide for the redemption of the Treasury notes issued under the act. The purchasing clause of the Act of July 14, 1890, was repealed by the Act of November 1, 1893. The War Revenue Act of June 13, 1898, authorized and directed the coinage of standard silver dollars to the amount of not less than one and one half million dollars a month, from the bullion in the Treasury purchased under the Act of July 14, 1890. The Act of June 9, 1879, made the subsidiary silver coins of the United States legal tender to the amount of $10. The minor coins are legal tender to the amount of twenty-five cents.

At this writing the report of the Director of the Mint has not been published, but the coinage for the full year 1897 may be stated as follows: gold, $76,028,484; silver, $18,486,697; and for the year 1898, gold, $77,985,757; silver, $23,034,034. From January 1 to June 30, 1899, the coinage was: gold, $65,915,020; silver, $12,780,441.

It is sometimes thought that the silver dollars are not a full legal tender, but this is not so. They are an unlimited legal tender for all debts, public and private. The Treasury does not, in practice, redeem silver dollars in gold, but successive Secretaries of the Treasury have announced their readiness to do so, if necessary to keep the silver dollars from depreciating,—that is, preserve their parity,—which the law directs.

Silver certificates and gold certificates are not legal tender, but entitle the holder to receive the kind and amount of coin named on their face.

The value of gold bullion in a dollar of that metal is 99.991125 cents, or practically 100 cents. The value of the silver bullion in a dollar of that metal is about 45 cents. It varies, however, with the fluctuations in the market value of silver.

It will thus be seen that the bullion value of a silver dollar and of a gold dollar differs greatly, but the equality of the purchasing power of the two coins is due to the fact that the silver dollars are receivable for public and private debts, that they are indirectly exchangeable for gold, by depositing them in the banks, and that the government is pledged to redeem them in gold, if necessary to preserve their parity with gold.

As early as 1826 the United States began to export domestic gold, beginning with an export of $1,056,088 of gold coin and bullion, and receiving an import of $678,740. Up to 1897 the grand total of exports of gold coin and bullion amounted to $2,186,238,541, and the total imports to $1,112,138,766, an excess of exports over imports of $1,074,099,775. In 1898 the imports of gold coin and bullion into the United States were $120,391,674, and the exports $15,406,391, making the net imports $104,985,283.

From 1821 to 1897 the grand total of exports of silver coin and bullion from the United States was $1,152,688,776, and the imports $730,325,881, making an excess of exports over imports of $422,362,895. In the fiscal year 1898, the silver imports were $30,927,781, and the exports $55,105,239, making the excess of exports $24,177,458.

The total product of gold in the United States from 1792 up to 1896 was $2,113,034,769, and of silver $1,444,970,000, making a grand total of the precious metals of $3,558,004,769. The total value of the entire world's production of gold, between the years 1493 and 1896, was $8,983,320,600, and of silver $10,556,700,800, making a grand total of gold and silver of $19,540,021,400.

As a comparison of the money status of the United States at the beginning and end of the century, the following figures are interesting: In 1800 the population was 5,308,483; the estimated bank notes outstanding, $10,500,000; the estimated specie in the country, $17,500,000; the total money in the United States, $28,000,000; the specie in the Treasury, $1,500,000; the money in circulation, $26,500,000; the amount per capita, $4.99. In 1898 the population was 74,522,000; the total coin in the United States, including bullion in the Treasury, $1,498,993,249; total paper money, $1,138,440,126; total money of all kinds, $2,637,433,375; coin, bullion, and paper money in the Treasury, $799,537,480; total circulation, $1,837,859,895; circulation per capita, $24.66.

Perhaps no law relating to the coins and currency of the United States has been so widely discussed, or has borne more directly on the attitude and influence of political parties than the Coinage Act of 1873. This act grew out of a proposition to revise our coinage laws, made by John Jay Knox to the Secretary of the Treasury, in April, 1870. Mr. Knox, in his rough draft of a bill, provided for a silver dollar of 384 grains, to be a legal tender for sums not exceeding $5.00. Thus, the standard silver dollar of 412½ grains was eliminated. It did not appear in the bill as it passed the Senate, January 10, 1871, nor in that reported to the House, March 9, 1871. The bill underwent protracted and thorough discussion, and on May 27, 1872, was passed in the House. As passed, it contained the original provision for coining a silver dollar of the weight of 384 grains—twice the weight of the silver half dollar. These dollars were to be a legal tender for amounts not exceeding $5.00. The Senate amended this House bill, by substituting a trade dollar of the weight of 420 grains for that of 384 grains, at the same time preserving the legal-tender limit of $5.00. In the amended form, it passed the Senate, January 17, 1873, and the House, February 7, 1873, and became a law. It will be seen that the standard silver dollar of 412½ grains was never in the bill, and could not, therefore, have been secretly omitted, as was afterwards charged. It was omitted from the first draft, and all through, because none were being coined, and those that had been coined were exported, the silver bullion in them being, at that time, worth more as bullion than coin. By joint resolution of Congress, approved July 22, 1876, the trade dollars provided for in the act were deprived of their legal-tender quality. It was supposed they would circulate in China, but they proved useless even for that purpose.

III. EARLY BANKING IN THE UNITED STATES.

The first banks in the United States owed their origin to Robert Morris and Alexander Hamilton. Morris, as early as 1763, conceived the plan of a bank to assist in developing American trade, and in 1779, Hamilton proposed the organization of “The Company of the Bank of the United States.” These plans did not mature, but were followed, at the suggestion of Thomas Paine, by an association of ninety-two subscribers to a fund of 300,000 pounds Pennsylvania currency to support the Revolutionary army. This association became known as the Pennsylvania Bank. It commenced business July 17, 1780, and after a career of a year and a half, during which time it greatly aided the government in furnishing army supplies, its affairs were wound up.

On May 17, 1781, Hamilton presented the plan of a bank to Congress, which was to be truly national, and “created avowedly to aid the United States.” Its name was to be the Bank of North America, with a subscription of $400,000 in gold and silver, and its notes, payable on demand, to be receivable for duties and taxes in every State. Congress approved the plan, and Morris, then Superintendent of Finance, published it, with an address showing its advantages to the government and people, then suffering from the ill effects of a depreciated currency.

The Bank of North America was organized November 1, 1781, and began business January 7, 1782. It creditably fulfilled its mission “to aid the United States,” and, after the expiration of its charter, became a State institution. In 1864 it entered the national banking system, though retaining its old name. This bank was followed by the Bank of New York, which began business June 9, 1784, and by the Massachusetts Bank, which began business July 5, 1784.

First United States Bank.—This institution grew out of the recommendations of Alexander Hamilton, and formed a part of his scheme of strengthening the public credit and bringing about a closer union of States. His plan was incorporated into a bill which passed the Senate January 3, 1791, and the House, January 20, 1791. Washington signed it February 25, 1791. The bill was hotly opposed as unconstitutional by Secretary of State Thomas Jefferson, Attorney-General Edmund Randolph, and in general by representatives from the Southern States.

The capital of the bank was fixed at $10,000,000, one fifth of which was to be subscribed by the government. The remainder was subscribed by individuals, and two hours after the opening of the books the capital was oversubscribed to the amount of 4000 shares. The central bank was located at Philadelphia, and afterwards branches were established in New York, Boston, Baltimore, Washington, Norfolk, Charleston, Savannah, and New Orleans. Business was first opened in Carpenters' Hall, Philadelphia, December 12, 1791. In July, 1797, the site was removed to a new building on Third Street, below Chestnut, and it remained there till the dissolution of the bank, with the exception of a brief removal to Germantown in 1798, during the epidemic of yellow fever. Though this bank proved a profitable enterprise for the government, it failed to secure a renewal of its charter in 1811, chiefly because so many of its shares had passed into foreign hands.

Early State Banks.—From 1790 to 1811 the number of State banks increased from four to eighty-eight; their circulation from $2,500,000 to $22,700,000; their capital from $2,500,000 to $42,610,000. In the same time the metallic circulation of the country rose from $9,000,000 to $30,000,000. These banks failed to meet the monetary necessities of the War of 1812, and in 1814 practically all of them south of New England suspended specie payments. Their notes were poured out in all denominations from six cents upward, and, with coin redemption stopped, they depreciated rapidly. This led to great financial distress in 1818–1820, and to excessive bank failures. The seriousness of the general situation, and the declining credit of the government, led to the establishment of the second Bank of the United States.

Second Bank of the United States.—In October, 1814, Secretary Dallas laid a report before Congress, in which he deprecated the uncertain amount and value of the paper currency. "There exists," he said, "at this time no adequate circulating medium common to the citizens of the United States. The moneyed transactions of private life are at a stand, and the fiscal operations of the government labor with extreme inconvenience." He then recommended as the remedy the establishment of a national banking institution. A bill, based upon Dallas's plan for such an institution, failed of passage in the House in 1814, and again in 1815, though passed by the Senate. It was, however, finally passed in an amended form, but was vetoed by President Madison.

On December 24, 1815, Mr. Dallas laid before Congress another plan for a national bank. A bill was framed authorizing such an institution, with a capital of $35,000,000, $7,000,000 of which were to be subscribed by the government, the central bank to be at Philadelphia, with power to establish branches, payments to be made in specie at all times unless otherwise authorized by Congress. This bill passed both Houses of Congress, and was signed by President Madison, April 10, 1816. When the subscription books of this bank were closed, it was found that the subscriptions fell short of the authorized $35,000,000 by $3,000,000, which amount was taken by Stephen Girard.

The bank could not lend more than $500,000 to the government without authority of Congress, was to be the fiscal agent of the Treasury, and to receive deposits of public moneys. No notes of a less denomination than $5.00 were to be issued, and the penalty for refusing to pay notes or deposits in specie on demand was twelve per cent per annum until paid. It began business January 7, 1817. Owing to the impending financial crisis and bad management, the bank verged rapidly toward insolvency, but was resuscitated under the vigorous management of a new president, Langdon Cheves, who was elected March 6, 1819. He was succeeded by Nicholas Biddle in 1823, who was destined to see the fall of the great institution.

The national bank incurred the hostility of the State banks, which called it a monster because it refused to allow the notes of the local banks to accumulate as deposits in its branches without redemption. Various States passed discriminating laws against it. Jackson, in his message to Congress in 1829, attacked the constitutionality of the law establishing it, and charged that it had "failed in the great end of establishing a uniform and sound currency." At this time the Bank was an imposing institution with its capital of $35,000,000, its public deposits of six to seven million, its private deposits of a like amount, its circulation of $12,000,000, its annual discounts of $40,000,000, its annual profits of over $3,000,000, its palatial establishment in Philadelphia, its twenty-five branches throughout the Union, its five hundred employees, its stock distributed through nearly all parts of the world, and its notes current at par at home and abroad.

Jackson's message was not received favorably by Congress. His aversion, it was thought, was due rather to his belief that the Bank was his enemy than to any dislike of a national bank. The growing hostility between him and Henry Clay induced the latter to make the renewal of the Bank's charter a political issue. When the bill rechartering the Bank was passed in July, 1832, Jackson vetoed it, charging, in the main, that the Bank was a monopoly. This brought the question of the further existence of the Bank fully into the arena of politics, in the presidential election of 1832, with the "Hero of New Orleans" on one side, and on the other "monster monopoly," "Old Nick's money," and "Clay's rags." Jackson won, and speedily decided to remove the public deposits from the Bank. This decision precipitated a bitter war between Jackson and Congress. But Jackson did not swerve from his purpose. By 1835 it became apparent that the Bank could not secure a renewal of its charter from Congress. As a confession of its defeat, and just thirteen days before the expiration of its federal charter, the Bank obtained from the State of Pennsylvania, February 18, 1836, a charter for the United States Bank of Pennsylvania, for a period of thirty years. Shorn of its importance, in a restricted field, yet with enormous capital, it fell into large bond and stock investments of questionable value. Its troubles were aggravated by bad management. It suspended during the panic of 1837 and the next year, and again for the last time in 1841. Biddle resigned the presidency in 1840, and four years later died poor and broken-hearted. Thus perished what is sometimes called the third Bank of the United States, its predecessor, the second Bank of the United States, having fallen a victim to political intrigue and loss of prestige. The shareholders lost their entire investment of $28,000,000, but the circulating notes were all paid, and also the deposits. The government got back its investment of $7,000,000, and made $6,093,167 besides, from its connection with the Bank.

State Banks and Independent Treasury.—After the removal of deposits from the Bank of the United States, September 26, 1833, the public revenues were deposited in selected State banks, sometimes called "pet banks." In 1836 eighty-eight State banks in twenty-four States held public deposits to the amount of $49,377,986. As the State banks had thrown their influence against the national bank, they were rewarded by allowing them to use the public money intrusted to them as a basis of extending their loans and for enormous issues of their own notes. Banks were started for the sole purpose of issuing notes which they could use in buying public lands. As a consequence the government lost heavily through the depreciation of these notes and the failure of the banks. On July 11, 1836, the Secretary of the Treasury issued a circular forbidding the receipt of anything but specie in payment for public lands. This caused a run on the banks and aided in hastening the financial crisis of 1837. An act of Congress of June 23, 1836, authorizing the calling in of $37,468,859 of the public funds deposited in the State banks, for purposes of distribution, forced the suspension of specie payments by all such banks, with very few exceptions.

The unsatisfactory trial of both federal and State banks as custodians of the public funds led to the establishment of what became known as the independent Treasury system, by which the government collects its money and keeps it in the hands of the United States Treasurer or sub-treasurers, making disbursements when required. An act putting this system into effect became law July 4, 1840, but was repealed the next year. It was repassed August 6, 1846, and remained in operation until the passage of the National Currency Act in February, 1863, which gave the Secretary of the Treasury the right to designate certain national banks as depositories of public funds. There were in such banks, on February 4, 1899, United States deposits amounting to $81,120,873, secured by United States bonds belonging to the banks and deposited in the Treasury, amounting to $89,100,240. Prior to the adoption of the national banking system the country had a somewhat disastrous experience with what has been known as “wild-cat” banks. Many of them were organized for the sole purpose of issuing notes they never intended to pay. While they were numerous and dangerous, it must be remembered that in a number of States the leading banks carried on only a legitimate business, and State banks as they exist to-day compare favorably in their management with the national banks.

IV. HISTORY OF THE LEGAL-TENDER NOTE.

The first act authorizing the issue of legal-tender notes, known popularly as greenbacks, was approved by President Lincoln, February 25, 1862. It provided for the issue of $150,000,000 in notes, in denominations of not less than $5.00. Holders of these notes could deposit them with the United States Treasurer or assistant treasurers in any sum not less than $50.00, or any multiple thereof, and receive United States bonds bearing six per cent interest. The first notes were issued March 10, 1862. An act authorizing a second issue of $150,000,000 was signed by the President, July 11, 1862. Of these $35,000,000 were to be in denominations of less than $5.00. A third issue of $150,000,000 was authorized March 3, 1863, but this act deprived the legal-tender note of its convertibility into six per cent bonds at the option of the holder.

The withdrawal of this privilege worked no particular hardship at the time, for bond issues and various interest-bearing certificates were plenty during the period of war. But after the war had closed and the issues of new securities had ceased, the absence of this provision began to prevent the absorption of the legal-tender notes.

The highest amount of legal-tender notes outstanding at any date was on January 3, 1864, $449,338,902. Their depreciation was hastened by the issue of the short-time interest-bearing securities in large amounts. During 1862 the average gold premium was 113.3; during 1863, 145.2; during 1864, 203.3. In July, 1864, this premium reached its highest point, an average of 258.1.

In 1865 the country began to feel the necessity of a contraction of the currency, with a view to as early a resumption of specie payments as the business interests would permit, and the Congress expressed the public sentiment by an almost unanimous resolution. On March 12, 1866, an act was approved calling for the retirement and cancellation of not more than $10,000,000 of legal tenders within six months, and thereafter not more than $4,000,000 during any one month. The effect was to reduce the legal tenders outstanding on December 31, 1867, to $356,000,000.

This reduction, together with the rapid payment of notes of other classes, used as currency, led to so sudden a contraction of the circulating medium, and such stringency in the money market, that Congress, by act of February 4, 1868, prohibited the further reduction of the legal-tender notes. The amount outstanding, October 1, 1872, was $356,000,000, and on January 1, 1874, $382,979,815, the increase being due to a construction on the part of secretaries of the Treasury to the effect that they had power to reissue retired notes which were held as a reserve. On June 20, 1874, Congress enacted that the United States notes outstanding and to be used as part of the circulating medium should not exceed $382,000,000, and that no part thereof should be held or used as a reserve.

Another attempt was made in 1875 to reduce the aggregate of legal-tender notes, preparatory to the resumption of specie payments. The Resumption Act of January 14, 1875, authorized, among other things, the retirement and cancellation of legal tenders till the amount outstanding should be reduced to $300,000,000; $35,318,984 were retired under this law, but further reduction was prohibited by act of May 31, 1878. The amount outstanding at that date was $346,681,016, and this has continued to the present time, no new issues having been authorized.

On January 1, 1879, the resumption of specie payments took place as provided in the act of January 14, 1875. At this latter date, the only legal-tender coin recognized by law was the gold coin. But, in February, 1878, the coinage of standard silver dollars was authorized, and they were to be a legal tender for all debts, unless otherwise expressly stipulated in the contract. This led to the claim on the part of those who favored silver that the redemption of legal-tender notes, provided for in coin in the act of 1875, could be effected by the use of silver dollars. But the general, and doubtless sound, construction of the law of 1875 has been that it was an express contract to redeem the legal-tender notes in the coin then recognized as legal tender, and in no other; and so the Treasury has redeemed legal tenders since 1879, in gold, when the same is demanded.

In 1869 the United States Supreme Court, the bench not being full, declared the acts authorizing legal-tender notes to be unconstitutional. But subsequently, the bench having its full quota of nine, the Court sustained the constitutionality of the acts, on the ground, mainly, that they were a proper exercise of the war power vested in the Congress. In 1883 the Court decided that the reissues of these notes, made in time of peace, were constitutional.

At the time of the resumption of specie payments there were $135,000,000 in gold and bullion on hand to provide for the redemption of such notes as might be presented. By Act of July 12, 1882, it was provided that when the redemption reserve of gold coin and bullion in the Treasury fell below $100,000,000, the issue of gold certificates should cease. This is held to indicate that Congress regarded $100,000,000 as the limit below which the redemption reserve should not be permitted to fall.

If this reserve had not been called upon to bear other burdens, there would probably never have been any doubts as to its sufficiency. In 1878, however, began the coinage of silver dollars and the issue of silver certificates. These notes were kept at par in gold by their interchangeability in the operations of commerce for legal-tender notes. They were thus an indirect charge on the gold reserve. From 1878 to 1890 they were increased at the rate of over $2,500,000 a month. In that year (July 14, 1890) an act was passed providing for the issue of

Treasury notes in the purchase of silver bullion, which provided also for the coinage of some of the bullion purchased into silver dollars. These Treasury notes were redeemable both in gold and silver, and as the government never availed itself of its option to redeem in silver when gold was demanded for them, these notes as they were issued became a further burden on the gold reserve provided for the legal-tender notes.

By the beginning of the year 1893 the legal-tender notes, silver certificates, and Treasury notes had reached an aggregate of nearly $800,000,000, all depending on the Treasury reserve for gold redemption.

This reduction of the percentage of gold held to the amount of the demand liabilities raised doubts as to the ability of the government to maintain gold payments, and the legal tenders and Treasury notes were presented for redemption. The depletion of gold was so great that on one or two occasions there was danger that the reserve would be exhausted, and resort was had to the sale of bonds to procure gold to replenish the reserve.

The issue of further Treasury notes was stopped by the repeal of the act of 1890 in November, 1893, and since this repeal confidence in the ability of the Treasury to maintain gold redemptions has been gradually restored.

Under the provisions of the Act of May, 1878, the legal-tender notes when redeemed cannot be canceled. They must be paid out again, and therefore when reissued, they may again be presented for redemption. This constitutes the so-called endless chain by which the gold in the Treasury is always liable to be drawn out.

V. THE NATIONAL BANKING SYSTEM.

The desirability of perfecting the banking and currency system of the country was readily perceived on the breaking out of the Civil War in 1861. Secretary Chase in two annual reports, those of 1861 and 1862, recommended a system of national banks, whose supervision should be by national authority, and whose issues of notes should be based on deposits of bonds of the government. After several unsuccessful attempts, a bill, introduced by Mr. Sherman, passed both Senate and House, and became a law February 25, 1863. This act embodied the essential features of Mr. Chase's reports. Under it the first charter was issued to the First National Bank of Philadelphia.

The formation of national banks proceeded very slowly at first. In order to hold out greater inducements for the State banks to enter the national system, the act was amended on June 3, 1864. The first report of the Comptroller of the Currency, November 28, 1863, showed that only 134 national banks had been organized up to that date; but when the act of June 3, 1864, went into operation, new banks were formed more frequently. A more rapid increase took place after the passage of the act of March 3, 1865, imposing a tax of 10 per cent on the circulating notes of State banks. This increase was from 638 banks in January, 1865, to 1513 in October of the same year; with an increase in capital of from $135,618,874 to $393,187,206; and in circulation of from $66,769,375 to $171,321,903. Prior to 1869 national banks were required to make their reports on fixed dates, but after March 3, 1869, they were required by law to make their reports to the Comptroller five times a year on some past date fixed upon by the Comptroller.

National Bank Laws and Regulations.—The national banks are under the supervision of the Comptroller of the Currency, who is appointed by the President on the recommendation of the Secretary of the Treasury. His salary is $5000 a year.

A national bank may be organized by any number of persons not less than five, on permission of the Comptroller. The capital required is not less than $50,000 in any case, and this minimum applies only to towns the population of which does not exceed 6000; in cities having a population exceeding 50,000, the minimum capital is $200,000. For places having a population over 6000 and not exceeding 50,000, the capital required is $100,000. One half of the capital must be paid in before the bank is authorized to begin business, and the remainder in installments of not less than 10 per cent on the entire amount of the capital, as frequently as one installment at the end of each succeeding month from the time it is authorized to begin business. Capital stock is divided into shares of $100 each.

The banks are managed by a board of not less than five directors, chosen by the stockholders. Executive officers of the bank—president, vice-president, cashier, and assistant cashier—are chosen by the directors.

Shareholders are individually liable for the debts, contracts, and engagements of the bank to the extent of the amount of their stock therein, at the par value, in addition to the amount invested in such shares. This is what is known as the double liability of shareholders, and is one of the features adding to the strength of the system.

National banks are designated by the Secretary of the Treasury to act as depositaries or custodians of public money. Such deposits are secured specially by a deposit of United States bonds with the Treasury.

All national banks before commencing business are required to transfer and deliver to the Treasurer of the United States, as security for their circulating notes, United States registered bonds to an amount not less than one fourth the capital where the capital is $150,000 or less, and to the amount of $50,000 where the capital is in excess of $150,000. These bonds must be taken by the banks whether they issue circulation or not.

Circulating notes are issued to national banks on a deposit of United States bonds with the Treasurer. Notes are limited to 90 per cent of the par value of the bonds, also to 90 per cent of the capital of the bank. They are over-secured, and no holder of them has ever lost a dollar by reason of the failure of a bank.

The notes are secured by the government bonds, there being a difference of the 10 per cent between the par of the bonds and the notes issued, and the bonds nearly always command a premium. They are further secured by the first lien on the assets of the bank, including the double liability of shareholders, by a 5 per cent redemption fund in the Treasury, and also by the margin between the capital and the amount of notes permitted.

National bank notes are redeemable at the counters of the issuing banks and at the Treasury in “lawful money” of the United States. This term, as commonly used, means legal-tender money, and in practice, perhaps, gold coin or legal-tender notes.

Reserves of national banks are the amounts of money kept on hand to pay their deposits and current checks and drafts. This reserve is to be kept in lawful money,—gold and silver coin or certificates, and United States currency certificates or legal-tender notes. There are three central reserve cities, namely, New York, Chicago, and St. Louis. National banks in these three cities must keep a reserve of 25 per cent against their deposits, and this amount must be kept in their own vaults. There are twenty-four other reserve cities which are also required to keep a reserve of 25 per cent, but one half of that amount may be due from other banks in New York and other central reserve cities, approved as reserve agents by the Comptroller of the Currency. Banks outside of these reserve cities must keep a reserve of 15 per cent, three fifths of which may be due from approved reserve agents in the reserve cities or central reserve cities.

In times of panic when there is a run on banks they may use this reserve to pay their depositors, and it often happens that the reserve falls below the amount required by law. Under such circumstances the Comptroller may notify the banks to make good the deficiency; failing to comply with this request within thirty days, they may be closed.

National banks are not permitted to make loans on real estate. The regulations prescribed by the law for the management of these institutions are very stringent, supplemented by a system of examination and reports.

In 1896 the Comptroller of the Currency estimated that the government had made a net profit of $157,439,248.98 out of the revenues derived from the national banks. It was estimated in the same report that the average percentage of dividends paid to creditors of insolvent national banks was 75 per cent. There have been no losses on circulation. In 1878 the Comptroller estimated that the annual losses upon all the currency issued by State and private banks amounted to 5 per cent annually.

The national banks are not monopolistic. Any body of five reputable citizens can form one by getting together $50,000 capital. The total shares of the national banks are approximately 300,000.

Profits on national bank stock are not exorbitant. For a period of twenty-nine years the net earnings on capital and surplus have been only a little over 7 per cent.

Since the establishment of the national banking system 5171 banks have been organized, of which 1224 have gone into liquidation, 368 have become insolvent, and 3579 are in operation (February 4, 1899).

There is a marked falling off in the number of new national banks organized in recent years. In 1890 there were 307 organized, but in 1898 there were only 50 organizations reported, and that was the highest number reported since 1893. The capital of the national banks is also decreasing, but the deposits show a large increase.

At present the State banks are gaining in numbers more rapidly than the national banks.

Profit on National Bank Circulation.—Many suppose that national banks make an undue profit on the privilege they have of issuing notes to circulate as money, based on a deposit of bonds with the United States treasurer. Official figures disprove this. The total national bank notes outstanding, February 4, 1899, was $203,636,184.50. The law permits these banks to issue notes to the extent of 90 per cent of their capital. This capital, on February 4, 1899, was $608,301,245. Therefore they might have had notes at issue on that date to the amount of $545,871,120.50, instead of only $203,636,184.50. This is conclusive evidence that there is no substantial profit in the issuing of such notes.

In the figures furnished by the Comptroller of the Currency for 1898, he shows that the profit which a national bank could make by taking out circulation on a deposit of $100,000 of United States bonds, on October 31, 1898, was less than 1 per cent. On that date eight leading banks had no circulating notes at all out. The meagre profits of national banks explain why they do not supply an adequate paper currency. The restrictions on them make it impossible to render any substantial assistance to business in this respect. This is especially true in times of panic. Possessing gigantic strength, they are compelled to see the industries of the country attacked by doubt and distrust, and are unable to go to their aid because of the restraints which forbid them to exercise their legitimate functions.

VI. FOREIGN BANKING AND FINANCE.

Most foreign countries issue metallic money only, except those that are on a paper basis. In general the paper currency is issued by banks, many of which are more or less remotely associated with the government. Some of these banks issue notes on the security of the government or other stocks and bonds, while many emit notes based on no special form of security, but upon the general assets of the bank.

As compared with the United States there are but few banks in the principal foreign countries. England has less than one hundred; Scotland less than a dozen; Canada but thirty-eight chartered banks. As in other foreign countries, the Canadian banks have numerous branches affiliated with the head office. National banks in the United States are prohibited from having branches. The Bank of France, the Bank of England, the Imperial Bank of Germany, the Austro-Hungarian Bank, the Imperial Bank of Russia, are all more or less intimately associated with their respective governments.

The Bank of England was incorporated by royal charter, July 27, 1694, its incorporators lending £1,200,000 to the government, in return for which the Bank was permitted to issue notes to a like amount. It had a practical monopoly up to 1826, and even now, it is believed, no bank within a radius of 65 miles of London may issue notes. It has suspended specie payments more than once. In 1844, the banking and issue departments of the Bank were separated. One fifth of the reserve may be silver, though in practice the reserve is kept in gold coin and bullion. Its notes are based on gold, except £16,800,000, which are secured by the government debt and other securities. It is compelled to buy all gold offered at a fixed price, paying for it in notes. So it must redeem all notes on demand in gold. When so redeemed they are canceled and, after five years, burned. No notes of a less denomination than five pounds are issued. The Bank checks gold exports by raising the rate of discount. The building covers about four acres of ground, and employs over eleven hundred persons. It is the keystone of the entire system of British credit, and commands the assistance of the Government when needed.

The Scotch banks issue notes on their own credit to the amount outstanding at the time of the passage of the Bank Act in 1844. Their rate of interest is said to be the same at all of their thousand offices. A unique feature of the Scotch banking system is that of cash credits, by means of which a person of good credit may get his checks cashed without a deposit of actual money, the banks simply entering the credits on their books.

The Bank of France has a monopoly of note issues, charges a premium on gold for export, and may redeem its notes in either gold or silver. The Imperial Bank of Germany and a few other German banks issue notes on gold and other securities, and further amounts on their general credit. Beyond a fixed sum, called the emergency circulation, a tax of five per cent is levied. Other European banks are generally modeled on the same leading principle—a central bank of issue, with numerous branches, and associated with the Government directly or indirectly. The Imperial Bank of Russia issues notes practically covered by gold and redeemable in that coin. Japan tried a system of national banks combined with Government paper money, but is now substituting a system of bank notes issued by the Bank of Japan.

VII. UNITED STATES GOVERNMENT DEBT SINCE 1857.

In 1857 the Government owed only $10,000,000 over and above the cash held in the treasury. At the breaking out of the Civil War the debt had increased to about $80,000,000. By August 31, 1865, it had increased to $2,756,000,000, with an interest charge of $150,000,000. In twenty-eight years, down to June 30, 1893, the Government extinguished $1,917,500,000 of its debt, paid $2,364,000,000 for interest on its debt, and $118,000,000 for premium on bonds redeemed, making a grand total of $4,400,000,000, or an annual average payment of $157,000,000 for the entire period.

In 1865 the annual interest charge on the public debt was $150,977,697. In 1898 it was only $34,387,408.

From 1791 to 1898 the gross receipts of the Government were $30,547,063,336.06 and the gross expenditures $29,768,597,237.24. The net ordinary receipts, which do not include loans or proceeds from the issue of Treasury notes, were $405,321,335.20 for the fiscal year ended June 30, 1898, and the net ordinary expenditures, which do not include payments on account of premiums or interest on the public debt, were $405,783,526.57.

VIII. POSTAL SAVINGS BANKS.

Many believe that a system of postal savings banks could be generally introduced into the United States. Such banks doubtless appeal to those who have more confidence in the Government than in any association of individuals. Their safety may be conceded, for when the Government fails other institutions are likely to go the same way. But when people deposit money in a postal savings bank, they make a loan to the Government. This implies that the Government must be a perpetual borrower, whereas, until recent years, the United States has been a debt-paying nation, and in the course of affairs may soon be again. Unless we are to have a large permanent debt, the deposits in postal savings banks would have to be invested in general securities. Such investments could not well be made by the post-office officials of the country.

In Great Britain these banks have been in existence for about thirty-eight years, and their number has grown to about 12,000, with more than 6,000,000 depositors. The system prevails in a number of other countries. The more concentrated and paternal system of government prevalent in countries having these banks renders their management a much less difficult problem than it would be in the United States with our large areas, vast number of post-offices, and general diversity of conditions. In Great Britain the deposits in the postal savings banks are made at the money order post-offices in a pass book held by the depositor. Withdrawals are made by filling up blank forms, and these withdrawals may be made at any money order post-office. Deposits are invested in the public debt, and the rate of interest is about two and one half per cent. The postal savings banks of Great Britain contain deposits approximating $527,000,000; those of France, $152,000,000; those of Italy, $90,000,000; those of Belgium, $67,000,000; those of Canada, $31,000,000.

IX. SAVINGS BANKS IN THE UNITED STATES.

There are no worthier financial institutions in the country to-day than the savings banks. Most of these are organized on what is known as the mutual plan. They have no capital, no stockholders, and all the assets are held in trust for the benefit of the depositors. They are managed by a board of trustees, who serve without pay. The investments which the banks are permitted to make are generally restricted to high-class securities insuring safety. The savings banks in New York State, especially, are closely restricted in investing their funds, and failures in recent years are almost unknown. A deposit in one of these banks is hardly less safe than an investment in Government bonds. The savings banks are the primary schools of economy and thrift, and I believe that an extension of the mutual savings bank system throughout the country, under proper legal safeguards, would be of the greatest benefit to the people of the United States.

The deposits in banks of this kind are usually limited by law to amounts not exceeding $3000 to one depositor, as they are not intended to be used by the wealthier class of people.

In addition to the mutual and stock savings banks in the United States, a system of school savings banks, introduced into the schools of the United States by J. H. Thiry, of Long Island City, N. Y., is worthy of mention. Such banks have been very successful in inculcating habits of thrift and economy among the children of the country.

X. THE CLEARING-HOUSE.

A clearing-house may be defined as an institution for saving time, money, and labor. Its underlying principle is that of setting off one claim against another.

A bank in a large city receives every day in its mail a great number of checks or drafts drawn on banks in the same place. It does not present these checks directly to the banks on which they are drawn for payment, but sends them by messenger to the clearing-house. Let us say, for illustration, that the First National Bank presents to the clearing-house checks on other banks amounting to $100,000. At the same time the other banks send to the clearing-house checks they have received drawn on the First National Bank, aggregating $75,000. A payment of $25,000 in money to the First National Bank will be all the cash required to pay checks representing $175,000. The economy in the use of money is still better illustrated by the following statement of an actual transaction. On a day in the latter part of 1898 the Bank of the State of New York took to the New York Clearing-House checks on other banks amounting to $15,647,583.82, and other banks brought checks against it amounting to $15,647,401.85. The sum of these items was $31,294,985.67, and they were paid with $181.97 in money, which represents the credit balance due to the Bank of the State of New York. This instance shows what large transactions may be effected with small sums of money by employing proper banking machinery. Banks multiply the usefulness of money many fold.

The New York Clearing-House Association was organized September 13, 1853, and the first clearing made by the Association took place on October 11, 1853. The banks belonging to the New York Clearing-House Association reported on April 1, 1899, loans and discounts, $779,951,100; deposits, $898,917,000; specie, $187,114,300; circulation, $13,870,600.

Clearing-House Loan Certificates.—These are simply devices that the banks have invented for use in times of panic. They are issued by a committee of the Clearing-House Association on the deposit of approved securities by the bank desiring them, and are used only to settle balances between the banks. They are not money, but serve a useful purpose in diminishing the demand for money; for when the banks agree to accept these certificates among themselves, it makes that much money available to be loaned or paid to depositors. In 1893, and in other years of financial stringency, the issue of these certificates afforded great relief to business interests and saved the country from some of the most disastrous results consequent upon such panics.

These certificates are not to be confounded with clearing-house gold certificates issued by the Association on deposits of gold coin. They are used in making payments of balances between banks, and obviate the necessity of frequently passing the actual coin from hand to hand.

On April 11, 1898, the clearings at the New York Clearing-House for that day amounted to $352,882,567—the largest amount ever reported up to that time. The balances to be paid in money were $17,345,452, or only about five per cent. For the year 1898 the bank clearings at New York were $41,971,781,684, and for the whole country, $68,750,000,000.

An investigation of the amount of credit paper used respectively in the wholesale and retail trade was made by the Comptroller of the Currency in 1896. In his report for that year the Comptroller says: “From the face of the returns the conclusion to be drawn is that 67.4 per cent of the retail trade of the country is transacted by means of credit paper (checks), that

95.3 per cent of the wholesale trade is so carried on, 95.1 per cent of business other than mercantile, and 92.5 per cent of all business."

XI. PANICS AND THEIR CAUSES.

A panic is generally due to inflation and speculation, and these, of course, have their origin in various sources not easily determined. An unusual increase in the production of precious metals, bountiful crops, a speculative craze taking possession of the public—such as the tulip mania in Holland—all these and many other causes lead to speculation. The fall in prices due to a stoppage in speculation brings on the panic. Sometimes the catastrophe is produced by war or rumors of war, often by the most trivial circumstances, and not infrequently without any apparent cause. Before everybody had desired to buy; they now became as eager to sell, and this rush to convert securities and commodities into money precipitates a panic.

Crises may be divided into commercial and financial. The last one in the United States, whatever may have been its ultimate developments, was in its inception and culmination essentially a financial panic. The Treasury and the banks were both regarded with more or less distrust.

Panics or crises more or less severe have occurred in the United States in 1814, 1818, 1826, 1837–39, 1848, 1857, during the Civil War, 1861–65, 1873, 1882, 1884, 1890, 1893. Some of these should hardly be called panics, as they were mere local disturbances. Different causes have been given for each of these revulsions. Overtrading and speculation were doubtless responsible for them. The panic of 1857 was coincident with large net imports of merchandise. On August 24, 1857, the onward wave of prosperity, which had been steadily rising to a great height, received a check by the failure of the Ohio Life Insurance and Trust Co., followed by numerous other failures. On October 4 every bank in New York, except the Chemical, suspended specie payments, and they did not resume until December 12.

The speculation in gold in 1869 culminated in what is known as the Black Friday panic, September 24, 1869. Fiske and Gould were conducting a speculation in gold, and sought to corner it. They forced the price up to a high figure, but the Government suddenly appeared as a seller of gold and broke the "corner."

The year 1873 witnessed another revulsion of confidence and another disruption of the commercial and financial affairs of the country. Business had long been unduly expanded, and the collapse finally came. The failure, on September 18, of the honored firm of Jay Cooke & Co., which had not only been identified with the building of the Northern Pacific R. R. but had been a strong supporter of the credit of the Government when it was in the direst distress, was the first bad news. House after house fell. The Stock Exchange closed its doors on September 20, and did not reopen them until September 30. More than fifty Stock Exchange firms suspended, and several of the leading banking institutions of New York and other cities had to stop business.

During this panic the New York Clearing-House Association issued clearing-house certificates to those of its members who needed available funds, and during the trouble issued $24,915,000 of them. In May, 1884, it issued $24,915,000; in the 1890 panic, $16,645,000; in 1893, $41,490,000.

Following the resumption of specie payments the times were good for several years. The production of the precious metals was averaging $75,000,000 or more per year. From 1879 to 1883 we imported about $190,000,000 of gold. Railroad construction reached a higher point than was ever recorded, either before or since, nearly 40,000 miles of track having been laid in five years. All seemed well, when another collapse came in May, 1884. This was preceded by the failure of Grant & Ward, and it was followed by the failure of the Marine and the

Metropolitan Ranks. The disclosures of bad faith on the part of men occupying positions of great trust, made the 1884 panic one of distinct characteristics of its own. The previous activity in all lines of enterprise may have made the revulsion timely, but individual dishonesty greatly aggravated the situation.

The panic of 1890, in the United States, was but a reflection of the great Baring failure in London in the fall of that year. This crash was due to South American speculations, and was one of the greatest failures of modern times. It is the opinion of many well-informed financiers that this was one of the causes which operated to produce the panic of 1893 in the United States. The course of the United States in regard to the purchase of silver, doubts as to the tariff, deficiency in revenues—all, perhaps, had their share in creating distrust. But back of these were the conditions superinduced by an era of inflation and speculation. The 1893 panic bore most heavily upon the banks. There was a continued demand upon the Treasury for gold, and the deposits in banks were withdrawn so rapidly that hundreds of failures ensued. The period of depression continued for nearly three years, and has been succeeded by an era of general prosperity, which it is hoped may be long continued.

The Century's Progress In Fruit Culture

By H. E. VAN DEMAN,
Late Prof. of Horticulture, Kansas State Agricultural College.

From the earliest histories of civilization we learn that the cultivation of fruits has been a delightful pastime and also a substantial means of living. Their tempting colors, fragrant perfumes and luscious flavors are unequaled in combined attractiveness and satisfaction to the human senses by anything else among all the products of nature. Their juices are at once appetizing, nutritious, and wholesome. Millions of people have subsisted upon them largely, from time out of mind.

It is, therefore, not a matter of wonder that our forefathers, when they came to the shores of this New World, brought with them seeds, cuttings, and plants of the best fruits they had at their old homes. Thus it was that the apple, pear, peach, plum, cherry, grape, olive, date, almond, European walnut and chestnut, and many other less valuable fruits were first cultivated in North America.

The Beginning.—Previous to the beginning of the nineteenth century there had been considerable development in fruit culture in the colonies. Small apple orchards were quite common in the settlements, from New England to the Carolinas. The pear, peach, plum, grape, and a few other fruits were cultivated in less degree. The Spanish had introduced the peach and orange in Florida, and the French had planted the grape and pear in their sparse settlements in the Mississippi Valley and near the Great Lakes. There are to-day, and yet in a healthy condition, near Detroit, Michigan, several immense pear-trees from these first plantings, that are nearly three hundred years old. The Catholic fathers planted the vine and the olive, and occasionally the date palm, at their mission stations along the Rio Grande and on the Pacific coast.

Thus we see that when the year 1800 ushered in the century now closing, there were many feeble beginnings in the way of fruit culture scattered over the Continent. The Indians, contrary to what we might have supposed, helped materially in the distribution of some of the orchard fruits. In 1799, when General Sullivan made his famous raid against the tribes which composed the historic "Six nations," he found bearing apple orchards in Western New York. In Southern Canada and Michigan the Indians occasionally planted the apple and pear. The tribes living along the Gulf of Mexico had peach-trees in their little cultivated patches, having obtained the seeds from the Spaniards; and to-day we find the descendants of these Spanish or "Indian" peaches commonly grown throughout all the Southern States, and to some extent all over the peach-growing sections of America.

The Experimental Stage.—During the life of the generation which existed for the first thirty or more years of the century the culture of fruits was still principally in the experimental stage. Some of the foreign species and varieties had not proved satisfactory, and they were being critically tested or abandoned. New varieties were being originated on our own soil. Our native fruits were being brought under culture, too, and with the most satisfactory results in many cases. It was learned that we had in them the foundation of almost unlimited development. Their progeny has revolutionized some lines of fruit culture. This is especially true in our vineyards and berry-fields.

There were men of noble and patriotic cast of mind, who devoted their lives to the development of this lovely and wholly humane work. They deserve to rank beside the heroes of our battlefields. Their victories were those of peace, and were followed by an increase of the delightful products of the orchard, vineyard, and garden.

Once that our forefathers were free from the bondage of European greed, this art of peace kept pace with our civilization on other lines. There is nothing in the whole list of our scientific attainments or material industries that can show more substantial progress. Nor is there a nation on earth that has so rich, varied, and adaptable soils, together with climatic conditions so admirably and generally suited to fruit culture; nor a people more alive to their opportunities in this direction.

The Age of Progress.—During the generation of fruit growers who lived from about 1830 until the time of the Civil War, the region lying between the Alleghany Mountains and the Missouri River, and extending from the Ottawa River in Canada to the mountains of Tennessee, which is now the great apple bin of America, as well as its granary, was being rapidly filled with energetic settlers. These pioneers carried with them carefully selected seeds, cuttings, and trees of the best varieties of fruits known in their Eastern and Southern homes. These were planted in the rich, virgin soil of the new territory, which was then known as "The West." Under the happy influences of a congenial climate and careful cultivation, they developed into fruitful orchards and vineyards, yielding finer specimens, and, in some cases, larger crops than had ever been known in the older parts of the country. This gave a great impetus to the culture of fruits. The first large commercial orchards of the apple, peach, and pear in the central United States were then being planted in Michigan, Ohio, Indiana, and Kentucky.

The South had not yet awakened to a knowledge of her possibilities in fruit culture. Under slave labor the land was almost solely given up to cotton and tobacco. Florida had not then even dreamed of her wonderful developments in orange culture. In Missouri, Kansas, Arkansas, Texas, and the great Northwest, where now there are fruit plantations of almost unparalleled extent, only the first trees and plants were being set, and it was only thought *possible that some day* fruits could be produced in abundance there. The Rocky Mountain and Pacific States had scarcely been heard of, even as Territories, and only an occasional plantation of vines and trees around some mission station could be found.

The Age of Triumph.—At the close of the Civil War, which had somewhat distracted the attention of our people both North and South from the progress of the peaceful arts, there was a great expansion of our rural population. The love of travel had taken possession of many who had been in the armies. They were no longer content with the narrow boundaries and the poor lands of the old Eastern farms. They wanted new fields for their energies. The building of the great railroad systems across the continent solved the question of the settlement of the "Far West," and the mythical "American Desert" that was supposed to lie this side of it. The prairies were covered with homesteaders' shanties, sod houses, and "dug-outs." The forests of Michigan, Wisconsin, Minnesota, Missouri, and Arkansas fell before the axe of the pioneer. The "Boys in Blue" who had seen the natural advantages of the Southern States, while there on the dread errand of war, began the rehabilitation of the country they had helped to devastate. They took with them their Yankee notions and Western vim, and planted many kinds of farm crops, trees, vines, and berry bushes upon the old plantations where little else than cotton and tobacco used to grow. Florida was veritably turned into a garden of orange trees and truck patches. The chocolate hills and rich black lands of Texas were planted to grapes, peaches, and berries. The dry plains and mesas of the Rocky Mountain region, that were naturally almost devoid of vegetation, were irrigated and made to produce the most delightful fruits in abundance. The giant forests of Oregon and Washington were invaded by the lumberman and the homeseeker, and in their stead were planted trees which yielded the largest and best of fruits. And California,—what shall we say of her wonderful valleys, grassy foothills, and timbered mountain slopes? All of the fruits of the temperate zones are growing there, and in some places the hardier of the tropical kinds succeed. California is indeed a land of fruits.

Taking the whole of North America, except the frozen regions of the British possessions, and Alaska, where few cultivated fruits can be grown; and half-civilized Mexico, where progress is scarcely known; the last thirty-five years have witnessed such advancements in fruit culture as seem almost beyond belief. It has truly been an age of triumph. Not only has the territory of its successful culture been wonderfully extended, but the whole plan and science of fruit-growing has been almost revolutionized. Old things have largely passed away. New varieties, new methods of culture and new markets for the products of the fruit farm have been found. Some of the old varieties have been retained, but many new ones have been originated here; some by chance and others by scientific breeding. Valuable kinds that had long been lying in obscurity have been brought into public favor. Others have been imported from foreign countries. Almost the entire world has been ransacked in order to obtain fruits that might prove of value to us.

At the beginning of this period of unparalleled progress the experiments of former years had shown the success or failure of the different species and varieties already in cultivation in many parts of the country; and now, at its close, after nearly forty years more of experience, there is scarcely a section within the entire domain of North American fruit culture where it is not quite well known what is and what is not adapted to each locality.

The methods of culture are changed from the old ones, which were largely those practiced in Europe, to such as have been evolved by the peculiar necessities of our soil, climate, and varieties. This is especially true of our vineyards; for, except on the Pacific slope, where the foreign grapes succeed, our native vines require much less severe pruning, and a much more roomy trellis upon which to grow than those old kinds. The first vineyards were planted very thickly and trained by the stake method, which is the French and German style. I remember working in such vineyards just prior to 1870, and of seeing the dwarfing and dwindling effect upon the vines. Nothing of the kind is now seen this side the Rocky Mountains, because our American grapes will not endure such treatment and continue to bear well.

Horse culture has in a great measure succeeded hand culture. Without such a change it would be impossible to profitably cultivate the vast stretches of orchards, vineyards, and berry-fields that are to-day found in many parts of the country. The common plow and harrow were about the only tools available thirty or forty years ago. They are now supplemented, and in some cases superseded, by various kinds of cultivators, weeders, and improved plows and harrows. They are made to carry out the modern idea of frequent but shallow stirring of the soil. This method of culture disturbs the roots but little and retains the moisture in the soil, by keeping the surface finely pulverized, thus forming a “dust mulch.” Some of these tools are so made as to enable one man with one horse to easily cultivate twenty-five acres per day, and with a two or three horse implement, to thoroughly pulverize the surface over fifty or more acres in that time.

The tendency during the last half century has been towards heading orchard trees lower. The old style was to have them with trunks so tall that a horse could walk under the branches. Low heads have the advantage of giving the winds less purchase upon the roots, the fruit is more easily gathered, and the sun is less likely to scald the trunks.

The old idea of our forefathers was, that apples were chiefly to be used for making cider, peaches for brandy, and grapes for wine. We have become a nation of fruit-eaters, as compared with our predecessors and the Europeans. The greatest impetus ever given to American fruit culture came from the increased demand in our own country for fresh fruit. It is a staple article of diet here, rather than a luxury, as it is in most parts of Europe. Nearly all of our fresh fruits are consumed in the homes of our people, or exported. A very little is made into cider, brandy, or wine, and the larger part of the remainder is dried or canned. The proportion of grapes made into wine east of California is trifling, while there it is considerable. The enormous production and consumption of berries of various kinds by the Americans is unparalleled in the history of the world; and nearly all of this has come through the development of our wild berries.

Instead of buying largely of foreign fruits and their products, except such as are strictly tropical and cannot be grown within our borders only in a limited way, we have nearly stopped their importation, and have, in turn, become exporters. The rapid increase in our population demands more and more fruit, and it is not to be wondered at that our imports of oranges and lemons is increasing; but if it was not for our home production of these fruits the present amount would be more than doubled. Our raisins and dried prunes have almost driven out the foreign products, and their quality is so good that there is a growing demand for them in England and some other foreign countries. The same is true of our canned and preserved fruits. Our apples bring the highest price of any that reach the markets of Europe, and the demand for them is increasing. Fresh pears and peaches have also been sent to England in limited quantities from as far west as California and Oregon. Our oranges also have an enviable reputation there because of their beauty and delicious flavor. Our apples are sent to Mexico, China, and Japan. The street venders of Bombay, India, cry their sale with great gusto: “American apples! true American apples!” and sell them at a price which would require more than a whole day’s wages of a good workman to buy a single one.

The world is beginning to know the value and goodness of our fruits. We are selling, inside their dainty skins, a portion of our sunshine and water; for the golden, pink, and crimson tints are from the glowing sun, and the water, which is the main part of all fruits, is fresh from nature’s fountain.

Growth of Apple Culture.—From the first settlement of the country well into the present century, the principal purpose for which apples were cultivated in America was to make cider. This was a common beverage in England and on the continent of Europe, whence our forefathers came. Here they introduced the Old World custom of drinking hard cider “in season and out of season.” In 1721, in one “town” near Boston, wherein lived about forty families, there were made in one year three thousand barrels of cider, and in another of two hundred families, near ten thousand barrels. This is fifty barrels to the family, which seems ample for a great many drinks per day for each person, with plenty left to sell to the cider-loving citizens of Boston. Colonel John Taylor of Virginia wrote, in 1813, nearly one hundred years later: “The apple will furnish some food for hogs, a luxury for the family in winter, and a healthy liquor for the farmer and his laborers all the year.”

But hard cider did not always satisfy. “Applejack,” which is the strongest kind of brandy, suited the taste of many of the old-fashioned folk much better. The Virginia gentleman, the Dutch burgher, whose ample acres fronted upon the Hudson, the solemn Philadelphia Quaker and the staid Puritan of New England, all loved their dram and took it frequently.

Besides alcoholic liquors, vinegar was made in considerable quantities. But as late as the middle of this century there was scarcely a good family apple orchard to be found, such as we now have, with varieties arranged to ripen from early to late. Nor were there many commercial orchards of consequence. The famous orchard of Robert L. Pell, in Ulster County, New York, was a remarkable exception. It consisted of 20,000 trees, all of the

Yellow and Green Newtown apples. Fruit from this orchard sold at wholesale in London, England, in 1845, at the enormous price of $21.00 per barrel, but the next year the price had fallen to $6.00 in New York city, ready for foreign shipment. This orchard gradually fell into decay, and was not soon followed by others of so large acreage. The Newtown apple proved unsuitable for general culture, and is now grown only in two localities with much success. In the mountain “coves,” or sheltered slopes and valleys, of the Blue Ridge, in Virginia and North Carolina, where it is called “Albemarle Pippin,” there are many orchards that produce as fine fruit as any from the Pell orchard, and it now sells from $5.00 to $12.00 and more per barrel in England. In the higher foothills of California and Oregon this variety does equally well, and apples from there are being sold in England during this closing period of the century at almost fabulous prices.

In the old days, if an orchard furnished an abundance of apples for cider, brandy, vinegar, apple butter, some for drying, and a few of fair quality that would keep for winter use, it was all that was expected.

Most of the trees in those old orchards were inferior seedlings, and it is no wonder that the people of those days did not use apples as we do. A few of them were very good, and it is from such chance favorites that we have preserved to us, by grafting, the Baldwin Winesap and hundreds more that fill our orchards to-day. We have developed a new race of American seedlings. Most of the old varieties that were so highly esteemed across the ocean are now rarely mentioned. Our newer and better kinds have largely supplanted them. As time advanced more choice varieties were added, until we may now confidently boast of having the best apples in existence. Whoever has eaten our delicious Grimes Golden, Jonathan, and Northern Spy, need not look for better kinds, because they cannot now be found. Indeed, the name “Seek-no-farther” has been triumphantly applied to one variety. However, we are still seeking and expecting to produce by skillful breeding, if not to find, others which may be even better than those we now possess.

A history of the recognized and named varieties of apples of American origin would be a book in itself. It should begin almost with the first settlement of the country. At the beginning of this century the Early Harvest, Baldwin, Swaar, Esopus Spitzenberg, Rhode Island Greening, Yellow Bellflower, and a few others which are yet popular, were already grafted into hundreds of orchards, some of them being as far west as the Mississippi River. William Coxe, in his excellent book on fruits, published in 1817, mentions 100 kinds. William Prince, of Long Island, who kept the first nursery of note, had 116 varieties of apples in his published list in 1825, of which about half were of American origin. Now there are nearly 1000 kinds offered by the nurserymen of the country, and the books on pomology contain nearly 5000 varieties, a large part of them being American. Truly this is progress.

We have the best and by far the most extensive apple country in the world. The largest apple orchards in the world are in America. The biggest of all belongs to F. Wellhouse & Son, of Kansas, in which there are 1600 acres. There are others in Missouri, Illinois, Iowa, Colorado, and New Mexico that are nearly as large.

The variety principally grown in these orchards is the Ben Davis. It is a thrifty, rugged grower, a most productive bearer, and a handsome apple to sell. Its brilliant red stripes, large size, and ability to keep, make up for its deficiency in flavor. It is, to-day, the business apple of America. Baldwin is the business apple of the Eastern States. Both these varieties are well known in every market of this country, and wherever our apples are exported.

The first government record of exported apples was in 1821, when “68,643 bushels,” or about 22,781 barrels of apples, were sent abroad. In 1897 there were 2,371,143 barrels exported, which is the largest quantity ever shipped to foreign countries in one year. During the same year there were also exported nearly 31,000,000 pounds of dried apples, 94,000 gallons of vinegar, and 750,000 gallons of cider. Certainly this is a good showing for the surplus products of American apple orchards. The year 1898 gave a lighter yield, but 1899 will, perhaps, about equal it.

The Pear.—Whoever has eaten a delicious little Seckel pear must know that its equal in richness and spicy flavor is not to be found. This little gem is one of the triumphs of American fruit culture. How far beyond and above the old “choke” pear of our grandfathers’ days is this one, and many more of the delicious pears that grow in our orchards and gardens to-day!

Pear growing was only a side issue until lately. A few trees were planted about our forefathers’ houses or in the edge of the apple orchards; but these were often sprouts from some neighbor’s seedling trees. As the appetite for good fruit increased, the false idea that pears should be ground and pressed into cider, called perry, decreased, until now no one thinks of wasting this delicious fruit by making it into an intoxicating drink.

The Bartlett is our most popular pear of good quality. It originated in Berkshire, England, about 1770, where it was called Williams. When brought to America early in this century and planted at Dorchester, Mass., the original name was lost, and it was renamed in honor of Enoch Bartlett, who first propagated and distributed the trees and grafts. The old tree, from which came the millions that have been and are now a source of delight and profit to our people, is still in bearing condition at Dorchester, and I have lately eaten as good Bartlett pears from it as ever were grown. The variety flourishes better in America than in its old home, and every year large shipments of the fruit are sent to England and sold at a very high price.

Some fifty years ago there were brought from China seeds of a type of a pear that was entirely new to this country, and was called by us the “Sand” pear. The only apparent reason for giving it this name is, that it is gritty, hard, and little better to eat than so much sand. But the seeds made trees that grew with remarkable vigor and were much alike, and so was their fruit.

From this stock came up a seedling some thirty years ago, in the garden of Peter Kieffer, in Philadelphia, that has almost revolutionized pear growing in America. It is supposed to be the result of a cross between a Chinese Sand pear-tree and a Bartlett that stood near each other, although this is mere supposition. The fruit is only of medium quality, and some say it is very poor; but it is large, very beautiful when fully mature, late in ripening, and endures rough handling with as little harm as so many potatoes. It is very popular with the canners. The greatest point in its favor is the freedom of the tree from blight, its vigor and almost never-failing and abundant bearing. It is the business pear of to-day, despite its inferior quality.

The Peach.—When the peach was first planted in America by the Spanish and French, and later by other nationalities, there was little thought of it ever becoming a great commercial fruit. The trees that sprang from the seeds brought across the ocean grew so luxuriantly and bore so abundantly that their progeny was soon scattered far and wide. Peach trees were early found growing wild, like our native trees, wherever seeds had been dropped by travelers or hunters. There was no attempt at commercial peach orcharding until well into the present century, and for the first half of this there were scarcely more than a few seedling orchards planted for family use or for making brandy. In some sections dried peaches were an article of trade before any commercial peach orchards, in the true sense, had been planted; but they were always the product of women’s work, and were prepared under the disadvantageous conditions with which they are usually hampered. It is no wonder that the grade was low, for the peaches were generally of poor quality, and no other mode of drying was then known than on boards and wooden trays, exposed in the open air to flies, moths, and dust. All that was sent to market was first taken in at the stores where the country people came to trade, and it was a mixed mess, indeed, that was thus collected. What fresh peaches were sold brought a very low price, rarely more than twenty-five cents per bushel.

Early in the century budded peach-trees were almost unknown in America. A few were brought over from France and the fruit houses of England, all of which did very well here. However, it was soon learned that there were seedlings of American origin that were equal to the best of the foreign kinds. Among the first of these were Heath, Early York, Tillotson, and Oldmixon Cling and Free. A little later, two large yellow freestones came up by accident on the premises of William Crawford, of Middletown, N. J., one ripening early and the other late. Early Crawford and Late Crawford are, after more than sixty years of trial, still very popular upon the markets. Many other kinds, once popular, have long since been discarded and forgotten.

Just before our Civil War the Hale peach was discovered and, being earlier than any kind then known, it became very popular. About 1865, the Amsden, Alexander, and some others came to notice. They were a month earlier than the Hale. A peach, called Peen-to, was imported from southern China about the same time, that ripened still a month earlier; but as it belonged to a very different race from our other peaches, and was exceedingly tender, it has been found suitable only to Florida and other semitropical regions.

The most popular peach of the present day is the Elberta. It was originated by Samuel H. Rumph, of Georgia, about twenty years ago. Its large size, creamy, yellow color, and good flavor, added to its productiveness, make it very acceptable to both grower and consumer.

The most extensive peach orchards in America are located in Georgia, North Carolina, Southern Missouri, Western Colorado, and California. A few are each more than a thousand acres in extent.

The advent of patent evaporating machines, about 1870, aided greatly in the production of high grade dried fruits of all kinds, and the peach shared in the progress. California and Oregon alone shipped in a single recent year nearly 40,000,000 pounds of dried peaches. The peach is canned more than any other fruit, as may be seen upon the shelves of any grocery store, or in the fruit closets of the country housewives. Whether eaten fresh from the trees, served up with cream and sugar (a dainty dish unknown in Europe), evaporated or canned, the peach is one of the blessings of our great country.

The Plum.—There are three general classes of plums grown in America to-day, the European, American, and Japanese. European plums were introduced here at an early day, but were grown very sparingly until within the last thirty or forty years. The principal reason for this is the presence of a deadly enemy to the plum, apricot, and some other fruits, commonly known as the plum curculio. It is a *little* enemy but a *mighty* one; for it deposits its eggs in the young fruit, and they soon hatch into little grubs that work their way into the fruit and cause it to die and drop off. West of the Continental divide there are none of these insects. There the soil, climate, and all else seem to conspire to enable the plum-grower to prosper. Great prune orchards are planted in the fertile valleys from New Mexico and Colorado westward. Some of them cover thousands of acres in a body, and the yield is enormous. The rainless autumns of California permit the drying of the fruit in the open air and in the most economical and perfect way. From an infant industry twenty years ago it has now grown so great that, in 1897, California alone produced nearly 98,000,000 pounds of dried prunes. Oregon, Washington, Idaho, and some other western States are almost equally well suited to this industry.

East of the Rocky Mountains plum-growing is not so easy. The curculio damages all classes of plums to some extent, but the European kinds seem to be much less able to endure its attacks than any other. This led to the selection and cultivation of the best varieties of our several native species. Their fruit is not so large or so richly flavored as some of the foreign kinds, but much of it is very good, and the brilliant red, purple, and yellow colors are greatly admired. The Japanese plums are of quite recent introduction. The beginning was in 1870, when the Kelsey, which is the largest, the latest to ripen, and about one of the least valuable varieties of this class was brought to California. Later importations have brought us many very valuable kinds. The trees bear well, the fruit is mostly large, handsome, of good quality, and resists the stings of the curculio quite as well as our native kinds.

One of the most interesting and promising steps in plum-growing is only beginning to be made, in the crossing of the three classes named. The most skillful and patient worker in this field is Luther Burbank, of California, who has already produced, by artificially pollenizing the flowers, some most excellent varieties. Some of these new varieties are larger than any plums ever before seen, delicious in flavor, and blood-red to the stone.

The Cherry.—Away back in the history of our country, cherry trees were planted here and there, but only for family use. The list of varieties was meagre. Most of them were sour, bitter, or small. Now we have hundreds of named varieties and of all grades of color, from creamy yellow to black, and both sweet and sour, early and late.

In Washington, Oregon, and California the cherry does better than in any of the regions farther East. The first cherries of the season to ripen are in the famous Vaca Valley of California, and sometimes shipments from there reach New York as early as April 1. The largest cherry trees in America are found in the foot-hill regions of Pennsylvania and Virginia. Trees are sometimes seen there that have trunks three feet in diameter, with a spread of branches of more than fifty feet. Such trees sometimes yield more than fifty bushels of fruit at a time.

The Apricot.—All over the Eastern and Central States the apricot is almost an entire failure because of the ravages of the plum curculio. After many years of trial its culture there has been almost abandoned, except by those who are willing to follow the jarring of the trees to catch the insects. Across the Continental divide, where this enemy does not exist, the apricot flourishes as well or better than anywhere else in the world. It is one of the profitable fruits from western Colorado to the shores of the Pacific. California dried and sent to market in one year over 30,000,000 pounds. There is also a great amount of apricots canned there every year, a large part of which are shipped all over the world.

The Quince.—Although sour and unfit for eating from the hand, the quince is one of our most delicious fruits when cooked. No store of sweetmeats is complete without a generous supply of quince jelly. This fruit delights in a moist soil and a cool but not severe climate. However, it succeeds very well over the main part of North America. Almost every home plot has a tree or two. In western New York many commercial quince orchards have been planted within the last twenty-five years, some of them being of forty acres in extent.

American Grape Culture.—In no department of American pomology has there been more remarkable advancement than in grape-growing. It was the belief of those who first began to grow fruits here, that the grapes of Canaan, Persia, Greece, and Rome, which were brought down through the ages to the vineyards of modern Europe, would grow equally well in

America. One great reason for this belief was the abundance of wild grapes of many kinds that were found from Nova Scotia to Texas.

One of the first things the pioneers of civilization did in New England, at Roanoke Island, and at Jamestown, was to make wine of the native grapes. The Spaniards in 1564 also made wine of the wild grapes of Florida. After testing the wine and finding it inferior to that produced in their old homes, they were more determined to grow vineyards of the choicest grapes of Europe. The French established a vineyard of this kind in Virginia, and another in southern Illinois; and William Penn did the same near Philadelphia in 1683. The most notable attempt that was made was by John James Dufour, a native of Switzerland. He came to America in 1796, and at once set about doing the wisest thing that he could have done, by first visiting and critically examining the vineyards that had already been started. He was not favorably impressed by what he saw, for the European vines had done very poorly, because of some unknown disease or weakness that seemed to cause them to make but feeble growth, or gradually dwindle and die. The cause has since been found to have been the fungus diseases and insect pests that are peculiar to the eastern half of America. But Dufour thought the right varieties had not been tried, except a few that he found near Philadelphia. From these he secured a start, and in 1799 organized a stock company with $10,000 in capital, to plant a vineyard, Henry Clay being one of the stockholders. A tract of 633 acres was selected near Lexington, Ky., and there he began work in the most enthusiastic manner. He induced two of his brothers to come from Switzerland to join him, and they brought other varieties of their best grapes. But after three years' trial he gave it up as a hopeless effort and turned his attention to the cultivation of our native grapes.

The beginning of successful grape culture in America may be said to have been made by Dufour, in his next or second attempt, which was in 1802, at Vevay, Ind., on the banks of the Ohio, and with a variety of the wild *Vitis labrusca*, or fox grape, found near the Schuylkill River before the Revolutionary War. It was at first called the "Cape" grape, from a mistaken notion that it had been brought from the Cape of Good Hope. It was also known by several other names. Although this grape was the first of a very long list of native varieties which have made our country famous in grape culture, it has long since been entirely abandoned for better kinds. But the vineyard at Vevay, planted largely of this variety, was the first really successful one in America.

The next forward step was the introduction of the Isabella and Catawba, both having originated in America, not long previous to 1820, although of unknown parentage; but, perhaps, as the results of accidental crossing between our native wild grapes and some of the foreign kinds. The Isabella is supposed to have originated in South Carolina, and was brought from there by Mrs. Isabella Gibbs and planted in her garden in Brooklyn, N. Y., where it came to the notice of William R. Prince in 1816, when in full bearing. He named it Isabella in her honor, and introduced it to the general public.

The Catawba is supposed to have originated as a seedling near the Catawba River, in North Carolina, but was not generally known until Major John Adlum, of the District of Columbia, found it in bearing on the premises of Mrs. Scholl, a tavern keeper of Clarksburgh, Md. He was at once delighted with its good qualities, and planted it in his experiment grounds at Georgetown in 1819, and introduced it to the fruit-loving public soon after.

The next impetus to grape culture was caused by the introduction of the Delaware and Concord. The exact origin of the Delaware is not known, but it came to public notice about 1855, through the efforts of Mr. A. Thomson and George W. Campbell, of Delaware, O. It was learned afterwards that the same variety was growing in 1850, in the garden of a Swiss immigrant, Paul H. Provost, at Frenchtown, N. J. It may be that it originated at this place from a chance seed, and that cuttings were thence carried to Ohio. It is evidently a cross between the foreign species and one of our natives, and is to-day about the best of all the grapes grown in the Eastern States.

The Concord is a pure native seedling, produced by Ephraim W. Bull, of Concord, Mass., and first shown to the public at Boston in 1853. It has proved itself to be the greatest blessing of all grapes that have ever been grown in America. Its thriftiness and reliability under all circumstances are unequaled. It is not only good in itself, but it has been the parent of a race of seedlings which have filled our vineyards, gardens, and markets with the most delicious grapes, and at a very slight cost of labor or money. Whoever gathers or buys a basket of blue-black Concord or Worden, purple Brighton or opal Niagara, should render a silent thank-offering to the memory of Ephraim W. Bull, who made their existence a possibility.

The first commercial vineyard of importance was planted by Nicholas Longworth, on the hills overlooking the Ohio River, about ten miles below Cincinnati, and it was largely of Catawba. Many others followed his example, and from about 1830 to 1860 so great an interest was shown that the hills bordering the Ohio for many miles were dotted with vineyards. But mildew and black rot devastated them and almost destroyed their usefulness. These diseases are now largely overcome by spraying with a solution of sulphate of copper.

In northern Ohio, about Cleveland and Sandusky, and on the islands near the southern shore of Lake Erie, the Catawba was planted with much better success, owing, perhaps, to the climate not being so favorable to grape diseases. The lake region of western New York is perhaps more densely planted with grapes than any section east of California. Thousands of carloads of grapes of high quality are shipped from there every year. The Southern States have awakened somewhat to the importance of grape culture. Some of the poorest sandy lands of North Carolina and Florida have been planted to vines and found to produce, when fertilized, excellent grapes. Texas is also a most productive grape region. Their earliness causes them to find a ready market in the North.

But in all of North America there is no section where the grape flourishes with such wonderful success as in California and other regions beyond the Rocky Mountains. There the tenderest and most delicious of all the grapes of France, Italy, Persia, and Palestine ripen their luscious clusters beneath the glowing skies. The grapes of Eshcol, I imagine, did not surpass those now grown in California, Arizona, New Mexico, and Idaho. All up and down their fertile valleys and foot-hills may be seen great stretches of vineyard after vineyard. The raisin industry alone is immense; and the product is of such high quality and is produced at so low cost that the importation of European raisins is becoming less each year, and may soon be practically at an end. We have already begun exporting our raisins to England and other parts of the world. Over 103,000,000 pounds, filling 5000 cars, were shipped from California alone in one year. Single clusters of grapes have frequently been grown in California that weighed from ten to fifteen pounds, and four or five pound clusters are very common. Truly, America is a land of grapes.

The Berries.—America stands alone in the popular use of berries. Except in the matter of gooseberries and currants, which are rather plentiful in some parts of Europe, and a few strawberries and raspberries there and in Japan, there are very few berries grown outside of America.

The strawberry was found wild here in all sections. The fruit was small but of most delicious flavor. A few of the varieties grown in the mother country were brought over here, but they did not flourish. About 1834 C. M. Hovey, of Cambridge, Mass., grew some seedlings of the old Pine strawberry, which is an offshoot of the wild strawberry of the west coast of South

America, and his introduction of varieties named Hovey and Boston Pine marked the first step in our modern strawberry culture. Next came the Wilson, which originated about 1850 on the grounds of John Wilson, of Albany, N. Y. This variety really popularized the growing of strawberries, because of its hardiness and productiveness. Soon after this the Crescent was found at New Orleans, La. Other kinds were soon originated from seed by experimenters, and chance seedlings were found coming up in all fruit-growing regions. It was not long until there were hundreds of named varieties of good quality and that bore abundantly. Within the last decade or two there have been hundreds more originated by the most skillful hybridizers using our native species and the foreign ones also. Others just as good were picked up wherever they chanced to grow from seed. Thus, we now have the most wonderful assortment of varieties of the strawberry in the world. They are early, medium, and late. The facilities for shipping are so convenient that, now, it is possible to have strawberries in the fancy markets almost every day of the year, from some section of our great country. In the flush of the season they are so cheap and abundant that the poor can enjoy them along with the rich. From little garden patches fifty years ago, and very small ones too, we have now come to grow them by the thousand acres.

The raspberry is another of our delicious berries. At first our pioneers were satisfied with those they could gather from the wild bushes. Following the same plan that was used with most other fruits, the European raspberries were brought over the sea and planted in the gardens of America. But they did poorly, and about 1850 our people began to plant the native varieties. These grew and bore well. Now we have hundreds of the very choicest named kinds, black, red, purple, and yellow, early and late, and more being originated every year.

The history of the gooseberry is almost identical with that of the raspberry. The foreign kinds, although bearing very much larger fruit than our native kinds, were ruined by mildew. About 1845 Abel Houghton, of Massachusetts, grew a seedling from the wild berry, which was named Houghton, and from this came another seedling, the Downing, which was originated at Newburgh, N. Y., some years later. These two varieties are now among our very best kinds. Since the benefits of spraying with fungicides have been known, the larger and milder flavored English kinds are being grown with considerable success.

The blackberry is found native only in America. It has been one of the most useful of all our wild fruits from the earliest settlement of the country, and was used by the aborigines for centuries before. Until about 1840 there was not enough thought given to blackberry culture to make the least attempt in that direction, when Captain Lovett, of Beverly, Mass., gave the name Dorchester to a chance variety, and distributed it. Soon after 1850 the Lawton was taken from its wild habitat on the banks of the Hudson River. This variety was the first really good blackberry that was named and distributed. The Kitatinny followed about ten years later, having been found wild in the mountains of western New Jersey. At least two white varieties, and several having pink berries, that were found growing wild, were named and sent out. These novelties are yet cultivated by a few amateur horticulturists. It may seem strange to say that we have white and red blackberries, but it is a fact. At this date we have many kinds of later introduction, some early and some late, and of most delicious flavor.

Perhaps all Americans know that cranberry sauce goes with Thanksgiving turkey. No country in the world has so many cranberries as North America. The bogs of Cape Cod are famous for this fruit, and the Pilgrims of Plymouth colony knew of them, and served them on their rustic tables. Now the wild marshes along the Atlantic are nearly all under cultivation, and the product has been increased many fold. Fully 1,000,000 bushels are marketed when the crop is good. The same is being done with the bogs in the vicinity of the Great Lakes. Cranberries grow in untold quantities on the marshes of Alaska.

Citrus Fruits.—When the Spaniards invaded Florida in search of gold they brought with them seeds of the citrus fruits from the regions of the Mediterranean. There the orange, lemon, and lime were planted in the genial climate of our Southern borders. The fruit was carried hither and thither, and soon escaped the bounds of the cultivated areas. The forests in places were filled with wild orange trees, the most of which bore fruit of poor quality. When the tide of immigration set southward after the Civil War, these wild groves were budded to good varieties, and new land was cleared and planted with small seedlings. These were budded to good varieties in due time. Orange culture was soon a fixed industry in Florida. This increased rapidly up to the time of the severe freeze of 1894–95, when there were shipped over 5,000,000 boxes. Since then the results of the freezing of the trees has greatly lessened the product, but it is steadily increasing again.

The lemon has attracted much less interest than the orange, but I have seen one lemon orchard in Florida of more than two hundred acres, and there are many smaller ones.

The lime is but little called for, and is therefore grown more as a novelty than for commercial purposes.

The pomelo, by some misnamed "grape-fruit," is a very large, wholesome, and delicious citrus fruit that is becoming quite popular where it grows, and in the northern markets.

In California the orange was first planted by the mission fathers centuries ago. The first real orchard is said to have been planted at San Gabriel in 1804. Before the discovery of gold in that far-away region very few orange orchards existed there, and they were of small size. Up to 1872 very little more than this was done, when the founding of the colony at Riverside, and the fortunate introduction of the Bahia or Navel orange from Brazil by our government, at this juncture, was the start of prosperous citrus culture on that coast. Now there are annually about 5,000,000 boxes of oranges sent out of that State alone, and the amount is steadily increasing. A large part of these are of the justly famous Navel variety.

Lemon growing is also becoming a great industry there. Orchards of one hundred acres are rather common, and some are fully five times larger. Over 2,000,000 boxes of lemons were produced the past season.

The Olive.—Among the historic fruits of Palestine and southern Europe the olive holds a conspicuous place. Numerous but futile attempts were made in early times to establish it in Virginia and along the Atlantic coast, the climate there proving unsuitable. But in the warmer parts of California the olive is perfectly at home. The first olive orchard of consequence was planted by Ellwood Cooper, at Santa Barbara, in 1872, and in 1876 he made oil from the fruit grown on the trees. Now there are many extensive orchards in many parts of the State. It is estimated that there are nearly 2,000,000 olive trees now growing in that State. The oil and pickled fruit are steadily becoming popular in our fancy markets in competition with the foreign product.

The Fig.—Very little is done in fig culture east of California, although the trees are not tender along the Gulf coast, except in case of extremely severe winters. In California it is a decided success, commercially as well as for mere pleasure. The past year dried figs to the amount of nearly 4,000,000 pounds were sent to market, and the quantity has been constantly increasing for several years.

The Pineapple.—Those who have never seen pineapples growing are apt to think they are produced on trees. This is far from the fact. They grow on the tips of stalks about two feet high. The plants have large narrow leaves that cluster at the ground, from the centre of which these stalks spring. A few patches were planted on the islands near the Florida coast in 1860, but it is only about fifteen years since the first vigorous attempts were made to grow this delicious fruit in the United States. Florida is the only region within our country where the climate is sufficiently moist and warm for it to flourish. Along the east coast, from Rock Ledge southward, and on the west coast below Tampa, are the most favorable sections. Many acres are devoted to its culture there. Frosts damage the plants sometimes, but they soon recover. In central Florida, many acres are grown under sheds. These are made of frame-work, which is covered with slats or boughs as a protection from frost. Upwards of 3,000,000 fruits of marketable size are now produced in Florida annually.

Other Fruits.—The date is just beginning to be set in the arid regions of Arizona and southern California, and with good prospects of success. Already many trees are in bearing, and the fruit is of excellent quality. The choicest varieties have been imported from Africa. The guava is being grown in the warm parts of Florida and California. The mango has been fruited in the warmest parts of Florida and California.

Nuts.—The sweet almond of southern Europe has long been tested in America, but nowhere with success except in California, where there are almond orchards of several hundred acres each. The Persian (wrongly called English) walnut is a great success in the richer lands of California, where orchards of majestic trees have been in full bearing for many years. Of our native nuts the pecan is the best of all, and it is about the only one that has so far proved worthy of cultivation. It is found in a wild state in Illinois, Missouri, and Nebraska, and southward to the Gulf of Mexico. The creek and river bottoms suit it best, but it will do very well on almost any rich land. On some of the hammock lands of Florida hundreds of acres are now planted to the pecan. The largest pecan orchard is that of F. A. Swinden, of Brownwood, Texas, which covers over five hundred acres, and is being increased from year to year.

Our native chestnut is of better quality than the foreign kinds, but the nuts are much smaller. The largest are from Japan, some of which are two inches in diameter. Many of these choice kinds have been imported, and others were originated from seeds, which are now being planted in orchards. The best of the European chestnuts have also been imported, and new kinds have been grown here from the nuts. Nearly all of these varieties succeed in America, and many small orchards have been planted. Some have grafted sprouts from our native chestnut stumps and small trees with these improved kinds, and found them to grow and bear abundantly.

The cocoanut is strictly tropical, and can only be grown in the very warmest parts of Florida. It will not endure as low a temperature as the pineapple without injury. As a commercial venture its culture will probably never pay in America, but for ornamental purposes and as an interesting novelty it is already a success from Lake Worth southward. The waving plumes of this giant palm are a source of constant delight to those who are privileged to see them. The huge clusters of nuts are indeed an interesting sight.

Surely we have a great and fruitful country, from the cranberry bogs of arctic Alaska to the waving cocoanut groves of Florida. This century closes and the new one begins with wonderful advances in fruit culture beyond those of a hundred years ago.

The Century’s Commercial Progress

By EMORY R. JOHNSON, A.M.,
Asst. Prof. of Transportation and Commerce, University of Pennsylvania.

Commercial activity has three phases, trade, shipping, and shipbuilding. In each of these three phases of commerce the nineteenth century has witnessed a remarkable progress. The expansion of both domestic and international trade has far exceeded the anticipations of those who lived a hundred years ago; and the agencies of transportation by water, the numerous auxiliaries of commerce and the shipbuilding industries, have undergone a technical revolution so complete, and with consequences so beneficent to our social and industrial life, as to make the commercial progress of the past hundred years one of the salient features of the history of the century. We shall better appreciate the nature and scope of the commercial progress of the past hundred years, if we glance for a moment at a picture of the commerce of the world at the close of the eighteenth century.

I. MAIN FEATURES OF THE WORLD’S COMMERCE AT THE CLOSE OF THE EIGHTEENTH CENTURY.

A hundred years ago, the volume of trade, both domestic and foreign, was necessarily kept within proportions relatively small as compared with present traffic, because of the slowness and high costs of inland transportation. Domestic inland traffic is directly dependent upon facilities for water and land transportation, and until the railroad came into use, some seventy years ago, only those countries having numerous navigable rivers or well-developed canal systems could extend their commerce much beyond the cities and districts adjacent to tide water. In all ages since the world became civilized enough to engage in commerce, an overland traffic by caravan or wagon has been carried on; but the amount of commodities could not be large, and the kinds of goods transported were necessarily limited to articles of high value per unit of bulk or weight. Such an inland traffic as this did not establish the basis for a large coastwise or over-sea commerce.

At present, bulky commodities produced long distances from the sea-ports comprise a large portion of international traffic, and supply the coast cities with the raw materials from which they manufacture the articles they contribute to swell the volume of foreign trade. When the means were wanting for the inland transportation of these bulky commodities, only a few countries, such as Phœnicia, the Italian cities, Portugal, the Netherlands, the United Kingdom, and the British colonies in America, could develop an important maritime commerce. During the past fifty years, the improvements in transportation have been such as to enable all industrial countries, inland as well as maritime, to engage extensively in the world’s trade. Commerce has become general; and countries like Switzerland and Saxony readily market their wares the world over.

The volume of foreign trade, as late as a hundred years ago, was really small, even in the case of the most important commercial nations. The imports and exports of the United Kingdom in 1800 amounted to about $360,000,000, which, for a population of approximately 18,000,000, would be about $20 per capita. At that time the trade of the United Kingdom was about one tenth what it is now. At the present time the foreign commerce of the United Kingdom amounts to nearly $100 for each inhabitant of the country.

The thirteen British colonies in America and the original commonwealths of the United States were all maritime States with navigable rivers, and their industries, lumbering, fisheries, production of food products and tobacco, called for the exchange of large quantities of commodities with the manufacturers of the home country, and with the tropical islands of the West Indies. For their time, then, these States were large traders. The statistical information which we possess of their commerce is meagre, but we know that the total trade of the colonies with the mother country in 1770 was about $13,000,000 a year, or something over four dollars per person. There was a trade of considerable proportions with the West Indies, some with the Mediterranean countries and Africa, and, after the colonies became States, with the East Indies and the Orient; but in all probability the foreign trade of the Americans did not reach ten dollars per capita until after 1790. At the present time, in spite of the very rapid growth of population in the United States that has continued throughout the nineteenth century, our foreign trade is equal to twenty-five dollars per person.

It is when the commerce of the eighteenth century is viewed from the standpoint of the transportation agencies by which it was served—the size, speed, and efficiency of the ships—that the contrast with present conditions becomes most striking. Two hundred years ago, the 560 ships owned at London averaged 157 tons. A century ago, a vessel of 300 tons was still considered a large ship, and as late as 1840 vessels of that size traded from the United States to India and China. The Grand Turk, of 564 tons, built in 1791, was probably the largest ship built in America up to that time. During the fourth decade of the nineteenth century numerous vessels of over 1000 tons were constructed, and in 1840 the Great Britain of 3000 tons was ordered. In her day the Great Britain was more of a marvel than is the recently launched Oceanic, of 28,500 tons displacement.

When we consider that these small vessels in use a century ago took from a month to six weeks to cross the Atlantic,—their speed being about one third that of the freight steamers of to-day,—we realize the great difference in the efficiency of the merchant marine of the present as compared with that by which commerce was served in 1800. The efficiency of the ships, however, does not depend alone upon their size and speed. The commercial auxiliaries which enable vessels to enter and clear harbors without delay, and to load and unload cargoes quickly,—lighthouses, beacons, buoys, spacious wharves and docks equipped with mechanical appliances for handling freight,—make it possible for vessels to spend a greater portion of the time at sea. A merchant marine to-day has fully five times the efficiency that one with an equal tonnage had a century ago. We shall better see how this has been brought about, by briefly reviewing the technical revolution which has taken place in ocean navigation during the past seventy years.

II. THE CENTURY’S TECHNICAL REVOLUTION IN COMMERCE.

During the first four decades of this century the wooden sailing vessel was the sole carrier of ocean traffic, and in the construction and operation of such ships the Americans had special advantages and manifested peculiar ingenuity. For forty years the American sailing clipper, whose fine lines made it stanch and speedy, had been “the type and model of excellence in ship-building;” but before the middle of the century the supremacy of the wooden clipper-ship had been destroyed, and the technical superiority of steam and iron had been demonstrated.

There are six distinct steps in the technical evolution of the ocean liner of the present day,—six changes which mark the epochs in the history of the substitution of steam and steel for sail and wood. The first step in the evolution was taken when the steam engine and the paddle-wheel took the place of wind and sails. Like most epoch-making changes, this one was made slowly; indeed, it was preceded by thirty years of hesitation and conservative experimentation. Robert Fulton, taking advantage of ideas and plans which he had obtained in Europe, produced his Clermont in 1807, and demonstrated the practicability of the steamship for river traffic. Five years later, Henry Bell of Scotland constructed the Comet, the first passenger steamboat built in Europe, a vessel only forty feet long, ten and one half feet in width, and of four horse-power. The Clermont was somewhat larger, having a length of 130 feet, a beam of eighteen feet, and a hold six feet in depth. She succeeded in making five miles an hour against stream. These little vessels attracted great attention, and the problem of constructing ships that could cross the ocean by steam power began to be studied. In 1819, the Savannah was fitted with engines and crossed the Atlantic, using both steam power and sails, but the vessel did not prove a success, and her engines were taken out the following year. Indeed, it was not until 1833 that a vessel steamed all the way across the Atlantic; and this ship, the Royal William, a Canadian craft of four or five hundred tons, was able to make the trip from Quebec to Gravesend on the Thames only by stopping for coal at Picton, Nova Scotia, and Cowes near Portsmouth, England.

The first steamships to cross the ocean without recoaling were the Sirius and Great Western, which arrived in New York the same day, April 23, 1838, the former vessel having sailed from London and the latter from Liverpool. This achievement on the part of these two wooden craft, neither one capable of carrying more than seven hundred tons, created a great impression. The New York "Courier and Enquirer" said, in its issue of April 24, 1838:—

"What may be the ultimate fate of this excitement—whether or not the expense of equipment and fuel will admit of the employment of these vessels in the ordinary packet service—we cannot pretend to form an opinion; but of the entire feasibility of the passage of the Atlantic by steam, as far as regards safety, comfort, and dispatch, even in the roughest and most boisterous weather, the most skeptical man must now cease to doubt."

The employment of steamships in the regular packet service was assured in 1839, when Samuel Cunard founded the famous English line that still bears his name, and ordered four steamers of moderate size that cost between four and five hundred thousand dollars each. These, however, were wooden vessels, and it was not until 1856 that the conservative Cunards constructed any iron ships.

The construction of iron ships for ocean navigation marks the second important phase of the technical evolution of the past century's commerce. It began on a small scale about 1830, and in 1837 an iron vessel, The Rainbow, of six hundred tons was built; but the first large iron steamer was ordered in 1840, and was the famous Great Britain before referred to, constructed by Brunel, the engineer who subsequently built the unfortunate naval monstrosity, the Great Eastern. The completion of the Great Britain, in 1843, was an important event in the progress of ocean navigation, not only because she was five times the size of her largest iron predecessor, but also because of the fact that Brunel decided, while building the vessel, to adopt the screw for propelling the ship.

The substitution of the screw instead of paddle-wheels represents a third phase of the technical evolution of ocean navigation. John Ericsson, who subsequently built the famous Monitor, had demonstrated the practicability of the screw as a propeller in 1836, and, three years later, the Archimedes, of two hundred and thirty-seven tons, was fitted with a screw. It was the success of the Archimedes that led Brunel to adopt the screw on the Great Britain.

The superiority of the screw over paddle-wheels, and the greater merits of iron ships compared with wooden vessels, have long been accepted; but the adoption of iron as a material and of the screw for a propeller came about slowly. Indeed, iron ship-building made little progress in Great Britain before 1850, and in this country wood was adhered to till much later. One reason why the English did not change to the screw and iron more quickly was probably the great influence exerted by the powerful Cunard line, whose conservatism caused it to hold to wooden ships until 1856. The Great Eastern, finished as late as 1859, was an iron ship, but was fitted with both screw and paddle-wheels. Of the total tonnage built in the United Kingdom in 1853, about twenty-five per cent was steam tonnage and a little more than twenty-five per cent was of iron. At the present time three fourths of all British-built vessels are steamers, and no wooden ships are built in the United Kingdom.

America was slow in changing from wood to iron, because the cost of iron was so high. We had wood in abundance, numerous yards for the construction of wooden vessels, and were the builders of the best type of wooden ships. In 1853, the year just referred to for Great Britain, twenty-two per cent of the tonnage of the vessels built in this country was in steamships, but only an inappreciable portion was in iron vessels. The adherence of American ship-builders and owners to wood is well illustrated by the action taken by the owners of the famous but unfortunate American Collins line, established in 1847. The company began, in 1850, to run four palatial steamers, built without regard to cost, and supplied with luxurious appointments, some of which are retained in vessels of the present day; but the company built the ships of wood and propelled them with paddle-wheels. The great American ship-building firm, William Cramp & Sons, founded in 1850, did not begin constructing iron ships till 1870. Even in 1898, the tonnage of wooden vessels constructed was one and a half times the steel and iron tonnage. About twenty-six per cent of our merchant marine, foreign and domestic, is now made up of iron and steel vessels.

The next important step in maritime progress, following the adoption of iron and the screw, was taken about 1870, when the compound engine came into general use. Though the compound engine had been used on a small vessel in France as early as 1829, it was first extensively adopted as the result of the rapid development in steam navigation which took place in the seventies. In the compound engine the steam, instead of being used in only one cylinder in passing from the boiler to the condenser, exerts its force in two or three cylinders, and even in four, in the quadruple expansion engines. This results in a great economy in the amount of fuel used. In the earlier marine engines the pressure of steam in the boilers was thirteen pounds to the square inch, and the consumption of coal per horse-power per hour was five and one half pounds; whereas, at the present time, a pressure of two hundred pounds per square inch is maintained, and the fuel used has been reduced to less than one and a half pounds per hour for each indicated horse-power.

Ten years after the compound engine came into general use, the cheapened cost of steel made it possible to adopt steel in the place of iron in the construction of hulls. This may be regarded as marking a fifth epoch-making step in the progress of commerce; because the steel ship was stronger, lighter, and able to carry more cargo than iron vessels of the same size. The substitution of steel for iron in the British yards was made rapidly. In 1879, only ten and a quarter per cent of the tonnage constructed on the Clyde was of steel; but in 1889 the per cent had risen to ninety-seven.

During the past twenty years there have been many improvements made in the construction and appointments of ships; but the more important changes have consisted in dividing vessels, by means of bulkheads, into several water-tight compartments, and in substituting twin screws for the single screw. The Inmans placed twin screws on the City of New York in 1888, and since then their use has become general on the larger ocean liners. The twin screws add somewhat, though not greatly, to the speed of vessels; but they render ships much safer and less liable to be disabled. An ocean steamer with twin screws and water-tight compartments can suffer any one of the common accidents—such as breaking of one of its shafts, losing one of its screws, having its rudder damaged, or one of its engines give out, or having its side punctured by collision—without being disabled. Although ocean travel still has its dangers, the risks at the present time are far less than they were a half or a quarter of a century ago.

The technical progress of commerce during the nineteenth century is well summarized by Mr. Henry Fry in his book on the History of North Atlantic Steam Navigation, written in 1895. He says:—

“The Comet of 1812 has multiplied into twelve thousand steamships, measuring over sixteen million tons.... Her twenty tons have been multiplied into a ship of eighteen thousand; her forty feet to six hundred and ninety-two feet; and her four horse-power to thirty thousand in a single ship. Symington’s four-inch cylinder has grown to one hundred and twenty inches; the pressure of steam in the boiler has increased from thirteen pounds to two hundred pounds on the square inch; the two hundred and forty-three knots, the maximum of the Great Western in 1838, to five hundred and sixty; and the average speed from 8.2 to 22.01 knots, while the consumption of coal has decreased from about five and one half to one and one half pounds per indicated horse-power per hour.”

The century’s naval technical progress is epitomized in the White Star liner, the Oceanic. The length of this mammoth vessel is over an eighth of a mile, being 705 feet, 6 inches. 13½ feet longer than the Great Eastern was. When loaded, the Oceanic draws 32 feet, 6 inches of water, and on that draft her displacement is 28,500 tons. The figures for the Great Eastern were 25 feet, 6 inches, and 27,000 tons. The capacity of her engines is 28,000 horse-power, or two and one third times the capacity of those in the Great Eastern. The pressure in her boilers is 192 pounds to the square inch, or ten or twelve times that in the boilers of her famous predecessor. Though not built for speed, the Oceanic can average 500 miles a day, or sixty per cent more than the Great Eastern did. The Oceanic will accommodate 400 first-class passengers, 300 second-class, 1000 third-class, and a ship’s company of 394, making a total of 2104 persons. In this regard, however, her figures are fortunately less than those of the Great Eastern, for that vessel was designed to carry 4000 persons, besides crew. These figures regarding passenger accommodations indicate in a forceful way the great advancement that has been made in the comforts of ocean travel during the past forty years.

III. IMPROVEMENTS IN COMMERCIAL AUXILIARIES.

The progress of commerce during the nineteenth century has been promoted not only by the evolution of ships of great speed and capacity, but also by the improvements made in numerous other auxiliaries of commerce. Chief among these aids to commercial activity have been the betterment of natural waterways and the construction of ship-canals, the improvements of harbors, the laying of cables, and the extension of international banking facilities.

The improvements of such rivers as the Rhine, Danube, Hudson, and Mississippi, and of such natural waterways as the chain of Great Lakes in the northern part of the United States, are conspicuous instances of the manner in which the canalization of natural waterways has been undertaken for the promotion of traffic. That part of the Rhine River traffic which passes Emmerich and Mannheim amounted to 2,800,000 tons a year from 1872 to 1875, but by 1895 it had increased to 10,300,000 tons. The traffic on the rivers of the Mississippi Valley, according to census statistics, increased from 18,946,522 tons, in 1880, to 29,485,046 tons, in 1889; and since that year the increase must have been considerable. The effect of the improvement of waterways upon commerce is most strikingly shown in the case of our Great Lakes. In the seventies, the demands of traffic were for channels and harbors 12 feet in depth. During the next decade it was necessary for the United States to increase the depth to 16 feet; and in the nineties the channels had to be made deep enough to accommodate vessels of 20 feet draft. At the present time the traffic on the Lakes is probably over 70,000,000 tons annually. During the year 1898 the freight that passed the locks at the Sault St. Marie equaled 21,000,000 tons, two and a half times the tonnage passing the Suez Canal.

During the last third of the nineteenth century six important ocean ship-canals have been opened; the Suez, opened in 1869; the Rotterdam Canal, in 1872; the canal connecting Amsterdam directly with the North Sea, 1877; the canal across the Isthmus of Corinth, 1893; the Manchester Canal, 1894; and the Baltic or Kiel Canal, finished in 1895. The Panama Canal was begun in 1882, and the construction of the Nicaragua Canal was commenced in 1889; but the date of the completion of these most important works is still problematical.

In the improvement of its harbors every government has been active. Thirty years ago a depth of 23 feet was considered ample, but after 1880 it became necessary to adopt 27 feet as the standard. During the past five years the larger seaports have required harbors with 30 feet of water in order to accommodate the largest ocean vessels, and the limit has by no means been reached. The United States Government has just recently, 1899, authorized the deepening of New York harbor to 35 feet. As noted before, the Oceanic can be loaded to a draft of 32½ feet.

The docks of the great seaports have been improved at a cost of many millions of dollars. As an illustration of this Liverpool may be cited. The city's position gave it great commercial possibilities, but a troublesome bar at the mouth of the Mersey, and a tide with a rise and fall of thirty feet made the construction of its harbor and docks a difficult matter. The problem was solved by the construction, under public control, of a large number of commodious wet docks with gates which are opened only a few hours a day, during high tide. These harbor improvements have made possible Liverpool's phenomenal expansion in commerce during the past quarter of a century, an increase that has given the city third place among the seaports of the world, with an annual tonnage of vessels entered and cleared of 16,000,000 tons.

The achievements of Manchester during the past decade are even more notable than those of Liverpool. Manchester is situated on a small stream thirty-five miles from the ocean; but she has become a seaport for the largest ocean vessels, and has docks and wharves equipped with the most improved appliances. Her dock-sheds, for instance, are twin structures, three stories in height, and the arrangements for handling freight are such that goods are taken directly from the ships to any one of the three stories of the sheds.

In the United States, the government and private corporations are rapidly improving the harbor facilities of our ports. During the past decade the Gulf ports have received especial attention, with the result that a large part of our export trade is now moving through the Gulf harbors. As an instance of what private corporations are doing, mention may be made of the fact that a railway corporation has recently completed a wharf in New Orleans that cost $2,000,000.

Besides these harbor improvements, the erection of more and better lighthouses and signals has made the approach of vessels safer. The United States Weather Bureau has also done much to lessen the dangers of navigation by its weather forecasts and its warnings of approaching storms. Although the Bureau was established only twenty-nine years ago, and in a small way, its services have so increased and in such a practical manner as to have come to be regarded as indispensable by the commercial interests.

The first successful trans-Atlantic cable was laid in 1866; at the present time there are 170,000 miles of submarine telegraphs in use. The cables now used for commercial purposes number 320 and include about 150,000 miles of lines, the other 20,000 miles being short government lines connecting forts, batteries, signal-stations, and lighthouses. The total cost of these cables has been about $250,000,000. The influence of the cable upon commerce has been so great as to revolutionize the methods of international trade that prevailed a century ago; indeed, ocean telegraphy has made it no more difficult to effect international sales and purchases than it is to make domestic exchanges. With thirteen cables in successful operation between the United States and Europe, we have had no difficulty in building up an immense trade across the Atlantic; but, with no trans-Pacific line, we are experiencing much difficulty in securing a large place in the trade of the Orient. Of course the development of our commerce with the East is conditioned by numerous other factors; but no one doubts that the construction of the proposed Pacific cable will be of assistance to our commercial progress in the Orient.

Among the other agencies that have promoted the progress of commerce, mention should be made of the extension and improvement of international credit systems and banking facilities. In this regard the United Kingdom leads the nations of the world, London being the clearing-house for a large part of the world's trade. Germany, France, and the Netherlands have also developed good facilities for international banking; but the United States has not yet done so. Our merchants are still obliged to settle most accounts through foreign banks, but it is probable that our recent acquisition of foreign possessions will cause us to establish some system of international banks.

IV. EXPANSION OF INTERNATIONAL TRADE DURING THE CENTURY.

In the introductory paragraph of this paper it was stated that the commercial progress of the past hundred years is one of the salient features of the history of the century; and, in contrasting the commerce of a hundred years ago with that of the present, a few figures were cited that indicated in a general way the growth that the foreign trade of Great Britain and the United States has enjoyed. The expansion of international trade during the century merits fuller presentation and analysis.

Accurate figures for the whole world's trade are not obtainable for the earlier years; and if it were possible to present comparative statistics of the international trade of the world, as a whole, the comparisons would not be so instructive as those which present the progress of the commerce of those countries which rank highest among trading nations. Accordingly it will be most profitable to confine our statistics and analytical study to the commerce of Great Britain, Germany, France, and the United States.

During the first four decades of the century, the growth of the commerce of the United Kingdom, though considerable, was not rapid,—the figures for 1839 showing an increase of 73 per cent over those for 1800,—but during the fifth, sixth, and seventh decades the progress was phenomenal. The value of the exports in 1873, as compared with 1839, shows a gain of 379 per cent, and the total foreign trade increased nearly 450 per cent; that is, it was five and a half times as much in 1873 as it was thirty-four years previous. Since 1880, the quantities of imports and exports have largely increased, but the fall in prices has been such as to make the increase in the total value comparatively small.

The commerce of the German States during the nineteenth century did not grow very rapidly until after 1850. During the early part of the century the great Continental wars rendered commerce nearly impossible. Peace was restored in 1815, but the German States had neither political nor commercial unity. Each State had a tariff which applied against all other States. Gradually a Zollverein, or customs union, grew up, which, by 1854, had come to include all the German States except Austria, Holstein, Mecklenburg, Lauenburg, and the three Hanse towns, Hamburg, Lübeck, and Bremen. In 1866, the North German Federation was organized, and this paved the way for the formation of the German Empire in 1871. The Zollverein made commercial progress possible, and political unity gave it a great impulse.

The statistics of the German trade before the establishment of the Zollverein are very meagre. A German authority, Otto Huebner, estimates the value of the total import and export trade of the German States to have been $309,019,200 in 1850, and $504,988,200 in 1855. The value of the imports of Hamburg, the chief port of Germany, rose from an annual average of $92,320,050 for the five-year period 1851–55, to $157,660,472 during the half decade 1866–70. The growth of Germany's foreign commerce during the past twenty years has been phenomenal, and her trade is now second only to that of Great Britain. In 1881, the imports were valued at $704,904,000, and the exports at $707,978,000, being slightly more than the imports; whereas, by 1890, the imports had risen to $986,641,000, and the exports to $792,620,000, a sum nearly a hundred million dollars less than the value of the imports. The foreign trade of the country, particularly in imports, has continued its rapid growth since 1890, the figures for 1897 being, imports $1,231,756,862, and exports $977,447,198, a total trade of $2,209,204,060.

The foreign trade of France at the beginning of the nineteenth century consisted of $80,500,000 worth of imports and $59,000,000 of exports, a total of $139,500,000. The Continental wars, up to 1815, were even more disastrous to French trade than they were to German; but with the restoration of peace, commercial progress began, and between 1815 and 1831 the total trade increased from $119,200,000 worth to $168,152,000 worth. The growth by decades since 1830 has been as follows: In 1840, the value of the total foreign trade was $278,383,200; in 1850, $358,748,400; in 1860, $805,659,200; in 1871, $1,242,765,600; in 1880, $1,640,712,300; and in 1890, $2,003,557,516. These figures show that the rapid expansion of French commerce began about 1850. The highest point was reached in 1891; but since then there has been a slight falling off in the total trade, due to a decrease in imports. In 1891, the value of the imports was $1,155,973,310; in 1897, $991,537,500. The exports were valued at $920,839,130 in 1891; and at $926,998,300 in 1897. The total trade for these years was $2,076,812,440 for 1891, and $1,918,535,800 for 1897.

During the first quarter of the century France had a strong balance of trade in her favor: that is, she sold more commodities than she bought; and between 1825 and 1840 the exports and imports about balanced each other; but since that date, with the exception of the years 1871 to 1875, when the huge war indemnity was paid, the balance of trade had been unfavorable, as would naturally be expected of a country such as France, whose people are extensively engaged in manufacturing. France, as well as the United Kingdom, Germany, Belgium, Switzerland, and other European countries, imports raw materials and food in large quantities.

The decline in the value of French trade, though due to falling prices rather than to a decrease in the quantities of commodities, has given the French people much concern. It is not probable, however, that this decline is due to permanent causes. The population and industries of France have not reached a stationary stage; they are going to increase and cause a natural growth in the country's foreign commerce. The commercial progress of France, however, can hardly be so rapid as that of Germany and the United States. These are the countries whose commercial vitality is strongest, and of these two countries, the United States possesses greater natural resources and larger possibilities, industrial and commercial. The progress of the commerce of the United States merits a somewhat closer survey than has been given its three leading rivals in trade.

V. THE TRADE OF THE UNITED STATES DURING THE CENTURY.

The economic progress of the United States during the past hundred years is most clearly indicated by the growth of its foreign and domestic commerce. Being a new country, busied with occupying and developing our large territory, our domestic commerce has been of enormous proportions. With nearly two hundred thousand miles of railroads, comprising four ninths of the total railway mileage of the world, with our chain of the Great Lakes and our admirable system of navigable rivers, it has been possible to exploit our natural resources on a large scale, and to develop an inland traffic several times the volume of our foreign commerce.

Our international trade, however, although smaller than our domestic traffic, has been large throughout the country, has grown rapidly, especially since the year 1850, the period of the Civil War excepted, and is now increasing in such a manner as to give our foreign rivals much concern.

During the first half of the century, the expansion of our foreign trade was not especially rapid. The Continental wars, lasting from 1793 to 1815, and our own war with England, from 1812 to 1815, interfered considerably with international trade. Probably our tariffs of 1816, 1824, and 1828 had the effect they were intended to accomplish, and restricted somewhat the volume of our foreign commerce. The chief reason, however, why our trade progress was much more rapid after 1850 was, that it was not until about that time that the means of inland transportation became developed sufficiently to make possible a large domestic traffic. When our central West was able to exchange commodities on a large scale with the seaboard, then our foreign commerce began to increase rapidly.

The growth of our imports was very rapid for the period of fifteen years, 1879 to 1893, their value having risen from $445,777,775 to $866,400,922; but since then there has been a sharp decline to $616,049,654. Our exports, however, have increased in a phenomenal manner during the past decade. Prior to 1897, the highest point was reached in 1892, when the value of the exports was $1,030,278,148. In 1897, the value was $1,050,993,556, and in 1898 (the official year ending June 30), the value, as shown by the foregoing table, was $1,210,291,913. In consequence of this great increase in our exports the total foreign trade of the United States has not decreased in value during recent years, although there has been a considerable fall in prices and a large falling off in our importations. Our total trade, during the fiscal year 1898, was much larger than it was in 1890, and fell only $10,000,000 short of the value reached in the record-breaking year of 1892. The calendar year 1898 shows a larger trade than has been shown by any previous year, the value being $1,868,523,057.

The leading industry of the United States being agriculture, our exports consist largely of various products of the farm. In 1898 the exported agricultural products were valued at $853,683,570, and comprised 70.54 per cent of our total sales abroad. In spite of these large figures, the preponderance of agricultural over other products is being reduced with considerable rapidity by the growth in the exportation of manufactures. Before 1876 our exports of manufactures were less than $100,000,000 a year; whereas, in the calendar year 1898, they were $370,924,994. In 1880, agricultural exports comprised 83.25 per cent of our exports, and manufactures 12.48 per cent; and in the calendar year 1898, a year of exceptionally large foreign sales of food products, agriculture furnished only 69.06 per cent,—less than seven tenths of the exports, while manufacture supplied 24.96 per cent, or one fourth of the total. The year 1898 is a notable one in the history of American manufactures, for it was then, for the first time, that we sold to foreigners more of our manufactures than we bought of theirs.

Our exports of merchandise and gold and silver combined exceed our total imports by the large sum of $2,432,714,759. If the statistics of our imports and exports for each year since

1789 be consulted, it will be found that during the eighty-seven years preceding 1876 there were but sixteen years when our exports of merchandise exceeded our imports. The balance of trade was nearly always “unfavorable.” Since 1876, however, the balance has nearly always been on the other side, there having been only three years when our exports did not exceed our imports.

In return for something, we have given foreign countries nearly two and a half billion dollars worth more of commodities and precious metals than we have received in return. A part of this large sum, possibly one fourth, has been paid to foreigners for freights on our imported commodities, and we have also spent large sums in foreign travel. The chief reason why we have exported more than we have imported is, that we have been borrowing foreign capital to use in constructing railroads and factories and in developing our farms and mines. Prior to 1876, we received $1,084,339,912 more than we exported; we accumulated a large foreign debt. Since 1876, we have continued to borrow abroad; but we have been able to liquidate a part of our former debts, and also to exchange large amounts of commodities and precious metals for capital; for, since 1876, our exports have exceeded our imports by $3,517,054,671. If our present large excess of exports over imports continues, we shall soon become a creditor nation with large sums invested abroad.

The history of our foreign trade is highly gratifying to our national pride; our achievements have been signal, well-nigh continuous, and have been more marked during the latter decades of the century than at any previous time. The history of the American marine, however, presents a somewhat different picture.

VI. THE AMERICAN MARINE IN FOREIGN AND DOMESTIC COMMERCE.

In colonial days maritime industries held an important place. The location of the colonies adjacent to the ocean, their dependence upon the mother country for manufactures and upon the West Indies for tropical products, their need of foreign markets for their timber, fish, tobacco, and food products, and their abundant supply of lumber for shipbuilding, all tended to make them a seafaring people. This fondness for the sea was especially intense in New England, where the returns of agriculture were relatively meagre. The long Revolutionary War destroyed many ships and interfered seriously with ocean commerce, but the struggle gave the colonists what was of more value than ships,—a spirit of venture and hardihood. Hundreds of ships and thousands of seamen engaged in privateering, and when the war ended the maritime instincts of the Americans were stronger than they had been when the declaration of political and commercial independence was declared in 1776.

The imbecility of the general government under the Articles of Confederation and the restrictions placed upon interstate traffic prevented any considerable maritime progress between the Peace of Paris and the inauguration of a truly national government under the Constitution. But a stable government, sound credit, and uniform national laws for the regulation of commerce gave the maritime instincts of the Americans a chance to assert themselves, and the tonnage of our ships grew rapidly larger. Our tonnage registered for the foreign trade was only 123,893 tons in 1789; by 1795 it had grown to 549,471 tons; in 1800 it amounted to 667,107 tons; during the next five years it increased to 744,224 tons, and by 1810 it had reached 981,019 tons. Such a growth as this in twenty years, from such small beginnings, was truly remarkable.

The American ships soon crowded most foreign vessels out of our commerce. In 1790 we carried only 40.5 per cent of our imports and exports; but by 1795 we had secured 90 per cent; and, with the exception of a short period during and immediately following the War of 1812, it was not till fifty-two years later that as much as one fourth of our foreign trade was carried under foreign flags. Moreover, we not only carried our own commerce, but we also entered largely into the carrying trade of other countries. The great European war crippled the commercial activities of European countries, and made it easier for our ships to gain control of our own commerce and to secure employment as carriers for foreign merchants. During the fifteen years from 1793, the year of the outbreak of the European war, to 1808, when the blockade of European ports and the capture of American ships and seamen led us to attempt to prohibit our ships temporarily from engaging in foreign trade, our merchant marine rose from a position of obscurity to a place of great prominence on the high seas.

As long as ocean commerce was carried in wooden vessels, the maritime interests of the United States continued to prosper. The War of 1812–15, the panic of 1819, and the competition of foreign vessels after the restoration of peace in Europe, gave our marine a setback, so that it was not until 1847 that our tonnage in the foreign trade exceeded the figures for 1810; but during the period of fifteen years, from 1846 to 1861, our tonnage increased 150 per cent. When the Civil War, which proved so disastrous to the shipping interests of the United States, broke out in 1861, our tonnage registered in the foreign trade equaled 2,496,894 tons,—the highest point it has ever reached. The American sailing clipper was for nearly half a century the mistress of the seas. As J. R. Soley says: “It was in these ships that for nearly half a century not only the largest freights of the world were carried, but the finest and most profitable as well. Merchants having valuable cargoes to export would wait for the sailing of a favorite clipper, and merchants with goods to import would instruct their correspondents to wait in like manner.” As late as 1850 the higher grades of commodities were almost always shipped in the stanch and speedy American clipper ship.

Since 1861 the American marine in the foreign trade has played a rôle of decreasing importance. Three causes account for this. About the middle of the century our commercial rivals began to substitute iron ships for wooden; but we were not able to adopt the better material in the construction of our ships because of the high cost of iron in this country at that time. Great Britain could build the iron ships much cheaper than we could, and she soon began to displace us in the carrying trade of the other countries. And it was not long before she began also to carry a large share of our own foreign commerce.

The second cause for our maritime decline was the Civil War. In 1861 our tonnage registered for the foreign trade was 2,500,000 tons; by 1866 it had fallen to 1,387,756 tons, a loss of over a million tons. During the war period, nearly 800,000 tons of our shipping were sold abroad; 110,000 tons were captured by Confederate cruisers; and other casualties occurred. Of course there were no ships built for our merchant marine during the stormy years of the war.

Why, it may be asked, did we not restore our ships after the war and regain our former proud place on the high seas? For the simple, though possibly unsatisfying, reason that we did not find it profitable to do so. Capital is invested where the prospects for profit are best, and the inducement to put money into American ships for the foreign trade was not strong. It still cost more to build ships in our country than it did in Europe, and the expenses of operating them when constructed were greater. Moreover, our rivals had gotten possession of the lion’s share of the world’s carrying trade, and would not release any portion of their business without a keen struggle. At the same time the American capitalist was offered many opportunities for the investment of his property in domestic enterprises. During the quarter of a century which followed the war, we devoted our energies and capital to building our railroads, opening the West, exploiting our mineral and forest resources, and building the mills and factories whose products are now rapidly entering foreign markets in all parts of the world. America’s economic activities were industrial rather than commercial.

The result of these general causes has been the decline of our shipping in the foreign trade from two and a half million tons in 1861 to less than three quarters of a million tons in 1898; but it seems that the low-water mark has been reached and that the tide is turning. The man who writes the history of our merchant marine on the high seas during the first half of the twentieth century will, in all probability, write a record of rapid progress. We have already made much headway in substituting steel for wooden ships; and America's foremost iron manufacturer, Mr. Andrew Carnegie, says that steel ships can now be built as cheaply on our Atlantic coast as they can be built on the Clyde. Furthermore, the opportunities for investment in domestic industries are becoming fewer and less alluring, and there are good reasons for thinking American capitalists will be disposed from now on to put their ventures in ships to sail foreign seas.

The attitude of American capitalists, however, will depend very largely on the maritime policy adopted by the United States. That policy should unquestionably be as liberal as the policy adopted by our rivals in commerce. Whatever differences of opinion may rightly exist as regards specific measures for the restoration of the American marine to the high seas, all parties should agree as touching the justice and necessity of treating our maritime interests as generously as Great Britain deals with the owners of her mighty marine.

Our domestic marine, being free from foreign competition, has had a prosperity as great as the adversity of our foreign marine. The present tonnage of domestic shipping is nearly 4,000,000 tons, our growth during the period since the Civil War having been nearly a million tons. The traffic on our northern lakes now employs 3256 vessels, canal boats, and barges, with a total tonnage of 1,437,500 tons; and two thirds of this tonnage consists of steamships. In 1888 our lake tonnage was only 874,102 tons; the growth during a decade having been nearly 80 per cent.

It is hardly necessary to remark that the increase or decrease in the efficiency of a marine during the last few decades is not measured by the growth or decline in the tonnage statistics. The modern steamship, aided by the many commercial auxiliaries that facilitate it in receiving and discharging its cargo, is a much more efficient transportation agent than was its smaller predecessor propelled by sails, and loaded and unloaded mainly by human labor. Our present domestic marine of 4,000,000 tons is at least twice as effective as was the domestic shipping of 3,000,000 by which we were served a generation ago.

VII. AMERICAN SHIPBUILDING.

One great aid to the achievement of maritime greatness is a strong shipbuilding industry, and every nation with commercial aspirations endeavors to establish the business upon a sure foundation. For some countries, as in the case of the United Kingdom, that is much easier than for others; and that is one reason why Great Britain has so easily succeeded in maintaining her place as mistress of the seas.

The business of building ships in the United States, to be used in foreign trade, has passed through a golden age of triumphs, followed by a period of decline and discouragement, and it is now entering upon an epoch of revival. The golden age came in the days of wooden vessels. It began in early colonial times and lasted until the middle of this century, when the world began to buy iron ships of the United Kingdom. The magnitude of our shipbuilding industry at the middle of the nineteenth century is indicated by the fact that during the decade beginning with 1850 the tonnage built in our yards equaled 3,988,372 tons, an annual average of nearly 400,000 tons. During the three years 1854–56 we constructed over a million and a half tons.

The decline in American shipbuilding set in sharply after the Civil War, and, in spite of the continued growth of our domestic marine, the tonnage constructed by American builders steadily declined until 1886, when only 95,453 tons were built. The causes of this decline have been stated in what has been said regarding the substitution of iron and steel vessels for wooden. The period of decline seems now to be safely passed, for we are annually building over 200,000 tons on an average, and every indication points to rapid progress in the near future.

What is more indicative of progress than the increase in the tonnage constructed is the growth in the percentage of steamers and iron and steel ships built, as compared with the wooden sailing ships turned out. During the decade 1872–81, we built 800,000 tons of steamers and 224,000 tons of iron and steel ships; in the decade following, we constructed 1,200,000 steam tons and 485,000 tons of iron and steel vessels; and from 1891 to 1898 our yards turned out 730,432 tons of steamships and 543,850 tons of iron and steel vessels. As these figures indicate, the reconstruction of our merchant marine is progressing with a fair degree of rapidity. At the present time one half our tonnage consists of steamers; but our percentage of iron and steel is still small as compared with other countries. Over seven tenths of our tonnage consists of wooden ships, whereas our chief commercial rival has practically no wooden vessels whatever. Only 7 per cent of the French marine consists of wooden ships, and in the case of Germany less than 5 per cent.

The outlook for iron and steel shipbuilding is so promising that a rapid increase in iron and steel tonnage is certain to come. Largely through the influence of the reconstruction of our navy, numerous large plants for the construction of steel ships have been established at Bath, Philadelphia, Wilmington, Baltimore, Newport News, San Francisco, and other seaports. Cities on the Mississippi River, and especially those on the Great Lakes, are engaged in building ships of iron and steel. There are several steel plants in the Lake ports, and in them we have built the larger part of our steel tonnage. Our iron ships have been built chiefly in the seaboard yards. During the present year, 1899, the American yards are busy constructing vessels both for the navy and for our merchant fleet, and new yards are being established. Having begun selling crude and structural iron and steel and various classes of machinery in Europe, even in Great Britain, we shall ere long be selling iron and steel ships. The excellence of our navy has brought us orders for war ships, and the skill and invention of our shipbuilders will bring us foreign orders for merchantmen.

VIII. CAUSES ACCOUNTING FOR THE CENTURY'S COMMERCIAL PROGRESS.

The commercial progress of the nineteenth century, the salient phases of which have been depicted in the foregoing pages, has been the result of three sets of causes, economic, political, and social.

The economic causes of most importance are the improvements in transportation, the reorganization of industry on a large scale, the accumulation of capital, together with the growth of corporations and credit institutions whereby the utility of capital has been enhanced, and the discovery of large stores of gold.

Transportation is the handmaid of trade. Whatever enables this handmaid to do her work cheaper and quicker enlarges the scope and volume of the world's commerce. When one considers that it cost nearly four times as much in 1875 to ship wheat from New York to Liverpool as it did twenty years later, and fully three times as much from Chicago to Liverpool, one can readily understand how transportation has removed hindrances to commerce.

Cheap and rapid transportation has made an extensive commerce possible, but it has been the organization of industry on a large scale that has created the chief demand for commerce. Industry at the present time is, to a large extent, so organized as best to promote the territorial and international division of labor; and each large producer regards the whole world as his market. The amount of commerce required increases with the concentration and specialization of industry, and with every widening of the producer's market.

It has been the accumulation of capital and its increased availability for purposes of production that have made possible the organization of industry on its present basis, and enabled men to construct the highly developed transportation system by means of which commerce is accomplished. The material progress of the past century is unprecedented. Industry has created wealth as with the touch of a magic wand; and this rapidly growing wealth has been made available capital through the instrumentality of the corporation which, by means of stocks and bonds, has gathered into giant organizations the property of hundreds and even thousands of individuals. The industrial corporations have been greatly assisted in their work of concentrating and applying capital, by the banks and other institutions that have enlarged credit and made a given amount of property capable of performing a much larger work. The expansion of industrial credits, furthermore, has been greatly facilitated by the issue of government bonds in large amounts during the century. These state obligations constitute excellent business securities, of which banks, other corporations, and individuals make extensive use. Such are some of the factors that have promoted the accumulation of capital and increased the volume of commerce.

Money is not capital, but an adequate supply of a sound and stable medium of exchange is essential to industrial and commercial progress. Twice in the history of the world the discovery of large supplies of the precious metals has given a great impetus to industry and trade: once, in the sixteenth century, when the Spanish galleys brought to Europe rich treasure from the silver mines of America; and again, in the middle of the nineteenth century, when the rich finds of gold were made in Australia and California. The very rapid increase in the commerce of the United States and of the world at large, which began about 1850, was in no small degree the result of the rising prices which followed the discoveries of gold. The closing decade of the century is witnessing a similar occurrence. For many years prices declined rapidly; the demands made upon the world's gold supply were rapidly increased at a time when the annual output was declining. From 1850 to 1870 the annual output of gold averaged over $130,000,000; it then declined so rapidly that it amounted to only a little over $100,000,000 a year, in 1885 and 1886. It was only $118,848,700 in 1890; but the present annual production is nearly $300,000,000, and the fall in prices has been cheeked for a while at least. The very rapid enlargement in commerce during the past two years must have been facilitated by the recent increase in the annual production of gold.

A second general cause accounting for the world's progress in commerce is political—the commercial policy followed by the leading nations of the world. Up to the nineteenth century, practically every country strove to promote its trade, navigation interests, and its power as a nation by means of the mercantile system,—a system of strict and detailed regulation of foreign trade by means of tariffs and navigation laws. Each country strove to determine the nature of its international trade, and endeavored to carry on its commerce in its own ships. In the case of one country, at least, the mercantile system was eminently successful. Great Britain entered the great Napoleonic wars with a powerful naval and merchant marine, and emerged from that struggle the unquestioned mistress of the ocean. Her industries also, as well as her ships, were stronger than those of other countries; and she soon concluded that both her foreign trade and her shipping would profit by doing away with the restrictions of the mercantile system, and adopting the policy of entire commercial freedom. She made no mistake, for her industries and commerce have wonderfully prospered.

The success of free trade and freedom of commerce in the United Kingdom had much influence upon other countries, and, during the third quarter of the nineteenth century, several countries began to move cautiously in the direction that the United Kingdom had taken. They soon found, however, that for them free trade and shipping meant British trade and shipping, because of their inability to compete successfully with their powerful rival; and, during the last quarter of the century, the dominant commercial and maritime policy outside of the British Isles has been one providing for the regulation of trade by tariffs, and for the promotion of the mercantile marine by postal payments and bounties. At the present time, the two most powerful commercial rivals of the United Kingdom are the United States and Germany; and their trade policy is one of regulation instead of freedom. It would seem, therefore, judging by results, that both the United Kingdom and her competitors have acted wisely, and that in both cases the means adopted were such as conditions demanded.

The third cause of the world's commercial progress during the past century has been colonial expansion. Germany, France, and other countries, influenced by the great success of the United Kingdom, have established colonies in different parts of the world, and assumed control over uncivilized peoples, until there are now 125 colonies, protectorates, and dependencies. These 125 regions comprise two fifths of the land surface of the globe, and contain one third of its population. These colonies and protectorates import annually over $1,500,000,000 worth of commodities, and of this large sum more than forty per cent is bought from mother countries. The last nation to adopt the policy of colonial expansion is the United States, her principal colony, the Philippine Islands, having been made a part of her possessions because of our desire to secure a larger share of the trade of the Orient.

IX. THE TWENTIETH CENTURY PROSPECT.

The world is entering upon the twentieth century with the nations of the earth bound to each other by much closer relations than existed a hundred years ago, and chief among the forces that draw the countries of the world together is commerce. It is commerce, more than anything else, that has brought about the existing organization of industry in which each nation is dependent upon every other.

The nations of the world are mutually dependent, but their interests are not identical. In the future, as they have done in the past, nations will compete with each other, each striving to secure for itself a maximum of economic advantage; and this competition will continue to take the form of commercial rivalry. The great international struggles of the present day are being carried on to secure trade advantages; and at no time in the past have those contests been more earnest than they now are. The conflicts of the twentieth century will be commercial struggles, and they will be intense.

In the centuries when Phœnicia, Greece, Carthage, Rome, and Venice were successively powerful, the Mediterranean was the theatre of commercial activity and international rivalry. The navigators and explorers, whose exploits closed the mediæval period and inaugurated the modern era, carried the world's commerce from the Mediterranean to the Atlantic and transferred the centres of national greatness from the southern to the western and northern nations of Europe. The great industrial countries of the present are those of Europe and America adjacent to the North Atlantic. These countries originate the larger part of the world's commerce; and the main streams of international trade are those which connect these countries with each other and with those regions of the earth less highly developed industrially.

The Isthmus of Suez, just north of the Tropic of Cancer, and the Isthmus of Panama, a short distance south of that line, were the only barriers which nature placed across an otherwise continuous water route around the earth in the northern hemisphere. These barriers diverted the lines which the world's largest volume of traffic tends to follow far to the south around Africa and South America, or did so until 1869, when Europe overcame the barrier of most consequence to her by the construction of the Suez Canal. Since the opening of that waterway Europe has enjoyed advantages for international trade superior to those enjoyed by our country. Our regions most highly developed industrially are tributary to the Atlantic and Gulf of Mexico. To the east of us lies Europe, a region of great industrial advancement, demanding little more than our surplus food products and raw materials; to the south are the countries of the South Atlantic lying along the line of the world's secondary commercial routes; countries, moreover, whose trade we can secure only in direct competition with Europe, which has already forestalled us at many points. In pushing their trade westward the industrial States of the United States—and they are found in the eastern half of our country—find that the possibilities of a traffic by land are restricted within narrow bounds by the heavy costs of a long haul over the elevated Cordilleran Mountain ranges, while shipments by water have to take the circuitous and expensive route around South America. Until an isthmian canal is constructed the United States will be handicapped in its competition with Europe for the trade of all countries bordering the Pacific Ocean.

The United States looks forward to the coming century, confident of sharing largely in the world's commerce. With an enormous and rapidly growing foreign trade, and with her industries sending their wares into all quarters of the globe, the future of her trade is certain. Shall we also become a great maritime nation? Shall we be as successful in the age of steel steamships as we were in the days when our clipper-ships, "those strong-winged gulls in timber, put swift girdles around the earth?" Unquestionably, yes! The commercial advantages which our rivals have possessed for half a century have nearly all disappeared. Our maritime instincts are not dead; and when we again turn our attention in earnest to the work of international navigation, we shall "win anew the wide-reaching seas our sires loved and occupied so well."

Education During The Century

By FRANKLIN S. EDMONDS, A.M.,
Asst. Prof. of Political Science, Central High School, Philadelphia.

The nineteenth century has been characterized by a deep and abiding interest in popular education. One hundred years ago there were many close observers who strongly opposed all attempts to provide schools for the masses, lest they should be educated above their station in life. This feeling was particularly strong in conservative countries like England. It led the Duke of Wellington to remark to one who was explaining to him the work of Joseph Lancaster, “Take care what you are about; for unless you base all this on religion, you are only making so many clever devils.” So careful a critic as Alexis de Tocqueville, after his visit to the United States in 1831, wrote to Jared Sparks: “Are the effects of education uniformly good? Does not a man who obtains an education above his social condition become an unquiet citizen?” The first triumph of the nineteenth century was the conquest of this fear; and there is to-day a general belief that it is the duty of each community to provide a well-developed school system, that each child may have an opportunity for making the best and highest use of his powers and capabilities.

Perhaps no single element has contributed more to this change in the popular attitude towards schools than the writings of the great group of thinkers who, with lofty ideals and keen acumen, have devoted themselves to the study and discussion of educational questions. Germany has been foremost in its contributions to educational literature. Foremost in time as in influence is John Henry Pestalozzi (1746–1827). Although endowed with an “unrivaled incapacity for government,” Pestalozzi has yet become an inspiration to modern pedagogy, because of his love for teaching and the tender sympathy of his nature. After various educational experiments, he opened, in 1805, a school at Yverdun, on the Lake of Neufchatel, which soon won for him a European reputation, and became a centre of interest to educators from all Europe. The Emperor of Russia gave him a personal proof of his favor, and Fichte, the great German philosopher, declared that he saw in Pestalozzi and his labors the dawning of a new era for humanity. In his writings and in his teaching Pestalozzi emphasized the importance of the home in education; he asserted the truth that all instruction is based on observation: “Neither books nor any product of human skill, but life itself, yields the basis for all education;” and in a general way he aimed to develop the child through his own personal activity, rather than to furnish him with useful facts.

The most eminent of Pestalozzi’s disciples was Friedrich Froebel (1782–1852), the founder of the kindergarten. After a varied career as a forester, student at Jena, etc., Froebel went to Yverdun in 1808, and for two years was a co-laborer with Pestalozzi. The impulse which he here received never lost its force. It brought him to consider the problems of elementary education, and finally led, in 1837, to his establishment of the first kindergarten at Blankenburg in Thuringia. His idea may be well expressed in his own words,—“I can convert children’s activities, energies, amusements, occupations, all that goes by the name of play, into instruments for my purpose, and therefore transform play into work. This work will be education in the true sense of the term.” His great theory was idealistic—he believed in the unity of the universe, in the essential harmony of the world. It was the duty of the teacher to fit the child for his place in human society. This could be best done if the child was taken at a very early age and prepared for life in an ordinary school. The kindergarten, or child-garden, is thus a school where a child learns social life, where his play is systematized and his activities are directed. The average course of study takes hold of the child when he is six years of age; the kindergarten usually fills in the two preceding years. As an educational institution, the kindergarten has met with little public support in Europe, although in Paris there are a number of "maternal schools," which correspond closely to Froebel's plan. In the United States, Miss Elizabeth Peabody became the first apostle of the movement. The idea of caring for the children below the regular school-age won instant favor, and in a number of large cities kindergartens were opened under private auspices. As their success became clearer and more positive, they were taken under the control of the public. In 1896–97, the report of the United States Commissioner of Education shows that there were 1077 kindergartens in the United States connected with the public-school systems of cities having more than 4000 population, with an enrollment of 81,916 pupils. The International Kindergarten Union, formed for the purpose of "gathering and disseminating knowledge of the kindergarten movement throughout the world," has aided greatly in stimulating an intelligent interest in Froebel's ideals in America.

None of the great German philosophers has been honored with a more loyal cult than Johann Friedrich Herbart (1775–1841), who directed general attention to the necessity of studying the principles of education. In his writings and lectures while professor at the University of Göttingen, Herbart started an inquiry into the theoretical basis of instruction. He found the final aim of all education to centre in the formation of moral character, while the keystone of instruction is interest. "The final aim of instruction is morality. But the nearer aim which instruction in particular must see before itself in order to reach the final one, is many-sidedness of interest." Herbart's influence in arousing and directing thought has been most felt in Germany, but in America his name has been taken by one of the most active educational associations, "The National Herbart Society."

Next to Germany in its list of great educational thinkers must come England. At the beginning of this century there were no "public schools" in England, in the American sense of the term. The great preparatory schools,—Eton, Rugby, Harrow, Winchester, etc.,—although called "public" by the English, were in reality endowed boarding-schools, where as a rule only the children of the rich could be found. General education was cared for by the village schools under the direction of the vicar of the parish, and usually presided over by elderly dames with varied degrees of attainments. At the end of the eighteenth century, the work of Andrew Bell and Joseph Lancaster began to arouse some interest. Working independently, the one in India and the other in London, both developed the same method of providing general instruction at a minimum of cost, by using the more advanced pupils to instruct the beginners. "By the aid of monitors," said Lancaster, "one master can teach a thousand boys." In 1798, Lancaster opened the first English school of this kind in Southwark, London, placing this inscription over the door: "All that will may send their children and have them educated freely, and those that do not wish to have education for nothing may pay for it, if they please." In 1808, the Royal Lancasterian Society was organized, to agitate for more schools; and although its name was changed, in 1814, to British and Foreign School Society, its work has continued down to the present time. In 1818, Lancaster came to America, and was at once placed in general charge of the public schools of Philadelphia. He was made principal of a model school for training teachers, which is believed to have been the first attempt at a normal school in America. After extensive agitation in New York, in Canada, where in 1829 he received an appropriation from the legislature to enable him to start his monitorial schools, and even in South America, Lancaster's work was done.

Probably the greatest teacher of the century in England was Thomas Arnold, whose character will long live in literature through the loving portraiture of his pupils. While contributing little of importance to the science of pedagogy, he was yet able to work a revolution in the general conception of teacher and pupil, and their relations to each other. He insisted that his teachers must continue their studies after they had secured positions, and so raised professional ideals. "The pupil," said he, "must drink from the running fountain, and not from the stagnant pool." His sympathy gave him rare power to mould the character of boys. He trusted his boys and they became worthy of it. "It is a shame to tell Arnold a lie! He always believes one,"—was the common saying. As a consequence, there went out from Rugby School from 1827 to 1842, the years of Arnold's headmastership, a group of clean, healthy, whole-souled boys, well fitted to become leaders in English life.

Many contributions have been made to the literature of pedagogy during the century, but there is none that has attracted more attention or stimulated more earnest discussion than Herbert Spencer's "Education." In the first chapter of his book, Spencer asks the question which aroused the educational world,—"What knowledge is of most worth?" It at once directed inquiry into the very heart of educational theory. The course of study, the order in which subjects should be considered, the time to be given to each,—all these problems were vitally concerned with the answer to this question. Mr. Spencer's solution won instant favor: "How to live," said he, "that is the essential question for us.... And this, being the great thing needful for us to learn, is, by consequence, the great thing which education has to teach. To prepare us for *complete* living is the function which education has to discharge." This point of view led to the accenting of useful and practical subjects. The human body should be studied,—this is necessary to fulfill the first law of nature, self-preservation. The natural sciences should be an essential part of education: this is necessary for our acquaintance with the world in which we must live and work. History and social science should be studied: that each one may become fully in touch with the society in which he forms a unit. Naturally, little time would be left for branches that were æsthetic or cultural, and so Spencer would have the student give but his surplus time to these. But the important thing was that he should know himself, his world, and his society, so that he would be fitted to do his work in the most complete way. His practical influence upon education is best seen in the great increase of appreciation for the natural sciences, which has led to the introduction of nature observation and study, even in the most elementary schools.

In America there have been important contributions to educational theory during the century. There has been a perfect flood of educational books, pamphlets, and periodicals, whose merit is so great as to extort even reluctant admiration from foreign critics. While there has been much unevenness in quality, yet Americans have no reason to feel ashamed of their contribution to pedagogical literature. The best work has been done in the discussion of specific questions, rather than in an elaboration of general ideals. Administration, with its manifold problems, has appealed strongly to the American genius; and consequently the greatest names of the century are those of men who have devoted themselves to some practical work, the ideals and details of which they have thoroughly mastered, and so have left enduring monuments of their lives' work.

The great achievement of the century in the United States has been the establishment of a system of free and public schools. Like most of the nation's intellectual impulses, this spirit seems to have come from New England. There, the democratic ideals of the people led to an early appreciation of the necessity for universal education. There can be little doubt that it was from the Puritan settlements in Massachusetts that the original impulse toward universal education came. Thus, in 1647, the Colonial Assembly required that each town containing one hundred families should establish a grammar school to prepare youths for the university. During colonial times more and more schools were steadily established. But the movement, which was zealously supported in New England and encouraged in the Middle States, especially by the Friends, met with opposition in the South, where education was considered a family duty, and not within the province of the State. Whatever, therefore, was accomplished in an educational line prior to the Revolution depended upon the spirit of the individual colonies; consequently, there was the widest possible divergence in the policies and methods of different localities.

But as soon as the Revolution had been accomplished, and independence had become a fact, a renewed interest in general education was evident. It is exceedingly interesting to watch the development of the point of view that free schools were a necessity for the existence of the republic, and hence must be established by the State. The early fathers of the nation were not slow to recognize this. In the words of Franklin, “A Bible and newspaper in every house, a good school in every district—all studied and appreciated as they merit—are the principal support of virtue, morality, and civil liberty.” “In proportion as the structure of a government gives force to public opinion,” said Washington, “it is necessary that public opinion should be enlightened.” And Jefferson, with his broad philosophical appreciation of democracy, started the battle against the ideas of Governor Berkeley, of Virginia, when, in 1779, he introduced into the General Assembly of Virginia a bill providing for the establishment of schools “for the free training of all free children, male and female.”

The half century from 1790 to 1840 is the period of the battle for free public schools. It was a hard fight, complicated in many States by local questions and conditions that rendered success almost hopeless. Some opposed from the old point of view that education was an individual matter,—each should get for himself just so much as was possible. Others raised the objection of cost,—if taxation was proposed, was it right to take money from one group to educate the children of another? Religious disputes hindered progress,—many of the denominations had founded sectarian schools, and were unwilling to see them replaced by public schools, where no creed would be taught. Especially, in some States, as in Pennsylvania, where Swede, German, Scotch, Irish, and English lived side by side, did the race problem enter as a perplexing element. Should any language other than English be taught? What respect should be given to the traditions and customs of each race-group? Moreover, when the conservatism began to yield to progress, it compromised with great reluctance. At first, provision was made whereby the children of the poor should have their school fees paid by the State. Then public schools were started exclusively for the poor, which were branded with the stigma of “pauper schools.” But these difficulties only served to increase the ardor of the public-school advocates, and at length their success was complete.

Some episodes of the struggle deserve special mention. Horace Mann (1796–1859) has been called the St. Paul of education in America. In 1837, the State Board of Education was created in Massachusetts, and Horace Mann was appointed its first secretary. For twelve years he labored with unflagging energy to build up the public interest in education. By speech and by pen, he awakened in his State an appreciation of the value of the public school system that has never since decayed. He established on an enduring basis the business side of education in the State, by systematizing the school funds. The personal sacrifice was enormous. He addressed public meetings all over the country. When he found that no arrangements had been made at Pittsfield to prepare the schoolhouse for his meeting, Horace Mann and Governor Briggs themselves swept out the building and set it in order. One of his first interests was the provision of good teachers. In order to spur the Assembly to its duty, he begged from his friends the sum of $10,000, which, with an equal sum appropriated from the state treasury, was used in the establishment of the Massachusetts normal schools at Lexington and Barre (1839). Outside of his administrative work, his fame must rest upon his stanch advocacy of the principle of “the obligation of a State, on the great principles of natural law and natural equity, to maintain free schools for the universal education of its people.”

In Pennsylvania, the hero of the battle for free schools was Thaddeus Stevens. In 1834, a law was passed by the legislature establishing a state system, and abolishing the distinction between rich and poor which had been noticed in the old pauper schools. Two years later, a determined effort was made by the combined forces of ignorance, prejudice, and caste, to repeal the act of 1834. Nothing but the stanchness of Governor Wolf and the power exerted by the eloquence of the “Old Commoner” saved free schools for the Keystone State, and so established the system which to-day receives more direct aid from the state treasury than in any other State of the Union.

West of the Alleghanies, the interest in popular education has always been deep and thorough. Settled in large measure by the steady sons of New England, education found there a most fertile soil. Moreover, by the wise foresight of Congress, provision was made for school funds in a most satisfactory way. The Ordinance of 1787, which organized the territory north of the Ohio River, contained a provision that one section of land in each township should be devoted to public education. If this grant, which was originally suggested by Jefferson, had been carefully watched, it would have been sufficient to endow the public schools of many Western States. The national government gave to education in the first hundred years of its history nearly eighty million acres of public lands, but these grants were not always conserved with sufficient care. In 1896–97 the total revenue of the school systems in the United States was $188,641,243, of which less than five per cent was from state school funds or rent of school lands, while over eighty-six per cent was derived from state and local taxation.

To these grand totals must be added the million and more in attendance at private schools throughout the country, and the rapidly increasing number (now 217,763) of those who receive higher instruction, in universities and professional and normal schools. This makes for the United States a grand total of 16,255,093 pupils and students of all grades in public and private schools. The growth during the last generation has been most marked. The statistical table gives an opportunity for comparison with the year 1870–71,—the span of a generation,—and it has been estimated that within this period the average total amount of schooling has increased from 2.91 years to 4.28 years. In other words, the amount of education which each one felt able to afford has increased almost one half. Such is the magnificent result which has grown out of the isolated village schools of our New England ancestors, fostered by the democratic desire for intelligence found all over the country.

Equally great has been the change in the spirit of the school. In the early days the schools were very crude. Population was scattered, and since the children could not go as far to school as their elders did to church, the number of schoolhouses was very great. They were usually put up by the people of the neighborhood with little pretense at adornment. The average schoolhouse was located either at a fork in the roads or on an elevation, where it shared, with the church, the honor of conspicuousness. We give a picture of Old Sleepy Hollow Schoolhouse, made famous by Washington Irving’s elaborate description of Ichabod Crane, its ruler in the colonial days. But a structure of this kind is luxurious compared with the hardships of more sparsely settled regions. From Wickersham’s “History of Education in Pennsylvania” the following description is culled: “The pioneer schoolhouse was built of logs, sixteen by twenty feet, seven feet to the ceiling, daubed with mud inside and out, a mud and stick chimney in the north end, and in the west a log was left out, and the opening covered with oiled paper to admit light; holes were bored in the logs and pins driven in, on which to nail a long board for a writing-table, and slabs with legs answered for seats. The early schoolhouses were generally situated near the roadside or cross-roads, being without playground, shade-trees, or apparatus.”

Here the master kept his country school for a term of from six to twelve weeks. In the winter time the pupils were almost frozen, and there were other dangers which the hardy lad of those days had to encounter. Nevertheless, rude, uncomfortable, and inadequate as they were, it was here that our forefathers obtained their scanty schooling. The three R's, Readin', Ritin', and 'Rithmetic, formed the basis of the course of study. Methods were very simple. Much of the early instruction was religious in its trend, and the child was expected to use books which would teach moral lessons. Church books, containing creeds and hymns and catechisms, might be used in the school for study. Then there were the primers or books to teach the A B C. The famous "New England Primer" was published in the latter part of the seventeenth century. Later editions contained rhyming couplets upon each letter of the alphabet, illustrated with such imagery as the art would allow. A page from the "Child's Guide," published in London in 1762, is shown on page 527. Its verses were easily memorized, and sometimes gave a basis for a spelling lesson. There were no graded readers until this century.

Writing in some neighborhoods was taught only to boys, on the general ground that it was an unnecessary accomplishment for the sex which never engaged in business. Ink was home-made from bruised nutgalls placed in a bottle with water and rusty nails. The writing was done with a quill pen, and one of the foremost duties of the old-fashioned pedagogue was to make and mend pens.

The master set the copies by writing a lesson which was to be imitated by the pupils. There was no set style, but usually the teacher wrote a bold, legible hand which in time was acquired with a fair degree of success. Arithmetic was taught without text-books. Sums were given out by the master and worked out on paper on the desk. Nothing but the more rudimentary principles was taught, and the higher branches of algebra and geometry were unknown in the public schools of this time. Spelling was one of the favorite studies. It gave free scope for the memory, and provided an opportunity for one of those public exhibitions in which Americans have always delighted. "Spelling on the book," says Wickersham, "was taught by attempting to lead the pupil to give the names of syllables and words by naming the letters of which they are composed. The first lesson consisted of combinations of a word with one or more consonants, arranged so that a kind of rhyme aided the pronunciation, as *ab*, *eb*, *ib*, etc." ... "Spelling off the book" consisted in naming the letters of words pronounced for that purpose. But the chief enjoyment of spelling came from the old-fashioned contests, or "spelling-bees." Sometimes it was to discover the best speller of the district; again, one district might be pitted against another. The spellers would be arranged in two rows. The first word would be given to the first speller on one side, the next to his rival, the third to his comrade, and so on. If one missed a word, he at once took his seat; presently the contest would narrow down to a few, until at last all would have missed save one, and he or she became the champion speller.

The teachers of the time formed a group of varied attainments, and oftentimes with little professional enthusiasm. Teaching has always suffered from the fact that a great number of young men enter upon its practice, who use it merely as a stepping-stone to some other and more attractive pursuit. The number of those who have taught a few terms, in order to save money for a college, law, or medical course is legion; and this fact has laid the profession open to the reproach that only the unambitious and the unalert follow it permanently. In the early days of our country's history, this stigma was intensified by the number of "itinerant schoolmasters," men who wandered from place to place, teaching a term in one village and then moving to the next,—"odd in dress, eccentric in manners, and oftentimes intemperate." Their work was simple in its nature; they were to keep order and to teach the rudiments. Their methods in the latter have already been referred to; for the former, they relied, almost universally, upon the unsparing use of the rod.

The wisdom of the practice of flogging has only been questioned in the latter part of this century. In the early days it was the one recognized punishment, even for students whose maturity and attainments would suggest an appeal to reason. With this mode of punishment was associated a more or less ingenious series of devices, such as the dunce-block, the fools' cap, etc., all calculated to bring the offender into ridicule, but utterly destructive of that good feeling between teacher and pupil, upon which so much stress is laid to-day.

In the course of the century the old-fashioned school has either passed away or else has been modified materially. To-day it is to be found in only sparsely settled districts, while in the cities and in the more cultured neighborhoods one finds carefully planned systems of education that show the fruits of the study and direction of some of the keenest minds that our country has produced. While it is impossible in the space of a single chapter to refer to *all* the changes, yet some of the most important will be considered.

Foremost in real importance come the changes in the course of study—in the list of subjects which the well-educated young man may be expected to have mastered. One hundred years ago the average child would have gone to the village school for the three "R's" with, maybe, a little training in geography and parsing. If a college career was open to him, he would then go to an academy, usually a private institution, for his introduction to the classics, Latin and Greek, and to algebra. While instruction was given in other branches, yet these formed the backbone of the course. The average age of admission to college was considerably less than it is at present. In the ordinary college there was a required course of study, in which Latin, Greek, and higher mathematics played the most conspicuous part. The scientific studies were counted less educative, and were usually rather poorly taught. Literature, history, and philosophy were sometimes included in the college curriculum, and in many ways the course of study was modeled to suit the preferences and abilities of the different teachers. Nowadays this is all changed. In the United States a graded school system has been created, that is, a complete course of study has been worked out, whereby certain studies are specified as suited for each year of the school life. This is not the same for all parts of the country, for the American school system, unlike that in Germany and France, is not national in its organization. The authority over the schools is vested in the individual States, and as a consequence each State shows peculiarities in course of study, in laws, and in methods that make the whole seem chaotic. There is, however, more similarity than would appear at first sight, and while what is asserted in general may not be true of each particular locality, yet certain lines of development may be clearly seen.

The schools of the country may be divided into three groups,—elementary, secondary, and higher. The elementary schools are built in some places upon the kindergarten; they are ordinarily supposed to occupy the first eight or nine years of the child's school-life, and are classified as primary and grammar schools. During that period the pupil studies a great variety of branches,—language studies, reading, writing, spelling, and grammar; arithmetic, geography, United States history, civil government, nature study, physiology and hygiene, physical culture, vocal music, drawing and manual training in boys' schools, or sewing and cooking in girls' schools. Several of these subjects have been introduced only within the last few years. The tendency toward enriching the curriculum is quite manifest to-day; it is based upon the fact that by far the larger part of the pupils never enter the higher schools, since their education is ended with the elementary schools, therefore it is thought desirable to bring some of the higher subjects into the grammar school.

With the completion of this elementary course the pupil passes into the secondary school. Earlier in the century this was ordinarily a private academy, either conducted for profit or by a religious society. In exceptional cases these schools were public; but as the benefits of higher education were recognized more completely, the popularity of these schools increased enormously. Public high schools were opened, and success led to their rapid multiplication, until to-day they form one of the most useful elements in our system, sending forth year by year leaders of thought and moulders of opinion. Their course of study has been the subject of much controversy. The old academy prepared for the college; the new high school prepares for life; consequently there ensued a breach between the high school and the college which only now is being closed. The ordinary high-school course is four years, and includes languages, Latin, French, German, and sometimes Greek and Spanish; mathematics, algebra, geometry, trigonometry, and sometimes analytical geometry and even astronomy; history, literature, physical geography, physics, chemistry, biology, geology, drawing, and occasionally political economy, ethics, and civics. It will be noticed that subjects formerly taught only in the colleges have been brought into the high-school curriculum. This again is due to the "enriching process," and is illustrative of the fact that for so many of its students the high school is the crown of their education. The stress laid upon nature study and the physical sciences, and the introduction of modern languages, are among the most significant changes of the century, as indicative of the desire to bring the schools in touch with the conditions of practical life.

From the high school or academy, the student passes to the college or university. Within the last decade an attempt has been made to give a definite pedagogical content to each of these terms. A *college* is an institution where the liberal arts are studied for purposes of general culture. A *university*, on the other hand, prepares a man for one definite line of work, either professional or technical. Both confer degrees upon those who have successfully completed their courses, but those of the university (Ph. D., A. M., M. D., etc.) are of a higher type than those of the college (A. B., Ph. B.). There were twenty-four colleges in the United States in 1800. The six oldest were: Harvard, established in 1687; William and Mary, 1693; Yale, 1701; Princeton, 1746; University of Pennsylvania, 1749; Columbia, 1754.

In 1896 there were 472 colleges and universities in the United States, representing most of the States and Territories in the Union. Many of these are entirely public, being supported by State appropriations; some receive State aid; others were originally founded by private endowment, but have become public in their management; some are entirely private in both endowment and control. Most are non-sectarian, but many require worship in accordance with the services of some denomination. In general, all recognize their lofty function in society and are anxious to discharge it properly. Originally aristocratic in many ways,—prior to the Revolution some colleges classifying their students in the catalogue according to the social rank of their families,—they have become among the most popular institutions in the educational world, largely because of the high worth of their graduates.

Universities, in the scientific sense of the term, did not exist prior to 1800, except in the few medical and law schools and theological seminaries. The American conception of the university has been very largely moulded by the experience of Germany. The college does not exist as a degree-conferring institution in Germany, but its place is taken very largely by the *Gymnasium*. The German system comprises three grades of schools:
1. *Volkschulen* (primary schools), where the elementary instruction is given.
2. *Gymnasia* and *Real-Schulen* (secondary schools), which provide a nine years' course for the pupil, usually covering the period from ten to nineteen years. The aim of the first is to prepare for the university, while the *Real-Schulen* fit their students for the ordinary business callings of life. 3. Universities, in which the studies are arranged in four faculties; theology, law, medicine, and philosophy. On account of the thoroughness of the German teaching, many American students have gone to Germany for their university course. A sincere effort has been made in America to develop universities according to the German concept, with its

detailed study of particular topics based on a thorough general education. Johns Hopkins University, Baltimore, opened in 1876, has done most along these lines.

During the century a determined and successful effort has been made to break down the old-fashioned college curriculum, with its absolute and unvarying requirements from every student. Harvard University, under the leadership of its brilliant executives, Thomas Hill and especially Charles W. Eliot, has led the way by providing a series of elective courses from which the student might select a sufficient number to make up his roster. This has given scope to the exercise of a freedom of choice that has been most wholesome in its effects upon both the scholar and university. It has led to the neglect of the poor courses and to the encouragement of the good ones; and it has promoted individuality in the different students to a marked degree. The success of the elective system, and the development of post-graduate courses in the university, taken in connection with the very great interest in all the phases of higher education, constitute the chief lines of advance during the century.

It is evident, then, that the student of to-day has a tremendous advantage over his fellow of one hundred years ago in the subjects which he may study. The courses have been enriched, instruction has been systematized, new subjects, more closely allied with popular needs, have been developed. But a gain which transcends in importance even these alterations in the curriculum, is that which has come through the teacher.

We have seen that the teacher of our forefathers was a man of doubtful attainments and uncertain character, and while there were golden exceptions to any general criticism, yet it is beyond question that as a class the teachership was not well esteemed. As a rule, there was no stable salary,—the teachers "boarded around" at the homes of their pupils or received payment in produce from the farmers. At the school he was janitor as well as educator. Outside of New England, there was little intelligent supervision of his efforts, and, on the whole, very little effective home coöperation. Within the century, however, there has been a marked increase in the esteem in which the teacher is held, and in the popular appreciation of his work. Moreover, to-day, the teacher better deserves esteem and respect. While the profession still contains a vast floating element who look forward to a future in other lines of work, yet on the whole its members possess a keen interest in their work and a desire for professional improvement. A most powerful means toward this end has been found in the various teachers' organizations. The Institute, with its annual assembly of all teachers within a given district, who for two or three days discuss school questions and listen to lectures upon educational topics, has been introduced throughout the whole country with great success. The teachers in the various States have organized State associations, and there are innumerable voluntary organizations, whose meetings give each teacher an opportunity for that free contact with others of his own kind that is so helpful and so suggestive.

The oldest educational association in America, maybe in the world, is the American Institute of Instruction, organized in 1830. During its nearly seventy years of life it has been a vast inspiration to thousands of teachers. It has drawn its support chiefly from the New England States and recently from Canada, but its influence is widespread. Annual meetings have been held regularly. Among its leading spirits, it has numbered such men as W. E. Sheldon, Francis Wayland, Henry Barnard, etc. Out of the success of the various State associations, and perhaps suggested by the necessity for more general action, grew the National Educational Association, founded in 1857, with the objects "to elevate the character and advance the interest of the profession of teaching and to promote the cause of popular education in the United States." Its first president was Zalmon Richards, and his successors have been the foremost educators of the country, including James P. Wickersham, Emerson E. White, William T. Harris, Albert G. Lane, Nicholas Murray Butler, Charles R. Skinner, etc. Its membership has grown from 80 in 1857 to 10,654 (1898), and it has been estimated that some of its conventions have brought twenty-five thousand people in their train. In spirit it is thoroughly national, meeting in every section of the country in turn, so helping to promote uniformity in school ideas. As the Association grew larger, and its work became more complicated, its organization became involved. To-day it consists of seventeen departments, each of which devotes itself to one phase of education, usually reporting at the annual meeting.

Since 1892 the National Educational Association (N. E. A., as it is popularly called) has appointed three committees to investigate special lines of work in separate departments of the school system. The Committee of Ten, whose chairman, Charles W. Eliot, was the distinguished President of Harvard University, submitted a most useful report in 1893 on Secondary School Studies. In 1895 the Committee of Fifteen, of which Superintendent Wm. H. Maxwell was chairman, then of Brooklyn but since chosen to be the first Superintendent of Schools of "Greater New York," made a valuable report on elementary education, including reports of sub-committees on the Training of Teachers, Correlation of Studies, and the Organization of City School Systems. In 1897 came the report of the Committee of Twelve on Rural Schools, Superintendent Henry Sabin, of Iowa, as chairman. These documents have been epoch-making; they have accumulated a mass of trustworthy information; they have procured opinion upon a wide variety of topics, and their influence upon the general systematization of the school system has been enormous. Their additional value lies in the fact that they have been prepared by teachers who thoroughly understood the topics which were being considered, and they have furnished to educators generally that consensus of professional opinion which has been so badly needed in America.

In this work of gathering and disseminating information, a most potent part has been played by the national government. The limitations of the Constitution left education as a State interest, to be worked out by each commonwealth as it should think best. There had always been a general desire among teachers for some national organization, and at last, after the Civil War, Congress established a department, and then later made a Bureau of Education in the Department of the Interior. In 1867 Hon. Henry Barnard was appointed the first United States Commissioner of Education. A wiser choice could not have been made. Dr. Barnard's career in education covers a period from 1830, when he was appointed Secretary of the Board of School Commissioners in Connecticut, down to the present. Beyond question, his greatest work has been the organization of the National Bureau of Education, which to-day is a grand educational clearing-house, sending forth in its excellent reports an account of ideas and work of each State to the others. Its high efficiency has been due, in a large measure, to the character of its commissioners: Henry Barnard, from 1867 to 1870; John Eaton, 1870–1886; Nathaniel H. R. Dawson, 1886–1889; William T. Harris, 1889 to date. The present incumbent has had the satisfaction of the knowledge that his position has been removed from the list of partisan appointments. By his tactful prudence and genuine scholarship, Dr. Harris has brought his office into touch with every good educational work for a decade, and has made his name a synonym for genial wisdom throughout the whole country.

The teacher has been aided in his work by his professional associations. It is, moreover, true that to-day the teacher enters upon his work better equipped for his duties. The normal-school system has spread over the whole country, and every year thousands of young men and women are sent forth with a preparation that fifty years ago was not even dreamed of. Since the teacher better deserves respect, he has commanded it the more readily. Gradually the barbarisms of the schoolroom have disappeared. As the sympathy with education increased, the necessity for excessive flogging passed away. To-day there is a wide variety in opinion as to the efficiency of this mode of discipline. In one State, New Jersey, corporal punishment in schools is forbidden by law; but in most of the others it is permitted in special cases, as a general part of the teacher's power when *in loco parentis*. The teacher is now paid a regular salary, but unfortunately it is the lowest paid in any profession for which formal preparation is required. In 1896–97 the average monthly wages of teachers was, for males, $44.62, and for females, $38.38. In comparison with the standard of life throughout the country, this is poor pay. Superintendent N. C. Schaeffer, of Pennsylvania, in a recent annual report, states that "one superintendent found that there were teachers in his county teaching for four dollars less per year than it cost the county on an average to keep one pauper." This is an exceptional case, but it illustrates the general truth.

One consequence of this low pay has been to accent a tendency which is fast removing education from the list of those professions in which men will engage. From 1870–71 to 1896–97 the percentage of male teachers decreased from 41.0 to 32.6; especially is this true in the older States. This is in striking contrast with one hundred years ago, when, except in infant schools, teachers were almost universally of the male sex. A variety of causes may be given for this change. The preëminent fitness of women for guiding the child during certain ages is acknowledged. Again, the decline of the rod and the introduction of a happy sympathy between teacher and pupil have helped the tendency.

But of all the forces which have contributed to this change, none has been more potent than the great increase of opportunities for the higher education of women. At the beginning of the century the United States was not behind European nations in its provision for the education of young women. No one thought of making anything like the same provision for both sexes. Women were refused admission to the colleges, and were obliged to content themselves with an elementary education or else meet the expense of private tutorage. Gradually, in protest against this state of things, girls' seminaries were opened and girls' high schools were established in the large cities. The idea of a seminary, "which should be to young women what the college is to young men," was first given definite shape by Mary Lyon, who collected funds for that purpose, and in 1837, two hundred years after Harvard, Mount Holyoke Female Seminary was opened. Its success was complete; it offered the regular English and classical course, and its graduates entered generally into the teaching profession. Presently, colleges for women were incorporated, of which to-day the best known are Vassar, Wellesley, Smith, and Bryn Mawr. As the demand for the higher education of women increased, presently it was queried, why may not the two sexes be trained in the same institution? Is there any real necessity for a duplication of plants with the consequent weakening of resources? The West has advanced far beyond the East toward co-education. Oberlin College, founded in 1833, opened its doors to both sexes from the first, and most of the institutions that derive their spirit from the West have followed the same plan. As a result, some of the city systems are trying co-education in their high schools and elementary grades, and thus far, while there are many opponents, the general verdict is favorable.

But the women were not content with a general collegiate training or a normal course that fitted only for teaching. Within recent years they have entered into the other professions with a keen enthusiasm. They are allowed, in a few institutions, to take theological courses fitting for the ministry. The first woman physician was graduated in 1849 from the school at Geneva, N. Y.; since that time special medical schools for women have been opened and some colleges have decided to admit women on the same terms as the other sex. In most law schools, women may be admitted, and in several States there are women practicing at the bar. While the influence of tradition has been strong, yet there is to-day no reason why an American woman should not receive as full an education and as complete a training as her brother.

In considering the changes in school-life, the improvement in buildings and equipment must not be overlooked. With the appreciation of the value of education, there has come an attention to the environment of the pupil that manifests itself in the provision of text-books, in the erection of larger and better ventilated buildings, and in the adornment of school grounds. School architecture, especially where populations are dense, has become an important science, involving problems of light, heat, ventilation, etc., together with questions of furniture, fire-proof construction and playgrounds. There was a time when the most interest was aroused by the exterior, that the school might be an adornment to its neighborhood. To-day the important problems of arrangement receive the most attention, and deservedly so. We give two suggestive pictures of modern schoolhouses. Professor Liberty H. Bailey of Cornell University, in a pamphlet which has been extensively circulated, has advocated a judicious arrangement of shrubbery around a schoolhouse, as space permitted, with a view to the elimination of all bare and cheerless features from the landscape. This is especially adapted to country districts. As a comparison, the new Central High School of Philadelphia is given as one of the best types of a complete city schoolhouse. It has been erected at a total cost of over one million dollars.

The furnishing of a school has undergone characteristic development. The hard bench, upon which our forefathers sat, has in a large measure disappeared, and in its place has come a variety of desks patterned with chairs fitted to each curve of the back, etc. Blackboards came into general use about the middle of the century. In certain studies, maps, charts, models, etc., seem indispensable, and the modern schoolroom contains all these. Moreover, as soon as science teaching had won a place in the curriculum, the cry went up for laboratories, that a higher grade of work might be done with the more advanced pupil. It is rather a singular fact that in many places the public high school led in this demand, rather than the more conservative college. To-day no high school would count itself able to do its work without one or more laboratories where each pupil might work for himself. In the new high school of Philadelphia there are physical, chemical, and biological laboratories, as well as a completely equipped astronomical observatory.

Text-books were just coming into use at the close of the eighteenth century. The “Child’s Guide” was being superseded by such works as Noah Webster’s Spelling Book, Grammar, and Reader (1792). Within a few years came Lindley Murray’s “English Grammar,” the work of a Quaker merchant who wrote his famous text-book primarily for a young ladies’ school in his immediate neighborhood. The instant success of these books demonstrated what a need there was for such a class of literature. The writing and publication of text-books has become one of the most flourishing industries of the country. On account of hard usage, a text-book does not last more than a few years, and this gives continual opportunity for a new book more nearly up to date than its predecessor.

Within recent years, less stress has been laid on the text-book, and its influence is being minimized. In the elementary schools the teacher explains the lesson, and in the higher schools the professor lectures upon his subject. Consequently, the text-book is relatively less important. This does not mean that less reading is being done, but it does mean that the reading covers a wider ground. Particularly is this true where libraries have been established. The public library system is a most valuable auxiliary to the school system, and is fast becoming indispensable. This is one of the great advantages which city pupils have over those whose home is in the country, and it will lead in the end to district libraries. In some States, as in New York, a successful effort has been made to inaugurate a system of traveling libraries, whereby a case of fifty or one hundred volumes, relating to a particular topic, will be lent for a time to any circle of readers. Massachusetts has best developed a library system, since there are but nine towns in the State that have not free libraries. The growth of the universities has led to the accumulation of great collections for special research and study. In 1800 there were but eleven college libraries in America worth mentioning; to-day there are almost five hundred, of which the largest, Harvard, contains a half million volumes. Libraries are of use, not only for pupils, but also for adults as well. They have aided materially in solving the great question of adult education.

In the New England towns of the middle part of the century, the lyceum lecture was exceedingly popular. University extension has recently come to the front as the latest form of the lyceum system. The idea of lectures to the people by university teachers came from England, where it was suggested just after an extension of the suffrage had attached a new value to the education of adults. Societies for the extension of university teaching have been formed in Oxford, Cambridge, and London. Their methods are on the whole identical,—university men are sent to town or village centres to give a course of lectures upon some general topic; after each lecture a voluntary class is held where questions may be asked and answered; at the conclusion of the course an examination based upon the course and collateral reading is given to those who care to take it; and sometimes a certificate or testimonial may be given. The method has been transplanted to America and generally adopted by the universities, with greatest success, perhaps, in the Middle States, where the American Society for the Extension of University Teaching has organized the field. During the period 1890–99, 862 courses of lectures were given under the auspices of the American Society to audiences aggregating 952,068. Another movement of equal importance is that done by the Chatauqua Literary and Scientific Circle, which prepares lists of books for home reading, with a view to encouraging system in one's use of spare time. Perhaps the most interesting public work for adults is being done in New York city, where a lecture department has been organized by the Board of Education, by which free lectures are given in schoolhouses to the people. In 1898, 1866 lectures were given to 698,200 people, and the president of New York's School Board has declared that "these lectures have contributed more than any other agency to the distribution of general intelligence among the masses." These forces have supplemented very well the work that is being done by the public night schools, which are established in most large cities, with a view to providing elementary, and sometimes technical, instruction to those adults who care for it.

No educational question has aroused more interest in business circles than the problem how to train best those who will devote themselves to a commercial life. This has become a live question recently to the American people. With improved processes in manufacture, the power of production has grown far beyond the consumption of our own people. Consequently America is competing with the great industrial nations of Europe for a control of the markets of the world. As soon as this competition became evident, the need for a better trained class of commercial leaders was felt. The example of Germany has had a great influence upon other countries. There is a general conviction that the leading position among commercial nations which Germany has won for itself is due in large measure to the technical education given to German artisans and the commercial education provided for business men. For illustration, the German government has recently established in Berlin a school where young men, preparing for business careers in Asia, can learn Chinese, Japanese, Arabic, and Turkish. German youths have been supplanting English young men, to an appreciable degree, in the great commercial houses of London. As a consequence, there has been a strong demand in America for the establishment of commercial high schools,—public institutions in which German, French, and Spanish will be taught, together with economics, industrial history, commercial geography, public finance, social science, etc. These institutions differ entirely from the business colleges, of which there were 342 in the United States in 1897, in that they are broader in scope and content. The latter qualify a man to be a good clerk by teaching him stenography, typewriting, bookkeeping, etc., but the former aim to give him a broad, liberal education, enabling him to have an intelligent comprehension of all matters which interest him in active business. This movement is too recent to have borne much fruit, but in many of the larger cities of America, as New York, Philadelphia, Boston, Brooklyn, and Cleveland, commercial courses have been established in connection with the regular high-school course; and in some of the larger universities, as Pennsylvania, Chicago, Columbia, schools in economics and politics have been created,—all with a view to equipping a young man for an active business career. In view of the present interest in this movement, more may be expected in the near future.

The close of the Civil War brought the American people to a problem, vast in its importance and intricate in its solution. The negro race had had no opportunity for education under the institution of slavery. But with their freedom came the necessity for creating a system of schools which could be of special help to this new body of citizens. The South has preferred generally that separate schools should be provided for the two races. In the ante-bellum days, the wealthier families usually sent their sons and daughters away from home to obtain their education under better auspices than their own neighborhood could afford. So when the war concluded, and there was but little sign of public schools, a new system must be created, and at once. The first work toward educating the negro was done by the national government, through the schools opened by the Freedman’s Aid Society. The different religious bodies throughout the country took a hand in the good work, by establishing special missionary boards for work in the South. Private benevolence lent substantial assistance. George Peabody, the philanthropist, and John F. Slater, both founded trusts which they richly endowed to aid in the establishment of schools in the Southern section. But the greatest work was done through the awakening of the people to the value of education, leading to liberal appropriations and to a firm public support.

Within recent years, negro education has assumed a new and interesting phase. Booker T. Washington, principal of the Tuskegee Normal and Industrial Institute, Alabama, is the leading educator of the Afro-Americans, and he has won his high place by the success which has attended his efforts at industrial education. His school at Tuskegee was started in 1881, and to-day contains over one thousand students. While fully appreciating the value of an academic education, Mr. Washington has felt that the first necessity for his people was the knowledge that would earn a livelihood. As a consequence, the industrial side of education has been accented; twenty-six different trades or industries are in operation at Tuskegee, and one is taught to each student of the Institute. As a consequence, its graduates have gone forth into active life, well equipped to become bread-winners and to fill a useful place in society.

The care of those who, from birth or by accident, do not possess all the powers of a normal person, has aroused much interest during the century. The deaf-mutes, the blind, and the mentally deficient, have each had institutions created, where they are taught as much of the knowledge of the world as is possible. The instruction of the deaf and dumb proceeds along two lines. The manual or sign method of conversation, based on gestures, was founded by Abbé de l’Epée in 1760; while about the same time Samuel Heinicke, a German, introduced the oral method, by which the eye of the mute is trained to perform the part of the ear, by learning the meaning of spoken words through observation of the changes in the position of the vocal organs. Special institutions for these classes abound in Europe and America, with the difference that, in the former, they are generally private or maintained by charity; whereas in the latter they are maintained by the State. Rev. T. H. Gallaudet and his son, Dr. Edward M. Gallaudet, have been the leaders in the instruction of deaf-mutes in the United States, and have achieved a high degree of success.

The teaching of the blind is of equal value to education. Two methods are generally followed; an alphabet of raised letters is employed in some cases, or, and more generally in the United States, a system of raised dots or points, which do not resemble the letter in form, but are a kind of shorthand to the reader. In both methods, the sense of touch takes the place of sight. In some cases, notably Laura Bridgman and Helen Keller, the success has been so complete as to excite universal wonder. Perhaps no institutions alleviate more human misery than do the schools for the blind, by bringing world-ideas within the limited horizon of this afflicted class.

Much also has been done for the training of idiots or those who are mentally deficient. In 1848, the Massachusetts School for Idiots and Feeble-Minded was opened, and other States followed with equally generous provision. Within recent years, special schools have been opened in connection with the school systems of large cities, so that children who need individual care and watchfulness may receive more attention than they could secure in the graded class-room. All these tendencies are exceedingly hopeful, as indicative of society's recognition of her duty to those who cannot satisfactorily care for themselves. Humanitarianism in education has been a powerful and constant force during the whole of this century.

It must not be forgotten that other agencies beside those established by States have been contributing to education. The Sunday-school movement is one of the great efforts of the century, to help in training children by a voluntary organization. In 1781, Robert Raikes employed some teachers for the poor children of Gloucester, in order that their Sundays might be spent quietly and with profit. Presently, as the number of Sunday-schools increased, men and women proffered their services gratuitously. The teaching followed two general lines, secular (reading, writing, etc.) and religious. The former was of help, especially to children who were employed during the week. From England, the movement came to the West. The American Sunday-school Union was organized in 1824, and has ever since continued to stimulate the establishment of more schools of this kind. In 1896, there were 132,697 Sunday-schools in the United States and 9097 in Canada, with a total membership of 12,288,153 and 721,435 respectively, while it has been computed that in the world the number of Sunday-schools was 246,658, with an enrollment of 24,919,313.

In European states, they have been solving the same problems as in America. The importance of education once admitted, the next problem is to secure the funds and develop the system.[5] Because of administrative centralization, this has been far easier in Europe than in America. The Minister of Education in France or Germany orders, and his directions are carried out; the United States Commissioner advises, and while his recommendations influence public opinion, yet the latter method is by far the slower. As a consequence, the European schools are more systematized and better organized than our own. Their course of study differs widely in details from our own, and generally shows more influence on the part of the pedagogical expert. Technical and professional education has been developed to an exceedingly high degree. England has had a peculiar problem to face, in determining the

---

[5] The comparative interest in education is well illustrated by the following extract from an address by Dr. Charles R. Skinner, recently delivered before the N. E. A.

"The United States, to-day the youngest of all, is the only great nation of the world which expends more for education than for war. France spends annually $4 per capita on her army and 70 cents per capita on education; England, $3.72 for her army and 62 cents for education; Prussia, $2.04 for her army and 50 cents for education; Italy, $1.52 for her army and 36 cents for education; Austria, $1.36 for her army and 62 cents for education; Russia, $2.04 for her army and 3 cents for education; the United States, 39 cents for her army and $1.35 for education. England 6 to 1 for war! Russia, 17 to 1 for war! the United States 4 to 1 for education! The United States spends more per capita annually for education than England, France, and Russia combined."

relation between the church schools and the secular schools, and has only solved it by maintaining both. Most European countries have adopted the principle of compulsory education for children within a certain age limit, and the same principle has been accepted in thirty-two States in America. In general, it may be said that in the changes in course of study, in equipment, in the teachership, etc., Europe and America have been working along parallel lines. As a rule, these changes have come more quickly in America, where traditions were as yet unformed; nevertheless, the progress in Europe has been constant and very great.

Canada has a well-established and well-regulated system, in which the principle of free and public education is recognized. The eight provinces contain twenty-four colleges, and the schools have over one million pupils. Education is more or less compulsory in all of the provinces, but the law is not very strictly enforced. In Ontario, Quebec, and the Northwest Territories there are separate schools for Roman Catholics; in the other provinces the schools are non-sectarian. There is a high professional spirit among the teachers, so that the schools may be expected to keep fully abreast of the times.

The nineteenth century has been a century of continuous advance in education. Its spirit has been healthy, its achievements are notable, its work has been great. It would be futile, however, to assert that all is yet accomplished. The problems in elementary education are so many and so important that there have been times when solution seemed impossible. Nevertheless, the system is now established and is assured of public support, and with an education within the reach of every child, the security of free institutions is forever guaranteed.

“The Art Preservative”

By THOMAS J. LINDSEY,
Editorial Staff Philadelphia “Evening Bulletin.”

I. THE PRINTING PRESS.

When Benjamin Franklin edited the “Gazette,” in Philadelphia, a century and a half ago, he set up the type, worked off the paper on a wooden hand-press of primitive construction, made wooden types for use in his office, and engraved the cuts with which to illustrate the articles. In those days printing was an art which figured among the mysteries of science, and was practiced by men of high social standing and advanced education. The sixty years which passed between Franklin’s purchase of the “Gazette” and his death saw the discovery of many scientific wonders, but the art of printing moved so slowly as to leave it at the close of the eighteenth century practically in the condition in which Franklin found it when he began his career as proprietor of his Philadelphia printing establishment.

And this condition of affairs applied to England as well as to the United States.

With all the rare ability possessed by the printer philosopher, he was able to do but little for the advancement of the profession which was instrumental in making for him an international reputation.

In all that pertains to the printing business there is nothing with which the name of Franklin is connected as inventor; yet he is referred to invariably as in the highest degree representative of the “art preservative of all arts.”

Were the distinguished scientist, statesman, diplomat, printer, and philosopher to come forth from his grave in the cemetery of Christ Church, at Fifth and Arch Streets, Philadelphia, and go into one of the great printing houses of the country, how astounding to him would be the revelation! No more the wooden types or the unsymmetrical metal pieces; no more the wooden hand-press, the wood engravings, the ink balls, and the process of printing a few hundred sheets an hour. The terrific rapidity with which the newspapers are turned out to-day, printed, cut, pasted, and folded; the fineness of the work done on books and magazines; the wonder of one press putting on different colors at the same time; the setting of type by machines seemingly possessed of human intelligence; the rapidity and the simplicity of making stereotype plates; the dexterity of forming ordinary metal types into all kinds of forms; the millions of books,—secular and religious,—papers, and general literary productions turned out daily, would so puzzle the gigantic brain and cloud the understanding of the philosopher as to cause him to exclaim: “Take me back, O spirit of death, and let me forever rest from this seething, surging, whirling sphere of inventive progression.”

When the genius of invention was turned toward the printing art, it is worthy of note that the press which attracted the greatest attention was the production of a Philadelphian who once had been an associate of Benjamin Franklin. It was known as the Columbian press, the invention of George Clymer, and was regarded as of sufficient consequence to meet the approval of the printing fraternity of Great Britain as well as of this country.

In the National Museum in Washington, D. C., is the hand press which Benjamin Franklin used to print his Philadelphia paper, the “Gazette.” It had been built for him in London, where he had used it about five years prior to its being brought to Philadelphia.

What a curious-looking affair it is! Yet it was little less in the way of primitiveness compared with that used prior to 1817, when Clymer’s Columbian came into use. When these productions are contrasted with the magnificent contrivances of to-day, from which can be thrown sixteen hundred papers per minute,—papers of ten, twelve, and fourteen pages, printed on both sides, pasted and folded,—the comparison is like putting the steamboat of Fulton by the side of the monster ships which cross the Atlantic ocean from New York to Southampton in less than five days.

The Columbian press was looked upon, when presented to the printers, as an advance worthy of note in the art. It is easy to imagine how much prominence was given Clymer’s invention when it was placed beside the old common press. To-day, this supposed-to-be great piece of mechanism would not even be dignified by a place in the most un-modern backwoods printing establishment. And yet from this were printed the literary productions of Great Britain, as well as of the United States, in the early part of the nineteenth century.

The Columbian mechanical advancement consisted of the use of rollers for inking the type,—very much like the process now employed in inking the type when a rough proof is desired,—thus dispensing with the balls, which were managed by boys; the use of screws under the bed of the press to hold in position the form, into which had been securely adjusted the type; and the application of a long bar to obtain pressure sufficient to make the impression on the paper. The picture of this press shows the flat carriage upon which was placed the type, the platen or pressing surface, the bar which forced the platen upon the type, the spring which carried the platen back to position when the impression had been taken, and the track upon which the carriage was moved forward and backward,—primitive enough, and sufficiently simple in construction to show the limited capacity of the inventive genius of our great-grandfathers.

It was about 1829 when the Columbian gave way to the Washington press, and this was used for some time for fine book-work. The feature of it was an automatic inking roller attachment.

While the Washington press had the capacity for producing fine work, it was deficient in the speed required for meeting the demand then growing for books and newspapers. Then the printers turned to a cylinder press which had appeared in the last decade of the eighteenth century. The London “Times” had taken hold of it, and brought it to such a condition that its speed was raised to something like a thousand impressions an hour. König, a native of Saxony, in 1815, produced a press for printing both sides of the sheet. It resembled two single presses placed with their cylinders toward each other, the sheet being carried by tapes from the first to the second cylinder. Its capacity was 750 sheets, both sides, an hour.

Cambridge University about this time was furnished with a press in which the types were placed on the four sides of a prism, the paper being applied by another prism. It proved unsuccessful. In this press, however, were first introduced the inking rollers formed of a combination of glue and molasses. Rollers are made of these two materials to this day.

Cowper, an Englishman, in 1815, introduced curved stereotyped plates and fixed them to a cylinder. Two place cylinders and two impression cylinders were soon afterward worked together on one press by Cowper, printing both sides of the sheet at the rate of one thousand copies an hour.

This seems to have been the period when inventive skill began to assert itself in the printing press. The educational advancement of the people in this country and in Europe, with the lack of facility for furnishing information of the campaigns of Napoleon Bonaparte, the desire for facts regarding the events transpiring in England, France, and Germany, the meagreness of the details which had been furnished of the conflict between Great Britain and the United States in 1812, convinced the publishers of newspapers in this country and abroad that the laws of supply and demand were not equally balanced. The outcome of this was a press constructed to print both sides of the sheet from type, and was soon followed by the introduction of four impression cylinders. These were applied to the reciprocating bed to carry the type for one side of the sheet, the sheets being fed from four feeding boards, the impression cylinders alternately rising and falling, so that two sheets were printed during the passage one way, the other two on the return passage. A pair of inking rollers between the impression cylinders obtained ink from the reciprocating board.

The capacity of this press was five thousand an hour, and this was regarded as a feat worthy of public mention, record of it being made in the newspapers of that period in a way which shows the general interest in the work.

The first power-press used in the United States was made by Daniel Treadwell, of Boston, in 1822. Two of them were used by the Bible and Tract societies.

The London "Times" had succeeded in applying steam to the movement of the printing press as early as 1814—a cylinder press being brought into requisition, to the use of which they had the exclusive right.

Following the Treadwell press, about 1825, came the improvements of Samuel and Isaac Adams, and the general use of the press which is still worked in the book offices of this country and Great Britain. It was on one of these Adams presses, in 1863, that was printed the book written by Dr. Elisha Kent Kane, describing his second expedition in search of Sir John Franklin, the Arctic explorer.

It was found that the Adams press could be used for newspaper as well as exceedingly fine book-work, its construction admitting of the use of plates or type, and its speed such as nearly came up to the requirements of that period. In this press a feed board holds the paper, which is fed by hand to a second board or tympan, having points to make holes in the sheet to regulate the second side. The type rests upon a bed which is raised by straightening a toggle-joint against the upper plates.

The fountain for the ink is carried at one end of the press. The inking rollers pass twice over the form. The paper is caught by grippers, carried in a frame called a frisket over the form (or type), receives the impression, and is carried by tapes to a fly frame in the rear which delivers it to the sheet board.

With the two-, three-, and four-cylinder presses, the Adams press, steam power and various improvements in the make of inks and rollers, the first half of the nineteenth century was looked upon as having made for the printing press extraordinarily rapid advancement. Great Britain held first place in the production of newspapers and books, the United States was a slow second, then came France, Germany, Russia, Italy, Spain, and Austria, in the order given. The greatest evidence of this march of improvement was the enormous increase in the production of the Bible, and the bringing of the cost to a figure which then was looked upon as placing it within the reach of all classes. Scientific and literary works were being put out in great numbers, newspapers were being started in every town in this country and England, and the editions put out in such European centres of advancement as Paris, Madrid, Berlin, Brussels, London, Liverpool, Dublin, Glasgow, St. Petersburg, Vienna, and Rome reached proportions then supposed to be enormous. The London "Times" at that period had a circulation of about 30,000,—and this was the leader in journalism. In the United States the leading newspapers did not issue daily editions greater than 20,000, while a circulation of

10,000 daily was regarded as being entirely satisfactory to the business ideas of the average publisher.

The opening of the last half of the nineteenth century may be spoken of as a quiescent period. It was the calm in the affairs of the United States which preceded the occurring of stormy events which put to the full test the strength of the young republic, the attitude of the nations of the old world toward us, and the power of the people successfully to maintain a government "of the people, for the people, and by the people."

Millard Fillmore became the President of the United States in July of 1850, succeeding Zachary Taylor, who died. The Congress had taken a stand on the disturbing question of slavery by the passage of the fugitive slave law, and had made the first step toward freedom for the negroes by the abolition of the slave trade in the District of Columbia. It was in this year that New Mexico and Utah were admitted as Territories, the entire population of the United States being only 23,191,876; ten years later the population reached 31,443,321. The people were beginning to realize how important was the printing press in placing them in communication with the statesmen of the country. They were looking to Webster, Calhoun, Clay, Meredith, Everett, Scott, Crittenden, Collamer, Marcy,—then in the fullness of mental vigor,—and they were demanding information of their acts in the cabinet, their speeches in Congress, their views on state rights and slavery.

It was at this time that the Hoe American Printing-press Company startled the world by producing the ten-cylinder press, the speed of which was limited only by the ability of the feeders to supply the sheets. The first one of them to be used in the United States was that upon which the Philadelphia "Public Ledger" was printed. It at once came into general use in Europe and America. Its speed was 20,000 copies an hour.

In this press—still in use in many cities—the form of type is placed on the surface of a horizontal revolving cylinder of about four and a half feet in diameter. The form occupies a segment of only about one fourth of the surface of the cylinder, and the remainder is used as an ink-distributing surface. Around this main cylinder, and parallel with it, are smaller impression-cylinders. The large cylinder being put in motion, the form of types is carried successively to all the impression-cylinders, at each of which a sheet is introduced, and receives the impression of the type as the form passes. One person supplies the sheets of paper to each cylinder. After being printed they are carried out by tapes and laid upon heaps by means of self-acting flyers. The ink is contained in a fountain placed beneath the main cylinder, and is conveyed by means of distributing rollers to the distributing surface on the main cylinder. The surface being lower, or less in diameter than the form of types, passes by the impression-cylinder without touching. For each impression there are two inking rollers, which receive their supply of ink from the distributing surface of the main cylinder; they rise and ink the form as it passes under them, after which they again fall to the distributing surface. Each page of the paper is locked up on a detached segment of the larger cylinder, which constitutes its bed and chases, termed the "turtle." The column-rules run parallel with the shaft of the cylinder, and consequently are straight, while head, advertising, and dash rules are in the form of segments of a circle. The column-rules are in the form of a wedge, with the thin part directed toward the axis of the cylinder, so as to bind the type securely. These wedge-shaped column-rules are held down to the bed by tongues projecting at intervals along their length, which slide in rebated grooves cut crosswise in the face of the bed. The spaces in the grooves between the rules are accurately fitted with sliding blocks of metal, even with the surface of the bed, the ends of which blocks are cut away underneath to receive a projection on the sides of the tongues of the column-rules. The form of type is locked up in the bed by means of screws at the foot and sides, by which the type is held as securely as in the ordinary manner upon a flat bed.

This press was regarded as the highest degree of perfection, until William A. Bullock, of Philadelphia, put out his web perfecting press. This completely revolutionized the printing business so far as the newspapers were concerned. It came into use in 1861,—just before the breaking out of the war of the rebellion in the United States,—in time to meet the enormous demands made upon the printing press at home and abroad. It had been in operation but a short time when the newspaper owners of Great Britain took hold of it, and for several years no other press was used by the newspapers of large circulation.

How slow and toy-like it seems in comparison with the monsters of the present day! And yet this machine met the demands of a period when it was supposed the circulation of the daily press had reached an altitude never to be surpassed. A newspaper like the New York "Herald," which had attained a daily circulation of about 75,000, was looked upon as achieving the highest degree of success. In this last year of the nineteenth century the "Journal" and "World" of New York send out at least a million copies of their papers 365 days in the year.

William A. Bullock worked at his web printing press for six years before he had it in shape to pronounce it applicable to the requirements. It was not long after it was in successful operation that one of his limbs caught in the machinery of one of his presses, and death was the result. As the presses first were made, and indeed for many years thereafter, the paper was cut in the press before being printed, and it was a difficult matter properly to control these single sheets until they were delivered, while the presses were without any folding attachment. But these old style Bullock presses did succeed in turning out 6000 eight-page papers an hour, printed on both sides.

In 1873 a great improvement was made in the Bullock presses, which allowed of the papers being printed on the endless roll before the paper was cut.

With the aid of other improvements subsequently made these presses attained to a capacity of 16,000 eight-page papers an hour. But an unexpected limit was found in the impossibility of delivering beyond a certain rate from the fly. Then R. Hoe & Co. (about 1877) invented a contrivance which obviated the difficulty. It consisted of an accumulating cylinder, on which six or eight sheets were laid one above the other and then delivered from the fly at one motion. This increased the capacity of their perfecting press to 18,000 an hour. A folding attachment was then added; next a pasting and cutting attachment. Thus, in 1879 they were able to turn out a press which produced 30,000 perfect eight-page papers an hour—printed, cut, pasted, and folded.

The next great achievement was put in operation in a New York pressroom in 1885. That was the double supplement press, which in reality combines two presses in one. It was the first press to insert supplement sheets automatically, and it was the first press to print from two rolls of paper, one roll being placed at right angles to the main roll. As the name of the press implies, from the secondary roll the supplements are printed at the same time that the main part of the paper is being printed from the other roll. And by means of what to the ordinary man seems a miraculous contrivance, but which to the initiated in the mysteries of mechanics is no doubt very simple, the supplement is automatically inset and pasted into the main paper before reaching the fly, and dropped out folded ready for the newsdealer.

From this press has been evolved the superb printing machine which, in recent years, has astonished the world. On it can be printed eight-, ten-, or twelve-page papers at a running speed of 24,000 an hour, or 400 a minute, and whether eight, ten, or twelve pages are printed they all come out with the supplements inset and the paper pasted and folded. From this press was developed the next triumph, the quadruple press. Marvelous machines these quadruple presses are, and it seemed impossible that any press could be built for many years to come that would beat them.

The printing business stood amazed, awe-stricken at the sight of so many papers being turned out each hour. And before the amazement had subsided there came forth the machine which is destined to go down in history as one of the great achievements in mechanics of the nineteenth century,—the sextuple press, manufactured by Hoe & Co., which has brought forth as many wonderful improvements as any mechanical concern in the world.

Although it is impossible to explain in language comprehensible to the man who is not an engineer how this monarch among printing presses does its work at a rate of speed which is well-nigh incredible and outstrips the flight of imagination itself, yet it is possible to convey an idea of what the extent of the work is.

This machine will print, fold, paste, and deliver 90,000 of a four-page paper or six-page newspaper in one hour. It will require some figuring to convey an adequate idea of how fast that is, for, as a matter of fact, it is faster than a man can think, and that is why I say that the speed of the machine outstrips the flight of imagination.

Ninety thousand copies an hour is equivalent to fifteen hundred copies a minute, and fifteen hundred copies a minute means twenty-five copies per second!

Now take out your watch, and while the second hand is passing from one second to another try to grasp the idea that in all that brief interval of time twenty-five six-page newspapers have been printed. You can’t do it. It is faster than you can think.

And yet in that second those twenty-five papers are not only printed, but the inside sheets are automatically pasted in, and the twenty-five papers are all cut and folded ready for delivery to the newsdealers. Is there anything more marvelous than that recorded in the “Arabian Nights”? Who said that there are no miracles in this nineteenth century? Why, if old Gutenberg,—peace to his soul,—or Faust, or Caxton, or even our own Benjamin Franklin had seen anything of the sort, they would have sworn that it was either a miracle or the work of the supernatural, with the chances in favor of the latter.

Each page of the average newspaper has six columns, and in each column there is on an average 1800 words. Six multiplied by six and the product of that by twenty-five, and that again by 1800, you will find makes 1,620,000, which is just about the number of words that this press prints in a second when it is turning out six-page papers at the rate of twenty-five a second. That is something that will stagger any man’s imagination if he tries to realize what it is.

This press will print, cut, paste, fold, count, and deliver 72,000 copies of an eight-page newspaper in one hour, which is equivalent to 1200 a minute and 20 a second.

It will print, cut, paste, count, and deliver complete 48,000 copies of a ten- or twelve-page newspaper in one hour, which is equivalent to 800 a minute and a fraction over 13 a second.

It will print, cut, paste, fold, count, and deliver complete 36,000 copies of a sixteen-page newspaper an hour, which is at the rate of 600 a minute, or 10 a second.

It will print, cut, paste, fold, count, and deliver complete 24,000 copies of a fourteen-, twenty-, or twenty-four-page newspaper an hour, which is at the rate of 400 a minute, or very nearly seven a second.

This is lightning work with a vengeance, and yet it is possible that there may be some who read this who will live to call it slow. That will probably be when they have found out all about how to put a harness on electricity. No one can predict when inventive genius will reach its limits in the printing press. Before this press was built, the fastest presses in the world were Hoe's quadruple presses, which will turn out 48,000 four-, six-, or eight-page papers an hour, 24,000 ten-, twelve-, fourteen-, or sixteen-page papers an hour, and 12,000 twenty- or twenty-four page papers an hour, all cut, pasted, and folded.

The sextuple press has a well-nigh insatiable appetite for white paper. To satisfy it it is fed from three rolls at the same time, one roll being attached at either end of the press, and the third suspended near the centre. It is the only press which has ever been able to accomplish that feat. Each roll is sixty-three inches wide. When doing its best this press will consume 25-7/8 miles of 63-inch wide white paper in one hour, and eject it at the two deliveries, each copy containing an epitome of the news of the world for the preceding twenty-four hours, and each copy cut, pasted, and folded ready for delivery. It is a sight worth seeing to see it done, and in its way it is just as impressive as Niagara.

A man turns a lever, shafts and cylinders begin to revolve, the whirring noise sets into a steady roar, you see three streams of white paper pouring into the machine from the three huge rolls, and you pass around to the other side and—it is literally snowing newspapers at each end of the two delivery outlets. So fast does one paper follow the other that you catch only a momentary glitter from the deft steel fingers which seize the papers and cast them out.

The machine weighs about fifty-eight tons. It is massive and strong, with the strength of a thousand giants. And yet, though its arms are of steel and its motions are all as rapid as lightning, its touch is as tender as that of a woman when she caresses her babe. How else does the machine avoid tearing the paper? Paper tears very readily, as you often ascertain accidentally when turning over the pages. Truly wonderful it is, and mysterious to anybody but an expert, how this huge machine can make newspapers at the rate of twenty-five a second without rending the paper all to shreds.

It has six plate cylinders, each cylinder carrying eight stereotype plates, and six impression-cylinders. These cylinders, when the press is working at full speed, make two hundred revolutions a minute. The period of contact between the paper and the plate cylinders is therefore inconceivably brief, and how in that fractional space of time a perfect impression is made even to the reproduction of the finest, is one of those things which, to the man who is not "up" in mechanics, must forever remain a mystery.

A double folder forms part of the machine. A single folder would not be equal to the task imposed on it. As it is, this double folder has to exercise such celerity to keep up with the streams of printed paper which descend upon it that its operations are too quick for the eye to follow.

The press has two delivery outlets. At each the papers are automatically counted in piles of fifty. No matter how rapidly the papers come out, there is never a mistake in the count. It is as sure as fate. By an ingenious contrivance—if I should try to describe it more definitely most people would be none the wiser—each fiftieth paper is shoved out an inch beyond the others which have been dropped on to the receiving tapes, thus serving as a sort of tally mark.

Truly it is a marvelous machine—this sextuple press. Nowhere you will find a more perfect adaptation of means to ends, nowhere in any branch of industry a piece of mechanism which offers a finer example of what human skill and ingenuity is capable of. And it is free from that reproach which is sometimes brought against the greatest triumphs of inventive genius in other departments of human activity,—that they make mere automatons out of human beings.

There was recently manufactured by the Hoe Company for a New York paper an addition to this wonderful piece of machinery designated an octuple press. Running at full speed it will print, paste, cut, fold, and count 96,000 eight-page papers an hour. It is nearly 14 feet high, and 25 feet long. Ten men are required to operate it. The cylinders revolve 200 times in every 60 seconds.

This monster is divided into two working parts. The printing is done on the half of the machine to the right. The paper passes over the cylinders there, where it is printed from the stereotype plates, and then runs through the other half of the machine on the left, where it is cut, inserted, pasted, delivered, and counted from four outlets folding in half-page size.

This press shows four distinct double printing machines, each fed by its own roll of paper. The paper from each roll passes against two sets of stereotype plate cylinders—one for each side of the printed sheet. The machine is so perfectly adjusted that by simply turning a screw and moving a gear a few inches each of the four sets of cylinders can be thrown out of operation; that is to say one quarter, one half, three quarters, or the whole press can be operated at will.

The folder is harmonized for each adjustment of the printing cylinder. The folding of the papers has been brought to the highest state of perfection. The sheets are folded, cut, and delivered by a rotary motion at a speed that could never have been attained with the reciprocating arms, such as were used prior to the Hoe inventions.

When a sixteen-page paper is being printed it comes in four-ply thickness, and then doubles and shoots eight thicknesses under the knife.

When a twenty-four-page paper is being printed it passes over the longitudinal folder in six-ply thickness and passes under the knife in twelve thicknesses. All this is attained without the use of guiding tapes. In fact, the speed could not be attained with them.

As the papers are folded and delivered from the four outlets, with a speed too great for the eye to follow, the machine itself counts them in total and in bundles, as is done on the sextuple press. This monster octuple machine has a perfected system of ink distribution with which no other presses are equipped. Under the system results are obtained by decreasing the size and increasing the number of ink-rollers around each cylinder of plates.

The arrangement of the type cylinders is such as to make the press one that can be handled with great ease and rapidity. Along the right hand of the machine, between the two rows of cylinders, is an open passageway. It is large enough for men to pass through either from the ground or from the gallery near the latitudinal centre of the press.

From this open passageway the pressmen are able to watch every movement of the machine's interior working, and from it they are able to make quick changes on the plate cylinders. The change in position of only two ink-rollers is necessary to change a plate on any cylinder. This is a matter of great importance to a paper which prints many editions, for it is necessary to change plates so often and to economize every minute of time in order to catch the fast mails which carry the paper to all quarters of the earth.

On the octuple presses each roll of paper is guarded against breakage. There is a device in the shape of a short endless belt of rubber which passes over two pulleys and rests on top of the roll of paper. The paper is then pulled from the roll as gently as the thread is pulled from the spool of a sewing machine. The belt pushes the roll along at a speed equal to and sometimes a little greater than that of the stereotype cylinders. Hence, all tension is removed from the paper.

From the stereotyper’s department, where they have been made in a few minutes, come the plates of curved, bright metal. Passed to the pressmen, they are locked on the cylinders as fast as they can be handled. The rolls of paper have been placed in their proper positions.

This accomplished, the men step back from the machine, the brakeman pulls the lever, and the giant press begins its work. Slowly its cylinders revolve at first, but as headway is gained the rumble that accompanied the start increases into a shrill shriek as the limit of speed is reached.

The paper rushes from its continuous rolls, is printed, folded, cut, and thrown out from the four outlets at a speed that would be over twice greater than that of any express train if it were confined to one roll. Every paper is just like every other one, perfect in every detail.

When this has gone on for an hour, two hours, or however long it may take to run off the editions, the monster press can be stopped in an instant. With the simple touching of a lever all its movement will cease before the cylinders can revolve five times, and they had been revolving two hundred times a minute before.

The two wonders just described are confined to newspaper work. This same American firm has produced presses upon which are printed the fine specimens of magazines where the work takes a striking resemblance to lithograph printing. They have a speed of 8000 an hour. From them come booklets of 16, 20, or 24 pages. From the presses of 4000 an hour come books of 32, 40, and 48 pages. In construction they are complicated and grand.

Then come the presses upon which are printed different colors. These are made in England and the United States, and are used with satisfactory results on prominent publications in both countries. A recent issue of the “British and Colonial Printer” directs attention to this advance in mechanism through the medium of the Hoe art rotary form feeder. It says:—

“This machine carries the mind back naturally to pre-rotary days, when the Hoe multi-feeder held the field as the newspaper machine, to the days of the heavy, and as we consider in these advanced days, clumsy turtle. When the creative genius of Colonel Hoe evolved the rotary press, the multi-feeder was almost at once relegated to the lumber room of obsolete mechanics. It is hardly conceivable that it entered the mind of any practical man at this time that the principle of multi-fed flat sheet printing would ever be adapted to the production of high art illustrated literature, at a speed equal, or nearly so, to the former Hoe news machine. It has, at all events in our country, long been a settled opinion that such work could only be successfully accomplished upon a flat-bed machine, that the mere curvature of a plate must destroy the beauty of a fine process block for example, and that any attempt to travel at a greater speed than 1200 to 1500 an hour must be at the sacrifice of depth and sufficiency of rolling. Whether this is really so readers will now be able to form their own opinion from the pages of the ‘Strand Magazine.’ Those pages abound in very varied methods of engraving, woodcut and process, line and nature, and reproductions alike from photos and from wash and crayon drawings. Every page has undergone the process of electrotyping, cast straight and curved subsequently, and therefore the conditions of printing at the high speed of 4000 (or to be strictly accurate, four sheets of 16 pages each put through at the rate of 950 each, or 3800 per hour) are as severe as could be desired.

“The British printer has yet to acquire a full mastery of its capabilities, and the engineer has equally before him in some degree a period of development. Some of the portraiture, human and animal, is equal to anything seen. The make-ready (upon hard packing) exhibits the highest quality, and the distribution of color perfection. The plate-cylinder is made as large as the desired speed renders practicable, in order that the curvature of the plates may be reduced to a minimum. The provision for securing adequate distribution and in-rolling is upon a liberal scale, but not one whit more so than is requisite, extent of surface and speed of running considered. There are 16 inkers and 38 distributors, with 16 iron distribution cylinders. The sheets are fed in two at either side of the machine, those from the right hand feeders being delivered upon the table at the extreme left, the other upon the inner delivery board. The plates are rigidly secured by special clutches. To facilitate the imposition of the plates, or any attention required by the cylinder, the short rear portion of the machine back of the cylinder is detachable and can be run out upon an extended base, and then closed up and put into gear again. This renders it perfectly accessible at the most essential point. The sheets are of course printed on one side only. We have not yet attained to the perfecting stage in art work in combination with high speed; the introduction of the Hoe art rotary press, however, marks a distinct epoch in this class of printing in Great Britain. Color printing-presses are in use in the newspaper and magazine offices in this country, and from them are produced the artistic as well as the lurid styles of art."

What the possibilities of the printing press are, looking at the degree of excellence at present attained, it is difficult to predict. It would seem as if the height of perfection now had been reached. The probability is that the printer at the end of the first quarter of the twentieth century may look with something akin to contempt upon the machines which now are regarded with so much pride.

Such a thing is possible in this age of invention.

II. THE SETTING OF TYPE.

In the beginning of the nineteenth century, when the little metal pieces of type were picked up one at a time and placed in the composing "stick" by hand, there was attached to the work an importance which elevated it almost to the ranks of the trained professions. In England, as late as 1817, compositors arrogated to themselves the dignity of carrying swords. At the close of the nineteenth century, the art is seen to be passing into the sphere of mechanics,—the methods in vogue making it entirely a mechanical operation. Before many years of the twentieth century have passed, there will have been attained a degree of advancement which will dispense with the hand of man in guiding the movements of the machine. The inventive skill which brought the printing press to such a high point of excellence and speed has been turned toward the work of type-composing, and the forward march is likely to be as rapid.

Outside of the actual learned professions, no occupation has contributed so many prominent figures to the history and progress of this country as the composing-room. They have filled important places in journalism, politics, Congress, state legislatures, the army and navy, and the world of literature.

Horace Greeley, the founder of the New York "Tribune,"—writer, statesman, and man of affairs,—is one of the notable figures of the present century, who laid the foundation of his career at a case of type.

Schuyler Colfax, who became Vice-President of the United States in 1869, passed the early years of his life setting type.

And, strange to say, these two men, when the presidential chair seemed a possible realization of their ambition, were opposed by men of their craft simply because they had seemed to run so far above the "stick" and "rule."

Simon Cameron, of Pennsylvania, once Secretary of War, United States senator, representative of the United States abroad, and for many years political master of his great

State, was proud to say that he had begun his career as a type-setter in a country printing-office. It is worth while noticing that this printer-politician’s life covered nearly a century of existence. His life spanned every president from John Adams in 1799 to Benjamin Harrison in 1889, while his active political control of Pennsylvania covered a period of sixty-five years,—a record made by only one man within the history of the United States.

Every state in the Union has contributed to history its quota of printer-statesmen, printer-authors, and printer-journalists. How many of such there have been in this nineteenth century would be beyond ordinary research to ascertain. But printers—compositors—can refer with just pride to the fact that in all the advanced walks of life are to be found men who have been members of the guild.

The setting of type by hand prevailed universally until as late as 1880. That may be put down as the period when there came into anything like general use the machines for type composition, although experiments in that direction had been going on for sixty years.

As early as 1820, printers realized that machinery eventually must be brought into play for composing type. But how to do it was the scientific as well as mechanical problem. It was argued that the machine must be so constructed as to pick up the type, uniformly distribute the space between the words, and “justify” the lines, that is, make them the exact width.

“It is beyond the range of possibility,” suggested the printer. “Mechanism never can be applied to art. The great Benjamin Franklin would have discovered the way to make such a thing possible, if it were possible—which is impossible.”

And the scientific electric discovery made by Benjamin Franklin in the eighteenth century is, at the close of the nineteenth, the motive-power used for driving the machines for type composition,—the seemingly impossible has reached the stage of possibility.

Dr. William Church, of Connecticut, produced a machine looking to machine type-composition in 1820. It did not come into use, although he spent large sums of money on it, and devoted a vast amount of energy toward having it taken up both in this country and in England. At the Paris Exhibition in 1835 there were exhibited several machines of this sort, one of which—the patent of Christian Sörensen, of Copenhagen—was used upon a daily paper issued during the exhibition. In 1871, at the International Exhibition in London, there was shown a machine possessing peculiar features. It used a perforated ribbon, through the medium of which types were worked into position. The machine was cumbersome, complicated, and expensive, and could not be brought into anything like general usage. In 1875 M. Delcambre, of Paris, after twenty years’ work produced a machine in New York. It had the same objections as the others. While this machine could do as much as the labor of three men by hand, it required a man to operate, another man to place the set type in lines, steam to keep it in motion, and a big cost to construct.

Up to this period, all the experiments had shown the want of something which would obviate the presence of a man to make the lines of the proper length and with equal spacing between the words. All the machines which were anything near available picked up and placed in position separate types. At the Centennial Exhibition of 1876, in Philadelphia, there were shown machines which used brass dies and cast a line of type. These seemed to possess the element for successful use, and the outcome was the production of the machine which is now in use in all the big newspaper offices in this country—the “Mergenthaler Linotype.” Practically it has driven all the other machines out of use, but how long it will hold sway is a question. Already men of genius are experimenting with two objects in view,—increase of speed, decrease of cost,—and it is fair to presume that before the twentieth century has gone very far into history these two objects will have been attained.

The linotype, as here shown, has the appearance of a heavy and cumbersome piece of machinery. It actually is so only when there are several of them placed in line—then they give to a composing-room the appearance of a machine shop. This machine, instead of producing single type of the ordinary character, casts type-metal bars or slugs, each complete in one piece, and having on the upper edge, properly justified, the type characters to print a line.

These slugs present the appearance of composed lines of type, and serve the same purpose, and for this reason are called "linotypes." The linotypes are produced and assembled automatically in a galley, side by side, in proper order, so that they constitute a "form," answering the same purposes and used in the same manner as the ordinary "forms" consisting of single types.

After being used, the linotypes instead of being, like type forms, distributed, are thrown into a metal pot of the machine to be recast into new forms.

The machine contains, as its fundamental elements, several hundred brass matrices. Each matrix consists of a flat plate having in one edge a female letter, or matrix proper, and in the upper end a series of teeth, which are used for distributing to their proper places in the magazine matrices containing different letters. There are in the machine a number of matrices of each letter, and also matrices representing special characters, and spaces or quads of definite thickness for use in tabular and other work of a complicated nature.

The machine is so organized that on manipulating the finger-keys it will select matrices in the order in which their characters are to appear in print, and assemble them side by side with wedge-shaped spaces at suitable points in the line.

This composed line forms a line matrix, or in other words a line of female type, adapted to produce a line of raised printing type on a slug, which may be forced into or against the matrix characters. After the matrix line is composed it is automatically transferred to the face of the mold, into which molten metal is delivered to produce the slug or linotype, after which the matrices are distributed or returned to the magazine to be again composed in new relations for succeeding lines.

These operations are performed by mechanism, as shown in the outline here presented.

A is an inclined fixed magazine, containing channels in which the assorted matrices are stored, and through which they slide, entering at the top and escaping at the foot, one at a time. Each channel is provided at the lower end with an escapement device, *B*, connected by a rod, *C*, with a finger character of the matrices in the corresponding channel. There is a key for each character, and also keys for quads stored in the magazine. The keys are actuated by the operator in the order in which their letters are to appear in print. As a key is depressed, it operates the corresponding escapement, *B*, which allows a matrix to fall out of the magazine through one of the channels, *E*, to the inclined traveling belt, *F*, which serves to carry the matrices down in succession into the assembler stick, *G*, in which they are stored side by side. A box, *H*, contains a number of elongated spaces, *I*, and a discharging device connecting with a finger-key bar, *J*, by which the spaces are permitted to fall into the line of matrices at the proper points during composition. It will be perceived that the operation of the various keys results in the selection of the matrices and spaces, and their collection in assembler, *G*, until it contains all the characters to be represented by one line of print. After the matrix line is thus composed it is transferred, as indicated by the dotted lines, to the front of a mold or slot extending through a mold wheel, *K*, from front to rear. This mold is of the exact size and shape of the slug required. The matrix line is pressed tightly against, and closed in front of, the mold for the time being, and the characters, or matrices proper, face the mold cell or space. While the line is in place in front of the mold, the wedge spaces are pushed up through the line, and in this manner exact and instantaneous “justification” is secured. Behind the mold there is a melting pot, *M*, heated by a flame from a gas burner, and containing a quantity of molten metal. The pot has a perforated mouth arranged to fit against and close the rear side of the mold, and contains a jump plunger, mechanically actuated.

After the matrix line is in place, the plunger falls and forces metal through the pot mouth into the mold, against and into the characters of the matrix line. The metal instantly solidifies in the mold, forming the slug or linotype, having on its edge raised type characters formed by the matrices. The mold wheel next makes a partial revolution, turning the mold from the original horizontal to a vertical position in front of the ejector, which then advances from the rear through the mold, pushing the slug out of the latter into the receiving galley, at the front.

A vibrating arm advances the slugs laterally in the galley, and thus assembles them side by side in column or page-form ready for use. In order to insure absolute accuracy in the height and thickness of the slugs, knives are arranged to act upon them during their course to the galley.

After the matrices in the line have served their purpose in front of the mold, they are returned to the magazine to be again discharged and used in the following manner. The line is lifted from the mold and shifted laterally until the teeth at the top engage the teeth of bar, *R*. This bar then rises as shown by dotted lines, lifting the matrices to the distributor at the top of the machine, but leaving the spaces, *I*, behind to be shifted laterally to the magazine or holder, *H*, from which they were discharged. Each matrix has distributor teeth in its top, arranged in a special order or number, according to the character it contains. In other words, a matrix containing any given character differs in the number or relation of its teeth from a matrix containing any other character. This difference is relied upon to secure proper distribution. A distributor-bar, *T*, in a single piece, is fixed horizontally over the upper end of the magazine, and is formed with longitudinal ribs or teeth, adapted to engage the teeth of the matrices and hold the latter in suspension as they are carried along the bar over the mouths or entrances of the channels.

The teeth of the bar are cut away to vary their number or arrangement at different points in its length, so that there is a special arrangement over the mouth of each channel. The matrices are pushed upon the bar at the end, and made to slide slowly along it while suspended therefrom. Each matrix remains in engagement, and travels over the mouth of the channels, until it arrives at the required point, where, for the first time, its teeth bear such relation to those of the bar that it is permitted to disengage and fall into its channel.

The travel of the matrices is secured by longitudinal screws, which lie below the bar in position to engage the edges of the matrices. The matrices pursue a circulatory course through the machine, starting from the bottom of the magazine and passing thence to the line being composed, thence to the mold, and finally back to the top of the magazine. This circulation permits the operations of composing one line, casting a second, and distributing a third, to be carried on concurrently, and enables the machine to run at a speed exceeding that at which any operator can finger the keys.

One half horse power is generally used in driving a machine. About five square feet is the space occupied by the machine; it weighs 1925 pounds, and consumes about fifteen feet of illuminating gas each hour to heat the metal pot. Each machine will do complete work equal to that of five men by hand. The simplicity of the machine bears a striking resemblance to the typewriter, and this is operated successfully by young girls. When the matter set by the machine is placed together, the page presents a surface equal to an entire new set of type, or, as the printers say, "We take on an entire new dress every day."

That is a production of the nineteenth century. How commonplace it will appear when the achievements of the twentieth century are placed on record.

III. EVENTS AS THEY OCCUR.

When the nineteenth century opened, great events were occurring in the world. Napoleon Bonaparte was the central figure in the eye of Europe. He had, but a few years previously (1797), gone through the most brilliant campaign known. He had crossed the Alps, defeated the Austrians at Montenotte and Millesimo, defeated the Sardinians at Ceva and Mondovi, and conquered Lombardy,—all in a few weeks. The year following he had conquered Egypt, and in 1800 had become the first consul and the ruler of France, to be declared Emperor four years later.

Then followed, in rapid succession, the events which caused the world to look upon Napoleon as the probable coming ruler of the universe. It was in 1805 that he began the war of aggrandizement. He crossed the Rhine, compelling the Austrian army to surrender at Ulm; he entered Vienna and routed the Russian and Austrian armies at Austerlitz. This was followed by his move to make himself master of Southern and Central Europe. He established his brother Joseph as King of Naples; his brother Louis as King of Holland; his stepson Eugene as Viceroy of Italy; and his brother-in-law, Joachim Murat, as Grand Duke of Berg. The following year he defeated the Prussians and entered Berlin.

It was not until his abdication at Fontainebleau, in 1814, that Europe and America breathed freely. His final overthrow at Waterloo in 1815 removed him from the stage as an active participant in the world's history of the nineteenth century.

In the United States, the close of the eighteenth century was marked by the death of Washington, while 1800, 1801, 1802 saw us make a treaty of peace with France, remove the national capital from Philadelphia to Washington, D. C., declare war against Tripoli, purchase Louisiana from France, and enter upon the disputes with Great Britain which culminated in a declaration of war with the mother country, in June of 1812.

While these events at home and abroad were making history, long periods of time elapsed between their occurrence and their being given to the people. There was no telegraphic communication which flashed messages around the globe. It was a wait until the mails brought the news. Two months, probably, elapsed after the battle of Waterloo ere this country was furnished with the story which meant so much to the peace of Europe.

What a change in this respect was wrought between the downfall of Napoleon Bonaparte in 1815 and the downfall of his nephew, Louis Napoleon, in 1870! On the fateful second of September, 1870, when the Emperor of France, Napoleon III., surrendered to the Emperor William of Prussia, on the field of Sedan, the news was flashed to America in less than two hours. On that hot, sultry day eager crowds surrounded the bulletin boards of the newspapers, on which were displayed the facts connected with the overthrow of the Napoleonic dynasty. The difference in time made it possible for us here to know all that had been done by the two emperors and by Bismarck an hour ahead of their actual happening. For days before that the crowds had surged around the newspaper offices, for days afterward they did the same, and facts were given with a rapidity which showed how wonderful had been the scientific stride between 1815 and 1870.

Had any one in 1815 predicted the possibility of such scenes, he would have been put down as a fit subject for a writ of *de lunatico inquirendo*. Such, too, would have been the comment on the one who then would have suggested the likelihood of a newspaper in this country reaching a circulation of a million copies daily,—and yet such has become an accomplished fact.

At the close of the first quarter of the nineteenth century there had been no practical advance in the rapid transmission of news. This was the period when the press lacked the facility to rapidly furnish the people with the events which were occurring in all directions. Newspapers still depended upon the mails. Home events were many weeks reaching sections remote from their happening. In this respect there had been some little improvement at the close of the first half of the century. That was the time when the electrical current was being brought into operation in the transmission of signals from which messages were being recorded, and these were being utilized for the sending of information at short distances. Scientific men were even talking of the possibility of connecting distant points on the coast, and whispering their hope for an Atlantic cable. In 1858 that wonderful event came to pass. The old world and the new were connected by cable from Valencia Bay, in Ireland, to Newfoundland, in North America, and messages of greeting passed between Queen Victoria and President Buchanan. The break which followed soon after the opening of this cable stimulated men of genius and men of capital to further efforts, and the governments of the United States and Great Britain came forward with generous aid. The laying of the Atlantic cable by the Great Eastern in 1864, and its successful operation in 1866, opened the doors for the possibilities of the press of to-day, and the realization of such scenes as were witnessed in this country on September 2, 1870.

Between that memorable year, 1866, and this, 1899, how wonderful has been the advance in the transmission of information from all quarters of the globe. From the Transvaal Republic, in South Africa; from the desert home of the Dervish in the Soudan; from the domain of Turkey’s Sultan, in Armenia; from the Holy Land; from the Oriental empires of China and Japan; from the snow-clad land of the Czar in Siberia; from the Bosphorus to the English Channel; from Valencia across the Atlantic; from Victoria Land in North America to Patagonia in South America; from Maine to Mexico; from the Atlantic to the Pacific; there are each day transmitted all occurrences of interest transpiring,—and these encompass peace and war, joy and sorrow, science and art, education and trade,—events which arouse the passions and quicken the pulse of humanity.

This is done through the medium of an organization known as the Associated Press. This wonderful combination has nearly forty thousand miles of wire from the different telegraph companies, for which there is paid a fixed price per mile. This, however, does not include its cable service, the charges for which are according to the number of words transmitted. The service of this organization costs a million and a half a year, divided among several hundred of the great newspapers of the United States. During the recent conflict between Spain and the United States its expenditure for war news alone was nearly $500,000. This can readily be understood when the reader is informed that the cable rate from Manila was $2.37 a word. Thus, a dispatch filling less than a quarter of a column of the average daily paper cost $1000. The rate from Porto Rico, at the outbreak of hostilities, was $1.90 a word, and it often happened that a single dispatch covering the movements of a body of troops in that island, with possibly a pen picture of a skirmish with the Spaniards, would cost $2000 in gold. The Santiago toll was $1.10 a word; and whole pages of newspapers were printed at that rate.

What a gigantic institution it has become for the rapid dissemination of news events!

In that war between Spain and the United States, General Toral, the Spanish commander, surrendered Santiago on July 14, at 2.15 o’clock in the afternoon. At 2.25 o’clock the message announcing the fact was received in Philadelphia. On the 12th of August following, at 4.23 o'clock in the afternoon, the Peace Protocol was signed in Washington by the French Ambassador Cambon and Secretary of State Day, and at 4.27 o'clock—four minutes later—the information was in the New York office of the Associated Press. Hundreds of such instances of this rapid transmission of news could be recorded in this last year of the nineteenth century,—facts never even dreamed of when Benjamin Franklin chained the electric current in the closing years of the eighteenth century.

The journey of a piece of news from the far East to the far West is something worth noting. The trip covers thousands of miles out of a direct route. As for instance, when Admiral Dewey annihilated the Spanish fleet in the Bay of Manila, on May 1, 1898, the fact was cabled to Hong Kong, China. There an operator transmitted it northward to Helampo in Russia, right on the border line of Manchooria, from which place it was sent across Russia to Tomsk, thence to St. Petersburg. From the Russian capital it zigzagged to Berne, in Switzerland; thence to Paris; thence across the channel to Penzance, and finally to Valencia, to be put on the cable for America. In two hours from the time the operator in Hong Kong started his dispatch, it was being hurried across the American continent—north, west, east, south—for distribution in the newspaper offices.

When a party of Mohammedans attacked a Christian mission in Calcutta, a telegraph operator dispatched the news to Bombay, whence it was transmitted to Aden. The next point reached was Suez, from which it was sent to Malta. It was next sent to Lisbon. From there it was given to Paris. From Malta it was also cabled to Penzance, thence to Valencia, and finally to the United States.

When that Manila piece of news from Admiral Dewey reached the Pacific coast in the United States, the date of its being started was yet several hours behind the time of its arrival. The attack on the Spanish fleet was made on Sunday, May 1, Manila time. The fact was not sent out by Dewey until the following morning, May 2 (still Manila time). It was started on its westward course that morning (May 2) at ten o'clock. By the route taken to Valencia with the relays, two hours were consumed. This brought it to London about three o'clock on that morning of May 2, owing to the difference in time. Traveling westward across the Atlantic ocean in advance of the sun, it reached New York about ten o'clock in the night of May 1. But little time was lost in retransmission to the Pacific coast, which point it reached about six o'clock on that Sunday evening of May 1—fourteen hours previous, by the day of the month, to its being started from Manila.

In this work of sending out news not a moment is lost that can be avoided. The aid of the typewriter enables the operator to keep pace with the sending operator, and his pace has been increased in the past few years by the introduction of a code system. Here is a specimen of the code system as used by the operator in sending out a news item:—

"Madrid, March 17—T Qn Regent h sined t Treaty of Peace btn Spn & t Uni Stas. T treaty wb frwded to t French Ambsdr, Jules Cambon, at Washn, fo exg w t one sined by Pr McKinley. No decree q sj wb pud d 'Official Gazette.'

"Ofl rlns btn t 2 govts wi nw b promtly rnud. Ix rmrd 5 Mir to t Uni Stas wb Snor. Don J. Brunetti, Duke d'Arcos, fmr Spnh Mir to Mex, wos wif is an Amn."

When this seemingly incomprehensible conglomeration of letters leaves the hand of the receiving operator it reads as follows:—

"Madrid, March 17—The Queen Regent has signed the Treaty of Peace between Spain and the United States. The treaty will be forwarded to the French Ambassador, Jules Cambon, at Washington, for exchange with the one signed by President McKinley. No decree on the subject will be published in the 'Official Gazette.'

“Official relations between the two governments will now be promptly renewed. It is rumored that the Minister to the United States will be Señor Don J. Brunetti, Duke d’Arcos, former Spanish Minister to Mexico, whose wife is an American.”

The London “Times” recently has been experimenting with a scheme whereby reporters in the Houses of Parliament operate the typesetting machines in the London office by the wire from their quarters in Parliament.

It is only a question of time when this practice comes into use in the reporting of all legislative proceedings.

In some of the New York newspaper offices, the receiving operator sits at a typesetting machine and puts into type the messages which come over the wires.

How rapidly we have advanced in this direction in the last half of the nineteenth century is thus shown. What will be done by our successors in the first half of the twentieth century, no man can at this time satisfactorily predict.

IV. TYPE-MAKING, STEREOTYPING, PICTURE-MAKING.

The manufacture of the small metal pieces called type has undergone little change in this nineteenth century. That which has been done has been in the way of producing artistic designs, so arranged that combinations can be formed pleasing to the eye, and an aid to rapid workmanship. The machinery in use has lost its crudity, the production has been increased, and the finish become more perfect. The setting of type by machinery has been a serious blow to this industry, and the time will come when it will be devoted entirely to the making of job or fancy types.

Benjamin Franklin attempted to make metal type in this country, but he did not succeed. It was not until 1796 that type-making was commenced here.

As in many other departures in the printing business, the city of Philadelphia took the lead. Binney and Ronaldson, of Edinburgh, Scotland, established the first foundry in this country, operating it in Philadelphia. After a severe struggle and with some aid from the State, a business was established by the two Scotchmen, which afterwards became known as the Johnson Foundry, under MacKellar, Smiths & Jordan, which is still in existence. They were followed by David Bruce, also a Scotchman, and by 1813 foundries had been established in New York and other large cities.

Since that time improvements have been introduced, but nothing has come forth which deserves to be ranked with the printing-press or the typesetting machine.

The type founder will tell you how much better are the machines used in 1899 than those which produced type in 1850. But he cannot point out any device connected with it which the mechanical world can designate as marvelous, or the people at large regard as a wonderful invention. Type once was rubbed into smoothness by boys. Now it is done automatically on the machine. By the hand process about four hundred types an hour were cast; by the present mechanism a speed of six thousand an hour has been acquired. Until about 1875, this output hardly met the demand; now it will do so. Before many years it will be far in excess of the requirements.

* * * * *

Stereotyping is the art of making plates cast in one piece of type metal from the surface of one or more pages of type. In the beginning of the nineteenth century, stereotyping was used to an exceedingly limited extent. The printers were prejudiced against it for reasons purely selfish. It was not until 1813 that it was introduced into the United States, and only a few years previously Lord Stanhope introduced it into the English printing business. “The Larger Catechism of the Westminster Assembly” professes on its title-page to have been the first work stereotyped in America. It bears the date of June, 1813. Now the process is in general use—plaster, clay, and papier mâché being used.

The process of stereotyping originally was to preserve the pages, so that an entire edition of a work could be finished without requiring large numbers of type, and to have it ready for future editions. For newspaper work it came into vogue to save the rapid wearing out of the type by the impressions made.

From the practical introduction of stereotyping in this country, in 1813, by Robert Bruce, until about 1850, the slow, tedious, and troublesome process of making the plates by plaster of Paris was in vogue. That was done by the plaster being poured over the face of the type. Molten lead was then run into the cast, after which the plate was finished. The time thus occupied caused the work to be confined to books, magazines, and weekly issues of small journals. When the plate was taken from the cast it was rough, imperfect, and unfit for use. Men, whose specialty was finishing, were employed to make the plate so as to meet the requirements of the printing press.

It was just at the opening of the last half of the nineteenth century that papier mâché began to be used in this country. A few years before that time it had been brought into use in London and Paris. Its introduction into the United States found the printing trade ready and willing to accept it, and but a few years passed before it came into general use by the newspapers. It is a peculiar combination. The paper matrix is formed by paste of starch, flour, alum, and water. This is spread over a thick paper, on which are placed layers of fine tissue paper. When ready for use, it is placed on the face of the type and a deep impression secured by being passed through a press. Then it goes into a steam chest to be dried, from there it is passed into the casting machine, the molten metal poured in, and a few minutes thereafter the plate is ready for the press. Up to a few years ago, the impression on papier mâché was secured by being beaten with brushes prepared for that use. The method had two disadvantages,—consumption of time and destruction of type. The press now used obviates these defects. The old way took about twenty minutes to produce a plate. Now it is done in from five to seven minutes. The machinery here introduced has been of benefit to the trade, but none of it ranks among the great inventions of the century.

The making of electrotype plates had its origin early in the century, when it was found that stereotype plates had a limit as to durability. Electroplating suggested to Josiah Adams, in 1839, the idea of a copper surface for the stereotype plate. It took ten years to bring it into practical use. His first successful work in this line was on the engravings and borders for a Bible issued in New York. It was found to be particularly adapted to engravings, producing a surface of sufficient smoothness to allow the pressman to make a print of exquisite fineness. The improvements introduced tended only toward the saving of time and the excellence of finish. Practically the same process is used now that was employed half a century ago. An impression of the type is made on wax, the electric current is secured by a deposit of fine graphite, the mold is placed in a bath containing a solution of sulphate of copper and is made part of the electric circuit, in which also is introduced a zinc element in a sulphuric acid solution. The current deposits a film of copper on the graphite surface of the mold. When it has assumed a sufficient thickness, it is taken from the bath, the wax is removed, and the copper shell trimmed. It is then backed with an alloy of type metal. The finishing process brings the plate to the proper thickness, after which it is blocked to the height required for printing. That is the process. To it in the last ten years there has been applied the use of steam machinery. In the old days the making of electrotypes required from ten to fifteen hours. They now are produced in from two to three hours.

* * * * *

The close of the nineteenth century witnesses the disappearance entirely from the printing establishment of the once generally used wood engraving. The rise and fall of this once splendid art is practically encompassed in the period of time covered by the nineteenth century. Thomas Bewick, an Englishman, gave wood engraving an artistic impetus by the production of illustrations for his “Histories of British Quadrupeds,” which appeared about 1790. Up to that period the work was crude. The books and magazines of the first decade of the century were illustrated in a way then regarded as highly artistic. The application of the Bewick method brought forth work which ranked in the line of high art. Of the development of this work volumes could be written. To simplify the situation it is only necessary to recall how these pictures were made. Squares of boxwood were used, on the face of which was spread a preparation of water-color Chinese white. On this surface the artist drew his picture, and then the engraver’s art was brought into requisition—the engraving being done alongside the pencil lines.

And here it was that the artistic instinct of the handler of the “graver” appeared,—the delicacy of touch being shown in the shading and in the finish of the lines. By this method there have been produced rare works of art, as can be seen by an examination of the books printed in the first half of the century.

The time taken in the making of the engravings, however, prevented the possibility of their being used by the newspapers and magazines as generally as was desired. This want was in a measure met by the introduction of machine “grooving.” The cuts, however, could not be used to print from directly in consequence of the warping of the boxwood, and it was necessary in every instance to make stereotype or electrotype plates. Then, too, came the realization of the fact that the reproduction of portraits needed something which would preserve features and expression. In those days some of the pictures produced were ludicrous in the extreme, and it became a standing joke in the newspapers that the best way to cast ridicule upon a public man was to print his picture. In the work of reproducing scenes the skill of the artist and the engraver frequently brought forth results which were marvels of excellence. For a number of years the wood engraving business flourished in this particular line, despite the dissatisfaction existing in regard to portrait work. In the production of illustrations for fine books, printed on good paper with flat presses and properly “under-” or “overlaid,” there was attained a degree of perfection in lines and shading which raised the pictures almost to the rank of steel and copperplate engravings. Many of those engaged in the work of drawing and cutting were possessed of a skill which would have won for them distinction in other artistic lines.

This, practically, was the condition of the profession when the end of the first half of the nineteenth century had been reached. Even then, however, the question of a substitute was under severe consideration in scientific as well as artistic circles. Experiments were made with copper, acids, and zinc, but satisfactory results could not be obtained. It was not until 1860 that a successful substitute was produced. Gillot, a Frenchman, brought forth a system of etching. By this means a photograph from an artist’s drawing was placed above a plate of gelatine, chemically sensitized. The parts of the gelatine exposed to the light became hard, and the remainder was brushed away with warm water. From this an electrotype could be made directly. That process has given way to the present system of photographing on zinc, and the use of acid baths for etching. Other improvements—principally the use of the screen—have resulted in the production of half-tones which are highly satisfactory in newspaper work. By this means there can be produced such reproductions as give the features of persons so that recognition is as easy as in the case of photographs. With the aid of different sizes of screens, backgrounds are secured which add materially to the artistic excellence of the pictures. So well done is the work in this direction that the plates can be used on the curved cylinders of the huge octuple presses, and enormous editions are printed from them. The peculiarity of this process is that the original can be reduced or enlarged so as to suit any width of column or page without affecting one way or the other the fineness of the work. Pen and ink drawings made by artists are photographed and backgrounded with the utmost accuracy as to design and detail. It has been found, however, that scenes in half-tones do not give as much satisfaction as do portraits, and it is believed to be only a question of time when there is a return to line engravings so far as the newspapers are concerned.

When one compares the photographic reproductions which appear in the magazines and newspapers of to-day with those of even ten years ago, there is seen an advancement which tells a wonderful story of the rapid march of artistic taste. The outline picture—excellent of its kind—has the appearance of crudity almost grotesque when placed beside the life-like half-tone reproduction of photographic art.

Wood engraving has been relegated to the days of the hand-press, the mail news-carrier and the plaster of Paris process of stereotyping. Inventive genius not only has advanced for the printing press and its adjuncts; it has also laid a heavy hand on art, causing it to pause and consider how soon the pencil and the brush will be superseded entirely by the rhythmic motion of the machine.

The Century’s Progress In Mines And Mining

By GEO. A. PACKARD,
Metallurgist and Mining Engineer.

When we consider how largely the discovery and exploration of America was due to the search for mines, that the precious metals might be found to replenish the depleted treasuries of European monarchs; and when we note that, as a result of this search, the world’s annual production of gold and silver had increased in the three hundred years following the discovery from $5,508,000, in 1500, to $48,995,000 at the beginning of the nineteenth century, we view with surprise the little progress made during this period in the art of mining.

At the beginning of the present century, we find in use the same general methods that were followed in the time of Columbus. The very first operation—the search for veins—was oftentimes conducted after the manner of the Middle Ages; for in Pryce’s “Mineralogia Cornubiensis,” which seems to have been one of the leading works on mining of the last century, there occurs, among other methods, a lengthy treatise on “How to Discover Mines by the Sole Virtue of the Hazel-tree.” Powder, although it had been invented for centuries, had been so little employed in mining that it was considered merely as a last resort. In a description of mining methods, another work says: “The soft vein is generally dug with the spade and turned out into wooden trays; but the hard veins are knocked out with a gad and a hammer. If the ore is so hard as to be incapable of breaking it in this manner, they usually soften it with fire. But a still more expeditious method is the working with gunpowder. *A small quantity of powder does great things this way.*”

In 1800 the coal miner was working by the naked light of the tallow dip. Cast-iron rails had been introduced but a few years, and rails of wrought iron, which could be bent to follow the curves of the drifts, were unheard of. The cars were pushed along the levels by boys. Water power, where it could be obtained and applied by means of the overshot wheel, was in general use for pumping, hoisting, and ventilating. But from many a mine the ore was raised by women, who pulled the bucket up “by walking away with the end of the rope” which passed from them over a sheave and thence down the shaft. In places the ore was still carried up the steep inclines to the surface on the backs of women and girls. Ventilation, when not secured by natural means, was obtained by bellows operated by men or mechanically. A mine which had been worked to a depth of one thousand feet was extraordinary. Though steam power, applied in the form of what was known as the atmospheric engine, a device utilizing for suction the vacuum formed by the condensation of steam in a chamber, had been used for years in draining mines, the steam engine, as invented by Watt, had been introduced for hoisting in only a few places. The power was applied to turn a long crank arm, which rotated the drum.

At the beginning of the century the mines of Cornwall, which were the greatest producers in Great Britain, were turning out about 5,000,000 pounds of tin and 10,000,000 pounds of copper a year, while the whole United Kingdom was furnishing only 170,000 tons of iron. South America was the greatest producer of gold and silver, wonderfully rich mines of the latter having been found in Peru and Chile. Humboldt places the production of the whole South American continent for the year 1800 at 691,625 pounds of silver and 9900 pounds of gold.

The United States at that time had practically no mining within its borders. Some small mines of iron, lead, and copper, which had been opened to supply the demands created by the Revolution, were producing spasmodically; but even as late as 1821, William Keating, in an address before the American Philosophical Society, said, “Upon the whole we think we may be warranted in saying that there are as yet no mines in activity in the United States. Coal, in most places, is taken from the surface, or dug from the foot of a hill. The lead mines of Missouri are rich and abundant, but the mining is a mere pilfering of the richest spots.”

In 1801 the Cornish pumping system was introduced. A long rod, extending from the surface to the bottom of the shaft, operates simultaneously a series of pumps placed, one above the other, at intervals of about two hundred and fifty feet. The lowest one lifts the water from the pump and delivers it into a tank from which the next one draws its supply, and this in turn forces it up to a higher tank. With this improved means of drainage mines began to be sunk deeper, a depth of three thousand feet having been reached with this method of pumping. The manufacture of iron pumps, which had begun to replace wooden ones toward the end of the eighteenth century, decreased the amount of repairs necessary on the pumps, and aided in making possible better arrangement of underground work.

It was at about this time, the beginning of the present century, that the method of opening ground by shafts, levels, and raises, which we refer to as “blocking out ore,” began to be more generally adopted, displacing the former mode of following down the ore by a series of irregular, isolated excavations. With it came overhead stoping, in which, after the shaft has been sunk, the level driven and timbered, and a raise made, the miner begins breaking down the ore from over his head, allowing it to run down into chutes. From these it is drawn out into cars pushed along the tracks in the level. The waste is allowed to accumulate on top of the stulls, or timbers, forming the top of the level above referred to, and serves as a platform upon which the miner stands in breaking down more ore.

The invention of the safety lamp, in 1815, is probably the most important event of the early part of the century. Previous to this the miners fired the gas in the “rooms” with their candles, which were raised toward the roof with the aid of a long pole, the miners lying flat on the floor of the level to escape the blaze, and sometimes putting on wet jackets to avoid being scorched. As first invented by Davy, the safety lamp consisted merely of a cylinder of wire gauze surrounding the flame, much as the flame is surrounded by a glass globe in the modern lantern, except that the diameter of the cylinder did not exceed two inches. This was based upon the theory that the gas set on fire by the light would burn inside the gauze without heating it hot enough to ignite the gas outside. The principle was correct, and the lamp worked satisfactorily when carefully used under proper conditions. It was soon found, however, that in a strong air current, or if swung at a more rapid speed than six feet per second in an explosive mixture, the surrounding gas would be ignited. As a man walking naturally on the surface moves at a rate of between five and six feet per second, it will be easily seen that even were the speed considerably diminished underground,—and any one who has tried to follow a mine foreman through mine workings knows the speed slackening is slight,—a very slight swing of the arm would bring the rate of movement of the lantern up to the danger point. Another and a very unexpected factor in causing explosions with the new lamp also developed; and that was the great carelessness of the men who used it. Armed with this device, and deluded by the quietly burning flame, the miner would seat himself upon a pile of coal, draw forth his pipe and fill it, and deliberately open the gauze to light it. As a consequence, for a time after the introduction of the safety-lamp, the number of accidents from explosions increased. This latter difficulty, the recklessness of the miners, was presently overcome by having the lamps locked, and by depriving the men of all matches before admitting them to the mine. An improved lamp, introduced by Clanny, wherein the lower part of the cylinder was replaced by glass, partially protected the flame from strong air currents, and also gave a better light. Later, Müseler added an interior sheet iron chimney, which divides the air current so that the hot air does not strike directly against the gauze, and the lamp as thus improved is very largely used, especially in Europe.

In 1831 the safety fuse was invented, a train of powder having been used before this for firing the charges. The same year a patent was granted to Moses Shaw of New York for an electrical device to fire several charges at once. It was at about this time, too, that the man-engine was invented in Germany. Some miner, noticing the slow and steady up and down motion of the long rods which operated the pumps in the Cornish system, had conceived the idea of nailing steps on to them at intervals, and riding up and down. As mines grew deeper and the time and labor required for the men to get down to their work increased, a special engine, utilizing an improvement of this device, was employed for raising and lowering men. This "man-engine" consisted of two parallel beams, moving slowly up and down the shaft with a reciprocating motion, the length of the stroke being about twelve feet. Upon these beams small platforms were nailed at distances equal to the length of the stroke. The miner wishing to descend stepped upon the top platform of one beam as it started on its down stroke. At the end of this stroke he found himself twelve feet down the shaft, on a level with the second platform of the other beam, which had in the mean time been coming up, and he stepped across on to this, which now began its down stroke. Thus by constantly stepping from one rod to the other at the completion of each down stroke, he was conveyed to the bottom. By reversing the process he was raised to the surface.

In general, mining progress was slow up to the middle of the century. The production of the baser metals, here and abroad, increased gradually with the demands of the mechanic arts, but it was not until the middle of the century that this factor, joined with the improved methods of transportation, and of metallurgy, gave to mining that impetus which, though through alternate recurring waves of prosperity and stagnation, carried it forward until the annual expenditure for technical skill, machinery, and supplies used in the industry is estimated to-day at one thousand million dollars.

The first mining excitement in the United States occurred in 1829, following the discovery of gold in the South; but these fields soon declined in importance without resulting in any improvements to mining methods and machinery.

The next mining fever resulted from the inauguration of work upon the copper properties at Keweenaw Point, Mich., in 1845. This caused the first mining-stock speculation in this country, and it is interesting to note that the century closes with a repetition of this same fever, founded upon almost the same ground. Yet the conditions have changed wonderfully. Upon the then barren peninsula, whitened with the tents of speculators and geologists, has grown up a multitude of towns, filled with thousands of people whose labors are performed at a depth of nearly a mile under ground. Thousands more transport the ore to the mills, separate the copper from the rock, and cut timber for the mines; while yet other thousands prepare food and clothing and shelter for all these. During 1898, the copper mines about Lake Superior produced nearly 160,000,000 pounds of copper, and paid in dividends $6,490,000.

This district is the only one in the United States where the man-engine has been used; but as the shafts were sunk deeper and deeper, it was found that even this method was not sufficiently rapid, and the men are now lowered into the mines by cages or skips. A "cage" is simply the miners' name for the ordinary elevator when used underground, and has developed from the bucket in use at the beginning of the century. A "skip" is a car especially designed for use on an incline. The roadway upon which the skip runs is so planned, at the top of the shaft, that the rear wheels run upon a track raised above the one over which the front wheels pass, so that the rear end is elevated and the skip is dumped automatically. At the De Beers diamond mines in South Africa are two of these skips which hold nearly five tons of rock each. At the bottom of the shaft are chutes containing the rock, and when the skip is in position a man pulls a lever, allowing the ore to run into it. Another pull closes the chute, a button is touched which rings a bell in the engine-room, and the skip starts up the shaft. At the top it dumps itself and returns to be filled again. In the mean time the other skip has been filled and is going up while the first is coming down. With these two skips, making ninety-two trips an hour, over four thousand tons of rock have been hoisted in less than twelve hours, from a depth of 1250 feet.

To handle these enormous quantities tremendous hoisting engines are used. At the Calumet and Hecla mines is a pair of quadruple expansion engines which will lift cages, carrying six tons of ore, a mile in a minute and a half. The "Modoc" hoist, built for the Anaconda Mining Company of Butte, Montana, is the largest hoist in the world. It is a double compound beam engine, and is designed to be used in sinking to a depth of 6000 feet. This machine weighs four hundred tons, and has seven separate subordinate engines for use in operating it. Think of it! An engine so ponderous that smaller engines are necessary to apply the clutches that set the reels in motion; other engines set the brakes, and another reverses the action, if need be. All these are controlled by levers operated from the engineer's platform, the "runner" having one foot and seven hand levers to handle. Besides these there are two indicator discs, directly in front, requiring constant attention, for these show the exact position of the cage in the shaft. Yet such wonderful skill have the runners in the control of these veritable flying machines that they instantly interpret the complicated signals, and drop the cage with such exactness that the car of ore is run from the track in the level to the track on the cage, almost without a jar.

Nor is the hoist the only large machine necessary in the equipment of the modern mining plant, for in sinking to great depths vast quantities of water have to be removed. The Chapin Mining Company, at Iron Mountain, Mich., have one of the largest pumping engines in the world. This engine is located on the surface, driving the pumps after the Cornish style, though it would be difficult to see much of the pump of 1801 in this magnificent machine. With a ten-foot stroke it conveys the power to the pumps through a walking beam weighing a hundred tons. In an hour it will raise nearly 200,000 gallons of water from a depth of a quarter of a mile.

Imagine the miner of 1800 "softening by fire" sufficient ore to supply a modern hoist. For the mines which now turn out 2000 tons a day can by no means be counted on one's fingers, and 2000 tons means more than a foot deep over a whole city block. Before the middle of the century the use of powder and drill had largely increased, and in 1845 an attempt was made to aid the man behind the drill with a machine which swung a hammer by steam power. In 1805 a machine was invented using compressed air in a cylinder, and this was gradually improved until it became a success in 1861, in the Mont Cenis tunnel. As finally employed, the power drill is practically a small engine, the drill being attached to the piston rod and moved rapidly back and forth by compressed air or steam. The machine has three functions: to strike the blow, turn the drill, and advance it, as the hole is driven deeper and deeper.

Soon after the machine drill became a success dynamite was invented, and these two have been the greatest factors in bringing about that rapid development and production which is the most pronounced attribute of modern mining. Dynamite alone has doubled the amount of ore which can be extracted from a face in a given time. Le Neve Foster, in his work on mining, gives the rate of advance in driving a tunnel by fire setting at two fathoms per month.

Compare with this the Niagara Falls tunnel, driven with power drills and high explosives, 342 feet in four weeks.

It is probably to the power drill more than to anything else that we are indebted for the development of the air compressor; the exhaust from a steam drill and the heat emitted from the pipes being very disagreeable under ground. As early as 1800 a Welsh engineer had attempted to run a blast by means of a water power a mile and a half distant, but it was not until 1865 that machines were operated to any extent by compressed air. The great difficulty had been the loss of efficiency, owing to the clearance spaces and the heating of the air. In driving the Mont Cenis tunnel but 16 per cent of the power developed was available, and up to 1880 the efficiency was extremely low; but to-day as high as 80 per cent is obtained. The air compressor is simply a force pump with ingenious devices to overcome the loss of energy. For ordinary use the air is compressed to a pressure of from 60 to 80 pounds per square inch. This is done in a single cylinder for low pressures, but for high pressures two cylinders are used. From the compressor the air is conducted to a reservoir, from which it is piped to the machine which it is to run.

One of the advantages of air-driven machines under ground is that the exhaust furnishes fresh air to the miners and cools the atmosphere. The result has been that in metal mines, where there are no noxious gases escaping from the ground, the exhaust from the air-drills, together with the natural air currents, has supplied sufficient ventilation. In the coal mines, however, it has been necessary to employ other means. After it was found that, even with the safety-lamp, gas would be exploded if a large amount of it had accumulated, more attention was paid to ventilation. Levels and shafts were divided to produce a natural current; the size of the drifts was carefully figured in order to regulate it; doors were put in to compel it to follow the faces; devices were adopted to split it, a part going to one room, the remainder to a second; and boxes were built to carry one current across another. Early in the century hand fans run by a wheel and pinion had been employed for forcing the air down the shaft, but it was soon found that the circulation produced in this way was inferior to the result of eduction. Large furnaces were then constructed at the bottom of the upcast shafts, in order to cause a strong upward current. Again, huge air pumps, run by machinery, were tried for exhausting the air. By 1850 exhaust fans were coming into use, and these, occasionally replaced by blowers, also used for exhausting, are now generally employed. The Guibal, which has been the most prominent of the fans, has been made as large as forty-six feet in diameter. The Capell, which is an improved form of the Guibal, has six curved veins, or blades, and is made from eight feet to fifteen feet in diameter. It is driven quite rapidly, making from one hundred and eighty to three hundred revolutions, and having a capacity of from one hundred thousand to three hundred thousand cubic feet of air, per minute. The result of this thorough ventilation is that the gas is removed from the mine almost as rapidly as it enters, and often the safety-lamp is no longer needed by the common miner. Nevertheless, it has by no means become useless, since as an indicator of the presence of gas it is invaluable. The action of the different lamps in the presence of gas varies, but in general the size of the flame increases in direct proportion to the increase in the amount of gas mixed with the air. Each morning, before the men go to work, the fire boss takes his safety-lamp and makes the round of the mine. When he goes into a room he watches the flame, and if it burns up to the point which indicates that it would not be safe to enter with a naked light, he makes a mark on the wall which serves as a danger line beyond which the men do not go.

Another machine, which, like the fan, has been developed by the demands of the coal mines, is the coal-cutting machine. Probably the lot of no man was as hard as that of the coal-digger at the beginning of the century. After he had performed the dangerous task of exploding the accumulated gases, he was often forced to work all day lying in the most constrained attitude.

Applied in this manner, his power was largely wasted, and much useless dust and small coal was produced. The first effort at relief was a machine which imitated the miner, striking a blow with a pick worked by a lever, and making as high as seventy blows a minute. These have been generally replaced by quite another type of machine, one which depends on the action of either a rotary bar, a rotary wheel, or a chain cutter. These machines are operated by either air or electricity. The Jeffrey rotary bar cutter will undercut a block of coal thirty-nine inches by fifty-four inches in six minutes. The chain-cutter is an endless chain carrying cutting knives and traveling horizontally. It is claimed that these machines will effect a saving of about ten cents a ton in the cost of mining.

When in 1848 the finding of gold in California was reported, followed in 1851 by the discovery of the Australian fields, large numbers of men were attracted to the placer mines, who later, as the placers became exhausted, turned their attention to vein mining. Nor did hydraulic mining itself fail to progress. When the placers were first discovered, the miner, standing in the shallow stream, washed the gravel, a panful at a time, and secured from fifteen to twenty-five dollars a day. As the placers became poorer he built sluices, and, shoveling in his gravel, turned the stream in to wash off the light rock, while the heavy gold was caught in the interstices between the blocks with which he had paved the bottom. If the ground became clayey, he brought part of the water through a hose and used it to break up the lumps in his sluice box. Then as he gradually removed the gravel and the banks about him became higher, he turned his hose toward the bank and brought more water from a higher level, until, to quote Bowie, "a forty-inch wrought-iron pipe has been substituted for canvas hose and a stovepipe, and an inch stream replaced by a river of water discharged through a nine-inch nozzle under a four-hundred-foot pressure." By this means, at North Bloomfield, Cal., nearly a million yards of gravel, containing but two and nine tenths cents per cubic yard, was moved in a single season, and at a profit.

As the banks became poorer, the miners turned their attention to the river beds. In New Zealand, in the early days, they worked the banks as far down into the river as they could reach with a spoon dredge. Then a dredge was made resembling a ladder of buckets, continually revolving, and operated by wheels driven by the current. When the river got low the current became too weak, and a steam engine was substituted. Then a revolving screen was put on to separate the large rocks from the fine sand, and gradually the modern dipper dredge has been evolved, with its pumps, screen, distributors, and tables and sluices, handling 2000 yards of gravel a day at a cost of three cents a yard.

In 1859 the Comstock lode in Nevada was discovered, and it is to this district that we owe the "square set" method of timbering, so largely in vogue in wide veins to-day. Some of the "bonanzas," that is, pockets of rich ore, were of enormous size. For example, one found in the "Gould and Curry" was 400 feet long, 80 feet wide, and 400 feet deep. As the walls were not sufficiently solid to stand unsupported, and a single stick of timber was too short to reach across, splicing was tried. It was soon found that this weakened the timber too much, and the method of square "setting" was invented. This consists in framing timbers together in rectangular sets, having a square base of four pieces, usually six feet long, placed horizontally as sills. Into these are framed posts, surmounted by a cap of four additional timbers which become the base for the next set. The timbers are usually twelve inches square, and cost on the Comstock about $10 a set. From 1870 to 1891 there is said to have been used up on the Comstock 200,000 acres of forest, valued at $45,000,000.

The amount of timber which is consumed under ground in a single year must be enormous. Mr. C. W. Goodale estimates that in Butte alone, in 1895, 37,500,000 feet, equal to 3750 carloads, were used in the mines. As the timber decays in from five to fifteen years, and has to be replaced, efforts are constantly directed toward decreasing the large expense which is thus continually recurring. In shafts and levels for permanent use iron is an economical substitute. Wherever possible, new methods of mining are being introduced. Thus in the Lake Superior iron regions, the mine development is planned along lines almost unheard of ten years ago. In the first place the gravel which overlies the ore is stripped off, even if it is fifty feet thick. This is done with steam shovels, which load the gravel upon cars. These are then pulled away by one locomotive while a second places new "empties" in position to be filled. One shovel will load from 150 to 175 cars a day; that is, will take from 3500 to 4500 tons of dirt from the sides of the pit and put it upon the cars. This method obviates the use of timber for holding up the surface.

After the overlying gravel is removed, should the conditions be favorable, the ore is taken out with a shovel. If this cannot be done, some method depending on rock-filling is adopted. At the Auburn mine, after stripping and driving the levels, raises are made to the surface at intervals of about fifty feet, the ore broken down around them, starting at the surface, and dropped down through them. This leaves openings in the shape of inverted cones, having their bases at the surface. Additional raises are then made halfway between the others, and the remaining material extracted.

At the Fayal mine they take out rooms twenty-four feet wide by three hundred feet long, with a twenty-four-foot pillar between them. These rooms are carried up from the first level to the surface, and filled with gravel which is run in from above. Then the pillars are mined by "slicing and caving;" that is, by running drifts along the sides of the pillar and caving the ore down from the roof. After removing this ore another drift is run, the roof caved, and another slice taken off. It is claimed the saving in timber by using this method amounts to ten cents on each ton of ore mined.

All of these, and many other inventions, have constantly tended to decrease mining costs. Yet the industry is carried on to-day in so many out-of-the-way places, and under such varying conditions, that the cost per ton of the ore mined vacillates between wide extremes. As an example of what can be accomplished, working on a large scale, and where supplies are easily and quickly obtained, the Atlantic mine, in Michigan, may be mentioned. This mine produced, in 1898, 370,000 tons of ore, at a cost of sixty-six cents per ton.

With all these wonderful advances in mine mechanics, engineering, ventilation, and lighting, have come the foundation and development of mining schools, the rise of technical societies, and a general governmental recognition of the importance of the industry. It is not so very far back in the preceding century that we find among the statutes of England the following: "Stealing ore out of mines is no larceny, except only those of black lead, the stealing ore out of which is felony without benefit of clergy." It would be interesting to know the name of the gentleman who owned the black-lead mine, for, in modern parlance, he certainly "had a pull." By 1833 mining legislation had so far progressed in England that laws were enacted regulating the employment of children under ground. In this country, in 1830, a state geological survey was inaugurated by Massachusetts, and this institution has since been copied by many States. The majority of the States where mining is carried on have passed laws tending to increase the safety of men working under ground.

Abroad, carefully prepared codes describe the method of lease or sale of mining rights, and define the rights of owners of ground. In this country the first legislation of this character was in 1807, when the government mineral bearing lands were withdrawn from sale and ordered leased. In 1834 the miners refused to pay the royalty, owing to the large number of illegal entries, and in 1847 the lands were opened to sale. It was not until 1866, after fifteen years of self-government among the miners of the West, that Congress earnestly undertook to regulate the acquisition of mining titles on the public domain. Leagues beyond the towns, miles from the nearest roads, hurrying from the scene of one excitement to another, pushed by the crowd of constantly arriving adventurers, with surveyors unobtainable and courts not accessible, almost without time to measure, and in a region absolutely unlocatable, it had been impossible for the miner of the West to secure a legal title to his land as contemplated by the act of 1847. Accordingly, there had grown up the custom which gave to the discoverer of a lode the right to a certain length of it, and it was this right which was recognized by Congress, and became the basis of the law of 1866.

So far our story has been of progress, but what shall we say of the action of Congress, which, in 1872, abrogated this law and substituted for it the prolific breeder of litigation called the law of the apex? To quote Dr. Raymond: “The leading characteristic differs from all previous mining laws of this or any other country. The old right of discovery, which was the basis of the miner’s title down to 1872, has dwindled under the present law to a nominal importance. It is true that the discovery of the lode within the claim is made a prerequisite to location. But the right to follow the lode in depth beyond the side lines of the claim depends no longer upon having discovered it, but on having included its top, or apex, in the surface survey.” Should the miner be so fortunate as to have a vein which outcrops plainly on the surface, he may stake out the ground without difficulty, so that the vein crosses the end lines. But if his vein does not appear on the surface, and he fails to guess its direction correctly, and finds, on developing, that it does not cross the end lines of his claim, he is suddenly cut off from all extra-lateral rights. Or should he, in laying out his lines along the rough, precipitous mountain-side, fail to make his end lines parallel, he again finds his rights limited. Nor has this law been made clearer by court decisions, but rather it has been complicated.

Certainly this is a peculiar condition of affairs. The century which has witnessed an advance from the hazel rod to the diamond drill, from the spade to the steam shovel, from fire softening to dynamite shattering; a century during which a clumsy car pushed over cast-iron rails by a boy has grown to a cable train, and a two-hundred-pound bucket raised by women has developed into a six-ton self-dumping skip hoisted by electricity; a century productive of new devices which tunnel mountains, cross ravines, or sink through quicksands with equal ease; a century which has seen the touch of a button and the turn of a wheel bring power from thirty miles away to light and drain the mine, as well as operate the drills and hoist; such a century closes with a law in force in the greatest mining country in the world which makes litigation one of the expected stages of mine development.

At the beginning of the century the mining engineer advised where to sink, the manner of working, and the method of dealing with the water: to-day he must not only be a mining, civil, and hydraulic expert, but a mechanical and electrical engineer, a chemist, and a lawyer.

The time was when he who leveled forests, built himself a home, and brought the land under cultivation, was regarded as the true pioneer of civilization. In later times the miner fairly divides this honor. Pursuing a hazardous occupation, he has invaded most out-of-the-way and desolate places, creating untold wealth, founding towns and States, and inviting vast and substantial populations. By his industry and enterprise he has not only revealed the seventy-seven non-metallic underground products which in the United States alone, in 1899, had a value approximating $500,000,000, but the twelve metals—precious and useful—whose value in the same year approximated $270,000,000. Around his gold mines—deep and placer—have grown California, Nevada, the Dakotas, Colorado, and even Alaska; while empires have sprung up at the sound of his pick and the introduction of his mighty machinery in Australasia and South Africa. In the development of silver he has contributed wealth, population, and institutions to Colorado, Nevada, Utah, Montana, and Arizona. His iron and copper mines have transformed the barren coasts of the Great Lakes. The quicksilver mines of Southern California brought San José and other towns to wealth and importance. In the history of Ureka and Leadville, Col., we have the romance of both the gold and lead mine. And so, whether the miner unearths the ores, the coals, the wonderful variety of buried materials which nature has provided for the use and comfort of mankind, he so frequently becomes the source of wealth, population, and permanent civic organization as to give him high rank among the "true pioneers of civilization."

Art Progress Of The Century

By JOHN V. SEARS,
Art Critic Philadelphia "Evening Telegraph."

I. PAINTING

At no period since the Renaissance has there been such marked progress in certain walks of art as during the period of reconstruction in the political, social, economic, and æsthetic world immediately following the French Revolution of 1798. The armies of France, returning from the conquest of Europe, brought home to Paris the treasures of art ravished from the great capital cities. The vast public galleries and numerous private collections established under the first Empire contained accumulations of pictures, marbles, bronzes, tapestries, decorations, and bric-à-brac brought from Italy, from Germany, from the Low Countries, from Spain, and even from Russia and Egypt, of extent and value unparalleled in the history of the human race. These treasures were dispersed under the Restoration and returned to their former owners; but, in the meantime, their educational influence upon the people of France, and especially of Paris, had produced profound and permanent impressions which abide to this day. To this practical education afforded by the models and examples of all that is noble and exalted, gathered from the galleries and safe deposits of the civilized world, France is primarily indebted for that cultured skill and that refinement of good taste which have enabled her to take and hold her acknowledged position as the leading nation in the realm of art in the nineteenth century.

At the beginning of the century the art of France was resting inert in the bonds of classic tradition. Academic conventionality held almost undisputed sway; only a few painters of portraits, as, for example, Madame Vigée-Lebrun, Isabey, and decorative artists like Greuze, venturing beyond the limits of the hard and fast rules prescribed by scholastic pedants. The only subjects regarded as legitimate for artistic treatment were illustrations of mythology or of Greek or Roman literature. Sacred pictures illustrating the Biblical narratives and lives of the saints were permitted for church adornment and for religious purposes; but historic and story-telling pictures of the order now known as genre were classic in subject and academic in treatment. Even in portraiture, where a likeness was the main consideration, military heroes were represented in Greek armor and distinguished civilians were invested with the dignity of the Roman toga.

The high priest of ancient pagan worship in France during the first quarter of the century was Jacques Louis David (1748–1825). David was a master of such real power that he was court painter to Louis XVI., director of Fine Arts under the Republic, and again court painter to the Emperor Napoleon. His great work, "The Oath of the Horatii," now in the Louvre, first exhibited in 1784, was universally admired and is still highly esteemed. This was followed by a triumphal procession of classic compositions, the most notable of which were "The Rape of the Sabines," usually considered to be his masterpiece, "The Death of Socrates," "Paris and Helen," and "Brutus and His Sons," all of which have been reproduced many times in prints. David was influenced, late in his career, by the romantic reaction, as shown by his "Napoleon Crossing the Alps" and his "Floating Martyr," but he championed classic art all his life, his last words expressing an aspiration to paint the head of Leonidas.

The downfall of the classic dominion in France was brought about by the revolt of Géricault and Delacroix, about 1820. Jean Louis Géricault (1791–1824) was declared by Viardot to have revealed an era when liberty in art was revived together with political liberty, joining the general movement of the human spirit in the march of progress toward independence. His epoch-marking picture, “The Raft of the Medusa,” in the Salon of 1819, created an intense excitement not only in artistic circles, where it opened the battle between romance and classic tradition, but also among the people. Instead of Greek heroes, posing like antique statues, this thrilling picture portrayed a group of French sailors, perishing amid the horrors of shipwreck and starvation, the subject being a scene in the awful tragedy incident to the loss of the frigate Medusa in 1816, a calamity which the nation was then mourning with unspeakable grief. Women wept and strong men paled before this terrible illustration of human agonies endured unto death, but the academicians attacked the work and the artist with almost savage fury. Géricault, a genius, sensitive and nervous, quailing before the storm which beat upon him, fled to England, but, pining in exile, returned home, only to die, crushed and broken-hearted.

Ferdinand Victor Eugène Delacroix (1798–1863) was a man of firmer fibre than his friend and fellow-student, and his was the strong hand to take up the gage of battle when Géricault fell in the fight. For daring to depart from the classic traditions, these two young painters of the commonplace subjects of every-day human tragedy and romantic drama were savagely denounced by the academicians as traitors, as charlatans, as assassins seeking to murder art. The persecution killed Géricault, but Delacroix laughed at it. As Théophile Souvestre said of him: “The blindness of ignorance, the intrigues and clamors of envy, have not arrested him for an instant in his valiant and glorious course.” By the splendor of his genius and the virility of his work, as shown in his great pictures, “The Bride of Abydos,” “The Two Foscari,” “The Amende Honorable,” and the magnificent series of Oriental studies by which he is best known, he established the romantic school on a firm basis and attracted to it nearly all the talented and promising young painters of Paris.

Among these students and unknown painters were many whose names subsequently became famous, as Horace Vernet, Paul Delaroche, Baron Gros, Ary Scheffer, Alexandre Decamps,—artists whose noble productions gave to the romantic school its finest triumphs. In the mean time, classic art was ably and effectively supported by the distinguished labors of Doménique Ingres, pupil and successor of David, Guillaume Guillon-Lethière, Hippolyte Flandrin, and Jean Baptiste Regnault. The Academy, though defeated, still lives, and modern lovers of art find that, especially in decorative design, there is much to admire in classic subjects.

After the revolt of the romanticists the most important movement in the world of art also took place in France, and is known as the “Revolution of 1830.” To understand this movement it is necessary to consider the state of art in England, as the “men of 1830” in France derived their inspiration from John Constable, an English landscape painter. At the beginning of the century the two great artists of England were Sir David Wilkie and J. M. W. Turner. David Wilkie (1785–1841) was a portrait, historic, and genre painter, and no English artist up to his time had ever attained such wide popularity as he enjoyed. His pictures are all known the world over, as witness such titles as “The Rent Day,” “Village Politicians,” “The Blind Fiddler,” “King Alfred in the Neatherd’s Cottage,” “The Village Festival,” “Reading the Will,” “The Chelsea Pensioners,” “Blind Man’s Buff,” “The Village School,” and “John Knox preaching.”

Joseph Mallord William Turner (1775–1851) was one of the most remarkable artists that ever lived; a most original genius, “without ancestors and without heirs.” He was a landscape painter and a most earnest and faithful student of nature, as shown by his wonderful illustrations, in black and white, of the scenery of England and Wales. In his paintings, however, he interpreted rather than portrayed nature, investing his subjects with the grandeur and glory of his imagination. His pictures were "golden dreams," revealing the beauty, the majesty, the sadness, and the terror inspired by nature, not from observed details "but from the image or ideal in his own mind." Of his many masterworks mention can only be made here of "Crossing the Brook," "Dido in Carthage," "Palestrina," "The Golden Bough," "Hannibal Crossing the Alps," "The Slave Ship," "Battle of the Nile," "Burial of Sir David Wilkie at Sea," and perhaps the greatest of all, "The Fighting Téméraire."

Turner created no school and left no successor, but he made a distinct impression on the art of England by stimulating an active interest in landscape painting. Patrick Nasmyth, Augustus Wall Callcott, John Linnell, and a score of artists turned to the study of rural scenery, with the result that they succeeded in establishing what is known as the Norwich school of landscape art. By far the most important name in the annals of this period, after Turner's, is that of John Constable (1776–1837). Constable presents the contrast of diametric opposition to Turner. His pictures, so far from being "golden dreams," are more like cast-iron realities. When Turner was an idealist, Constable was an uncompromising realist. If the one painted poetry, the other painted prose, and often very rugged, plain prose indeed. While Turner subordinated fact to fancy, illuminating his subjects with the glow of his fervid imagination, Constable devoutly stood before nature in the attitude of a worshiper, and faithfully labored to represent as truthfully as his powers permitted exactly what he beheld. In contrast with the shining canvases of his brilliant contemporary, Constable's pictures seemed dark, dull, and heavy to the British public, and the original genius of the conscientious artist was not recognized. His greatest works, "Dedham Vale," "The White Horse," "The Hay Cart," "Stratford Mill," "Salisbury Cathedral," "The Rainbow," and others were exhibited in succession during the second decade of the century, before an indifferent public, only his fellow artists and a few connoisseurs caring for them, the painter meanwhile starving in neglect.

In 1824 two of his pictures were shown in Paris, and were then instantly understood and appreciated. They created a profound impression and, as has been justly said, inaugurated the second revolution of the century in the realm of art. By this revolution the artists were driven out of their studios and out of the city, to study nature in the spirit of humble sincerity shown by John Constable. Among the young students who went forth to encounter poverty, hardship, and the severest toil were the "men of 1830," the founders of the Barbizon school of painting. Millet, Rousseau, Diaz, Corot, Troyon, Daubigny, and Dupré left Paris and the ways that then led to success, and sacrificed themselves to what they saw to be the truth in art. They carried the study of out-door nature further than ever before; created the standard of modern landscape art, and attained immortal fame, though not until their leader and prototype had perished in poverty.

Jean François Millet (1815–1875) has been called the greatest painter of the nineteenth century, and his masterpiece, "The Angelus," is regarded by many as second only to the "Sistine Madonna" of Raphael in the brief catalogue of the world's artistic treasures. He lived the life of a poor peasant in the rural village of Barbizon, attracting around him, late in life, the ablest of the "men of 1830," and producing there those works which have placed his name first on the annals of our time: "The Sower," "Waiting," "Sheep-shearers," "Woman Carding," "The Gleaners," "Shepherdess and Flock," and the few others that constitute the tale of his exceedingly careful and long-considered compositions.

Théodore Rousseau (1812–1867) was declared, by Edmond About, to be the Moses who led the landscape painters of France out of the Egyptian bondage of academic convention into the promised land of liberty, where rivers ran water, where trees were rooted in the ground, and where animals lived, moved, and had their being. As late as 1848 the Salon rejected Rousseau's noble work, "The Alley of Chestnut Trees," one of the finest landscapes ever painted; but this was the last act of the academic tyrants, the foolish offense against the great master causing the old classic pedants to be relegated to oblivion. Rousseau took up his residence in Barbizon, and in the forest of Fontainebleau and the adjoining country studied those rural and pastoral scenes that have given him his place as one of the first, if not the very first, of landscape painters. Of these magnificent examples of landscape art, mention can only be made here of "The Village," "A Pool under Oaks," "Edge of the Forest at Barbizon," "A Forest Interior," "Water Course at Sologne," and "Hoar Frost," these being the pictures best known to the public through reproductions in black and white.

If Turner was a painter of "golden dreams," Corot was a painter of silver dreams; the pearly haze of early morning, the pale sky and misty tree-forms of a gray day, and the soft, low tones of a still, cloudy afternoon attracting his loving devotion and commanding the conscientious exercise of his skill. Jean Baptiste Camille Corot (1796–1875) was certainly one of the happiest artists that ever lived. Like the other "men of 1830," he was ostracized by the Academy, and he was never allowed to receive the first medal of the Salon, but he had every other honor and compensation, and, late in life, was given a magnificent gold medal by popular subscription. For many years he could not sell a single picture, but, being fortunately independent, in a modest way, he continued to paint the subjects which, as he said, delighted his heart, and to treat them, as he again said, "with truth to your own instincts, to your own method of seeing, with what I call conscientiousness and sincerity." In due time Corot conquered his world and, in the height of his career, was earning not less than $50,000 a year by his brush. He was a constant visitor at Barbizon, maintained a close intimacy with his friends, there, and studied in the vicinity many of the hundreds of landscapes his industrious and tireless hand rejoicingly produced.

Jules Dupré (1812–1889) and Charles François Daubigny (1817–1878) are distinguished members of the "1830" group, each standing at the head of the department of landscape art to which he was especially devoted. Narcisse-Virgil Diaz de la Peña, called Diaz (1807–1876), another of the fraternity, was not technically so thoroughly trained as his fellows, but he was a stronger colorist than any of them and a romanticist of the most pronounced type. Constant Troyon (1810–1865) was the most eminent cattle-painter of the century. He came on the scene after the revolt of Géricault was accomplished, but was in full sympathy with the movement, and is usually accounted as one of the revolutionists. So also with Jean Leon Gérôme (1824), an artist surviving to the close of the century.

He first exhibited in 1847, but he took up the line of Oriental romance, following Delacroix, and made so strong an impression with his illustrations of the splendors and glories of the East that his influence in art will be felt for generations to come. After attaining fame as a painter, Gérôme also developed marked ability as a sculptor.

In strict chronological order the birth of the pre-Raphaelite movement in art preceded the "revolution of 1830," as the event actually occurred in Rome, about 1812. The movement was not originally known by the name subsequently given it, and it did not attain to more than local importance until it was fully developed in England, about 1850. It is to the great German artist, Peter von Cornelius (1783–1867), that the honor of originating the pre-Raphaelite revolution must be given. In 1811 Cornelius went to Rome and soon became the master spirit of the "Brotherhood of Painters," popularly called "Nazarites," banded together for the study of the thirteenth-century Italians, Cimabue and Giotto, and their successors in the century following, Gaddi, Simoni, and Orcagna. This Brotherhood was afterward imitated by Rossetti in London, and its purposes more fully developed; but it was the young German enthusiasts of the previous generation who affected a revival of the pure religious spirit, the devout simplicity, and the absolute sincerity of the Italian artists before the era of Raphael.

Cornelius returned to Germany in 1816, became the founder of what is known as the Munich school of painting, and was made director of the Art Institute of that city. He exercised a controlling influence in the evolution of modern German art and, indirectly, on art in England and in America. His pupil and successor, Wilhelm von Kaulbach (1805–1874), imparted vitality and power to the Munich school, attracting to his classes students from all civilized countries. During the second and third quarters of this century, Kaulbach reigned as the first artist of Germany and one of the first in the world.

Dante Gabriel Rossetti (1828–1882) founded his pre-Raphaelite Brotherhood in London, with John Everett Millais—subsequently president of the Royal Academy—and William Holman Hunt, in 1848. The pre-Raphaelite movement gave a richer and stronger color to English painting in the latter half of the century, and also awakened general interest in early Christian art, that is, the art of the Italian Renaissance. Beyond this, Rossetti’s new departure, though widely advertised by John Ruskin, had very little permanent effect. Millais soon left the Brotherhood and produced his master-works, the greatest historic-genre pictures of his time, in England, after outliving pre-Raphaelite influences.

Little known outside of England, that movement did not entirely absorb British art, as proved by such a man as G. F. Watts, a master of portraiture, who made studies of many of the most notable men of the century in England, besides many imaginative works of great interest. Others were Holman Hunt, with his powerful religious conceptions, and the talented Landseer family, the youngest member of which, Edwin, is world-famous for his animal pictures. The critic and philosopher, John Ruskin, studied art and became a proficient draughtsman, although never using his skill professionally. His literary works on art, however, have had so wide an influence that it seems just to include him in the list of contributors to art’s progress in this era. His criticism of the fantastic productions of James McNeill Whistler brought forth a controversy and law suit, resulting in a verdict of damages of one farthing to the injured artist, and enough advertising gratis to secure his fame. The genius of the latter for achieving artistic effects and personal notoriety are equal to his skill in avoiding oblivion. He is a unique and interesting figure, despite his abnormal vanity, for his unquestionable talent in many lines of art, and is American by birth, English by adoption, and now French by force of circumstances. Edwin Abbey is also an adopted son of Britain, although born in America. He is better known through illustrative work in black and white, but his superb decorations in the Boston Public Library testify to his great skill as a colorist. The most illustrious growth of foreign seed on British soil has been Lorenz Alma Tadema, whose wonderful representations of Greek and Roman life place him *hors concours* as an artist, and hold before our eyes a mirror of ancient days. Sir Frederick Leighton, the recently deceased president of the Royal Academy, was a true Briton and a leader of modern art in England, as also was Mrs. Elizabeth Thompson Butler, with her patriotic war pictures, as vigorous as any man’s could be. A talented young artist, whose untimely death cut short a promising career, was Frederick Walker, who is said to have been the original of “Little Billee” in Du Maurier’s famous novel of student life in the Latin Quarter, “Trilby.” That masterpiece takes us into the art atmosphere of Paris, and we readily understand why there is the centre of the artistic circle.

From thence have risen most of the great modern names, one of the greatest and most honored being that of Rosa Bonheur, who has received all possible distinction as an artist and reverence as a woman. Her animal pictures, especially horses and cattle, are known the world over, and the story of her early struggle for study, disguised as a boy, that she might work unmolested where a girl could hardly have gone, is well known, yet she never renounced an atom of her womanliness in adopting masculine attire. It is hard to avoid dwelling on the lives and works of the modern masters, but we must pass over the intermediate period between the revolt of 1830 and our own day, touching only an especially shining light here and there, such as Jules Breton, with his sturdy peasants; Léon Bonnat, Alexandre Cabanel, and Carolus Duran, with their elegant distingué portraiture. Besides these are Edouard Détaille and Alphonse de Neuville, showing faithful studies of soldier life and action; Eugène Fromentin, with his picturesque Arabs; and the decorative allegories of Puvis de Chavannes. The brilliant Spaniards, Mariano Fortuny and Don Frederick Madrazo, are practically Frenchmen in their art, although each is distinctly individual in manner. We must also mention Vibert, with his delightful little satires on the human frailities of the holy fathers of the Church, and Meissonier, the master of exquisite finish in detail, and Passini, with his small canvases crowded with Oriental figures glowing with color. In addition to the great French names of this time are Defregger, of the Munich School; Israels of Amsterdam, Schreyer of Frankfort, whose works all hold that quality dear to the popular heart, but despised by the high priests of lofty criticism nowadays, that is, they have a story to tell, and they tell it.

At the time these men were telling their artistic tales in Europe, such men as Washington Allston, the first great painter in this country; Thomas Sully, whose rare works in portraiture entitled him to paint the Queen of England, Victoria, when a girl; Henry Inman, also a great portrait painter; George Fuller, a painter of poetic dreams; and many others of talent, had said their say in America. Almost with the beginning of the new country, public interest had been roused in the fine arts by the efforts of such men as Gilbert Stuart and the Peales, Charles and Rembrandt, who bridged the eighteenth and nineteenth centuries together, and labored to advance the cause of art. Schools and academies, with adequate galleries for exhibition purposes, became necessary; and such institutions as the Pennsylvania Academy of the Fine Arts and the National Academy of Design in New York were established. The latter was started in 1802, but did not receive its charter until 1808; so the Pennsylvania Academy, which was incorporated in Philadelphia in 1806, was really the first of its kind in the country. In 1807, the minutes bearing the date of October 8 record as follows: “Until the funds of the institution will admit of opening a school on a more extended plan, persons of good character shall be permitted to make drawings from the statues and busts belonging to the Academy,” thus showing the humble beginning of art education in America. Naturally, for many years the facilities for learning were too limited to supply more than rudimentary instruction, and the pilgrimage to Paris was a necessity before an artist could feel qualified to launch out professionally. In these latter days that need no longer exists, for the great art schools of New York, Philadelphia, Boston, Chicago, and St. Louis can amply provide all that is required; but the charm of the Latin Quarter still draws as a magnet all who can afford to go there.

In that centre is a constant mingling of ideas from all sources seeking new forms of expression, out of which proceed the impulses that vibrate through the world of current art. Naturally enough many of the new departures are futile experiments, short lived and not sufficiently important to discuss; but within recent years the movement known as impressionism has been so widespread in influence, so radical in method, and so vital in result, that it has doubtless produced a permanent effect on art. Like its predecessor, the renaissance after the dark ages, this *mouvement moderne* was an upheaval of all forms of expression; and in painting it seemed as if a wave of dazzling color had burst over the studios, drenching the canvases with rainbow tints, flooding the exhibition galleries with bewildering brilliance. The unaccustomed eye was overwhelmed, and the confused and wondering public burst into loud outcry against the insane folly of these mad young painters, who showed purple and green gridirons, speckled with green and streaked with scarlet, and called them landscapes, marines, and figure studies as they chose. Of course the pendulum swung to its limit, the radicals carrying things to extremes after the fashion of their kind, and making foolish caricatures of work that was really great. By degrees, however, sober sense prevailed, the new ideas became better understood, the public point of view changed, and it was seen that there was method in this madness. The new movement was intended simply to interpret what the artist saw most forcibly expressed by any given subject, or, as the name implies, to record his first impression and convey the idea rather by suggestion than by explicit statement and detail. Applied to out-of-door subjects, these principles were carried out by the *plein air* colorists, as they were styled, from their efforts to suggest atmosphere glowing with light, a feeling of space and sunshine. Edouard Manet was the leader of the new school in figure work, and Claude Monet in landscape. No two styles could be more widely different save in their mutual abhorrence of detail; the first dark, heavy, and sombre in color; the latter luminous and palpitating, every conceivable tint vibrating into harmony, an example which is followed in this country by Childe Hassam, often successfully, but sometimes with extravagance. After reaching extreme high-water mark, the flood of brilliance has somewhat subsided, and latter-day painters do not find it necessary to observe the world through a prism. While returning to more sober statements of simple truth, without trying to copy a kaleidoscope, the vision men have had of pure color sparkling with light has given them an insight into Mother Nature's method that has left a lasting impression upon the minds and manners of the best workers and lifted the whole tone of modern painting. Whether one was prepared to enjoy truly impressionistic pictures or not, the force of them in a collection of works in the old manner of hard outline and heavy shadow could not fail to be felt like a beam of light in a dark room. However one might protest against the invader, the old friends looked dull and flat after a time, in spite of the most determined loyalty. The style of the Hudson River school was narrow and petty, full of trifling little details, the color often being forced and theatrical in effect. The striking scenery of that noble stream inspired the efforts of American landscape painters of the two decades from 1830 to 1850. Asher B. Durand was a leader among them, and for many years the manner of a generation past held sway until the new method forced a place for itself. It was an amusing experience in following exhibitions of late years to see, one after another, the leaders, long established in their own particular methods, finally breaking away from lifelong habits and coming into line with the new movement, some keeping step bravely with the vigorous newcomers, some halting along with pitiful attempts at a jaunty stride. The strong men neither hung back in sulky indifference nor flung themselves wildly about in exuberant freedom, but kept quietly on the even tenor of their way, absorbing what was best in the new, holding fast to what was best in the old, and producing the kind of work that is independent of schools and eras, but intrinsically great in itself. In Paris, the younger workers who began sending strange wild landscape and figure pictures to the exhibition at the Salon of the Champs Elysées, the most important annual exhibition in the world, were indignantly rejected by the horrified jury of selection. Equally indignant at their treatment, the young painters, who felt themselves to be the coming men, gathered their rejected treasures together in an independent exhibition of their own, and established a rival salon in the Champ de Mars, which has come to hold an equal footing in the world of art with the older institution.

By reference to "men" we do not at all exclude women, for there is no sex in art, and women of our time paint as well as men, folding equal rank in the exhibitions, equal places on the juries of selection, and receiving equal honors and awards. One of the foremost women of the day is a Philadelphian, Miss Cecilia Beaux, whose portraiture ranks among the highest. Miss Mary D. Cassatt is also a Philadelphian, although long resident in Paris, and highly esteemed there. Her name is mentioned in a recent notice of a Salon exhibition among those of distinguished men, which concluded with the words "and other strong men," meaning thereby no grain of disrespect to the woman, but only honor to the artist, classifying her as among the first painters of the time. Important exhibitions nowadays are likely to contain strong works by many women, such as portraits by Mrs. Sarah Sears of Boston or Mrs. Rosina Emmet Sherwood of New York, child studies by Ellen K. Baker, or animal studies by Mrs. Helen C. Hovenden, widow of the late master of modern genre, Thomas Hovenden, whose untimely death the art-loving public of this country has not ceased to mourn. His faithful studies of American domestic life have touched the people, who are, after all, the final art critics, despite the claims of those who feel themselves especially qualified by taste and training to tell others what they must and must not like. Many times public opinion has been unduly slow in setting the seal of its approval on worthy works, but once established in the heart of the populace, immortality is assured, and that place belongs preëminently to Thomas Hovenden, as proved by the throngs that stood before his picture "Breaking the Home Ties," at the World's Fair in Chicago. That cosmopolitan collection showed, among other interesting developments, a strong school of vigorous young Norsemen, hardy vikings of art from Scandinavia, of whom Anders Zorn was the leader, with a variety of figure subjects, studied indoors and out, with an unconventional freedom and dash as inspiring as the breezes of his native fjords. Prince Eugene, the handsome popular second son of the King of Sweden, was no mean contributor to this school. Fritz von Thaulow is a Norwegian by birth, but being well recognized in France he has taken up his abode at Dieppe, although still finding inspiration in his native land. He is an exponent of the theory of tone in painting, as it is technically termed. This refers to the quality of harmony, or perfect balance of light and shade and color. It does not depend upon the key of the picture, whether light and bright or dark and sombre, but consists in keeping the relations of the different masses of color true to each other, the small details subdued to their proper places, yet each having its correct value in the whole.

The Scotch painters, stimulated no doubt by the success of their literary brethren, have established the Glasgow school of art, most original in its methods, and in some cases highly peculiar in its results, but with unquestionable strength in its more serious and less fantastic work. John Lavery is a leader among these men. Germany prides herself on one of the greatest painters of modern times in the person of Adolph Friedrich Menzel, a Prussian, born 1815, contemporary with Meissonier. As the latter was devoted to the Emperor of the French, so was Menzel to his hero, Frederick the Great, and their vivid portrayals of their respective sovereigns will keep the personality of these conquerors fresh as long as art lasts. For many years Menzel has been artist laureate to the court at Berlin, painting Hohenzollern family portraits, battle pieces and scenes of court splendor in the most masterly manner. The Hungarian, Munkacsy, has been widely known by his huge religious works, lately exhibited in this country,—"Christ before Pilate" and the "Crucifixion." His work shows great power and much originality in conception, although often somewhat morbid, a not unnatural condition, as the unfortunate artist has become hopelessly insane. The opposite extreme of expression is to be found in the gorgeous coloring and superb compositions of Hans Makart of Vienna, notably his "Coronation of Catherine Cornaro at Venice." A revival of interest in religious subjects has recently appeared, possibly stimulated by the work of Mr. James Tissot, a Parisian, who has given ten years to the production of a series of careful studies of the life of Christ. These little paintings, numbering some five hundred in all, are the result of close research in the Holy Land into the conditions of life and customs which prevailed at the time of Christ, and are a tribute of religious devotion. Whether through this influence or not, Dagnan-Bouveret has been inspired to paint a number of strong scenes of biblical subjects, two conceptions of the Last Supper being very powerful. A young colored man, H. O. Tanner, has achieved success on similar lines, an "Annunciation" recently shown giving evidence of deep and original thought. Curiously enough, the women painters of distinction do not seem to be given to religious subjects. One serious lack in most of the work exhibited in recent years is the absence of any importance in subject. The artists have been so concerned to express what they saw in the simplest manner, that they have carefully avoided seeing or thinking about anything but the simplest things to be expressed. While some powerful work has resulted, it has often been labor worthy of a better cause, for the pictures produced have had little to tell beyond the skill of the painter. A nobly painted cabbage field, or a superbly handled stone wall with the tail of a woman's skirt disappearing around a corner, may be masterly painting, but it is not great art; and it is to be hoped that the day of meaningless canvases will soon pass, and the coming painters will not be content to discourse grandly about nothing.

Among the leaders of current art in America, the place of honor in portraiture belongs to John S. Sargent, who easily ranks with Boldini and Benjamin Constant in Paris. He is closely followed by Edmund C. Tarbell, John H. Alexander, with his love for long flowing graceful lines of drapery, Robert Vonnoh, and William M. Chase. John McClure Hamilton has made some striking studies of some of the most prominent people of our time, among them Gladstone and Pope Leo XIII. Elihu Vedder, John LaFarge, Will H. Low, Carroll Beckwith, Abbott Thayer, and E. H. Blashfield are figure painters whose subjects are frequently of a decorative or semi-religious character. The latter is noted for his literary as well as artistic ability. George H. Boughton, though called an American, really belongs to England, where he paints interior genre subjects usually of olden times. John Swan, the animal painter, is also English. The names of Moran and Sartain are distinguished in the history of American art, each family having contributed several generations of talented painters. The elders were contemporary with Daniel Huntington, long president of the National Academy of Design, and Eastman Johnson, whose "Old Kentucky Home" was famous. William T. Dannat, Herbert Denman, Frederick Bridgman, and F. L. Weeks are all strong figure painters, the last two being especially given to Oriental subjects. Winslow Homer includes figures with his marine studies, often presenting groups of peasants on a stormy shore, while Alexander Harrison and W. T. Richards usually confine themselves to marines pure and simple. The ragged, dirty little street Arabs of J. G. Brown have been exceedingly popular, and so have the landscapes of H. Bolton Jones. The list of modern landscape painters really deserving of mention is far too long to give in anything like complete mention. A few leaders, such as Charles H. Davis, Homer Martin, the late William T. Picknell, and George Inness must suffice to close our talk on the painters of this century.

II. SCULPTURE.

Human progress seems to advance in waves, sending forerunners to announce the gathering tide; and the ebb and flow of force is felt in all manner of endeavor, but in nothing so instantly or accurately as in the fine arts, the most sensitive and subtle forms of human expression. The plastic arts are as keen to record these changes as the pictorial, and the coming power of the nineteenth century found a few prophets in the dying years of the century passing away. Antonio Canova (1757–1822), born near Venice, left many graceful and delicately finished works. His "Three Graces" and group of "Cupid and Psyche" are well known, also his colossal bust of Napoleon and seated statue of Washington for the State of Carolina. France produced a master in Jean Antoine Houdon (1741–1828), more vigorous than his contemporaries, as seen in his powerful work, the seated statue of Voltaire. His statue of Washington, in the state capitol of Virginia, while preserving a faithful likeness, has a singular air of French elegance. Despite his strength, Houdon was not more accurate in study than the great Dane Thorwaldsen, born at Copenhagen, 1770. His famous "Lion of Luzerne" is known to all tourists, and his bas-reliefs are familiar the world over. His chief religious works, the colossal figures of Christ and the twelve apostles, are in the church at Copenhagen, where he died in 1844. The greatest name of this period in England was John Flaxman (1755–1826), who was as successful a teacher as he was a worker in his art. He was the originator of the cameo designs on the Wedgwood ware, being particularly happy in delicate reliefs. Christian Daniel Rauch (1777–1857) achieved the place of honor among German sculptors of this time by his heroic imperial monuments, of which the most important is the equestrian statue of Frederick the Great.

Although, for many generations, Rome was the Mecca of artistic pilgrims, and most of the great names have at one time or another been enrolled upon the list of students sojourning within her gates, the race characteristics of each strong mind were liable to find expression in spite of classic training; and when the mature artist brought forth his own creations independent of the touch of school or master, they were likely to present his own national tendencies of thought. Of late years, with increased facilities for studying other art centres, of intercommunication of ideas by travel and increasing duplication of works of art by various reproductive processes, the "art atmosphere" seems to have extended so as to absorb, and in a great measure obliterate, distinct lines of racial difference in manners of expression, the fundamental principles of truth being more generally sought for and applied. Thus, the unmistakably Teutonic aspect of German sculpture in the early half of this century shows in the great monument to "German Unity," by Schilling, at Niederwald on the Rhine, and the Walhalla decorations, by Ludwig Schwanthaler, for King Louis of Bavaria. German seriousness of purpose lends a dignity of appearance, even if it becomes somewhat grandiose at times, and German painstaking accuracy perfects the technique even to the finish of small details. During the same periods, in Italy, the classic influence was more dominant where the Roman school still held sway, and delicacy deteriorated into insipidity, and finish became finical. Religious and classic subjects were most frequently produced, beside more vital work in portraits, statues, and busts. Some there were who struggled for freedom, among them Lorenzo Bartolini (1777–1850), a Florentine professor, whose group, entitled "Charity," is in the Pitti Palace. Luigi Pampaloni achieved a surprising fame for his figures of children, one of which, from a monument on a Polish sepulchre, has been widely copied in cheap plaster under the erroneous title of "The Praying Samuel."

In France, the advance of sculpture has been more continual and consistent, the national artistic temperament finding abundant means of expression in the plastic art. The French dramatic instinct has a sure perception of the effect of a pose, the value of graceful or vigorous lines and the balance of proportion, so that whether under bonds to academic tradition in matters of technique, or broken loose and working under individual inspiration, the French sculptor is likely to create an artistic result. The minds of the common people are more awakened to artistic impressions through the general excellence of the public monuments and sculptural decorations, so freely displayed throughout the land, than are the masses in countries where art is at a low standard. Until after the middle of the century, French sculpture, like the rest, was mainly of smooth and delicate finish and inclined to be romantic, though François Rude was powerful and vigorous, as shown in his patriotic group "Le Chant du Départ" on the Arc de Triomphe. In England, the seeds of Flaxman's sowing slowly began to bear fruit in an awakening public interest, though the earlier efforts were sedate and conventional rather than spirited, the most important works being dignified and stately monuments and memorials. Westmacott (1777–1856), Francis Chantrey (1782–1841), whose large fortune was bequeathed to the Royal Academy as the "Chantrey Fund;" John Gibson (1791–1866), a pupil of Canova; Henry Weeks (1807–1877), who made the first bust of Victoria as Queen; and Alfred G. Stevens (1817–1875), are a few of the more notable men of the past generation. Thomas Woolner (1825–1892) expressed the feeling of the pre-Raphaelite movement in sculpture, as did Hunt, Burne-Jones, and Rossetti in painting.

American sculpture began with the new century and, like most American growths, began in a very small way; for although Rush had made a few figures, notably a fountain now in

Fairmount Park, one of the first pieces of sculptural work in the country was that of a poor New Jersey stone-cutter, John Frazee, who tried to comfort himself for the death of his child by making a memorial figure of him, although he had never seen a statue. From this meagre beginning started a line of ever-increasing strength, until now, in the plastic arts, as in all others, we can hold our own with the best in the world. Of course the earlier students, led by Horatio Greenough, of Boston, Hiram Powers, of Vermont, and Thomas Crawford, of New York, made their way to Rome, where they applied the traditional methods to traditional subjects with conventional results. Greenough's colossal statue of Washington is in the Capitol grounds; Powers's "Greek Slave" is owned by the Duke of Cleveland; and Crawford's "Orpheus seeking Eurydice," now in the Boston Museum, and "Colossal Liberty" in the Capitol, are his best-known works. Erastus Palmer, of Albany, contemporary with these, developed his talent at home, and secured models and subjects from his own neighborhood, giving a distinctly American character to his work. Among the most noted of the American colony at Rome, although not particularly given to American subjects, was William Wetmore Story, of Salem, Mass., born in 1819. Thomas Ball, born in the same State in the same year, was of the same class in Rome; but his themes are more patriotic, notably the "Emancipation" group in Washington. Harriet Hosmer is the first feminine name on the American list of sculptors. She also settled in Rome, where she completed many works. William Henry Rinehart and Randolph Rogers were both of the idealist school, the latter completing Crawford's unfinished Washington monument at Richmond. The name of Rogers is more commonly connected with the familiar little statuette groups of every-day domestic scenes so appealing to the popular taste. The sculptor John Rogers, of Massachusetts, has also made a few large works, among them the equestrian statue of General Reynolds, before the City Hall, Philadelphia. Henry Kirke Browne (1814–1886) made a number of equestrian statues of note, one of Washington being the first bronze actually cast in America. His figure of General Scott was cast from captured cannon, relics of the Mexican war. His pupils, Larkin Meade and J. Q. A. Ward, both attained high places, the latter being especially prominent in the progress of American sculpture through such works as his colossal Washington for the New York Treasury Building, and his "Indian Hunter," "Pilgrim," and "Shakespeare," in Central Park.

After the middle of the century, French art became emotional and dramatic, the notorious "Dance" for the Paris Opera House, by J. B. Carpeaux, being one of the first of the new utterances. Paul Dubois was less astonishing in manner, and Henri Chapu was still more restrained, although far more vital than the old conventional school. The name of Frédéric Auguste Bartholdi should be known to every American by reason of his colossal statue of "Liberty Enlightening the World," now standing sentinel in New York harbor. This, and his figure of Lafayette offering his services to Washington, were presented to America by the French government. Antoine Louis Barye (1795–1875) was a sculptor *sui generis*, a law unto himself of his own development; and though he has many followers, as a sculptor of animals he has no rivals. In many branches of art he was proficient, but his best-known works are the marvelous studies of animal life, modeled with infinite skill.

When the great wave of impressionism rose and flooded the land, carrying music, literature, and the drama before it, plastic art as well as pictorial was caught up too, and whirled into a variety of strange forms. Auguste Rodin led the new movement in sculpture, his manner being copied with varying degrees of success by lesser lights, and like all new movements run to foolish extremes by incompetent followers. His heroic group, "The Bourgeois of Calais," will indicate his style. From extreme realism on one side, with portrait statues in the last detail of modern costume, silk hats, kid gloves, and in one case holding a cigar, to the vague suggestions of a shapeless mass of marble, out of which protrude unfinished limbs and half-developed heads, sculpture has been pushed from side to side, but is settling into a vigorous, steady, onward movement, in which the best men of all nations stride along together. In the limits of a short article it is impossible to mention all deserving names, but a few will serve as types, and the Americans are well worthy to head the list.

Daniel French's grand majestic golden figure of Liberty, towering above the Court of Honor, the imperial hostess of the World's Fair at Chicago, placed him at once on a pedestal of fame. From the prominence of his beautiful Columbian Fountain opposite the golden Goddess, Frederick MacMonnies became known the land over. His greatest late work is the crowning of the soldiers' and sailors' memorial arch for Prospect Park, Brooklyn, with a colossal quadriga of Triumph and groups of the army and navy. Augustus St. Gaudens, though a cosmopolitan, is truly an American sculptor of the first rank, whose statues of Admiral Farragut in New York, Lincoln in Chicago, and the sturdy Puritan, Chapin, in Springfield, Mass., are well known. Olin Warner is another distinctively American product, although he had the advantage of some training in Paris. His work is French in technique but not French in spirit, having the native traits of freedom and originality, as shown in his figure of William Lloyd Garrison, and later in his relief portraits on the art building at the Columbian Fair. This great occasion offered opportunities to American sculptors of which they took full advantage, showing the high rank to which they were entitled. It made an American of Carl Bitter, the talented Austrian, whose decorations on the Pennsylvania Railroad Station, Philadelphia, are well known. It added further lustre to the name of John J. Boyle, whose heroic "Indian Mother" in Fairmount Park, and seated statue of Benjamin Franklin, are matters of just pride to Philadelphians. It gave prominence to such men as Lorado Taft, with his graceful work on the Horticultural Building; Philip Martiny, on the Agricultural Building; the great Columbus quadriga, by E. C. Potter and Daniel French, whose beautiful relief of "Death Staying the Hand of the Sculptor" is a masterpiece. All visitors to the White City will remember the vigorous animal studies by Edward Kemys, and the Indian figures of A. C. Proctor. The sculptural commissions of the Congressional Library in Washington have produced a remarkable collection of works by talented Americans, and every great exhibition brings interesting examples from those already named, and such others as Herbert Adams, Edwin Elwell, Bessie Potter, with her dainty little statuettes, portrait work by Charles Grafly, Catherine Cohen, C. E. Dallin, strange visionary suggestions, in the Rodin manner, by George Bonnard, and an array of lesser names too numerous to mention.

For this reason, but few of the notable names of modern foreigners can be given. However, Hamo Thornycroft, of England, must not be overlooked, whose famous "Mower" is much admired; nor Onslow Ford, more youthful and romantic in style. John Henry Foley, of Dublin, has had a pronounced effect on English sculpture, being a successful teacher, including among his pupils several distinguished women, among them the Princess Louise and the Earl of Elgin's granddaughter, Miss Grant. George Tinworth's terra cotta reliefs must conclude the list of English works. A few Russians have reached eminence, mainly by animal studies. Antocolski, a Jew of Wilna, of poorest parentage, has done powerful figure work of a serious, rather melancholy sort, the most important being a "Christ Bound." What is best in modern Italian and German work is practically French, and of the French themselves the list is too long to complete. A few must suffice, such as Jean Alexandre Falguière, who aspires, like Carpeaux, to give vitality by means of vigorous action to his figures. Emanuel Frémiet has worn with some distinction the mantle descended from Barye's shoulders. Vidal, another pupil of Barye, was blind for twenty years, yet gained two medals for correct anatomy in his modeling. Carrier Belleuse's "Hebe Asleep" is an example of the delicate style, and Alfred Boucher shows the other extreme in his rendering of sturdy masculine figures, toiling or racing, striving to present in sculpture the picture of human struggle for existence, as did

Millet in his paintings. These materialistic studies represent the fight for the bread and breath of life, while the impressionist contortions of the Rodin school try to suggest the conflict of emotions, good and bad, and the battle of spiritual and physical desires and development.

III. CERAMICS AND GLASS WORK.

From time immemorial to the present day men have been fashioning shapes of clay, experimenting with different kinds, different degrees of heat, and different chemical combinations to form glazes and colorings. The fundamental processes of pottery making have changed but little since prehistoric times, and wall pictures of the days of the Ptolemies show the potter's wheel whirling much as it does at present, although, of course, many modern inventions have been made to facilitate different forms of work. In the famous Sèvres factories in France, established under royal patronage and still remaining government property, a modern device has rendered possible the making of large vases of extremely thin ware. To prevent the delicate paste of which these are made from collapsing by its own weight before it can harden, the vase or jar is moulded in an air-tight chamber, the mouth of the object sealed, and the air exhausted from the chamber, leaving the object in a vacuum. The air contained in itself is sufficient to hold up the sides until they harden and danger of collapse is over, when it can be fired. Attempts were made in vain to equal the delicacy of the Chinese egg-shell ware, when, one day an educated Chinese visitor to the factories observed the method employed, and exclaimed, “This is the way we make those cups,” and, taking a mould, he dipped it into the liquid paste, rinsed it around and emptied it at once. A thin film like a soap bubble remained in the mould, which hardened enough to form the dainty ware the workers had been trying without success to produce; so the Chinese method was at once adopted. About the middle of the last century an impetus of development in ceramic art appeared all over the continent of Europe and in England. This was probably due to the discovery, in different places, of kaolin or the fine clay of which porcelain is made, which stimulated the pottery industry and caused the establishment of many factories which are still working to-day. The Dresden works, founded in 1700, were hidden in an old fortress, and their secrets jealously guarded. After about a century they went into decay, but in 1863 were revived and reëstablished in large new buildings of their own, where dainty flowered ware is produced, which has again come into popular favor. Italian ceramics are apt to be florid and overloaded with decoration, that called “majolica” deriving its name from the island of Majorca, where it was first made. “Fayence” comes from Faenza, and the French form of the name, “faïence,” has been used to designate porcelain in general. The town of Limoges, in France, has been a centre of ceramic art since 1773, when a French firm established a factory for the production of a peculiarly fine ware, made possible by the superior quality of the kaolin found in the neighborhood. In 1839 a lady in New York showed the Haviland firm a cup of delicate ware, asking them to match it for her. It was so much finer than anything they had seen that they desired to import some for their own business. With this end in view, Mr. David Haviland took the cup and went to France trying to find where it had been made. He was directed to Limoges and, in the factories there, he tried to have English shapes and decorations copied in the exquisite ware. The conservatism and slow methods of the place were not equal to his demands, and he therefore established a factory of his own, which, since the middle of the century, has been the most important in the town.

In England, the most celebrated potteries are all over a century old, and the ceramic art has been developed to the highest degree both in technical and artistic directions. The works of the Doulton firm, who own many potteries, are particularly rich in color, and decoration, those from their factory at Lambeth being especially fine. So also are the Coalport wares, celebrated for their rich blue color, the Royal Worcester and the Crown Derby. In these English factories, and also in those on the Continent, artists of great skill are employed as decorators, and in the Wedgwood works the delicate cameo figures in white relief on a tinted ground were originated by the famous sculptor, John Flaxman. In America, the Trenton potteries turn out a vast quantity of wares of varying degrees of artistic excellence, and one factory has the secret of an old Irish ware, the Belleek, of indescribable delicacy, like an iridescent sea shell, long thought to be a lost art. The Rookwood pottery, of most artistic quality in design and color, is made in Cincinnati, and was the invention of a woman who has trained a school of girls as decorators; as has also the Tiffany firm in New York for their marvelous glass work. An adequate description of the work of this firm would fill a book, as they have developed undreamed-of possibilities in the use of glass for decorative purposes. They have revived forgotten arts of coloring and invented new processes of treatment, that give results like fairy work, no two pieces being alike. These and many other forms of industrial art products are brought to a high plane of perfection nowadays, although the word "art" is grievously abused, being applied to everything salable, from writing paper to soap. The great schools and institutions which teach the arts and industries combined are doing vast good, however, in improving public taste and teaching the world to discriminate between true art and false, and their influence can already be felt in higher standards of decoration in articles of common daily use.

IV. INDUSTRIAL ARTS.

Closely following painting comes black and white art in various forms, either reproductive or original work, and it is difficult to discriminate between fine art and handicraft in the many processes employed. Engraving on metal has long been known, and steel was considered an especially valuable method of reproducing paintings until within a generation. Etching is another old form of black and white work, and is still popular, though less so than formerly. Wood engraving during this century has passed through many stages of development, and in the illustrations of books and magazines has been brought to a high standing as a fine art. It is still used in many ways, but all those processes that require line work by hand are being superseded by the photo-type processes, of which there are many kinds. The making of plates or blocks for printing required skilled hand work, and the engravers and wood-cutters were necessarily artists themselves, so that while they were copying the work of others they were also producing works of art themselves. The plates and prints were, therefore, valuable and expensive, and, as modern haste grew more and more to demand cheap quick work, the old careful style of working gave way to mechanical methods of greater speed. With the development of photography and its application to the engraver's art, while a certain individual artistic character in the work was lost, the actual copying of painting in all the details of light, shade, and half tones has been carried to a high degree of perfection. By what is known as photogravure, every tiny brush mark and every different tint of color is reproduced with scientific accuracy in black and white. This is accomplished by having a photograph of the painting taken on a gelatine film, which is suspended in a bath of acid in the line of an electric current. This current, playing over a sheet of copper, sets free the molecules of metal that are deposited upon the film, and filling all the little inequalities of the surface, produce what is practically a cast of the photograph in copper. The plate, thus secured, is gone over by hand and finished here and there with engraver's tools, and from this prints may be duplicated to any extent. In engraved plates the design is cut into the metal, incised lines being either drawn by hand with a sharp point, called "dry point" work, or eaten in by acids, the remaining surface of the plate being protected from the acid by a greasy film. In wood-cutting, the blocks show a reverse process, the design being left standing in fine lines, while the remaining surface is cut away, so that a wood-cut is in reality a carving in low relief. The modern electrotype processes produce a similar result on a metal block by the action of acid, a method capable of most speedy work and therefore in demand among the multitude of daily publications illustrating current events. Of course these hasty results can scarcely be called fine art, but they are developments of artistic industries, calculated to meet certain needs of our busy civilization.

For more artistic effects, various forms of lithography have given beautiful results. This valuable process was accidentally discovered in 1796, by a young Bohemian, Aloys Senefelder, of Prague. Desiring to write a list, and having no paper, he scrawled on a fine stone floor tile a few words, and later on, coming to remove them, he bethought him of an experiment with acid on the stone. This he tried, finding the stone eaten away all around his writing, leaving that raised in sufficient relief to print from, the lettering being done with a greasy writing substance that repelled the acid. Later experiments proved that the eating away of the stone was not necessary if the design were made with an oily material and the rest of the surface kept moist with a weak solution of acid. A greasy printing ink being applied would stick only to the oily design and not to the acidulated surface, which process made possible the printing from flat stones, which were not so liable to wear out as the relief designs. Senefelder died in 1824, living long enough to see his invention in use throughout the world, although of course he could not know the improvements that photography would bring. On the centennial anniversary of this great discovery in 1896, exhibitions of lithographic works were held in London and Paris, and the possibilities and developments shown. Mr. James McNeill Whistler has made many very interesting experiments with it, as have also Mr. Joseph Pennell and Mr. Hubert Herkomer. The latter has made innumerable experiments and inventions in his busy artistic career, and has just recently perfected an improvement on lithography which he calls "plate printing," and which has been dubbed by the irreverent the "Herkotype" process. It is simply painting in a peculiar oily ink on a metal plate, which, while the ink is moist, is dusted over with a fine powder which adheres to every brush mark on the surface. One ingredient of this powder is a metal that is electrically conductible, and, after the excess of powder is brushed off, the plate, with what remains sticking on the oily surface, is placed in an electrotype bath. The copper deposited thereon by the electric current hardens and forms a negative of the original painting, which can be stripped from the plate and used in a printing-press, giving an absolutely faithful reproduction of the artist's handiwork. A similar process, called "algraphy," has been invented by Mr. Scholz, of Mayence, who has developed the possibilities of aluminum for plate work, the advantage of this material over stone or other metal being its extreme lightness. These processes are especially valuable to artists who can work in black and white, as their own original conception is perfectly reproduced without the possibility of misconception by some copyist, as exists where a painting is interpreted by an etcher or engraver.

Of the new processes or improvements on the old, that have arisen because of the discovery of photography, it may be said their name is legion. Photography itself is rapidly being developed into a fine art, and has become one of the most important factors of modern existence. It combines science, art, and industry, and is equally necessary to all these occupations. While it is difficult to state what was the first attempt that led to the suggestion of photography, it may be supposed the experiments of the Swedish scientist Scheele were among the first. He found that the action of the sun's ray blackened silver chloride, and others experimenting after him, at the beginning of the century, had glimmering ideas of the possibility of a new art. As has so often happened with the dawning of some great idea, some new appreciation of a great natural law, the thought was working in many minds, and the discovery seemed to be almost simultaneous in several places. As early as 1802 Wedgwood published in the "Journal of the Royal Institute" an "account of a method of copying paintings on glass and of making profiles by the agency of light on nitrate of silver, with some remarks by Sir Humphry Davy." These gentlemen were, however, unable to fix the impressions they procured, and a Frenchman, De Niepce, seems to have been the first to succeed in this direction. In 1826, learning that M. Louis Jacques Daguerre was experimenting on the same lines, he conferred with him and they formed a partnership. The latter seems to have been the more businesslike of the two, and the process they evolved became known as the “Daguerreotype.” De Niepce died in 1833, and Daguerre continued the partnership with his son Isidore, making many improvements, and becoming really the pioneer of modern photography. The extent of advance may be calculated from Daguerre’s own remark, that “a landscape requires seven or eight hours to be photographed, but a single statue or monument, if strongly lighted, can be taken in about three hours.” Comparing this with the instantaneous camera work of to-day, that gives us the lifelike moving figures of the kinetoscope, will illustrate the change wrought in two thirds of a century. The earliest portrait work was slow and tedious, the first portrait in New York probably being produced by Dr. Draper, the scientist, although the celebrated Professor Morse was vastly interested in the new science or art, and advanced its cause in this country.

From the beginning of photographic experiments, the greatest desire has been felt to photograph in color, and numberless attempts with more or less success have been made, but the processes are mainly slow and very expensive. A new method of photo-printing in color, however, has recently developed very artistic possibilities. This is accomplished by means of three plates, one for each of the three primary colors; the negative having been made and the plate prepared for printing in each color, the inks of each color are applied separately. One printing produces a red impression, directly on this comes a yellow impression, and on top of that is put a blue; and as all gradations of color are composed of various proportions of these three primary tints, the “overlaying” of the three inks produces a picture containing all the variety of the original subject. A still more recent discovery makes an impression upon a glass plate that gives all three colors on the same plate; but this process is a secret, and is too new to be classed among the successes of industrial art as yet.

One of the later and more notable uses of photography is found in its application to the purposes of astronomy, an evolution in modern science, which, although still in its infancy, has already produced wonderful results. About the middle of the century photographs of the moon were secured by Warren De la Rue and other astronomers, which greatly facilitated studies of the earth’s satellite, and these were followed by photographs of the sun and the sun’s corona during eclipse. It was not, however, until Professor Henry of the Smithsonian Institute originated the idea of uniting the camera with the telescope that the marvelous possibilities of stellar photography were discovered. It is not too much to say that this discovery has revolutionized the science of astronomy, extending the field of human observation into the realm of the infinite. By the aid of clockwork attachments, the telescope is made to follow the apparent motion of the star to which it may be directed, throughout the night, if desired, and the sensitive photographic plate is exposed to the action of light during a corresponding period. “Each image, however faint, has a comparatively long time on the sensitive surface, and therefore exerts a cumulative action.” The result is that stars are pictured by the camera which no human eye has ever seen. It is estimated that the camera has revealed double the number of stars discovered by the most powerful telescopes. In 1887, at a convention of astronomers held in Paris, it was resolved to photograph the entire skies, with the purpose of making a new stellar atlas to include the latest discoveries among the heavenly hosts. With this object the firmament was charted in squares, and each observatory of importance throughout the world was assigned certain of these squares to work on. This monumental labor is still going on, and it will necessarily be extended well into the first quarter of the twentieth century.

The epoch-marking paper of Dr. Röntgen, in which he announced the discovery of the X-ray, was made public in the latter part of 1895. It immediately attracted the attention of the scientific world, and, since that date, endless successions of experiments have been made with the marvelous ray in all civilized countries. The X-ray produces no noticeable effect on the retina of the eye, and we therefore acquire knowledge of it through indirect agencies. One of these agencies is the photographic plate, on which, under certain conditions, the ray acts somewhat in the same manner as does a ray of light. It is not a ray of light, in the ordinary sense, as it penetrates opaque bodies which light cannot traverse. Just what it is scientists are not yet ready to state, but its discoverer defines it as "a longitudinal vibration of luminiferous ether." This vibration will traverse many substances opaque to light, as wood, paper, vegetable and animal tissues and fabrics, as wool, cotton, silk, etc.; and, if then directed upon a photographic plate, will produce an image there. The resulting picture is not of the object traversed by the ray, but of any intervening object which it does not pass through. As a consequence, the picture is the image, so to speak, of a shadow, and, hence has been called a "shadowgraph." To illustrate, if the ray is directed through a human body, it will give a "shadowgraph" of the bones, or of a bullet or piece of metal, if such foreign substance be encountered on its way. Again, the ray will traverse a diamond and cast no shadow, but it will not pass through the finest imitation ever made, the "shadowgraph" showing the manufactured article.

The Century's Advance In Surgery

By J. MADISON TAYLOR, M.D., and J. H. GIBBON, M.D.,
Surgeon in Pennsylvania and Children's Hospitals.

At the Dawn of the Century.—In the year 1579 the celebrated French surgeon, Ambroise Paré, probably the greatest of his day, in completing his work on "Chirurgery," made the following statement, which to us of to-day is both amusing and pathetic. He says: "For God is my witness, and all good men know, that I have labored fifty years with all care and pains in the illustration and amplification of Chirurgery; and that I have so certainly touched the work whereat I aimed that antiquity may seem to have nothing wherein it may exceed as beside the glory of invention, nor posterity anything left but a certain small hope to add some things." This great man had scarcely passed away when the practice of surgery of his day was a thing of the past, due to the realization of that "certain small hope" which he allowed as possible to posterity. Every reader, when he reflects upon the crude surgery practiced in those days, when the operations were those of necessity and not election,—that is, were done for injuries and not for disease, done to relieve and not to cure; when he remembers that not only antiseptics but also anæsthetics were unknown, must be filled with sympathy for this old gentleman, and wonder what he would think *now* were he to see what progress posterity has made and is still making.

It is not our purpose, however, to carry our researches so far back as Paré's time, but to begin with our own century and bring before the reader the advances in surgery since the day of our grandfathers.

In the beginning of this century surgery was practiced by many great men, men who did not enjoy the self-satisfaction of their predecessor, Paré, but who accomplished much by constant endeavor and faithful application to advance this art and science. They, too, realized manifold "hopes," and their children and grandchildren have moved on, and to-day are still pressing forward in the line of invention and discovery. But to us, the art of an hundred years ago appears widely different from that of our day. Anæsthesia had not then been discovered, no germ theory had been evolved, and, consequently, no such thing as antiseptic or aseptic surgery was known. The abdomen was opened for disease only, and rarely; and brain surgery consisted solely in trepanning for fractures of the skull. Surgery was not regarded as a specialty, but every surgeon was also an obstetrician and a practitioner of general medicine. Outside of the treatment of broken bones, dislocations, gunshot wounds and injuries, the surgeon at that time operated for strangulated hernia, for stone in the bladder—"cutting for stone," as it was called; for cataract and for cancer. Dentistry was just beginning to be taken up as a specialty, and all medical men extracted teeth, and many filled their cavities. Ophthalmic surgery consisted largely in operations for cataract, and was done by the general surgeon. One department of the surgeon's education at this time was well attended to, and that was his anatomic knowledge. Our bodies were the same then as now; and although the surgeon dared not trespass in anatomical fields which are familiar ground to the student of to-day, he did study the body after death, and was quite as well informed regarding the gross anatomy of the human body as the surgeon of to-day; and, had anæsthesia been known to him, he would probably have accomplished nearly all that was done during the middle of the century by his successors.

During the first quarter of the century no great advance was made in surgery, that is, nothing revolutionizing; but many minds and hands were at work perfecting old methods of operation and devising new ones. They had to trust to whiskey and opium to control the pain of the patient, and consequently operations requiring much time in their performance were avoided when possible, and, when necessary, had to be performed with such rapidity that the essential object aimed at was often missed. The patient was given a large dose of laudanum and a huge drink of whiskey or brandy, and was then held or tied on the table while the surgeon proceeded with his work. One can readily understand the torturing pain the poor patient had to endure, and the hurried and often unsatisfactory operation which the surgeon had to perform. The endurance of pain was not the worst part of the patient's lot, for afterward he ran the greatest risk of blood-poisoning and gangrene, which were common complications in those days. It was the rarest thing for even the simplest operation wounds to heal by "primary union," as it was called,—that is, without the formation of pus. Every wounded surface was expected to go through a certain amount of suppuration. Many patients lost their lives from compound fractures of their bones; and a compound fracture, that is, where there was a wound connecting the seat of fracture with the skin, usually meant many months in bed, and very often the loss of the limb.

Excepting for the purposes of removing a fœtus from the womb (the so-called Cæsarian operation, because Cæsar was from "his mother's womb untimely ripped"), the abdominal cavity was practically never opened, and when it was the patient nearly always died. The operation for the radical cure of hernia was seldom resorted to, excepting when strangulation of the intestine necessitated operative interference to save the patient's life. During the latter part of the eighteenth century the quacks, calling themselves "rupture cutters," were not scarce; but the great mortality of their practice produced a wholesome fear among the people. The operation was so often fatal that most of the best surgeons would only perform it under unusually urgent circumstances. What caused the deaths was peritonitis, or gangrene of the intestine, and not the method of operating; for at this time nearly every method of operating had been devised that was in vogue fifty years later.

Bone surgery, the treatment of fractures, dislocations, and diseases of the bones, was greatly improved in the first half of the century, this subject receiving more attention at the hands of surgical writers than any other.

Anæsthesia.—Anæsthesia may, certainly from the patient's point of view, be looked upon as the greatest advancement ever made in surgery. It was great not only for the reason that it gave the patient absolute unconsciousness during the time of the operation, but because it enabled the surgeon to work with greater exactness and less hurry. The conception of the anæsthetic state did not, however, come into being for the first time in our century, for, like most great ideas, it agitated the minds of medical and scientific men for centuries. Gross tells us that Theodoric, in the thirteenth century, recommended the inhalation of a certain combination of opium, hemlock, and other vegetable derivatives for the purpose of producing sleep, and that in India similar combinations were for centuries in use. It is needless, however, to say that the effect produced was nothing like that following the use of nitrous oxide, "laughing gas," ether, or chloroform, and that their use never became general. Toward the close of the last century Sir Humphry Davy and others performed repeated experiments with nitrous oxide gas, but finally gave up in despair. In the early part of our own century several methods of producing insensibility to pain were recommended, such as pressure on nerves and bleeding to the degree of producing unconsciousness, but none of them was ever sufficiently successful to render their adoption general; and it remained for a New England dentist, Dr. Horace Wells, in 1844, to first use satisfactorily upon himself and his patients the complete state of unconsciousness produced by nitrous oxide gas. This poor man, however, failed signally when he endeavored to demonstrate its powers before a body of medical men, and was subjected to the most unwarranted ridicule. However, a pupil of this man, another dentist, named Morton, two years later, experimented with ether, and finally proved upon himself and on patients the wonderful power of the vapor. He exhibited his discovery at the Massachusetts General Hospital at Boston, where Dr. Warren performed an operation upon a patient etherized by Dr. Morton. The fame of this man and his great discovery spread rapidly over the continent and into the Eastern Hemisphere, and in 1847 Sir James Y. Simpson in Edinburgh discovered the anæsthetic powers of chloroform. These two agents, ether and chloroform, have existed as rivals for professional favor for nearly half a century, one being more popular and more generally used in one country and the other in another. There is, however, a field for the use of both, the operator choosing the anæsthetic to suit the individual case. In our own country ether is more generally used in the North and East and chloroform in the South and West. Chloroform has had more deaths attributed to its use, but in many cases is a much safer anæsthetic than ether. It is most amusing to observe the attitude of the so-called conservative surgeon toward the use of anæsthetics soon after their discovery; this is particularly true of their employment in obstetric practice, many eminent obstetricians maintaining that the parturient woman was intended to suffer, and referring triumphantly to the Bible for authority. It is, however, needless to say that although many men were at first uneasy in the use of these new-found agents, those who did not take advantage of their wonderful powers found themselves rapidly becoming out of date and deserted by their patients, who preferred unconsciousness to the older method of using opium and whiskey.

Notwithstanding the great step made by the introduction of ether and chloroform, the medical man is to-day still dissatisfied and is continually endeavoring to discover some agent or combination of agents which will produce insensibility to pain without unconsciousness and without the slight danger and the uncomfortable after effects of chloroform and ether. An ideal anæsthetic then must be a local anæsthetic, one that will render the field of operation insensible and be without the slightest danger to the patient.

Local Anæsthesia.—At the beginning of our century freezing with ice alone, or with ice and salt, was the only method employed for producing local insensibility. Freezing as a local anæsthetic was, however, not extensively used until fifty years later, when Dr. Richardson of London showed the anæsthetic effect of spraying the surface of the tissues with ether. During the late sixties this method of freezing became quite popular for producing local anæsthesia for small operations such as extraction of teeth, removing nails, opening abscesses, etc., and occasionally was employed for more protracted operations, Cæsarian section having been performed a number of times by the aid of this agent. The rhigolene spray was found later to be more satisfactory than ether in many respects, and the two together were frequently used.

Another freezing agent which is now used very extensively and has entirely supplanted those just mentioned is the chloride of ethyl. This, when applied to the dry skin, produces in a few seconds complete freezing, and renders the surface comparatively painless for many of the minor surgical operations.

The properties of cocaine as a local anæsthetic were known thirty years ago, but it was not until 1884 that Dr. Kohler of Germany demonstrated its practical applicability. To-day most of the operations on the eye, nose, and throat are performed under the pain prevention afforded by this drug, and in general surgery it has an extensive field, being found satisfactory where freezing is inapplicable or general anæsthesia not desired, as, for instance, in removing small tumors, splinters, ingrowing nails, etc. In the eye, nose, and throat it is applied simply in solution to the mucous membrane, but where anæsthesia of the skin is desired, it is necessary to inject it under the skin with a hypodermic syringe. When used in strong solutions this remedy is dangerous, and it has lately been shown that weaker solutions when used in larger quantities are just as satisfactory and less dangerous.

A recent substitute for cocaine is eucaine; but, although less dangerous, it is less satisfactory and not harmless to the tissues themselves.

Antiseptic and Aseptic Surgery.—Excepting the introduction of anæsthesia, no greater step has ever been made in surgery than that which was brought into use by the antiseptic and aseptic method of treating wounds. It is now about thirty years since Sir Joseph Lister, believing in the so-called “germ theory,” evolved by Pasteur, Virchow, and others, advocated the use of agents which were destructive to germ life in the treatment of wounds. At first the great antiseptic, and the one used most generally by Lister, was carbolic acid, which was applied to the wound in solution, and used as a spray during the performance of operations, to protect the wound from infection by germs in the atmosphere. It was not long, however, before it was discovered that the danger lay not in the atmosphere but in the skin of the patient and in the hands of the surgeon and in the condition of his instruments and dressings; and to these sources attention was given with results known to us all. Other antiseptics, such as bichloride of mercury and boric acid, afterward came into use, and within the past ten years the first of these two has largely supplanted carbolic acid, and is the one reliable and practical destroyer of germs. The antiseptic treatment of wounds was probably not in full swing until about 1885–1890, and was quickly followed by the more recent aseptic method. These two can, however, never be successfully separate, as the latter is dependent entirely upon the former; that is, in order to render the field of operation and the hands of the surgeon aseptic, the antiseptics must be used. Asepsis means without poisonous germs, and, as applied to surgical treatment, it is essential that, after the instruments, the dressings, the patient’s skin, the surgeon’s and his assistants’ hands have been thoroughly cleaned with soap and water and rendered free from germs, there be use of antiseptic solutions in the wound or on the dressings. This has been a great step forward, this discovery that it was in the skin that the germs lurked, and that soap and water and a scrubbing brush were as necessary as antiseptics. Few surgeons to-day employ antiseptic solutions in wounds unless the wound itself is already infected, when it becomes necessary. In wounds which are clean and made by the surgeon under aseptic conditions, no antiseptic drug is required which may indeed be actually harmful, for these chemicals which destroy germs are not altogether harmless to healthy tissue, particularly when used in strong solution.

The discovery of anæsthesia and the promulgation of the germ theory of inflammation, together with the subsequent perfection of the means of destroying microbes, all within the memory of many now living, have revolutionized surgery to such an extent that the surgeon reaches fearlessly into regions which before were impracticable, and undertakes operations which were never even dreamed of a generation ago. One can readily imagine that no surgeon would care to undertake, and no patient would endure, the agony of an operation lasting for several hours without an anæsthetic; and that it must have been only an immediate and certain danger of death that compelled a surgeon, in pre-antiseptic days, to open an abdomen or brain when he realized the great probability of subsequent inflammation and death.

Let us look at some of the individual advances of surgery since the introduction of anæsthesia and of the use of germ-destroying agents, considering first, simple fractures.

Of Simple Fractures.—Anæsthesia was the means of permitting surgeons to “set” fractures in a satisfactory manner and without pain; and the use of antiseptics has prevented many of these fractures from becoming compound fractures. Lately there has been a change in the general treatment of fractures which is proving a great advancement. Formerly it was the custom to keep not only the broken bone itself perfectly quiet on a splint until union had taken place, but also to immobilize all the neighboring structures, joints, muscles, and tendons. This meant that when the limb was taken off the splint, not only would the bone be "solid," but there was also a tendency to fixation of the muscles and joints, so that it took the patient as long to get back the use of the limb as it did to unite the broken bone. This is now obviated in many fractures by beginning both the passive and active motion of the neighboring muscles and joints at a much earlier period than heretofore; in fact, in many fractures, such as those near the wrist, by never allowing these adjacent structures to get stiff at all, but keeping up the passive motion (while the fragments are held firmly together) from the very first dressing. In other more complicated and serious fractures where motion is contra-indicated, the use of carefully applied massage prevents largely the stiffness and the wasting of the muscles which results from long confinement on splints.

Compound Fractures.—In pre-antiseptic days compound fractures were one of the greatest causes of the amputation of limbs; and yet, to-day, these same breaks, which twenty-five years ago would have cost the patient his limb, are, by means of antiseptics, rendered aseptic and converted into a simple fracture by the closing of the wound, and the part is not only saved but fully restored to function.

Bone Diseases.—Diseases of the bones, as inflammation, caries, and necrosis, are now dealt with very differently from of old. The diseased structures are now thoroughly removed; and the inflammation which at one time kept the patient in misery and danger for a long time is subdued from the start.

Osteotomy.—This term, which means the division of a bone, is generally applied to the correction of deformities, such as bow-legs. This operation fifty years ago was not frequently resorted to, and then only in severe cases, the milder ones being left alone or treated with braces, which at best could do little more than prevent increase in deformity. When the operation was performed on the bone, it was then divided, usually with a saw. The operation nowadays for this condition is what is called subcutaneous osteotomy; that is, the wound made is only as large as the chisel used for severing the bone, about one half inch, and owing to our knowledge of microbes and our means of destroying them and preventing their ravages, hundreds of legs are made straight every year which a generation ago could not have been safely touched.

Amputations.—The first successful amputation at the hip joint, for either injury or disease, in the United States, was done in 1806 by Dr. Brasheur; the next was not accomplished until 1824. As late as 1882, the great American surgeon, Gross, wrote in his "System of Surgery:" "To no operation that can be performed on the human body is the oft-repeated maxim, '*Ad extremos morbus extrema remedia*,' more justly applicable than to amputation at the hip joint. The operation may become necessary both on account of disease and accident; but it is of so formidable a nature and so fraught with danger, that it should never be undertaken unless the patient has no other chance of escape. The great risk which attends it is chiefly due to shock, loss of blood, suppuration, erysipelas, and pyaemia.... Under highly favorable circumstances, much of the enormous wound may unite by the first intention; but, in general, more or less suppuration takes place, and in some instances the discharge is so copious as to lead to fatal exhaustion. The greatest danger of all, however, is the occurrence of pyaemia, or secondary abscess, especially in amputations at the hip joint in consequence of injury, as a compound fracture or a gunshot wound." This gives the attitude of the profession toward this operation a little more than fifteen years ago, and the dangers which attended its performance. Let us add that the mortality at this time may be expressed in the following figures. (Dr. F. C. Sheppard prepared these statistics for Dr. Ashhurst.) Of 613 cases in which the results are known, "237 occurred in army practice, of which 30 recovered and 207, or 87.3 per cent died;

71 were performed in civil life for injury, with the result of 47 deaths, or a mortality of 66.1 per cent; 261 were practiced for disease, with 105 deaths, or a mortality rate of 40.2 per cent; and of 44 amputations for unknown causes 34, or 77.2 per cent were fatal."

In 1890, Dr. John A. Wyeth of New York introduced his "bloodless method" of amputation at the hip joint, and he recently reports 69 operations performed after this manner by himself and others, in which there were 11 deaths, 5 of which occurred in cases of extreme injury, where the patients had lost a large amount of blood and vigor before operation. In 40 cases the operation was done for malignant growth, and 4 deaths occurred, 10 per cent. In 22 the amputation was made for inflammatory disease of the bone, and 3 died, 13.6 per cent. One has but to contrast these statistics to understand what antiseptic methods and recent improvements in the control of hemorrhage have done to lessen the mortality of amputations. The still more recent use of salt solution injected into the circulation of patients suffering from profuse hemorrhage has lately been the means of saving many lives which would have otherwise succumbed to the loss of blood and the shock subsequent to injury and operation. As illustrating the contrast between the septic and antiseptic methods, let us consider the surgery of our Civil War and compare with that of to-day, and we shall see the enormous differences in methods, and particularly in economy of limbs and organs as well as mortality.

Hemorrhage.—The arrest and control of hemorrhage has greatly improved within the past twenty-five years. The making of an aseptic wound does away largely with the much dreaded secondary hemorrhage of a generation ago, by preventing suppuration, which is usually the cause of secondary hemorrhage. The clumsy and complicated apparatus of former days for controlling hemorrhage has been superseded by the use of the Esmarch rubber tourniquet, the neat hemostatic forceps, and the sterile animal ligature. No surgeon thinks to-day of applying a silk ligature to a blood vessel and allowing it to hang out of the wound until it separates, so that in case of secondary bleeding he could readily find the vessel; but he applies an absorbable ligature, usually of catgut, which is sterile, and which is entirely absorbed by the tissues after it has done its work. Much suffering has been saved patients by the introduction of absorbable materials for ligation of vessels and sewing of wounds. Formerly one of the great dreads of wounds was the "taking out of the stitches." To-day where the wounds are not inflamed this is little complained of, and where the animal suture is used there is no discomfort whatever. Many means have, during the past century, been employed for the resuscitation of patients suffering from profuse hemorrhage and shock. The idea of injecting into the veins of the patient thus affected blood from another person or from an animal is not new, and has at times been quite successful. The most generally used method was to draw the blood from a healthy person or animal and inject it into the vein of the patient with a syringe: however, so-called "direct transfusion" was also employed, and consisted in pumping the blood direct from the vein of the healthy individual into that of the patient. Other materials than blood have been injected into the blood vessels of persons suffering from great loss of blood, notably milk. All of these methods have been put upon the shelf, never to be called into use again. The ingenuity of the nineteenth century suggested the substitution of a solution of common salt for blood and, to-day, the intra-venous injection of normal salt solution saves hundreds of lives. The solution is made to resemble as closely as possible the liquid portion of the human blood (the *liquor sanguinis*), especially as to specific gravity; and as it is always sterilized by boiling before being used, it is free from all the dangers which accompany the transfusion of one person's blood into another. No well-appointed operating room is without its transfusion apparatus and its salt solution ready for use.

Wounds.—Reference to the remarks on asepsis and antisepsis will show the reader that the treatment of wounds has undergone a complete change in the past quarter of a century; but probably the modern treatment of gunshot wounds illustrates this better than anything else.

Until 1885, only six cases were recorded where the abdominal cavity was opened for gunshot wounds, but since that time hundreds of cases have been treated in this way every year. The injuries were formerly considered almost certainly fatal, and if the intestine was injured the patient assuredly died. Now the abdomen is opened, hemorrhage controlled, wounds—often to the number of six or eight or even thirty or more—of the intestines closed, or an injured section of the intestines removed and the abdominal cavity cleansed and closed, with many favorable terminations to make the operation not only a justifiable one, but one of necessity and safety. There is no comparison with the present-day results of gunshot wounds of either abdomen or chest and those of a generation ago. It is the duty of the surgeon, in case of gunshot wound of abdomen, to open, explore, and repair, whereas formerly it was considered the part of wisdom to leave the patient without radical treatment and only to make him comfortable with opiates. Thus cases of damage to the intestines and viscera did occasionally recover in pre-antiseptic days, but it was the rarest occurrence.

What has been said of gunshot wounds applies also to stab wounds of the chest and abdomen.

The Alimentary Canal.—Probably the surgery of no portion of the body, unless it be the brain, has been so much improved during the past fifteen years as that of the alimentary canal. The esophagus or gullet is now opened with impunity for both disease and injury. This organ is not only approachable through the neck but also through the back part of the chest, by resection of the ribs; and the latter operation is frequently made necessary by the lodgment of foreign bodies,—buttons, false teeth, etc.—so low down in the esophagus that they cannot be reached through the mouth or through an opening made in the neck.

The Stomach.—This organ, which was formerly a forbidden field to the surgeon, is now subjected to the most varied surgical operations, from simple opening for the purpose of removing a foreign body or establishing a fistulous tract to the resection of a portion of it or to its complete resection, as has been successfully accomplished several times within the past year or two for malignant disease. The removal of the smaller end of the stomach for cancer is now a frequent operation. During the war of the rebellion there were sixty-four cases of wounds of the stomach, and only one recovered. In over six hundred and fifty cases of wounds of the intestines there were recorded only five cases of recovery from wounds of the small and fifty-nine from wounds of the large intestine.

The Intestinal Tract.—What has been said of the stomach applies also to this portion of the alimentary canal. No surgeon can nowadays call himself such if he is incapable of removing a diseased portion of intestine, it may be only a few inches or several feet, and bringing the dividing ends of remaining intestine into such apposition that healing takes place and the function is restored. Until recently, when the means of anastomosing the intestinal canal were perfected, it was the custom of the surgeon to bring the severed ends of the intestines into the abdominal incision and suture them there, establishing in this way an artificial anus with all its accompanying discomforts. This was certainly better than allowing the patient to perish from his disease, but how infinitely preferable is the present method of bringing the healthy cut ends of the intestine into apposition and reëstablishing the calibre. It is this operation which has so much reduced the mortality of intra-abdominal injuries, gunshot wounds, stabs, etc., and has made hundreds of sufferers from intestinal cancer either well again or comfortable for years. The perfection of the operation of joining one part of the alimentary canal to another has been due largely to the ingenuity and perseverance of American surgeons, who have devoted years to experimentation and practice upon the cadaver and upon animals.

The Kidneys.—The kidney has not been behind the other organs of the body in reaping the benefits of modern surgery. The first case of removal of the kidney was done in 1869 by

Simon, and was successful. It was done only after a number of dogs were operated on successfully to demonstrate that life and health are compatible with only one kidney. Since this time the removal of a kidney for disease or injury, when its fellow of the opposite side is healthy and performing its function, has been looked upon as an entirely justifiable operation. The surgery of this organ has lately so far advanced, however, that many kidneys are now treated by more curative operations. In 1880 the first operation was done for the removal of a stone from the kidney, an operation which now nearly every surgeon of much experience has performed. The operation for the fixation of a floating kidney, which is now so common, was first done in 1881. Now, since Simon's bold experiment the lives of between two thousand and three thousand persons have been thus saved who had otherwise certainly died.

The Bladder.—For generations the bladder has been considered a legitimate field for surgery, but modern methods and technique have greatly extended the domain. One of the greatest advances in bladder surgery has been the crushing of stone and its immediate removal. Until 1825 the treatment of all stones in the bladder was their removal through an incision made in the organ. At that time Civiale first performed the operation of passing a bladed instrument into the bladder and crushing the stone, then allowing the patient to pass it subsequently at urination. The operation became quite popular with certain surgeons as early as the middle of the century. The cutting operation has, however, never been entirely put aside, and even to-day it is, in many cases, the best and only procedure. In 1878 Bigelow, of Boston, devised the method which is now universally used, of crushing the stone and washing it out at once through a silver tube. This was a great stride ahead of the old method.

One of the great difficulties in deciding upon the removal of a kidney has been the trouble of finding out whether the other kidney is doing its work, and this Kelly, of Johns Hopkins University, has done much to overcome in devising his method of examining by looking at the openings of the tubes of the kidneys where they empty into the bladder. If the kidney is performing its function the urine will be seen flowing from its tube into the bladder.

Hernia or Rupture.—Probably the treatment of no condition has received more consideration from the surgeon of the nineteenth century than that of rupture, and it was not until 1891 that an operation was devised, simultaneously by an Italian and an American surgeon, which has proved for itself all that its originators claimed. Hundreds of operative methods have been brought forward for the cure of this troublesome and dangerous condition; but, until the operations of Halstead and Bossini were brought forward, little prospect of an absolute cure could be promised a patient, and the conservative surgeon would only undertake to operate upon very troublesome cases such as could not be controlled by a truss. Now nearly every case of hernia may be looked upon as curable by an operation.

Operative Gynæcology.—The operative treatment of the disease of the female generative organs has been revolutionized in our century, and its revolution has been largely due to American surgeons. The first ovariotomy ever performed was done in Kentucky, by Dr. Ephraim McDowell, in 1809. In the fifties, Marion Sims won great renown for himself and his country by his wonderful ingenuity and boldness in this line of work. The greatest advance here, as in all departments of surgery, has been made since the introduction of antiseptic and aseptic principles. To-day there is no disease or condition which, if seen early enough, cannot be cured, or essentially relieved at the hands of an expert abdominal surgeon. Thousands of women are now saved every year by these means who formerly would have certainly died or remained hopeless invalids.

Appendicitis.—This condition must seem to the ordinary reader to be either a new disease or one much more prevalent than in days gone by, but it is not the case. The cause of this appearance is the fact that in former times the condition was not recognized in its incipiency, and the exact cause of the trouble was unknown. The condition then advanced until it was called typhlitis, peritonitis, and obstruction of the bowels, etc., all of which would to-day occur if the conditions were not recognized early and treatment immediately instituted before the inflammation and infection extended from the appendix to neighboring tissues.

Brain Surgery.—This branch of surgery is practically a triumph of recent years. Formerly the brain was never interfered with except for injury (traumatic), and even then nothing was done excepting for the removal of pressure, as from a piece of depressed bone, and the institution of drainage. To-day the skull is opened for epilepsy; abscesses of the brain are opened and drained successfully, and tumors of the brain are removed, thus not only in numberless instances saving life but—what is equally important—saving the usefulness of the life and mind. The first actual successes in this line are recorded by Bennett and Godlee in 1884, who localized and operated on and ultimately found a tumor. The patient died, but the bold beginning was followed by a number of other surgeons, till this new region for exploration, hitherto untouched, has become a fertile ground for successful efforts. Abscess of the brain, until twenty years ago, was almost invariably fatal. MacEwen in 1879 located an abscess of the brain and begged to be allowed to operate, but was refused by the family of the patient. After the death of the patient he operated precisely as he would have done in life, evacuated the pus and demonstrated that had he been permitted to do so he could have saved life.

Where the cranium is wounded surgeons nowadays will not hesitate to open the skull, secure the bleeding vessels, remove clots, and thus many lives are saved. Even comparatively slight injuries to the skull, where the brain is damaged, involve oftentimes destruction to the arteries and blood is effused, producing such destructive pressure as causes very serious symptoms or even death. In other instances, the results of a blow or a fall without injuring the skull may cause profound damage and subsequent hemorrhage. In all these cases operative interference, now extremely safe and easy, may readily save life. Gunshot wounds of the brain are now only occasionally fatal, provided opportunity offers for prompt and clean operative work. Even where the ball has traversed the entire length of the cerebrum, recovery has followed operation. The results of brain surgery in relieving certain forms of epilepsy are occasionally most brilliant and frequently much relief is afforded. Where the epilepsy is of the character known as focal, and where there is evidence of irritation of the brain, due to a local pressure, whether of the cranial walls or of some new growth within the brain tissue, the removal of these sources of irritation has in many reported instances been most satisfactory. Again, certain cases of protracted headache, so severe as to render life insupportable, have been cured by trepanning the skull. Certain forms of insanity have been modified and relieved where this had followed upon brain injuries. It is of great interest to reflect upon the methods by which students of brain disease are enabled to determine so exactly the location of tumors, abscesses, hemorrhages, clots, scars, and other alterations of tissue giving rise to epilepsy and brain disorders, and which afford no indication of the diseased locality by any changed condition of the surface. In dealing with other parts of the body, if the precise locality of the part to be operated on cannot be at first determined, there is no hesitation in the minds of the surgeons in cutting down upon, and searching for, that which he proposes to remove. In dealing with so delicate an organ as the brain, however, this cannot be permitted; for a variation of the very smallest dimension will sometimes change the manipulations from those of perfect safety to the most fatal results. Our knowledge of the location of the functions of the brain and the areas from whence arise governing influences has been derived almost solely from experiments upon living animals. Among the names of the great pioneers in this direction must be mentioned those of Ferrier and Horseley, of England; Fritsch, Hitzig, and Goltz, of Germany. The researches which have thus opened up a new realm of operative possibility are among the very greatest triumphs in our means of saving life and affording opportunity for relief of the most serious disablements known to modern times.

For illustration of how these studies are pursued, it may be of interest to review the method used by Horseley.

The brain of a monkey having been exposed at the part to be investigated, the poles of a battery are applied over squares one twelfth of an inch in diameter, and all the various movements which occur (if any) are minutely studied. One square having been studied, the next is stimulated, and the results are again noted, and so on from square to square. These movements are then tabulated. For example, all those adjacent squares which, when stimulated, produce movements of the thumb are called the region for representation of the thumb, or “the thumb centre;” and to all those squares which produce movements of the hand, the elbow, the shoulder, or the face, etc., are given corresponding names. In this way the brain has been mapped out, region by region, and the same minute, patient study given to each.

These animals are etherized so that they do not suffer the least pain. Such operations, with few exceptions, even without ether, are not painful. The brain itself can be handled, compressed, cut, or torn without the least pain. A number of cases have already been reported in which a considerable portion of the human brain has been removed by operation, and the patients have been about their ordinary avocations within a week or two.

Studying in this way the brain in the lower animals, it is now possible to get a very fair knowledge of the localization of many of its functions in man.

Moreover, portions of the body can be entirely severed, and, if suitably preserved, can be replaced, and they will adhere and grow as if nothing had happened. When a wound is slow in healing, we now take bits of skin, either from the patient’s own body or provided by the willing family or friends, or even from frogs, and “graft” them on the surface of the wound. They usually adhere, and as enlargement takes place at their margins, they coalesce by one half the time required for healing. Even a large disk of bone, one or two inches in diameter, when removed from the skull, can be so saved and utilized. It is placed in a vessel filled with a warm antiseptic solution, which is again placed in a basin of warm water, and it is the duty of a special assistant to see that the thermometer in this basin shall always mark 100° to 105° Fahr. The bone may be separated from the skull so long as one or two hours, but if properly cared for can be replaced, and will grow fast and fulfill its accustomed but interrupted duty of protecting the brain.

Röntgen Rays.—One of the most recent advances in the art of surgery is the discovery and use of the X-rays. In December, 1895, Professor Röntgen, of Würzburg, announced his discovery, and since then its utility has continually increased, until to-day no large hospital or properly equipped teaching institution, indeed no first-rate surgeon, is without the X-ray apparatus. By its use many doubtful cases of both injury and disease in surgical practice are thus entirely rendered clear. In the diagnosis and treatment of many fractures it is nearly indispensable, showing the exact location of the break and the position of the fragment before and after dressing. Probably in no other condition, unless it be in fractured bones, has the X-ray proved itself of so much value as in the location of foreign bodies lodged in any of the organs or tissues of the body. Before Professor Röntgen’s discovery it was not of infrequent occurrence that an exploratory operation was necessary to positively prove the presence of a foreign body, and even this was at times of necessity a failure. To-day the X-ray picture enables the surgeon to learn the exact location of the foreign body and indicates to him the best point from which it may be attacked. With repeated improvements in apparatus the time of exposure required for making the picture of the part has been greatly reduced. The advantage of this was made manifest when it was discovered that destruction of the skin, the so-called “X-ray burns,” might follow long and repeated exposure to the rays. It is not always necessary to make a plate of the part to be examined, since by simply studying the parts by the eyes through the fluoroscope or the fluoroscopic screen the surgeon can readily see everything that a photographic picture could show him. The fluoroscope or screen is now often used during the operation of removing foreign bodies; through it the surgeon can watch the various steps of his operation, his approach to the foreign body and its final removal.

If the field of its usefulness continues to expand at its present rate, it will not be long before its use as a diagnostic measure will be as valuable to the medical man as it now is to the surgeon.

By such instruments of precision as this, and others less conspicuous, the old elements of intelligent inference and argument by analogy and exclusion are rendered of less value, and a rapid approach is made to scientific exactitude in surgery as well as medicine. All this has attained a far higher quality and scope in the last quarter of this century than in any other period of the world’s history, and we may look to great advances in the coming century, in all life-conserving and remedial measures whereby the race may enjoy a larger measure of relief as well as immunity from the onslaught of disease and the results of accident.

There is shown here for illustration a photographic picture of a limb, taken by the X-ray now growing familiar to every one. It should be borne in mind that while it is a simple matter for the casual observer to note obvious solutions of continuity in bones, or the presence of foreign bodies, this is not the chief item of usefulness to the surgeon, and certainly not to the medical practitioner. A special training is required to study and interpret the findings and appearances of the tissues, their altered relationships, densities, and many other matters entirely insignificant to the uneducated among medical men or laity.

Again, the picture here shown is similar in outline to but a reversal of the shading seen through the fluoroscope by direct vision, when the greatest skill is required in noting the significance of altered states in the denser or softer tissues.

When suits for malpractice are instituted against surgeons it is not to be admitted that the evidence or findings of the “highly intelligent” but not technically skilled witness can have the slightest weight as proving the condition of tissues of which they are very ignorant, not only physiologically but more so pathologically.

Progress Of Medicine

By FRANK C. HAMMOND, M.D.,
Instructor in Gynecology, Jefferson Medical College, Philadelphia.

"As a point of history pregnant with valuable deductions, it is good to look back upon the conditions of medicine in former times and find that it has always kept pace with the progress of the physical and moral sciences. Where these, however, have been marked by folly and credulity, medicine has exhibited the same imperfections."

It is difficult to trace the improvement in successive eras, because they melt into one another by indefinable gradations. During the earliest period it was believed that physic was an art which was supposed to be most mysterious, and it was presumed that the practicers held communion with the world of spirits. The practice of medicine in those days consisted in the usage of agents necessarily unreliable, as, for instance, the word abracadabra hung around the neck as an amulet to chase away the ague, etc.

Much time has been wasted in attempting to portray the first origin of medicine. Bambilla, a surgeon of Vienna, has asserted that Tubal Cain was the inventor of cauterizing instruments, apparatus for reducing fractures, and other instruments for surgical procedures, thus endeavoring to prove that surgery antedated medicine. It is evident that medicine must have had a very early origin, for mankind even in the earliest ages suffered pain and the train of sequences due to exposure, and hence soon discovered a method of alleviation. Their category probably consisted of herbs. Unacquainted, however, with the construction and function of the human economy, practitioners were unable to trace the progress of disease, and the more fatal internal maladies were ascribed to the deities whom they feared. Hence, various superstitious practices would arise and be handed down from one generation to another. We may imagine this to have been the origin of the healing art, and such is nearly its present condition amongst the savages of Africa, Australasia, Polynesia, Sumatra, etc.

Later on, the priests became the physicians, from being the oracles of the divinity whom the people wished to consult. The various remedies were handed down from one to another, as medical science did not exist at that time. Herodotus informs us that even in his time the Babylonians, Chaldeans, and other nations had no physicians. When any one was attacked with disease the patient was carried into the public street, and passers-by who had suffered from a similar affection, or nursed one who had, advised the sufferer to employ the measures that proved successful in former cases.

The earliest writers on medicine trace its origin, in common with that of most other branches of knowledge, to the Egyptians. They appear to be the first nation that cultivated medicine and furthered its progress. Many peculiar medical properties were attributed to the deities. All diseases were supposed to originate from the anger of Isis. Resin was burned in the morning, myrrh at noon, and a composition termed cyphy in the evening, in the temples of Isis, and the sick were taken there to sleep, during which the oracles might reveal to them the means which they should employ to effect a cure. This is an illustration of the superstitions which prevailed at that time.

The earliest authentic records which we can ascertain from collateral reading are to be found in the Scriptures. Here it is stated that Joseph commanded his servants and physicians to embalm him (1700 B. C.). This shows that Egypt at that time possessed a set of men who practiced the healing art, and that they embalmed the dead. This must have required an idea of anatomy, which, needless to say, was crude and unscientific, as dissection of the human body at that time was prohibited, the penalty being death.

According to Pliny, the Egyptian kings encouraged post-mortems, for the purpose of ascertaining the cause of diseases; and this method was fostered by the Ptolemies, during whose reigns anatomy was raised to a higher standard.

Through the writings of Moses in the sacred Scriptures, we learn that the medicine of the Hebrews appertained mostly to public hygiene. Meat of the hog and rabbit was forbidden, as being injurious in the Egyptian and Indian climate. The relation of man and wife and the purification of women were regulated. The measures suggested by Moses for the prevention of the spread of leprosy have not yet been surpassed. Next to Moses, Solomon acquired quite an efficient knowledge of compounding remedies.

The Indian races were divided into castes, the priests alone enjoying the privilege of practicing medicine. Their medical knowledge was condensed in a book which they called *Vagadasastir*. They believed the body gave rise, through seventeen thousand vessels, to ten species of gas which conflicted and engendered disease. So far as we know, they were the first to record a way of testing the specific gravity of urine. Though accused of many absurdities, they claimed to cure the bites of venomous snakes and compounded an ointment which eradicated the cicatrices of smallpox,—a result which has not as yet been attained in the present epoch. The Chinese attribute the invention of medicine to Hoâm-ti, one of their emperors, who lived about 2687 B. C.; but possessing no anatomical knowledge, their surgery, to say the least, was barbarous. For over four thousand years the Chinese were not allowed to communicate with foreigners, and naturally their progress was at a standstill. They used cups, acupuncture, fomentations, lotions, plasters, baths, etc. Their midwifery practice consisted mainly of murderous principles, and it is only since the introduction of missionaries that a reformation in the medical practice of the Chinese empire has been accomplished.

The condition of medicine in Greece did not differ from that of the “rude and uncivilized nations.” But later, Greek physicians are credited with the most brilliant discoveries. The most distinguished of Chiron’s pupils was Æsculapius, who occupies the most conspicuous place in the history of medicine. Æsculapius is always painted with a staff, because the sick have need of a support; and the serpent entwined around it is the symbol of wisdom. The sons of Æsculapius are considered the fathers of surgery, and, for their distinguished valor at the siege of Troy, have been classed by Homer among the Greek heroes.

The first operation of venesection, or blood-letting, formerly so promiscuously done, with at times good, but oftener disastrous, results, and now rarely resorted to, is attributed to Podalirius, of recognized Grecian medical skill, the patient being a princess.

The early Greeks above all recognized the value of physical culture, which to-day occupies a prominent place in our curriculum. Were the children of to-day, like those of the ancient Greeks, compelled to follow a routine of physical training, a rugged constitution would replace many a “delicate” and “infirm” one, and the race propagated would tend to develop a stronger character. Then the weak-minded, now so conspicuously present, would be eradicated, and many diseased conditions fostered by an “inanimate” race would disappear.

Hygeia, from whence comes Hygiene, or the art of preserving health, was a pretended sister of Æsculapius. Anatomy could not flourish in Greece, because a most exemplary punishment awaited any untoward conduct toward the dead. Their peculiar religious beliefs regarding the rest of the soul were responsible for this.

The knowledge of the functions of the body in health and disease was appreciated by Pythagoras. Diogenes asserts that Alcmæon, one of the Pythagoreans, wrote a work on the functions, which work would consequently be the most ancient known treatise on physiology.

The age of Hippocrates (B. C. 460–370) was marked by a revolution in medical science. “This central figure in the history of medicine” was descendant of a family in which the practice of medicine was hereditary. He was an extensive writer on such subjects as epidemics, acute diseases, dislocations, fractures, etc. Owing to the impossibility of establishing a physiology without an anatomical basis, his references to these subjects are crude and incorrect. To Hippocrates we owe the classification of endemic, sporadic, and epidemic forms of disease, and their division into acute and chronic. He wrote on diseases of women and epilepsy, and his therapeutics, though crude, were a marked improvement on what had preceded. He wrote fully on external diseases and surgical therapeutics. In obstetrics he was a close observer and a thoughtful teacher. The brilliant theories and practices so diligently observed and urged by this master were thrown in the shadow by his thoughtless followers. The well-instructed physician is not ignorant of the opinions of Hippocrates, for truly the “divine old man” is the “Father of Physic.” He caused a revolution in the practice of medicine, semeiology, pathology, and dietetics. He taught physicians to observe attentively the progress of Nature, proved the inutility of theories, and showed that observation is the basis of medicine.

An important age, and one of marked progress in medicine, is from the foundation of the Alexandrian Library (320 B. C.) up to the death of Galen (A. D. 200). Under the Ptolemies dissection of human bodies was allowed, and hence, as already stated, the science of medicine received quite an impulse. Herophilus deserves first mention as a dissector. He described the brain and its vessels, the eye, the intestinal canal, and parts of the vascular system. The valves of the heart were more exactly described by Erasistratus, who discovered the lymph vessels and pointed out that the epiglottis prevents the entrance of food into the lungs.

Aretæus, more than any other up to his time, attempted to found pathology upon a sound anatomic basis, an effort which shows the scientific progress of his age.

Of all the physicians of antiquity, Galen was probably the most brilliant genius. In the midst of disorder he led back to the safer road of sound doctrine and accurate observation which distinguished the Hippocratic school. He wrote extensively on anatomy, especially regarding the muscles. He was the first vivisector, by exposing the muscles of animals and demonstrating their functions, and his classification according to their use is at present in vogue. Carefully regulated vivisection has been, and always will be, of incalculable benefit to the development of accurate medical knowledge, and an indirect aid in the alleviation of human suffering. Galen divided the body into cranial and thoracic cavities, and described the organs, etc., contained therein. Anatomy and physiology, the fundamental bases of medicine and surgery, made the most progress during the period just reviewed, and next came the description of diseases, their medical and surgical therapeutics.

After the sixth century medicine was exercised almost exclusively by the monks of the West. They were unworthy the name of physicians, as they resorted more to prayers, and were retarded by ignorance and prejudice.

During the seventh and eighth centuries there were among the monks a few traditionary remains of science, originating from the East. The prelates, archdeacons, etc., though continuing the practice of the healing art, were gradually discouraged by the church, but as late as the middle of the fifteenth century the Bishop of Colchester was chaplain and first physician to Henry VI. In 1452 physicians of the University of Paris were not allowed to marry, the applicant, prior to admission, taking the oath of celibacy.

During the twelfth century the school of Salernum, through the personal interest manifested by Emperor Frederick II., acquired a degree of reputation attained by few similar institutions in ancient times. Schools in Paris and England were placed on an advanced standing, the professors being salaried; and about this period the titles of bachelor, licentiate, and master, were granted to the physicians.

During the thirteenth and fourteenth centuries medicine made remarkable progress in France under St. Louis. During the reign of this prince the teaching of medicine and surgery was divided into separate and distinct classes. Medical institutions now became greatly encouraged, and in the leading cities of Europe universities were erected under the auspices of royalty.

Medical instruction experienced an important revolution in the European countries during the fourteenth century. For the first time in Europe anatomy was taught by dissection of the human body. Guy de Chauliac, who lived at the end of this century, wrote a treatise on surgery which served as the basis of European instruction until Ambroise Paré of France published his celebrated work upon the same subject.

The fifteenth century was also one of improvement. The Arabs added a few observations on pathology, especially of the eruptive fevers. Some useful works on pharmacy and materia medica were published during this epoch. During this era the operation was devised for replacing the nose when removed by accident or disease, by using for the purpose a piece of flesh taken from the arm, and applying it by a grafting process. About the middle of this period the internal administration of metallic drugs was introduced. Towards the latter end, the invention of printing tended to assist the progress of medicine. Near the close of this century scurvy was first noticed in Germany. During this period more energy was devoted to postmortem demonstrations and the study of symptoms of diseases.

To Benevieni we owe the commencement of the study of gross pathology and pathological anatomy. Malgaigne remarks of him: “A eulogy which he merits, and which he shared with no other person, and which has not been accorded to him up to this time by the many historians of surgery, who have superficially searched among these precious sources, is that he was the first who had the habit, felt the need, and set the useful example, which he transmitted to his successors, of searching in the cadaver, according to the title of his book, for the concealed causes of disease.” His observations on anatomical heart lesions, gall-stone, and presence of parasites in the body, were original. John Fernel, who has been surnamed “the modern Galen,” divided medicine into physiology, pathology, and therapeutics. The fundamental maxim of therapeutics, that every disease must be combated by contrary remedies, was early laid down by him, and he claimed that anything that cured a disease was contrary to it. Surgery was placed on a high scale during this era, as thorough a course as the time afforded was given, and a rigid examination held at its termination. Ambroise Paré contributed largely toward making this a glorious century. He rose from the lowest walks of life to the highest professional attainments and honors. He was the first to control hemorrhage by tying the bleeding vessels, thus doing away with the former crude and painful method of pouring on hot oil. This procedure proved quite a boon to surgery; as an instance it may be mentioned that prior to the introduction of this method in amputations the bleeding was controlled by means of a hot iron, and this before the days of anæsthesia.

Every age of ancient, mediæval, and modern medicine has had its charlatans, and the more civilization progresses, the more popular these quacks become with certain types of people, particularly those of the middle and lower classes, although no class appears to be exempt. Latent, unscrupulous, and unprincipled, they play upon the credulity of the ignorant.

The central figure of the mediæval charlatans was Paracelsus, who was given to drink and debauchery. He advertised extensively, similar to the charlatans of to-day, and exerted an influence in his time. "The school which he would have founded was nothing but a school of ignorance, dissipation, and boasting—a school of medical dishonesty."

During the sixteenth century the greatest discoveries took place in anatomy, based upon dissections, the only rational method of ascertaining anatomical knowledge. The lesser circulation of the blood, or that through the lungs, was appreciated.

The officers of the universities were chosen by the students, who assisted in laying out the curriculum. Compare this with the rigid methods of medical instruction now in vogue. The practitioners were of roving habits, which were evidently contracted during their student days, as it was customary for them to go from one school to another, the poor classes defraying expenses by begging and singing.

There was evident improvement in the social and mental status of medical men upon the approach of the seventeenth century, and this period is signalized by the discovery of the circulation of the blood, one of the most important ever made in medicine. Chemistry now assumed the dignified aspect of a science, which fact benefited the progress of medicine.

It is difficult for us at the present time to understand why the circulation of the blood was not discovered prior to this period, but to the ancients it was incomprehensible. They believed the arteries contained air, because after death they were found empty. William Harvey, the discoverer of the circulation of the blood, did not publish the results of his investigations until 1628, first submitting them to fifteen years of proof. This naturally revolutionized physiology. The capillary circulation, or that intermediate between the arteries and veins, was described by Malpighi in 1628. Of course this was possible only through the means of a microscope. No less remarkable was the discovery of the lymphatic vessels. Peruvian bark (the alkaloid quinine being more commonly employed) so universally employed as a specific for malaria, was first used in the early part of this epoch.

During this period ophthalmology (which treats of the diseases of the eye) was cultivated in France, cataract was first recognized, and the diseases of the ear first systematically described. Altogether the century showed marked progression, closing with the teachings of Sydenham, "the English Hippocrates."

The eighteenth century was one of continued progress. The eminent observers devoted more time to microscopical work, studying the minute structure of the tissues and cells. One of the most prominent is Lieberkühn, who invented the solar microscope, with which he was enabled to exhibit the circulation of the blood. The systematic practice of the preventive inoculation against small-pox by vaccination originated in this decade. The first inoculation with cow-pox was in 1774. Edward Jenner, the English surgeon, was "the father of vaccination," which he first did in 1796. About 1800, Dr. Waterhouse, then professor of medicine in Harvard College, performed the first vaccination in America, the patients being his four children.

The treatment of the insane was changed from one of torture and barbarous methods to a more scientific one, conducive to the comfort and return to health of the patient.

This period marks the earliest example of medical teaching in this country, consisting of the demonstrations of anatomy in Philadelphia by Dr. Thomas Cadwalader, upon his return from Europe. This was previous to 1750, about which time a body was dissected in New York. In

1754–56 Dr. William Hunter of Scotland delivered a series of lectures on anatomy, accompanied by dissections, at Newport, R. I.

In 1762 Dr. Shippen laid the foundation of a medical school in Philadelphia, which finally developed into the Medical Department of the University of Pennsylvania. This was the first medical school established in this country. In 1768 a school of medicine was organized in New York, and the next in succession was the Medical Department of Harvard College in 1782. The fourth was established at Hanover, 1797, being connected with Dartmouth College. These were the only medical colleges instituted prior to the present century. The first book on American surgery was written in 1775 by Dr. John Jones, the title being "Wounds and Fractures."

"The tendency of the nineteenth century seems to be a continuation, and, perhaps, in some respects an exaggeration of the condition that obtained in France during the previous century; in other words, the world has become practically an enormous school of pathological anatomy and diagnosis—a school inaugurated by Bichat, as representing so-called scientific or exact medicine."

Darwin has promulgated "the most influential philosophic doctrine of this or any other century." Our materia medica and the laws of physics have been enriched by botanical discoveries, aiding greatly the experimental researches of to-day. Helmholz has given us an instrument called the ophthalmoscope, containing a series of numbered magnifying lenses, with which the interior of the eye can be explored by looking directly through the pupil of the eye, similar to looking through a door into a room. Through his knowledge of physics, Seebach was able to make fame through his discovery of thermal electricity. Daguerre, who invented photography, must not be overlooked, as by means of this process, many conditions are directly appreciated by the eye which could not be told in words and still convey an idea of the tumor, etc., being described. It may not be amiss to mention here that the biograph will in a few years prove an important factor in teaching the various operations. One surgeon in France is now employing it. We must not overlook Edison and his electrical achievements which directly and indirectly affect medicine; nor Bell's telephone, which is sometimes used to locate a bullet. By placing the receiver to the ear and probing for the bullet with electric conductors, the making and breaking of the circuit upon contact with the missile is transmitted to the receiver and distinctly heard. This procedure, however, has been discarded since the introduction by Röntgen of the X-ray.

A very significant feature of the age has been the extraordinary development of associations devoted to scientific discussions and the publication of medical literature and journals. The formation of medical societies, especially in the United States, has been quite active. But few counties are without a medical organization, referred to as "The ... County Medical Society."

The American Medical Association was established by Dr. Nathan Smith Davis in Philadelphia fifty-two years ago (1847). The first two years no meetings were held, but since then regular annual meetings have been in progress, the place of assembly being decided upon by a majority vote of its members. It has met in the city of its birth five times, the founder has been elected president twice, and is still (1900) in active practice at the age of eighty-two. He has attended all its meetings held in various cities from Boston to San Francisco.

The first medical journal in this country appeared in New York, 1797. It was called "The New York Repository," was published quarterly, and managed to reach its twenty-third edition. Fifty years ago there were about twenty journals published in the United States. At the end of the century there are two hundred and thirty.

In 1810 there were six hundred and fifty students of medicine in America, and one hundred graduates. At the present writing about twenty thousand medical students are enrolled in our various colleges, and during the spring of 1899 about three thousand five hundred received the degree of M. D.

The original branches, practice of medicine, surgery, obstetrics, physiology, anatomy, therapeutics, and chemistry, have been subdivided and specialized. Among the chief of these specialties are gynecology, which treats of diseases of women; pediatrics, which treats of diseases of children; dermatology, which treats of diseases of the skin; ophthalmology, which treats of diseases of the eye; laryngology, which treats of diseases of the throat and larynx; otology, which treats of diseases of the ear; neurology, which treats of diseases of the nerves; medical jurisprudence, which treats of the relation of medicine to law; pathology, which treats of diseased tissues and organs; bacteriology, which treats of the microbes; and physical diagnosis, which treats of the art of discriminating disease by means of the eye, ear, and touch. The nucleus of the teaching regarding the latter subject is due to the efforts and observations of Corvisart, of France. He was the first to ascertain the diseased areas of the lungs, by tapping on the chest with the fingers, and listening to the pitch of the note thus elicited. A low, dull note indicates that the lung is solid, as in pneumonia; a flat note that fluid is present, and so on. By placing the ear to the chest wall, sounds in health and disease are heard, which vary in intensity, degree, etc. Laennec discovered by accident that this method was greatly improved and the sounds more distinctly heard if a cylindrical tube was interposed between the ear and the chest wall. The outcome of this principle is the stethoscope.

The name of Pravaz, the Lyons surgeon, has been perpetuated by the hypodermic syringe which he devised. The employment of suitable drugs in this instrument is the method par excellence for relieving pain. With it drugs can be injected into unconscious patients. Suicides who refuse to swallow emetics can have their stomachs emptied most effectually of their contents by a hypodermatic injection of apomorphine.

The thermometer used for taking the temperature of the human body is so arranged that the mercury does not descend into the bulb until shaken down, hence after taking the temperature it remains uninfluenced until shaken down. Were an ordinary thermometer used, by the time it was removed from the patient to the light the mercury would descend several degrees.

Pasteur began the studies of fermentation in 1854. Through his observations, aided by the microscope, the opinion was reached that micro-organisms played an important role in the causation of disease. Many of the laboratory investigators became imbued with the spirit, and through their diligent observations the microbes causing many diseases have been isolated. It remained for Koch to discover the tubercle bacillus, or *Bacillus tuberculosis*, which is the cause of consumption. The sputum of a patient, properly stained, and examined under the microscope, will at once decide whether that individual has consumption.

Having ascertained that bacteria were the cause of disease, sepsis (blood poisoning), etc., it then remained to discover a method of killing them, without any undue injury to the patient. Sir Joseph Lister began experiments upon this hypothesis, and in 1867 was able to publish favorable results. But lo! the world was slow to bend to a new thought ably demonstrated, and for a score of years he was bitterly opposed.

It was Crawford W. Long, in a little village of Alabama, who, in 1842, was the first to put to sleep a patient with ether, and remove a small growth. The patient, upon awakening, had experienced no pain. This method of relieving pain was christened “anæsthesia” several years later, by the distinguished Dr. Oliver Wendell Holmes, whose writings did more than those of any other American to eradicate “child-bed fever.” Every woman in the land owes him an eternal debt of gratitude. To Guthrie, of Sackett’s Harbor, New York, is due the credit of first discovering chloroform, but Sir James Simpson, of Edinburgh, deserves the credit of first employing it in medicine.

The surgeons of America laid the foundation of gynecology, the progress of which has been more marked than any department of medicine. The first ovariotomy in the world was performed by Dr. Ephraim McDowell in Kentucky, December, 1809. This was prior to the days of anæsthesia and antisepsis, and a howling mob awaited outside, ready to murder the brave surgeon should his patient die during the operation. “In five days,” says Dr. McDowell, “I visited her, and much to my astonishment found her engaged in making up her bed.” Dr. J. Marion Sims, our illustrious genius who established an international reputation, did much to promulgate plastic work on the female genitalia. The deeds of medical men are soon forgotten by an ungrateful public, and the sons of Æsculapius are the last to have monuments erected to their memory. But four exist in America; one, in New York, to that grand old gynecologist, Dr. J. Marion Sims; one in Washington, to Dr. Samuel D. Gross, “the Nestor of American Surgery;” one in Bushnell Park, Hartford, Conn., to Dr. Horace Wells, the discoverer of anæsthesia; and one in the Public Garden in Boston to the discoverer of anæsthesia. This last bears no name. Antisepsis and anæsthesia have played an unusually important role in obstetrics, by alleviating the sufferings of childbirth and eradicating child-bed fever, thus reducing the mortality of both mother and child.

Physiology has made very rapid strides during this era. Beaumont, in his famous work, describes digestion in the stomach and experiments on the gastric juice. He was enabled to observe this in a voyageur who was accidentally wounded in the stomach by the discharge of a musket, June, 1822. Quite a large opening remained, which Nature closed with a valve. By pushing the valve to one side, the interior of the stomach could be explored.

Through the work of the experimental physiologists in the laboratories, the study of the action of drugs on the lungs, heart, liver, stomach, nerves, etc., has been greatly enhanced.

Anatomy is now being taught by the only true method, and that is dissection. Didactic lectures are given, but the student must dissect every part of the human body before he can receive his degree. Formerly graves were robbed, and the bodies sold to the colleges. Now, however, through legislative enactment, unclaimed bodies are turned over to the colleges, where they are preserved either by injection, a pickling process, or by cold storage.

The ophthalmologists of to-day fear nothing inside nor outside the eye. Cross eyes are straightened, cataracts removed, eyeballs taken out and glass eyes inserted.

This article would be incomplete, were not a few remarks directed toward the trained nurse.

The first training school for nurses in America was established in connection with the Lying-in Charity Hospital of Philadelphia in 1828. This school, still in existence, thus has the honor of being the oldest in this country, and is antedated by only one abroad.

The generally recognized profession for women, that of the trained nurse, is practically of recent development. Twenty-five years ago the training school connected with the Bellevue Hospital, New York, graduated a class of five nurses. This was a marked departure in the medical history of this country. Since then the demand for the trained nurse has been great, and no hospital is complete without such a training school.

The progress of medicine in the nineteenth century has been far more rapid, creditable, and momentous than during any like period of the past. This is true not only in the United States, but in every civilized country. Its entire scope, meaning, and purpose have undergone changes equivalent to revolution. Antique superstitions, idle theories, foolish speculations, absurd practices, the ridiculous jealousies and incriminations of opposing schools, have been largely eliminated. Medical institutions are upon the loftiest plane in their history. Teachers are better endowed than ever before. Periods of scholastic preparation have been lengthened and curriculums enlarged, thus securing for the fields of practice a higher mental equipment and more conscionable devotion to duty. Never before have the auxiliary and material agencies been turned to so frequent and preventive account. Electricity, the microscope, anæsthesia, antisepsis, laboratory experiment, hospital opportunities, etc., are ever constant inspirations to skilled treatment and fresh researches. As the grand army of humanitarian workers was never so large as at the end of the century, so it was never better fortified for attack upon the enemies of health, fuller of enthusiasm or more deeply established in the public confidence. One may not, as yet, assert that medicine is ridding itself of empiricism with a satisfactory degree of rapidity, or that it has arrived at the stage of an exact science, but it surely has approached such a stage as nearly as conditions will allow.

Evolution Of The Railway

By E. E. RUSSELL TRATMAN, C.E.,
Assistant Editor of "Engineering News," Chicago.

The railway as a means of rapid transportation and general intercommunication is one of the most important factors in the development of modern commerce and civilization, and, after reviewing what it has done and become in the nineteenth century, one cannot help wishing for the opportunity to review the railway wonders of the twentieth century.

While the history of the railway dates back far beyond the nineteenth century, yet the railway, as we know it to-day, is essentially a product of this century. It dates, in fact, from England in 1830, when the Liverpool & Manchester Railway, 31 miles long, was opened, and was operated from the beginning by steam locomotives. The Stockton & Darlington Railway, 37 miles, was opened in 1825, but this line was intended only for private coal traffic, while the other line was built for general passenger and freight service, and for the use and benefit of the public.

The United States followed this lead very closely. In 1828 the Delaware & Hudson Canal Company built a line from its mines to its canal at Honesdale. This was a private coal road, however, and may best be compared to the Stockton & Darlington Railway. The first public railway operated by steam was the Mohawk & Hudson Railway, from Albany to Schenectady, 16 miles, which was opened in 1831. The Baltimore & Ohio Railway was the first railway enterprise of more than local character, being designed to open communication with the Ohio River, a distance of 400 miles. It was chartered in 1827, commenced in 1828, completed to Ellicott's Mills (13 miles) in 1830, and to Washington (40 miles) in 1834. It is one of the great monuments of the American railway system, and it was examined by government commissions from Russia and Austria in 1831 and 1849.

In speaking of the railway we unconsciously associate with it the steam locomotive, since the two are so entirely interdependent. Railways operated by horses, or by cables and stationary engines, could never have become the great civilizing and commercial medium which the railway operated by swift locomotives has become. Similarly, the development of the locomotive grew apace, as soon as it was recognized that the smooth track of the railway—and not the rough track of the highway—was to be its field of operation.

At the end of the nineteenth century, after seventy years of development, the world has nearly 500,000 miles of railway, on which locomotives of 80 to 110 tons in weight (without their tenders) haul freight trains of 1000 to 3000 tons. Passenger trains, too, are run at speeds of 40 to 75 miles per hour in regular daily service, and even make bursts of speed at 80 to 100 miles per hour. The fact that in 1890 Europe and North America had about 320,000 miles of railway out of a grand total of 370,000 miles, indicates that this phase of nineteenth-century progress has been due mainly to peoples of Christian civilization, and besides this, it must be remembered that the railways of Asia, Africa, Australia, and South America have been mainly built by the same peoples. The central regions of these four latter geographical divisions are fields for twentieth-century development.

The great trunk lines of railway communication are hardly more important than the vast network of branch and minor lines which connect and intersect them. These latter lines bring the people of smaller towns and country districts into closer relation with the large cities, the centres of industrial and intellectual energy, enterprise, and wealth. They thus tend to reduce isolation and dependence upon purely local resources.

Railways also serve important military and strategic purposes. In India many of the railways have been built with a view to the defense of the northeastern frontier, and many European governments assume certain military authority over the railways. The first trans-continental railways of the United States and Canada were largely assisted by government subsidies on account of their great importance for the transportation of troops. The railway also serves purposes of pleasure, as well as of commerce and war. Not only do the ordinary railways carry much tourist and pleasure travel, but lines are built exclusively for such travel. Some of these take people to the summer and pleasure resorts, while others cater to the inherent desire of man to ascend great altitudes and to behold the world in its beauty and grandeur spread below them. For this purpose alone have railways been built to the summits of the Rockies, the Alps, and other mountain ranges.

At the end of the century the United States has about 185,000 miles of railway, which have cost about $53,000 per mile and earn $6500 per mile. Great Britain has about 22,000 miles, which have cost $225,000 per mile and earn about $20,000 per mile. A large proportion of this high cost of construction is due to the high prices for land and to the preliminary parliamentary proceedings which are necessary in securing the right to build railways.

One of the great economic purposes of railways in new countries is to reduce the cost of rapid transportation in bulk far below that of slow transportation in small quantities. Train speed is a matter of secondary importance in such cases, the traffic accommodation and capacity of the slowest train being far beyond that of road or canal transportation. Traffic will be served better and at much less cost by being carried in bulk on 500 miles of railway at 10 miles per hour, than on 100 miles of railway at 35 miles per hour, and then in small lots on wagons or canal boats at 3 miles per hour for 400 miles.

The advantages of the rapid transportation of perishable freight by rail, especially in regard to food supplies for cities, were early recognized, and by 1854 the trains brought car-loads of country milk into London every day. Previous to this, the supply was obtained from cows kept in stables, which was an unsanitary and expensive plan. Another immediate result of railway service was that people began to live farther out of the towns, and then began the growth of the suburban residence districts, which are such a feature of modern cities and city life.

The early railways were built merely as local lines, and there was little idea of their ultimate connection or extension. These small individual lines, however, with their own rate-making powers and systems of management, have been consolidated into great systems, thus effecting material economies and facilities in operation. Thus the Mohawk & Hudson Railway of 1831 was the first of a series of lines now consolidated to form the New York Central Railway; while the Liverpool & Manchester Railway of 1830 was the beginning of what is now the London & Northwestern Railway system. Not only is there this consolidation, but also a most comprehensive system for the interchange of traffic between different systems. Thus passengers can purchase through tickets and travel through from Paris to St. Petersburg, or from Boston to San Francisco, while freight cars can be sent through in a similar way. This is really a wonderful feature of railway development.

In some countries the government owns and operates all, or nearly all, of the railways, as in Germany, Belgium, and the African and Australian colonies. Switzerland, in 1898, decided that its government should acquire the railways. In Holland and Italy the government owns the railways, but leases them to operating companies. France, Brazil, and the Argentine

Republic have both state and private lines, with a greater or less degree of state assistance and control of the latter. In Great Britain the railways are owned entirely by private companies, but their operation is subject to government supervision in the public interests. In the United States there was at first almost absolute freedom of construction, but the consequent abuses and financial disasters, owing to unnecessary lines and cut-throat competition, have led some of the States to wisely exercise some degree of control over railway affairs. The interference of the federal government in railway affairs has been slight but important. In 1862 it aided the construction of the first transcontinental railway; in 1887 it passed the act for the regulation of rates, etc., in interstate traffic; and in 1893 it passed the act making compulsory the use of power brakes and automatic couplers on freight cars.

Government ownership and operation of railways is rarely satisfactory from a financial or a traffic point of view, but, on the other hand, an absolutely unrestricted railway element is liable to become a serious evil. The best system is undoubtedly that in which the railways are owned and operated by private enterprise, but subject to state supervision, like steamships, factories, etc. It must not be forgotten, however, that private enterprise is not always available. In Russia, for example, the development of railways would have been but slow on such a basis; and in India, government backing was needed to induce British capitalists to enter the field. It is unfortunate for China that neither the government nor the people have been competent or enterprising enough to deal with the railway question. The present system of development by rival interests of various nationalities seems almost certain to lead to the eventual dissolution of the empire and its partition among other nations, as Africa is already in large measure partitioned.

In the United States railway construction has gone by leaps and bounds, and there is now a vast network of lines,—main, secondary, branch, and local. The highest records of construction within the past twenty years were 12,800 miles built in 1887, and 11,600 miles in 1882, while the lowest record was 1750 miles in 1896.

Perhaps the railway of most recent interest is the first line in Alaska, which is twenty miles long, and was built as a result of the rush to the Klondike gold fields. This was opened on February 20, 1899. The great transcontinental railways, however, are of much broader interest. In 1835 the Rev. Samuel Parker, a missionary in the Northwest, suggested a railway from the Atlantic to the Pacific, and Dr. Samuel E. Barlow proposed one from New York to the Columbia River, 2000 miles, to cost $10,000 per mile, and to carry traffic at about seven miles per hour. From 1844 to 1849 Mr. Asa Whitney urged Congress to grant land to aid him in building a line from Lake Michigan to San Francisco, 2030 miles, to cost $20,000 per mile. Between 1853 and 1861 Congress had surveys made of five routes, but no definite action was taken until after the outbreak of the Civil War, in 1861, when the federal government soon recognized the importance of having direct communication with the Pacific States, which were at that time isolated. Companies were organized in 1862, and work commenced in 1864, under government subsidies and military aid and protection. On May 10, 1869, the Union Pacific Railway (from the east) and the Central Pacific Railway (from the west) met at Promontory Point, Utah, 1186 miles from the Missouri River and 638 miles from Sacramento, Cal.

Now, thirty years later, we have six so-called transcontinental railways, no one of which, however, has its own line from ocean to ocean, and none of which run through trains or cars. In Canada, however, the Canadian Pacific Railway (opened in 1887) has a through line from St. John and Montreal to Vancouver, with through trains daily between the latter points, 2905 miles.

Of the various completed and partly completed interoceanic railways across Central America, the most important by far is the Panama railway, in Colombia, 47½ miles long. This was opened as long ago as 1855, and was originally intended as a link in a route between New York and San Francisco, 5450 miles. In South America there are few railways of great importance, and the interior yet remains undeveloped, with the exception of the great plains of the Argentine Republic. A transcontinental line between Buenos Ayres and Valparaiso, 850 miles, is nearly completed, but work has been stopped for some years, leaving 50 miles yet to be built at the summit of the Andes. An interesting, but as yet visionary, scheme is that for an intercontinental railway through Central and South America. The distance from the southern frontier of Mexico to Buenos Ayres would be 5500 miles. About 1280 miles of this are built, but comprise many small lines which would have to be rebuilt. The total cost would be about $220,000,000, at a low estimate, and the total distance from New York to Buenos Ayres would be 10,300 miles by rail.

In Europe there is a vast and comprehensive network of railway lines, but the distances are less, even St. Petersburg and Constantinople being but about 1600 and 1800 miles from Paris. While the development of railways has been remarkable, the most striking features are the lines which cross the Alps to connect the interior with the Mediterranean ports. The first of these was the Semmering railway, on the route between Vienna and Trieste (1854). The Mont Cenis railway (1867) was mainly a surface line, with heavy inclines operated on the Fell grip-rail system. Its route followed the great carriage road built by Napoleon in 1803–10. The railway over the Brenner Pass was opened in 1868; in 1871 the Mont Cenis tunnel superseded the high-level line, and in 1880 the Great St. Gothard railway was opened. This was followed by the Arlberg railway in 1884, and the Simplon railway is now under construction.

Europe has the only railway within the Arctic Circle. It runs from Lulea, on the Gulf of Bothnia, northwest to the Gellivara iron mines, 44 miles within the circle. As the port is closed by ice during the winter, the line is to be extended to the Atlantic coast at Ofoten, 69° north latitude, where the influence of the Gulf Stream keeps the ports open. This end of the line will be 130 miles north of the Arctic Circle.

The countries of Asia (with the exception of India) are but scantily supplied with railways. Even Palestine—the Holy Land—has, however, been invaded, and has now two railways. One of these is from Jaffa (the biblical Joppa) to Jerusalem, 54 miles (1892); the other is from Beirut to Damascus, 70 miles. British interests have long advocated an “all-rail-to-India” project. The line would start opposite Constantinople, pass down the Euphrates valley, across Persia, and along the coast of Baluchistan to Kurrachee, connecting there with the Indian railway system. This great system aggregates 25,000 miles, and extends up to the Bolan Pass and the Khyber Pass, on the Afghan frontier. Southward, it has been proposed to connect with the Ceylon railways by a line of bridges and embankments along the reefs and shoals known as Adam’s Bridge.

Owing to the vigorous opposition of the government and people, China has but 350 miles of railway to its 4,200,000 square miles and its population of 420,000,000. Many lines are projected, but are all in the eastern portion, and the twentieth century will be well advanced before the railway opens up the heart of the country to civilization. Japan, the very opposite of China, has encouraged railway construction, and now has 3000 miles of railway to its 147,600 square miles and its population of 45,000,000.

The most notable of all the railways in Asia is the great Trans-Siberian railway, now being built by the Russian government. It was commenced in 1891, and may be completed by 1903, the distance from St. Petersburg to Vladivostok, or Port Arthur, being then about 5670 miles.

There are several large cities on the route, and the line does not pass through such a wild and uninhabited country as that through which the Union Pacific Railroad was built thirty years ago. It is now open to Lake Baikal, the trip of 3230 miles being made in about 12 days by the slow train, or 8 days by the less frequent fast train. The road is roughly and lightly built in many respects, so that high speeds cannot be maintained. The eastern end of the road will pass through Chinese territory, thus giving Russia a firm foothold in that empire. Hardly less interesting is the Trans-Caspian railway, from the Caspian Sea to Samarcand, 885 miles, with a branch from Merv to within 95 miles of the Afghan city of Herat. An extension to the Persian Gulf is also projected. As the Trans-Siberian railway has developed a new wheat-growing region, so the Trans-Caspian railway is developing a new cotton-growing region.

In Africa the railways already extend northward from Cape Town, through the land of the Boers and up to Buluwayo, the old Zulu stronghold, 1400 miles. There is a picturesque project for carrying the line on to the Mediterranean, a total distance of 5500 miles, but this will not materialize for many years. The Congo railway, passing the rapids, opens communication between the coast and a long stretch of inland navigation. Several lines are being pushed from the east coast into the interior, and a transcontinental railway from St. Paul de Loando, on the west, has been commenced, but there is not now much life in this latter project. The French have two favorite schemes for railways,—from Algeria to Timbuctoo, and from Tunis to Lake Chad, the latter line being about 1600 miles in length.

In Australia, the lines of the different colonies are gradually extending and connecting to form a continuous system, which is hampered, however, by differences of gauge. There is railway communication between the capitals of Queensland (Brisbane), New South Wales (Sydney), Victoria (Melbourne), and South Australia (Adelaide). The great stretch westward to the coast cities of Western Australia is yet in the future, as is also the South Australian transcontinental line from Adelaide northward across vast deserts (already crossed by the telegraph) to Palmerston.

Great bridges and tunnels are among the prominent features of the railways of the world, but space forbids entering into details of these works. They are in principle similar to those required for highways, but many of these great works would never have been undertaken for such traffic as is carried by a highway. The only railway suspension bridge ever built was the Niagara bridge, opened in 1855, and replaced by a steel arch in 1898. The development of bridges and traffic may be judged from the fact that the Victoria single-track tubular bridge over the St. Lawrence, at Montreal, which was opened in 1859, was replaced in 1897–98 by a double-track railway and roadway truss bridge on the same piers. The steel arch bridge, 1700 feet long, across the Mississippi, at St. Louis, cost $5,300,000. The tubular bridge, 6592 feet long, over the St. Lawrence, at Montreal, Canada, cost $7,000,000. The cantilever bridge, 8925 feet long, over the Firth of Forth, Great Britain, cost $13,000,000. The cost of the proposed suspension bridge, 3000 feet long, over the Hudson, at New York, is estimated at $13,000,000. The first railway tunnel was the Portage Tunnel, in Pennsylvania, built in 1831. The longest railway tunnel is the Simplon, in Switzerland. It is 12.25 miles in length, and is still under construction. The next longest is the Gothard, Switzerland. It is 9.30 miles long, and was opened in 1881.

In track construction, cast-iron rails began to be superseded by wrought iron in 1820, and many of the early American railways had strap iron laid on timber stringers. Within the past twenty years steel has been used almost exclusively. In place of rails weighing 25 to 35 lbs. per yard, and 3 to 15 feet in length, we now use rails of 80 to 100 lbs. per yard, 30 to 60 feet long. Stone blocks and wooden ties were first used to support the rails, and the latter are now generally used, although metal ties are extensively used and date back to 1846. In 1894 there were thirty-five thousand miles of railway laid with this form of track. The next development will probably be a permanent and continuous concrete bed for the rails; as the present construction, with wooden ties laid in stone or other ballast, requires continual attention and repair under the effects of heavy traffic.

The semaphore signal was introduced in England by Mr. C. H. Gregory in 1841, and is now used in all parts of the world, to govern and protect train movements. The first interlocking plant was erected in 1843, and the complete plants—as used to-day—date from 1856. Now, practically all important junctions are equipped with interlocking plants, which prevent conflicting signals and switches being so set as to lead to accident. The electric telegraph was patented by Cooke and Wheatstone in 1837, and in 1839 they secured its introduction to govern the train service on the Great Western Railway (England). The movements were telegraphed from station to station, and a train was not allowed to leave a station until the preceding train had passed the next station in advance. This was the beginning of the "block system," which is a great element in the safe operation of traffic, since it maintains an interval of space between trains. Mr. Edwin Clark's telegraph block system was introduced in 1853, and as traffic increased intermediate block signal stations were established between the regular stations, so as to shorten the distances between trains. This system is compulsory in Great Britain and is already largely used in the United States. It was at first held that it was not adapted to conditions in this country, where so many lines have but a single track, but experience has shown that it increases the facility as well as the safety of operating traffic on single and double track lines alike.

Steam locomotives were used on colliery railways in England as early as 1804, when Trevithick built an engine, which was the first to haul a train on rails. George Stephenson built his first locomotive in 1814, and in 1825 built the "Locomotion" for the Stockton & Darlington Railway. Horses, stationary engines, and steam locomotives were all proposed for the Liverpool & Manchester Railway, and in 1829 the directors offered a premium of $2500 for the best locomotive. Each engine was to consume its smoke, weigh about 6 tons, cost not more than $2750, and be capable of hauling a train of 20 tons at 10 miles per hour. This led to the now historical trials at Rainhill, in October, 1829, between the "Rocket" (Stephenson), the "Novelty" (Braithwaite and Ericson), and the "Sans Pareil" (Hackworth). The award was made to the "Rocket" as the most practicable machine, although the "Novelty" attained a higher speed, and the "Sans Pareil" was also a good engine and continued in use for several years. Seguin introduced the locomotive in France in 1827, having modified and rebuilt an old Stephenson engine.

The first locomotive operated in the United States was the imported "Stourbridge Lion," on the Delaware & Hudson Canal Co.'s line, in 1829. Cooper's "Tom Thumb" was run on the Baltimore & Ohio Railway in 1830, and in 1831 the directors of this road offered premiums of $4000 and $3500 for locomotives. Each engine was to weigh not more than 3½ tons, to have four wheels, and to haul loads of 15 tons at 15 miles per hour for 30 days. Five engines were presented, by Davis, Costell, Milholland, Childs, and James. The prizes were awarded to the first two, the Davis engine "York" being rebuilt under the direction of its inventor and Mr. Ross Winans, while the "Costell" was put in switching service. In 1831 the "John Bull" was built by the Stephensons in England, and was put in service on the Camden & Amboy Railway (U. S. A.) in the same year. In 1893 this old engine was readjusted and ran from New York to Chicago, 912 miles, under its own steam, hauling two cars of the type of 1836.

In 1898 there were about 19,500 locomotives in Great Britain and 36,500 in the United States. As a comparison between the little engines of early days and the huge and swift engines of to-day, it may be stated that modern passenger locomotives are now constructed with as many as six driving wheels, and ten wheels in all. Some of those in use on the Great Northern Railway, Great Britain, have driving wheels of 97 inches in diameter. On the Fitchburg Railway, U. S. A., locomotives are in use which weigh 75 tons. Some modern freight locomotives have as many as ten driving wheels, and twelve wheels in all, and a total weight of 115 tons.

Since the application of electric traction to street railways, it has frequently been said that it would eventually supersede the steam locomotive. In no instance, however, has it yet been applied to regular railway service, with heavy trains and long runs, nor is there yet any indication of increased economy or efficiency due to its use in such service. It is successfully used for local and suburban lines, but these form a class in themselves, and the conditions of operation are very different from those which obtain in ordinary service. The Baltimore & Ohio Railway has some heavy electric locomotives, but these are for hauling trains through a tunnel, to avoid the trouble and discomfort from the smoke and gases from the steam engines.

The early passenger cars were either open cars with cross seats, or had coach bodies on four-wheel platform cars. The coach-body cars on the Mohawk & Hudson Railway, in 1831, were 7 ft. 4 in. long and 5 ft. wide. In 1836 the American type of car was introduced on the Camden & Amboy Railway, having a long body mounted on two four-wheeled trucks. These cars seated 48 passengers, and cars for 60 passengers were in use in 1839, their cost being $2400. American day cars are now 60 to 80 ft. long, seating 60 to 84 passengers, and weighing from 30 to 47 tons. The standard day car of the Pennsylvania Railway is 60 ft. 7 in. long over all, and seats 66 passengers. Dining and sleeping cars weigh from 45 to 65 tons, much of the weight being due to the special equipment for the comfort and convenience of passengers, and consequently so much dead weight to be hauled. It can be said without dispute that in no other country have the railways done so much for the comfort and convenience of their passengers, and have charged so little therefor.

In Europe, the cars developed into the compartment system, with side doors, there being high transverse partitions with seats on each side, so that in a full compartment half the passengers must ride backward. The cars are usually short, with two or three axles, but about 1872 the American system of mounting cars on trucks was introduced, and longer cars on trucks are now somewhat extensively used. Within later years corridor cars have been introduced, with a corridor connecting the compartments. Such details as steam heat, toilet arrangements, ample light, luxurious finish, etc., which have long been a matter of course in this country, are quite “end of the century” improvements in Europe, and generally below the standards observed in this country.

Sleeping cars were used on the Cumberland Valley Railway (U. S. A.) in 1836. In 1856, Mr. T. L. Woodruff built a sleeping car, and in 1857 two were built by Mr. Webster Wagner and operated on the New York Central Railway. Mr. George M. Pullman began his experiments in 1859, and in 1864 he put in service on the Chicago & Alton Railway the first sleeping car with the berth arrangements now almost universally used. He pushed the business more vigorously than his predecessors and acquired many of their patents. The Pullman Palace Car Co. was organized in 1867, and in 1879 its various works were all concentrated in a new industrial town—called Pullman—near Chicago. In 1898 the company owned 2,428 cars, which were operated on 121,236 miles of railway, ran 190,562,758 miles, and carried 4,852,400 passengers. Most of the cars are in the United States, but some are in Europe and Australia. The Wagner Palace Car Co. owns 560 sleeping cars and 143 parlor cars. In Europe most of the long distance sleeping and dining car service is operated by the International Sleeping Car Co., which runs cars between Paris and Constantinople (72 hours), Paris and St. Petersburg (120 hours), Calais and Brindisi (25 hours).

Passenger cars are now usually lighted by oil, the mineral oil used in America being superior to the vegetable oils commonly used in Europe. Oil gas, compressed in tanks, is very extensively used, and gives an excellent light. The system was invented by Mr. Julius Pintsch, and was introduced in Germany in 1873, and in the United States in 1881. It is now applied to about 85,000 cars in 22 countries; 32,000 of these cars being in Germany, 17,000 in Great Britain, and 15,000 in the United States. The electric light is as yet used only on a few of the finest express trains, the current being generated either from a steam engine and dynamo in the baggage car, or from a dynamo on each car, driven from one of the car axles. Storage batteries maintain the light when the cars are at rest. American cars were heated by stoves at a very early date, and this developed into the hot water system, with a stove and circulating pipes in each car. Steam from the locomotive, however, is now generally employed, and its use is compulsory in some States. In Europe the passengers have to rely largely upon their own wraps and rugs.

In American freight cars, great improvements have been introduced, increasing the carrying capacity while reducing the weight. The capacity has been increased from 10 tons of load in 1870, to 30, 40, and even 50 tons in 1899 (an increase of 300 to 500 per cent). The weight has increased only from 10 to 15 or 17 tons (or 50 to 70 per cent). Cars are now being built entirely of steel, and while their first cost is greater, the cost per ton and the expenses of maintenance are less than for wooden cars of similar capacity. As sleeping, dining, parlor, tourist, and other special cars have been introduced for passenger traffic, so refrigerator, stock, horse, fruit, poultry, and furniture cars have been introduced for special requirements in freight traffic. In other countries, however, the use of such special equipment is much more limited. The ordinary foreign freight cars are the same as those of 30 or 40 years ago, being short four-wheel cars, weighing 5 tons, and carrying 8 to 10 tons. These are not well adapted to the handling of bulk freight, and greatly increased economy and facility in such traffic would result from the introduction of the American system, as has been done in Australia. In modern American practice, too, the cars are equipped with automatic couplers and power brakes, thus greatly increasing the safety and facility of operating heavy fast trains. In 1893, Congress passed a law requiring that by January 1, 1898, all freight cars should be equipped with automatic couplers and enough cars equipped with power brakes (operated from the engine) to put the trains entirely under the control of the enginemen. The date was afterwards extended to January 1, 1900.

As the speed and weight of trains increased, the dangers due to lack of brake power soon became alarmingly apparent, and numerous forms of continuous brakes were devised, to be applied to the wheels of every car, under the control of the engineman. In 1889, the British government passed the Railways Regulation Act, making compulsory the use of the block system, the interlocking system, and continuous brakes. In England and some other foreign countries, the vacuum brake (introduced about 1871) is largely used, but it is slower in action than the compressed air brake, and is therefore less efficient for long, heavy, and fast trains.

The Westinghouse brake is one of the most important factors in the safe and efficient handling of heavy and fast trains. Mr. George Westinghouse patented his straight-air brake in 1869, his plain automatic brake in 1872, and his quick-action freight train brake in 1887, while in 1892 he introduced his high-speed brake for express trains. Up to the opening of 1899, the Westinghouse brake had been applied to about 55,500 locomotives and 912,000 cars, of which 34,300 locomotives, 50,000 passenger cars and 750,000 freight cars were on American railways. With this brake, a passenger train of 300 tons, traveling at 60 miles per hour, can be stopped in about 4500 feet and about 90 seconds, or in 1200 feet and 31 seconds in case of emergency. A freight train of 800 tons, running at 30 miles per hour, can be stopped in about 950 feet in 32 seconds, or in 300 feet and 11 seconds by an “emergency” application. Very few countries have applied continuous brakes to freight cars, except the United States and Canada, and (to some extent) Russia and New South Wales.

The improvement in train service has been even greater than that in train equipment, and this improvement has been in speed, accommodation, and number of trains. Among the notable runs are those across the American and European continents. The Canadian Pacific Railway starts a train daily from each end of the line for a through run of 2900 miles. In 1888, a through train service (with sleeping and dining cars) was instituted between Paris and Constantinople, about 1800 miles, and through trains are run twice a week between Paris and St. Petersburg, 1600 miles. There is also a similar service between Calais and Brindisi, 1200 miles, in connection with the mail steamers between England and India. In 1898, the Trans-Siberian Railway was completed to Irkutsk, and a through train service between St. Petersburg and that city, 3230 miles, was commenced.

Railway trains were at first intended to have speeds of about 10 to 20 miles per hour, the latter being looked upon as almost excessive, but much higher speeds were very soon attained. There has been almost from the earliest days a public demand for higher and higher speeds, with consequent rivalry between the railways. The United States and Great Britain (and France within the past few years) have the fastest trains and by far the greater number of fast trains. The highest recorded train speed is that of the Exposition Flyer, 270 tons total, upon the New York Central Railway, May 10th, 1893. It ran a distance of one mile at the rate of 112 miles per hour, and again, on the same date, maintained a speed of 100 miles per hour, through a distance of five miles. As a daily train between New York and Chicago, it maintained a rate of 60 to 75 miles an hour, throughout the entire 980 miles of distance.

It will be seen that the speed of “100-miles-an-hour,” which is popularly looked upon as a sort of ideal, has been more than once exceeded, but it may be well to explain that such spectacular bursts of speed are really less important and less wonderful than the trips of 50 to 1000 miles at speeds averaging 50 to 65 miles per hour for the entire journey. Taking into account the loss of time by stops at stations, by changing engines, by the resistance of long grades, etc., it will be easily understood that in order to maintain the average speed from start to finish, the actual speeds must often range from 60 to 75 or even 80 miles per hour. The regular daily transcontinental train of the Canadian Pacific Railway has an average speed of 30 miles per hour, but maintains this for the trip of 2906 miles, which occupies 94½ hours. This is a train and a record of which railway men in general, and those of the Canadian Pacific Railway in particular, may well be proud. There are no such through trains in the United States, but in 1876 a special theatre train was run from New York to San Francisco in 3 days 7⅔ hours. In 1889, the time of the transcontinental mails was 5 days 8¼ hours, but that same year it was reduced to 4 days 12¾ hours, which schedule continued in force until 1899. On January 1, 1899, a new mail service was inaugurated, making the 3408 miles in 98½ hours, or at an average of 34½ miles per hour, including all stops, and the transfer of mail bags across Chicago by wagon from one station to another. The actual running speed is often 60 to 75 miles per hour for long stretches. Engines are changed 18 times and postal crews 7 times.

Fast passenger trains are a popular attraction, but only railway men can fully appreciate the advantages and economies of heavy trains for handling freight traffic. In Europe coal trains weigh from 300 to 400 tons, but in the United States the weight of coal, ore, and freight trains is from 800 to 2000 tons. Automatic couplers and power brakes enable the freight trains to be run as fast as passenger trains, with entire safety; improved cars carry greater loads, and more powerful locomotives are continually being put in service to haul heavier trains. The heaviest trains on record are as follows: (1) Pennsylvania Railway, 130 cars, 5213 tons, or 5560 tons with engine and tender; (2) New York Central Railway, 81 cars, 3478 tons, or 3595 tons with engine and tender. Both these were run in 1898, the length of journey being 160 and 140 miles.

The mails were carried by rail between Baltimore and Washington in 1834, on recommendation of the Postmaster-General. The U. S. railway service was instituted in August, 1864, between Chicago and Clinton.

The railway express business was started in 1838 by Mr. W. F. Harnden, on a suggestion from Mr. Josiah Quincy, who had to travel weekly from Boston to New York, and was in the habit of taking small packages for business acquaintances. Mr. Alvin Adams became associated with Mr. Harnden, and in 1845 formed the Adams Express Co. In Great Britain, this business is conducted by the parcels-post and the railway companies, but in other European countries it is mainly in the hands of the post-office department.

A very remarkable feature of railway development is that from the beginning there has been a tendency to increased traffic, better service, and a steady reduction in rates.

While the reduction in passenger rates has been comparatively small, it must be remembered that the safety, speed, comfort, and service have greatly improved. The marked reduction in freight rates has been made possible only by a still greater and more remarkable reduction in the cost of transportation. This has been effected by consolidation of companies, by improvements in roadway, bridges, etc., and by the introduction of heavier trains, with engines of greater power and cars of greater capacity. This economy can be still further extended. The reduction in rates has been much greater than that in the prices of commodities. Rates for wheat and hay, for instance, have decreased 23 and 20 per cent more than the market prices, and the rate for shipping anthracite coal to tidewater has decreased 50 per cent in the past ten years, while the price of the coal has decreased only 10 per cent. The average freight rate on the Pennsylvania Railway in 1898 was 0.536 cent per ton per mile, while the cost was 0.369 cent.

The lowest passenger rates in the world are on the Indian railways. In Europe the passenger rates average higher than in the United States, though the accommodation is inferior.

Railway transportation has almost entirely superseded barge, canal, and river transportation, except in special cases. This is due to the greater speed, the greater efficiency of service, the greater carrying capacity, and the extent to which spurs and branches are built to enable cars to reach mills, factories, and other industrial plants. It was for a long time held that the low rates of water transportation exerted an influence in keeping railway rates down, but with the present condition of the latter this no longer holds good as a general proposition, especially for the limited capacity of barge canals. The rates established for wheat and corn from Buffalo to New York by rail in 1899 are about 0.23 and 0.18 cent per ton per mile, which is but little above the canal rates, while rail shipments are much more advantageous.

The railway system is a vast employer of labor, directly and indirectly, and several million persons in the United States derive their support from the various railway industries, without taking into account such allied industries as rail mills, bridge works, locomotive works, and car works, etc. The number of direct railway employees (exclusive of the employees of terminal and sleeping-car companies, fast freight lines, etc.) is over 820,000, or over 1.2 per cent of the total population. A large proportion of these represent skilled labor of a high degree of intelligence. France has about 1110 employees per mile of railway, and 10 per cent of these are women.

The railway service especially demands some better and more intimate relation between the employers and employees than that of the mere buying and selling of labor for a price. Both humanity and self-interest have led several railways in this country and abroad to establish relief departments, providing temporary financial aid in case of accident or sickness, with other forms of benefits in addition, the object being to induce men to continue permanently in the employ of the road. Such associations have existed in England since 1850, in Canada since 1873, and in the United States since 1880, when one was started by the Baltimore & Ohio Railway. In 1896 there were six of these associations in the United States, with an aggregate of about 125,000 members. The six railway systems owned 15 per cent of all the mileage and had 20 per cent of all the railway employees in the country.

Before closing this review of railway development, brief reference may be made to certain special classes of railways.

Mountain Railways.—These include lines either isolated or forming part of main lines, having grades so steep as to require special means of traction. They may be operated by (A) cables, (B) grip rails, or (C) rack rails. Cables are used for many short lines, but are now rarely adopted for regular railway working. The grip rail system was first used on the Mont Cenis railway in 1867, and has been used in later years in Brazil and New Zealand. Rack rails were used in 1848 on the incline near Madison, Indiana (U. S. A.). In 1866 they were used on the Mount Washington railway (U. S. A.), (with the Marsh rack), this being the first mountain-climbing railway. In 1885, the Abt rack-rail system was introduced, and is a great improvement. It has been used both for ordinary railway service and for special mountain lines.

Rapid Transit.—Street or surface railways for city traffic date from 1831, in New York, and were operated by horses until 1873, when cable traction was introduced. Electric traction was introduced in Germany in 1881 and in the United States in 1884, and the growth of this system was such that in 1894 it was in use on 9000 miles in this country and 195 miles in Europe. Locomotives operated by steam, gas, compressed air, etc., have been used to a limited extent. For high speeds it was necessary to remove the railway from the street surface. The first elevated railway was built in New York in 1869, and now New York, Brooklyn, and Chicago have about 100 miles, operated by electricity and steam. The only foreign railway on this system is at Liverpool (England), the line being 5 miles long, and operated by electricity. The first underground railway was opened in London in 1863, and that city now has several miles of such railway, mostly operated by steam locomotives. Two underground electric lines are in operation and another is being built. Budapest (Hungary) and Boston (Mass.) have also underground electric railways. New York has for years needed and demanded a railway of this character, but political methods and extravagant demands for franchise rights have prevented the commencement of work upon the line.

Military Railways.—Railways cannot be made available to any extent for tactical purposes, but are of great importance as a means of supply and communication. They were used by the Russians in the Crimean war (1854), and were prominent features in some of the campaigns of the American Civil War (1861–65). In the Franco-German war (1870), the German army advancing on Paris was closely followed by a military railway, and in the Soudan campaign of 1898–99, the British army carried with it the head of a railway communicating with the base of supplies on the Nile.

Portable Railways.—These are narrow-gauge lines of light construction, for use on plantations, in lumbering operations, on engineering construction works, and for pioneer railways. The rails are riveted to steel ties, forming complete sections of track, straight or curved, which can be laid down, taken up, or shifted, as required. Such a line, of 24 inches gauge, was used to carry passengers around the grounds of the Paris Exhibition of 1889.

Ship Railways.—These are projected as substitutes for ship canals, but none have been built in modern times, if we except a few small ones for canal boats, including one at the Columbia River rapids, in Oregon (U. S. A.). One was proposed for the Isthmus of Suez in 1860, and in 1879 Captain Eads strongly advocated one across Tehuantepec (Mexico), to connect the Atlantic and Pacific oceans. This line would be about 150 miles in length, and the cost is estimated at $50,000,000. In 1888 work was commenced on the Chignecto ship railway (Canada), at the head of the Bay of Fundy, but it has never been completed. The general principle of the system is to float the ship into a dock and deposit it upon a wheeled cradle of suitable form. This would then be raised by machinery and hauled along the railway by a number of locomotives.

Advance In Law And Justice

By LUTHER E. HEWITT, L.B.,
Librarian of Philadelphia Law Association.

I. International Law.—Exclusive rights asserted in past centuries have been succeeded by freedom of the seas and privileges on the rivers. The principle back of the American guns off the Barbary coasts has prevailed. Crimes of one country against another are punishable in either. Extradition for nonpolitical crimes is general. Expatriation has been won for those who would change their country. Internal affairs of countries are free from interference; but a rule may be so revolting, or so hurtful to foreign interests, as to justify intervention. The Monroe doctrine was intimated in the Declaration of Independence, and has developed with our country. Regard for other nations has increased. Protectorates and spheres of influence are respected, while recognition of insurgent States will not be hurried. Devastation and weapons causing needless pain are condemned, while guerillas are regulated by requirement of a responsible head, a badge recognizable at a distance, and subjection to rules of war. The sick and wounded, attendants, and appliances are protected from intentional attack.

Open, unfortified places are in practice spared, and ransoms no longer extorted. Twenty-four hours are allowed for withdrawal of noncombatants from places to be attacked. Military occupation no longer confers sovereign power; and compensation on the closing of war has been recommended for private property of an enemy used in military operations.

Impartial neutrality is demanded. Nations once bound themselves for troops in case others went to war. This has ceased. Passage of troops through neutral territory is not allowed. Even sick and wounded will be denied if their passage would relieve a combatant's own lines; but neutrals have interned such refugees. The neutral cannot allow fitting out of armed expeditions or enlistment of troops. Jefferson advanced international law by demanding Genet's recall for such offenses. Carriage of signals, dispatches, or persons in military operations is unneutral, and the United States insisted that this ruled the Trent affair. A belligerent's ship of war can remain in port but twenty-four hours, unless in an emergency, like need of repairs. Coal will be afforded only to the nearest port, nor will a new supply be furnished within three months. Statutes enforce some of these rules. Neutral trade is not lost except on blockade, although goods which may be put to military uses are liable to seizure as contraband. "Free ships, free goods," was long contended for; and at last the Declaration of Paris, in 1856, provided even further, as follows: (1) Privateering is and remains abolished. (2) The neutral flag covers enemy's goods, with the exception of contraband of war. (3) Neutral goods, with the exception of contraband of war, are not liable to capture under an enemy's flag. (4) Blockades, in order to be binding, must be effectual. Spain, Mexico, Venezuela, and the United States declined to adhere to the Declaration. The United States adopted 2, 3, and 4, and offered to agree to the abolition of privateering if noncontraband property of the enemy were exempted under its own flag. The United States and Spain refrained from privateering in the recent war. Private property of the enemy on land has long been exempt from capture.

II. Law-Making Bodies.—State legislators were originally chosen from landed proprietors, except, perhaps, in Pennsylvania. Legislatures frequently had the selection of governors, judges, and other high officials, but the Ohio constitution in 1802 foreshadowed the coming democracy. Distrust has followed reliance on legislatures. Their sessions have been limited in about half the States to an average of less than ninety days, and almost everywhere made biennial. Increase of the members' own compensation is forbidden. Their duties are carefully prescribed. Common requirements are, reading of bills on three days; one subject for a bill, and that expressed in title; recital of old law, upon revision; prohibition of riders on appropriations. Nearly half the States require a majority in each house of all members elected thereto. Constitutional restrictions on state and municipal indebtedness and loan followed the burdens assumed in the first exultation over inventions in transportation. The Pennsylvania constitution, for instance, prohibits "local or special laws" in about thirty cases, such as in municipal affairs, descent of property, judicial proceedings, remitting penalties, exemption from taxation, regulating labor, chartering corporations. Boundaries between legislative and judicial proceedings have been simplified; special legislation in marriage and divorce has been forbidden; appellate jurisdiction has been taken from Senates once possessing it. The British House of Lords retains such jurisdiction, but within it sit the great judges, and the lay lords almost never vote on appeals.

Payment of expenses of members was derived from England, and although abandoned there has continued here. Members of Congress give attendance remote from home, so that they receive salaries rather than compensation. Sums for expenses are allowed in the other American republics, in France, Australia, Sweden, Switzerland, chiefly in the lower houses. Some are paid by the local constituency, but this tends to create classes. Representatives to Congress were generally elected at first on the State ticket, and in some States this continued until the Congress in 1872 required district election. The Revised Statutes appoint the day of their election, and require a printed or written ballot.

III. The Courts.—A feature of American jurisprudence which excites the wonder of foreigners is the power in the courts to declare legislative or executive acts void because unconstitutional. Before the Revolution the Rhode Island court struck down a statute contrary to the provincial charter; and a recent instance is the decision of the U. S. Supreme Court on the income tax. The power is exercised on individuals, without direct conflict between the great departments of government. The judicial power has otherwise widened. Civil trials without jury are frequent. In the counties judges exercise much administrative power. Road and bridge cases, grants of liquor licenses, appointments to educational and other offices, are illustrations. In what has been termed "government by injunction," functions both of the executive and of the jury have been assumed. Perhaps this justifies the demand that all judges shall be elected by the people. Frequently the choice of judges was originally by the legislature, or by the governor, alone or with the approval of the senate. The judicial tenure of office has generally been lengthened to a term insuring a long service. In Pennsylvania, a supreme court judge holds office twenty-one years, a county judge ten years. Age limit prevails in some States. In a democracy, it is not surprising to find the doctrine sometimes asserted that juries in criminal cases are judges both of law and fact. In certain civil cases, the jury is a crude but powerful engine for holding corporations to strict responsibility for the citizens' safety, although excessive or unfounded verdicts are to be deplored. Much of the old law of deodands has force to-day in subtler form. A feature to note in passing is the duty imposed on the judge to answer before the jury points of instruction framed by counsel.

IV. Civil Procedure.—Twenty-nine States and Territories rejoice in escape from puzzling classifications by substitution of simple statements. Extreme separation of law and equity had made the old condition worse. Equity might often soften legal principles, or law lend vigor to equity. Much of this has now been done; had been done, in fact, in Pennsylvania, from early days. Its enforcement of equitable rights through remedies at law was largely followed in the English Judicature Act of 1873 abolishing forms of actions at law and interblending law and equity. This statute has been copied largely in British colonies. England abolished the cumbrous system of real actions in 1834, and substituted simpler remedies for assertion of title.

The simplicity of present procedure is accompanied by ability to reach decision more promptly, and an old reproach has been greatly lessened.

V. Codification.—The New York Revised Statutes of 1828 embraced nearly the entire civil procedure, and in 1848 a “Code of Procedure” was adopted, although the original draftsman, David Dudley Field, complained bitterly of changes. Forty-two States now have more or less complete codes of practice; and criminal codes likewise are numerous. Codification of the branches of substantive law may be anticipated. Something of this is going on in England. The Bill of Sales Act, the Employers’ Liability Act, the Bills of Exchange Act, the Public Health (Scotland) Act of 1897, the Land Transfer Act of the same year, are instances. In Pennsylvania, there are codelets like the Evidence Act of 1887, or the Building Law for Philadelphia of 1893. Instances could be multiplied. A code intended for all the States on Negotiable Instruments has been prepared by commissioners, and has been adopted in New York, Connecticut, Colorado, and Florida. In Great Britain there has not been general codification, whereas the continental systems run largely that way, even in substantive law, being based on the Roman law.

VI. Criminal Jurisprudence.—The grand jury is no longer grand in many States; indeed, less than twelve members suffice in some; and their service may even be dispensed with under some Western constitutions. Individual malice has been avoided by the creation of public prosecuting attorneys. “Standing aside jurors” resulted from 33 Edward I., denying government challenge except for cause. It has been generally abolished, and the prosecution equalized by a number of peremptory challenges. Pennsylvania retains the old practice. Prisoners may now testify, but refusal is not to weigh against them. The statute 7 William III. allowed counsel in treason cases, but England did not extend the privilege to trials for other felonies until 1836. The courts in mitigation permitted counsel to prompt prisoners with questions. Penn’s charter gave prisoners privileges of witnesses and counsel, and this is now universal in American constitutions. Many States provide counsel for prisoners without means, some with compensation. “Standing mute” has become equivalent to a plea of not guilty. Unanimity in a verdict is essential to conviction of crime above misdemeanor, except in Utah, and there it is limited to capital cases. In civil and in minor criminal cases about a dozen constitutions in the far West or Southwest either recognize verdict by proportion of jury or else empower the legislature so to do. England refuses criminal appeals, but in this country they are allowed. The courts of this country have never been subservient to military passion, and all friends of the great French Republic must rejoice at the courage of the Court of Cassation in the Dreyfus case. The English law inflicted death for 160 crimes, some great and many otherwise, about the period of our Revolution, and in 1819 this number had become 200. American jurisprudence never had such stain of blood, yet 10 crimes were punishable with death in Massachusetts, and 20 in Delaware, at the time of the Revolution, and the pillory, stocks, shears, branding-irons, and lash were busy. Horrible prisons existed, filled with every foulness and immorality. The older penitentiary system has been modified in 20 States by the parole system under police supervision, and in 4 the policy of indeterminate sentences within fixed limits and ages has been adopted. Bertillon and other methods of identification have greatly lessened crime in England. The law of deodand, whereby the value of an object causing accidental death was forfeited for charities, was abolished in England in 1846. Societies to prevent cruelty to children, or to animals, attest the advance of refinement and humanity.

VII. Capital Punishment.—In England, treason and felony, except petty larceny and mayhem, were punishable with death. The fiction by which males who could read were supposed to be of the clergy saved first offenders, who escaped with branding. In the eighteenth century, the fiction was forbidden, and death imposed on additional offenses, so that 160 crimes were so punishable. In 1826, the efforts of Sir Samuel Romilly and Sir James Mackintosh, and later of Sir John Russell, resulted in a more merciful spirit, and since 1861 murder, treason, and firing of the great dock yards, have been the only capital offenses. The American colonies were more humane, yet Massachusetts punished 10 and Delaware 20 crimes with death. Since the Revolution imprisonment has been the general penalty. In Maine, Wisconsin, and Colorado capital punishment has been abolished altogether; in Rhode Island, except where murder is committed by a life prisoner; in Michigan, except for treason. In some States, as in Ohio, the jury may avert the death penalty. New York and Iowa, after experiments, restored capital punishment. The federal law imposes death for murder, piracy, robbery on the high seas, rape, treason. The introduction of degrees of murder has reduced the number of executions. In New York, electrocution has been substituted for hanging. Capital punishment has been abolished or qualified in the Argentine Republic, Belgium, Brazil, Chile, Costa Rica, Guatemala, Holland, Italy, Norway, Portugal, Russia, Switzerland (in eight cantons), and in Venezuela.

VIII. Police Power.—The citizen of the present day is protected by the police power to a degree which, perhaps, would have seemed marvelous a century ago. The sale of food is governed both in quality and quantity; building laws prescribe yards for light and air, height and thickness of walls, and forbid wooden buildings in many populous centres. Explosives are placed under strict regulations. Health laws protect from impurity of food and from pestilence, establish quarantines, deny the importation of rags, cattle, etc., likely to breed disease; medicine, pharmacy, dentistry, and nursing are protected from ignorance; immigration laws exclude persons or races deemed uncongenial or objectionable; railroads are subjected to provisions promoting safety, comfort, and impartiality of service; lotteries, gambling, threatening letters are forbidden; game laws preserve the various species from extinction; women and children are guarded by special laws. Almost the entire body of this division of law is new to this century, and much of it is recent.

IX. Married Women.—In 1800, a husband could appropriate his wife’s personal property not held in trust, and use her realty while he lived. Except for necessaries or for her separate estate, she could not contract. Her emancipation began in 1839, in Mississippi, and now her property, under the statutory interests secured to her by laws generally prevailing, is hers free from control or interference. This statutory estate includes property inherited, or derived by purchase or gift, or in some States by labor. The wife’s power to contract has been extended, and in some States has little restriction beyond perhaps inability to become surety. Before this era, some States, acting on a London custom, had allowed feme sole traders in cases of mariners’ wives, or of desertion or neglect.

X. Children.—Regulation of the labor of children in hours and employments is usual, debarring them from workshops and factories at certain ages and from occupations dangerous to their morals, as in theatricals, circuses, rag picking, mendicancy, street music. Laws prohibit their entrance into gambling, or worse, houses, into pool rooms, or unaccompanied into dance or concert halls, roller rinks, vaudeville theatres. Minnesota excludes them from criminal trials. Sale of liquor to minors is prohibited. Numerous recent statutes prohibit sales of cigarettes, cigars, or tobacco, and Utah and West Virginia forbid sales of opium. Oregon and Rhode Island prohibit their public use of tobacco. New Hampshire, Indiana, and Connecticut forbid children over three in almshouses. North Carolina makes it a misdemeanor to leave a child under seven, and unattended, exposed to fire. Prohibiting employment inconsistent with school attendance is usual. Compulsory education exists in twenty-nine States and two Territories, and largely throughout Europe and the colonies. Fourteen is the more frequent limit of age. Children's welfare now determines their custody, rather than the rights of either parent. Laws in some States protect children more or less from wills made before their birth by parents. Many States provide that bastards may inherit from their mother or from each other, and she from them, and that their parents' marriage legitimates them.

XI. Real Estate.—Ownership of land is no longer embarrassed by joint tenancies, nor need conveyancing resort to cumbrous fine and recovery; while transfer has been further lightened by title companies pending the adoption, likely, of the Torrens system of registration and certificate. Democracy has rejected distinctions of sex or age in inheritance, and the half-blood may share in many States after certain degrees. Disability of aliens to hold lands has been removed in some States, in others there are limitations in acres, value, or time, while in some disability ceases on declaration of intention to become a citizen. The English doctrine of tacking, whereby ownership of earlier and later incumbrances cut out intermediate titles, mortgages, etc., is inconsistent with the American recording acts.

XII. Copyright.—After printing became general, the author received some, if inadequate, protection, in England through the Stationers' Company, or sometimes through particular privilege; in continental countries, through such privilege. The statute of Anne confined him to such years, etc., as it specified, and the courts have decided with hesitation that there was no copyright at common law. The statutory rights have varied. Since 1831 the copyright period in this country is 28 years, with 14 more if author, widow, or children are living at expiration of first term; and in England since 1842 it is 28 years or author's life, whichever is longer.

The first known copyright directed to an author was granted by Venice in 1491. In 1791 France allowed copyright to all dramatists, extending it in 1793 to authors in general. Countries in sympathy with France adopted the policy. Prussia in 1794 extended copyright to authors represented by publishers at the Frankfort and Leipzig book fairs. General protection has now come about, aided by consolidation of European states into great nations. International copyright began with separate treaties; and the movement culminated in the Berne Convention of 1887, participated in by Germany, Belgium, Spain, France, Hayti, Italy, Switzerland, Tunis, Great Britain, Liberia. Authors resident in any country which was a party to the Convention may have copyright in the other countries. The United States did not join, although it had and since has had treaties with a few nations exchanging such protection. The International Copyright Law of 1891, however, protects foreign authors but not foreign publishers, it being required that the printing shall be done in this country.

XIII. Admiralty.—The difference between the majestic rivers of America and English streams was recognized in the case of "The Genesee Chief," wherein the Supreme Court rejected the English doctrine that admiralty has no jurisdiction except on the seas or where the tides ebb and flow. This has insured uniformity in the regulations of travel and commerce, and has protected such waters from local interference. International rules to prevent collisions at sea have been joined in by the United States. By acts of 1851 and 1884, Congress relieved innocent shipowners of liability for merchandise destroyed by fire, and provided that liability in case of collision, embezzlement by crew, etc., shall not exceed the owner's interest. The Harter Act of 1893 provides that on due diligence neither owners nor charterers shall be liable for faults in navigation or in management, nor for perils of the sea, defects in goods, etc., but prohibits agreements relieving from liability for injuries caused by neglect in fitting out, provisioning and manning the vessel, stowing the cargo, or in caring for or delivery of the same. Parliament, in 1890, protected seamen from commercial greed by requiring load lines to be marked on vessels at a height fixed by the Board of Trade.

XIV. Corporations.—The source of corporate life was formerly the king; to-day, the charters are virtually the general corporation law, and special incorporation is forbidden. For a season, minor amendments for particular companies were tolerated, but constitutions are forbidding even these. Applications for charters must state such particulars as name, nature, and place of business, amount of stock, limit of indebtedness, number and names of directors. Annual reports must be lodged with the tax authorities.

Doctrines respecting corporations have wonderfully changed. The Dartmouth College case held that charters were contracts and could not be impaired; and thereafter, by constitution or otherwise, the States provided that all new charters should be subject to alteration or repeal, although even this does not authorize radical change of corporate character. American law has recognized advantage of freedom in execution of corporate affairs. It has dispensed with the burdensome requirement of seal to contracts, and even in England the corporate seal is unnecessary, unless in unusual transactions. The American courts uphold negotiable notes and bonds given in authorized business. The company is confined to the business for which it was created, although a cautious tolerance exists in respect to related enterprises; and mortgages may be acquired if for debts contracted previously and not as a device. The old theory was that a company could not be held for misfeasance, since it could not authorize its agents to commit wrong; but corporations are now held for many torts sanctioned by them, such as trespass, assault and battery, infringement of patents, negligence, and even fraud and libel. Exemplary damages may be awarded against them. One or another kind has even been subjected to indictment, in cases of nuisance, violation of Sunday law, maintenance of disorderly house, habitual omission of lights or signals, etc. They may be guilty of contempt. They may be punished by penalties and forfeitures.

A corporation outside its own State cannot exceed either its own charter or the power granted like companies of the other State. Connecting railways are sometimes adopted in each of several States, but the parts remain foreign to each other as respects jurisdiction in the federal courts. Foreign corporations are subject to the police power, but not to interference by the State in their interstate commerce, except Congress so authorizes. Companies not engaged in interstate commerce nor in governmental service may have conditions placed upon their entry into a State, and may be practically excluded by taxation. Property within the foreign State is alone taxable there, but the value of the franchise may be considered. Usually, statements are required showing location of agent, names of officers, etc. Contracts made before compliance are differently regarded, being void in some States, and only until compliance in some others, and in some not void at all where penalty is imposed. Some States seek revenue by lax laws inviting outside companies. Thus, by Delaware law of 1899, companies need not oblige themselves to keep their original books nor hold their meetings there, assessment beyond subscription is forbidden, and taxation is light.

In 1825 and 1827 the free organization of trades-unions and banking associations was authorized, and thus was introduced into English jurisprudence the principle of free association familiar to the Roman Republic. In 1838, but more especially in 1844, limited partnerships with transferable shares were authorized by general law; and in 1862 freedom from liability beyond subscription was somewhat recognized. A form of partnership, *société anonyme*, has been known in France for six hundred years, and by law of 1867 may be organized without special leave. The managers alone assume full responsibility, and the association bears now a company name. Germany adopted the principle of general incorporation in 1870, as have the greater nations, excepting Russia and Austria.

So early as 1784 New York enacted a general incorporation law for churches, and for libraries in 1796. In 1811, woolen, glass, and some other manufactures were thus favored. The principle widened out, was adopted elsewhere, and became quite general by 1850. Pennsylvania adopted the policy in 1874, although its religious, library and charitable organizations had enjoyed such law since 1791.

XV. Religion.—Scorned, lashed, thrown into prison, his tongue cut out, banished to savage woods, such was the fate of the Massachusetts Quaker among the first settlers, and Roger Williams shared little better. A long stride had been taken when, in 1691, the Massachusetts charter proclaimed liberty of conscience for all "except papists." Then was the brave and gentle Penn securing religious liberty to all confessing one God. Yet much further progress was essential. Roman Catholics were excluded from office except in New York and Maryland; while even in Pennsylvania no Jew could sit in the legislature. Most of the States required some religious test for higher offices; Massachusetts allowed no voters or officials outside of the Congregational church; and church membership was essential in Connecticut and New Hampshire. In 1776 Pennsylvania admitted to the legislature any who believed in God and in a future state of rewards and punishments. Massachusetts threw down the barriers to office in 1780, except that until 1821 the governor should be of the Christian faith; but office-holding was limited to Protestants in North Carolina until 1835, and in New Hampshire until 1877. Jews received the same rights as other sects in Connecticut in 1843, in Maryland in 1825. The Virginia Bill of Rights declared that all are entitled to the free exercise of religion, and a few years afterwards, in 1786, proclaimed further in words written by Jefferson that religious opinions shall never affect civil capacities, and that no man can be compelled to support religious worship. The Lake region was secured from molestation for religious sentiments by the Northwest Ordinance of 1787, and the Constitution not only secures all from such interference by Congress, but prohibits religious test for federal offices or establishment of religion by Congress. South Carolina made the Episcopal the State church in 1776, but dropped establishment in 1790. Support of religion was likewise abolished in Maryland in 1810, but continued in Massachusetts until 1833; and New Hampshire authorizes public Protestant teachers of religion. Maryland, Kentucky, and Tennessee exclude clergymen from office. Political hierarchies and polygamy are not within constitutional protections. Courts have declared Christianity part of the common law; but in present law its force is in its principles. Christian institutions, in common with other religious or charitable agencies, are favored in policies and exemptions; and blasphemies, like railings in general, are forbidden. Bible reading in public schools is generally discretionary with the school board, although held illegal in Wisconsin; but religious garbs may not be worn in such schools by teachers. A public hospital may not be erected on sectarian ground.

The English corporation and test acts excluded from office all without the established church, until 9 George IV.

XVI. Summary of Advance.—Increased respect for the rights of others, both individually and as nations, characterizes the law of this century, and may be perceived in every direction. It has created a new international law, developed democratic institutions at home and abroad, almost revolutionized criminal jurisprudence, extended the police power in every direction, and secured freedom of conscience and separation of church and state. It has emancipated woman, thrown a protecting care over children, and favored charities, asylums, houses of refuge. Imprisonment for honest debts has been abolished, and the wretched sight of debtors imprisoned for paltry sums no longer reproaches society. Homestead and exemption laws preserve the family. Honest bankrupts are again lifted up in hope. The legal means of settlement and recovery of rights has been greatly expedited. England has followed America in making lands assets for payment of debts; and claims against the State have received recognition in some of the States and under act of Congress, and likewise in England. Barriers excluding persons as witnesses have been broken down, first in Connecticut in 1848, next in England in 1851, and now there is little exclusion unless the adversary has died. Something had been done before in compelling answers to written interrogatories, but with a weakness and lack of logic that should have ridiculed the whole exclusion. Promotion of uniformity of laws has engaged the attention of State commissioners, who have drafted a code concerning negotiable instruments which has been adopted in four States. Constitutional amendment has afforded an entire race opportunity to develop from the low estate of slavery into such condition as the future shall manifest. Questions of civil rights, due process of law, and of equal protection and privilege, are constantly bringing State laws before the federal courts, as do questions of interstate commerce. Anti-pool and anti-trust enactments mark both federal and State law, and lately have broken up the alliance of the trans-Missouri transportation companies. Inheritance and succession taxes were imposed in Pennsylvania in 1826, and now are found in some dozen States. The progressive feature, or increase of rate with increase of estate, has been sustained by high authority. Congress has imposed such taxes, but its power to do so is in dispute before the United States Supreme Court.

In the early days of the republic property requirements existed both for office and for voting. New States came in with manhood suffrage established either by law or custom. Original States threw open the polls,—Maryland in 1810, Connecticut in 1818, New York in 1821, Massachusetts in 1822. The white labor of Virginia was denied the suffrage in 1830, but gained it in 1850. Similar movement in England is marked by the Reform Bill of 1832; and now manhood suffrage is universal in Germany, France, and Greece, and wellnigh so in England.

Evolution Of Building And Loan Associations

By MICHAEL J. BROWN,
Secretary of Building Association League of Penna.

I. GENERAL PRINCIPLES.

"Do not forget to pay your dues to-night," is an expression familiar to the occupants of fifty thousand Philadelphia homes, one hundred and fifty thousand Pennsylvania homes, and six hundred and fifty thousand households in the United States. This means that nearly seven hundred thousand families are contributing towards gaining homes of their own through Building and Loan Associations. The entire membership is nearly seventeen hundred thousand, of whom fully four hundred thousand are women and children.

The picture "Paying their Dues" is a representative one, and in Philadelphia there are four hundred and seventy-five such gatherings every year. The Philadelphia associations generally meet once every month, but in some parts of the State, and in other States, many societies meet weekly, so there are fully ten thousand such gatherings every twelve months in the United States.

The women have shares in their own right, and the children are either paying dues for their parents or for themselves, the father or mother acting as trustee. The boys and girls know exactly what nights the associations meet, and are generally on hand with their money long before the officers are ready to receive the funds and give receipts in the pass books.

What is the meaning of these gatherings? To enable every member to become his own landlord—to purchase homes for themselves, by paying their money into a joint concern for a few years until each one has saved enough, with gains added, to buy a home, and in the meantime the entire receipts being loaned to the members to gain homes in advance of the final reckoning or maturity of the shares.

The members have well learned the principle that money makes money if well used, that if many pay rent for the benefit of the few, through the building association the many may combine together so as to put the rents into their own pockets.

II. THE SYSTEM.

For convenience, "a share" is the payment of $1.00 a month, five shares $5.00, and so on. The final value of a share is arbitrarily fixed at $200. The money received is promptly loaned to the members, on which the borrowers pay $1.00 per month interest on every $200 borrowed, until the final value of $200 is reached, which occurs in twelve years or less.

A member may have borrowed $2000 from the association on ten shares of stock ($200 being the limit loaned on each share), and the shares having matured, or become worth $2000, his loan of $2000 is canceled and his home is free. The member who has not borrowed receives $200 in cash for every share he holds.

The building association in its simplest form, and as it existed in Philadelphia for many years, took all its members in at one time, and the members paid from $2 to $20 each every month until the shares matured. At maturity all the borrowers received canceled mortgages, and the non-borrowers cash for their shares, and the society then closed its affairs. Hundreds of such associations have wound up their affairs successfully.

Very many associations are now working on the permanent plan; that is, they admit new members every six months or every year, the first set being the first to mature, and so on, one set going out every year and a new batch coming in.

Each series is a separate association so far as the dues are concerned, but the total gains are divided so as to give each dues dollar invested a like rate per cent per annum for the time of investment. There is really no positive or final division of profits. The gains are kept in a lump sum, and the division is on paper only for the purpose of showing the progress made towards maturity. When a set of shares matures, its portion of the gain is taken from the accumulated profits and divided to the stock that has reached its final value.

Some associations count all the loans as assets and all the dues and gains as liabilities. In such societies the borrower pays interest on his full loan until the end, and gets credit for profit on his dues until one account cancels the other.

Other associations, at the end of each year, deduct the dues paid in from the loans and charge interest on the net amount only of the loan. By the latter system the borrowers' payments decrease every year, but it requires a longer time to finally cancel the loan than by the former system.

When there is a demand for money, and more than one member is anxious to secure it, the funds are offered at auction, and the member who bids the highest premium secures the prize.

The bidding is generally done by offering so many cents per share per month above the required interest.

These payments continue until the shares mature. The dues are the contributed capital, and the interest and premiums are the gains.

III. THEIR EARLY HISTORY.

Their early history in England seems to date back as far as 1781. In Mr. Langford's "Century of Birmingham Life" mention is made of certain proposals for establishing a society for building on lands belonging to William Jennings, Esq. The society was organized by rules or articles, similar in some respects to those employed by the building societies of to-day.

Dr. John Henry Gray, in his "History of the Laws, Manners, and Customs of the People of China," describes some money-lending societies which seem to partake in some measure of the character of building associations, at least in their coöperative and equitable features. He tells us that these societies are called "Lee Woee," and were instituted by a person named Pong Koong, an official of great wealth, who flourished 200 B.C. during the Han dynasty. The money was loaned to members and returned in monthly installments with interest. Each member was compelled to contribute to the fund a sum equal to that which he contributed at the first meeting. One of the rules was, "Each member shall deposit in a lottery box, placed on a table, a tender or bid for the money, setting forth the rate of interest which he is disposed to pay on the amount in question; that the tenders shall be taken out of the box by the president, and the highest bidder takes the loan." When two bids were alike the first bidder took the loan. A fine was charged for non-payment of dues.

IV. AMERICAN ASSOCIATIONS.

There is no evidence other than that Frankford, now a part of Philadelphia proper, saw the first building society that was organized in the United States. It was called the "Oxford Provident Building Association," and was started in 1831, sixty-eight years ago. It closed its affairs in June, 1841. The second Frankford society, of the same name, was organized in February of 1841, and ran out in August, 1852. Isaac Whitelock was president, Samuel

Pilling treasurer, and Isaac Shallcross secretary, of the first association; and Henry Taylor president, Isaac Shallcross secretary, and William Overton treasurer, of the second association.

The Holmesburg Building Association was organized in January, 1842, and closed its business satisfactorily to the members, June 25, 1853. John B. Duff, a lumber counter by trade, was instrumental in organizing the first building society within the compactly built up city of Philadelphia, in the year 1847. The name of the society was the “Kensington Building Association.” The society issued five hundred shares of stock in one series, and wound up its affairs in ten years and two months after it was organized. The first advertisement of any building and loan association, so far as can be ascertained, appeared in the Philadelphia “Public Ledger,” February 5, 1847, and called for a meeting of the “Kensington.” Mr. Duff died in 1883, and a few months before that event he presented to the writer a document now known as “The Old Yellow Poster.” It is the call for the first building society in Old Philadelphia, a copy of which is herewith presented.

Mr. Duff seldom, if ever, held forth in public, but his efficient work was done by taking individual cases and converting them to the benefits of obtaining homes for themselves. Frequently he has been seen on a pile of lumber with chalk in hand, demonstrating a problem in building society arithmetic to converts to this system of saving.

There has been scarcely a great mind in the country that has not moved the lips to say some good word for the building society cause. Henry Ward Beecher in a sermon said,—

“I think that a young man who places before himself not a speculation, not a fortune, but some object that he means to achieve, who selects a particular piece of property that he would like to own, and aims steadily at acquiring it and works diligently for it, and saves for it, will be almost sure to succeed. I will say that every young man in a city, either through the instrumentality of a building association when there is one, or independently, when such an association does not exist, and when at last, having toiled and waited patiently, the debt is paid and the piece of property is earned, is a great deal richer than the assessor knows him to be. The assessor goes around and puts a valuation upon his property for the purpose of taxing it. But, ah, those habits of industry and self-control; those wise measurings, which we call economy,—all these the man has gained over and above the property. He has saved himself from a thousand temptations. He has protected himself against remorseless vices, which would have gnawed out his marrow. And though you call it merely amassing property, it may be amassing manhood. It is one step on the upward way.”

State officials who closely examine the workings of these societies never seem to tire in their praise. Superintendent Kilburn, of New York, in his last annual report, refers to the conservative and honestly managed building association as follows:—

“During the past year associations of this class alone have returned to withdrawing members dues and profits amounting to $8,014,039. During the same period no less than fifty-seven associations were engaged in the payment of matured shares, and $829,752 were paid to members who had faithfully continued payments through a series of years, and at last saw their confidence justified. But these sums are of small consequence when we consider the comfortable homes that have been erected, and the families that have been permanently and comfortably housed through the facilities for frugality and thrift, for self-denial and saving afforded by them. My attention was recently called to a village of the State in which it was said that nearly one-third of the houses had been erected through the agency of a small local association.

“Nor is this an exceptional case, unless the element of proportion be taken into consideration. In nearly all the cities of the State, and in many of the large villages, there are associations that are models of their kind, and are worthy of the admiration and support of every good citizen.

“Their educational influence, too, can hardly be over estimated. The workingman who joins such an association takes part in the administration of its affairs and learns his first lesson in finance from those of larger experience, and, who perhaps, touches elbow with the lawyer, the merchant, and the minister as they discuss the safety of an investment, or proper amendment to the articles of association, and will not lend a ready ear to teachers of socialism, of class hatred, or of financial heresies.”

As shown elsewhere, the members of the New York societies have over $37,000,000 invested. The Building Association League of Pennsylvania, an organization of twenty-six years’ standing, composed of the most active associations in the State, some years ago proclaimed a “Declaration of Principles,” from which we quote:—

“The local building societies of the State of Pennsylvania are true coöperative organizations, transacting no business with the public, and not amenable to laws affecting financial institutions that have dealings with the public. They encourage thrift among the wage-workers, help to create taxable property in its best form—real estate, educate their members in business methods and teach them both how to save and how to invest money.

“By this service they have created a state police of tens of thousands of home owners, more efficient for the protection of life and property than a standing army.

“They have lessened the cost for the maintenance of alms-houses, prisons, and asylums, by teaching men and women to be self-helpful and self-reliant, and in that way have benefited the State to an amount far exceeding any sum that could be gathered by taxation.

“The work of the societies is done gratuitously by the directors, and in no other way could they be maintained, the profits resulting from the services of men who, though they have never posed as philanthropists, are engaged in the best kind of charity, helping men and women who help themselves.”

Joseph H. Paist, a prominent Philadelphia building association expert, has been president of the league since it was organized.

Other States have leagues, and they are all combined as a National League, whose motto is “The American Home is the Safeguard of American Liberty.”

At certain intervals the national government, States, cities, and hundreds of industrial enterprises distribute earnings and accrued interest to those entitled to the same. The vast sums of money drawn out of thousands of banks and banking institutions represent millions of dollars of canceled debts. Within a few days after these distributions take place, at least nine tenths of this money finds its way back into the strong boxes that parted with it. One tenth of the money is, perhaps, held in the pockets of the people, to be gradually disbursed for current needs until the next pay arrives. I do not remember having received a statement or statistical report referring to the building association share in these distributions.

True, there are no set dates for building societies to part with money, but in Pennsylvania alone these coöperative companies distribute $20,000,000 annually in matured shares and withdrawals. This is no insignificant sum. To-day their accumulated wealth (mostly savings of people in the humbler ranks of life) is over $107,000,000, and in the United States fully $600,000,000. The annual outgo for canceled shares is about $100,000,000, or fully $8,000,000 every month.

Since these associations were organized, quite one thousand five hundred million dollars have been returned to the members in the value of homes clear of debt and in cash for withdrawn and matured shares. Despite these vast disbursements, there has been a gradual increase in their assets from year to year.

Beginning with one association in 1831, their number increased in a small way until probably not over two hundred societies existed in 1800. From that date until the present moment it is estimated that over 8000 have been organized throughout the land, increasing at a rapid rate every year, and leaving at present, after closing out a great number, nearly 5000 active associations distributed among the States.

It is estimated that of the above named membership over 325,000 are women. Of the $600,000,000 of assets, at least $100,000,000 is a gain credit to the sharer. It is believed that an average of at least three members of a family contribute toward the payment of the dues and interest, and although seventeen hundred thousand names are on the books, nearly five million persons actually contribute.

These societies have done more to teach the people practical thrift than any known device ever promulgated. Thrift is described as “good husbandry, economical management in regard to property, success and advance in the acquisition of property, increase of worldly goods, vigorous growth, as a plant.”

“He is a good wagoner that can turn in a little room.”—Bishop J. Hall.

“Economy is the parent of integrity, of liberty and of ease, and the beautiful sister of temperance, of cheerfulness and health. Without economy none can be rich, and with it few can be poor.”—Dr. Johnson.

While these literary economical truths proclaimed in all ages by wise men, which they themselves very seldom knew how to put into practical use, have no doubt caused millions to think and wonder how to do it, they, altogether, have not built half as many rounds in the practical ladder of “thrift” as the poor workingman who successfully induces his next door neighbor to save one dollar a month out of his *waste* money, and with it subscribe for one share of stock in a well-managed building society. Building society advocates have done much inducing, but always in a practical way. They have not merely proclaimed that “economy is wealth;” that “the best security for civilization is the dwelling,” but they have taken the arm of their friend and neighbor and have led him to the society meeting-room and shown him just how they saved their own money. They have also taken them into their own homes and told them, “This is my own home, paid for, or nearly so, through the aid of the building society.” In this way lessons in the practical benefit of thrift are daily given.

“Examples demonstrate the possibility of success,” said Colton many years ago.

Alexander Dumas brought the matter home to the door of every man when he said, “All the world cries, ‘Where is the man who will save us? We want a man!’ Don’t look for this man, you have him at hand. This man—it is you—it is I—it is each of us.... How to constitute one’s self a man? Nothing harder if one knows not how to will it; nothing easier if one wills it.”

It would seem that building society advocates were created to teach men how to will it. In this line of work they have certainly been eminently successful. To what class of citizens do these advocates belong, good, better, or best? In the early history of these associations they were organized and almost wholly managed by mechanics and laboring men; managed honestly, conservatively, and successfully; and to this “class” belongs the honor of organizing, conducting, and carrying to a point of magnitude and usefulness, that commands the admiration of financiers the world over, the building societies as conducted in Pennsylvania and other States.

The honest, thrifty home-seeker has proved himself to be the “best” citizen so far as managing a building society is concerned. When failures have occurred, the main causes have been the introduction into the management of financial ideas emanating from the brains of theoretical bankers and literary economists.

The man who works at the bench mending shoes has a better idea of what a dollar will do than the man who has at his command hundreds of thousands of dollars belonging to other people, but who never was blessed with the necessity of earning a real dollar by his own labor. The conservative building society is one of good common sense and not of class. It would be difficult to bankrupt a building society conducted by men endowed with honesty and good common sense. The “better citizen” is the man who spends less than he earns, pays his debts promptly, would rather give his neighbor a dollar than steal a dollar from him, looks upon the home institution as holy and sacred, strives to own a home of his own, obeys the laws and looks the world straight in the face. This “class,” without a penny to begin with, caused Philadelphia to be known the world over as “the City of Homes.”

In the many interesting cases of men redeemed from the habit of unthrift through the agency of building associations, and placed on the road to moderate fortunes, there are sometimes two sides to the story. One side is that related by the individual who has been saved from future poverty, and the other side that which could be related by the wife and mother, if she did not prefer and really strive to hide from the outside world the life she had been leading, its trials and gloom. The man simply tells how many days in the week he preferred not to work, and how he never tried to save a penny. The wife could tell how little the husband brought into the home in the way of money, and what her awful anxiety had been. One side is public property, for it is told by the husband for the purpose of inducing others to make a new departure on the road to thrift and home-ownership. The other side is supposed to be sacred, but it is only a secret in a sense that it is not proclaimed. No man who is often voluntarily away from his work, having a “good” selfish “time,” spending the earnings of days of actual work, need imagine that his friends and neighbors are ignorant of what the life in his home is, for it is as plain to all as if the house was constructed of clear glass.

Every man of good health, who will make an honest and determined effort, has it in his power to change such a home as has been described into a palace of joy, comfort, and happiness, and even beauty.

There are many thousands of men and women throughout the land who would not to-day have their own roof over their heads but for the building society and the thrifty habits acquired through it.

The officers and members of these societies are men who have, by degrees, worked their way on the path to independence, and they are highly respected by all who know them, and pointed out as examples by their neighbors.

Members of these societies, after becoming firmly established in thrifty habits, delight in relating their own experience as well as that of others. There are thousands of interesting cases on record, of which samples are given below:—

A short time ago, at a house of mourning, the members of the family called the writer’s attention to a girl about fifteen years of age, who had volunteered her services to the family until after the funeral. This remark was made: “Our case is sad enough (the death of a father), but the child you saw at the door has a father who has been confined to the house with a lingering illness. There are several younger children, and one girl older than the one you saw.

The two girls have been working in a mill, but on short time. Their case is sadder than ours, and they were the first to volunteer to help us.” The above is the sad part of the story, but there is a silver-lined side, since ascertained. The father joined a building society some years ago and bought a house for $2000, and while on his sick bed received a paid-up deed for his home, the building society shares having matured.

It is now twenty years since a big, strong man, under the influence of strong drink, visited the office of a building society secretary and asked if a Mrs. —— had any shares in the society. The books were examined and an affirmative answer was given. The next question was, “How much has been paid in on the shares?” Answer, “Three hundred and sixty dollars.” The inquirer brought his fist down on the secretary’s desk and exclaimed:—

“So it is true, is it? I will stop that game; that woman is my wife, and I have just heard that she is going to draw out the money and run away.”

The secretary measured the man, and, risking a fight, determined to hasten a climax.

“So you are the husband of Mrs. ——, are you?”

“Yes, I am.”

“And you are drunk?”

“Yes, sir.”

“How long have you been drinking?”

“For a long time.”

“Have you given your wife any money lately?”

“No, sir.”

“Have you given her any of the money in this society?”

“I don’t think I have.”

“Your wife takes in washing and goes out house-cleaning, does she not?”

“Yes, sir.”

“You eat at home without paying anything towards the support of the house?”

“Yes, sir.”

“You have nice children, and your wife takes good care of them?”

“Yes, sir.”

“You admit that all this is true?”

“Yes, sir.”

“Now, will you answer me an honest question?”

“I will.”

“Don’t you think that you are just the kind of a man that a good woman like your wife would be justified in running away from?”

“I do.”

The secretary asked who told him that his wife was going to run away; and he answered that it was a friend.

The secretary then addressed him as follows:—

“When your wife comes to the society, I have noticed that her hands were sometimes split and bleeding from hard work, and I know that she is saving this money to keep you and the children from the almshouse. In the first place, you should give up drinking and keep away from the people who have been talking against your wife; and then I would advise you to go home at once and tell all to your wife, and get down on your knees before her and ask her pardon.”

To the utter surprise of the secretary the man shook hands with him and emphatically gave his word that he would act on the advice given.

Not the strangest part of the incident is that the advice was exactly followed. From that time until now the man has abstained from drink. As soon as he got work he took shares in the society, and in a few years three of his children had subscribed for shares. Only recently two of the children withdrew shares to buy homes of their own. This is the kind of practical work done by every building society in every State in the Union, and the State as well as the entire country is the gainer by it.

Of course it goes without saying that the building society knows no secret plan for the payment of dues and interest greater than the borrower can afford. It does, however, point out a way for every man to gain a home of his own, but the price of the house must be in keeping with his income. If this rule is not observed the result is almost always failure to gain the desired object. It is an old saying that it is almost wise to go in debt for a home, but it is decidedly unwise to contract for a home that requires every dollar of income to keep it up.

Every home buyer should allow himself some margin in order to provide for the possible rainy day. The man who cannot save over twenty dollars a month outside of actual living expenses commits a serious error when he signs a contract requiring him to pay twenty-five dollars every four weeks. In doing this he robs himself first, and, second, is unfair to his family. It would be to his advantage to place aside three or four dollars out of the twenty dollars named as a nest egg.

This applies in particular to the careful man, who has been taught in the school of thrift. The man who has been unthrifty may be able (when he graduates) to save thirty dollars a month even when he thinks he cannot save anything. Building society managers make it their business to warn the thrifty not to undertake too much, and also to lead the unsaving into habits of economy.

Only recently a judge on the bench said, “Such associations, when properly conducted under judicious restrictions and management, are a helpful blessing and encouragement to any community. But the ambitions and extravagance of some borrowing members place themselves in a burdensome condition.... Far better for the public, the associations, and their membership, that many small loans be made rather than a few in number and large in amount. Moderate homes and a moderate price should be the criterion.... Their primary purpose was and should continue to be to promote industry, frugality, and saving, and convert the shiftless and discouraged tenant into a self-reliant and contented home-builder.”

Building societies since their inception have supplied the means for home purchasing, but these companies do not generally take any part in the erection of houses. Most of the small homes in Philadelphia have been built by those engaged in the business of building houses for sale.

Here is a picture of a row of houses containing seven rooms each. The purchase price is $1400 each. The lots are 14 feet wide and 60 feet deep. The houses are brownstone and brick.

They have good cellars, portable heaters, and range in kitchen, hot and cold water in kitchen and bathroom. On the first floor there are three rooms,—parlor, dining-room, and kitchen, and outside shed. Front door opens into vestibule; entrance to parlor from entry, and also from dining-room. Two front bedrooms over the parlor, bathroom in centre, and sitting-room back of the bathroom. The dining-room extends over the width of the lot less stairway room, and receives light from skylight. The kitchen has a window opening towards the back shed or backyard. A small toilet room occupies a small portion of the back shed.

Any person known to be prompt in the payment of dues and interest may purchase such a home by the payment of $200 in cash, and giving a building society mortgage for the balance of the purchase-money, namely, $1200.

The monthly cost would be about as follows:—

Monthly dues $6.00
Monthly interest 6.00
Monthly total $12.00

A fairly prosperous building society will mature its shares in twelve years, and at the end of that period the home would be free from debt. During this time the borrower must pay taxes and water rent, amounting to some $25.00 per year. The total payments would be about as follows:—

First payment $200.00
Dues and interest 1728.00
Taxes and water rent 300.00
Total $2228.00

This seems like a considerable sum of money for a house worth $1400. But it must be remembered that the borrower has lived in the house during these twelve years, and that he has saved in rent that he would have paid elsewhere, at least $1800.

He has paid $2228.00
He has saved 1800.00
Real cost of house $428.00

Now he is the full owner of his own home. During the next twelve years he will have nothing to pay but taxes and water rent, and possibly some slight repairs, at the most not over $400 all told.

His next door neighbor is still a renter, and pays $1800 to his landlord during the second period named; and the two accounts compared show:—

Rent payer $1800.00
House owner 400.00
Saving $1400.00

This is equal to a saving of, say, $10.00 a month for 144 months, and if used in the purchase of ten shares of building society stock would be worth at the time named $2000, instead of $1400 merely saved. The neighbor who is a tenant is still paying rent and owns neither a stick nor a stone, while the building society borrower owns one house free and also has the command of $2000 in cash, all on account of his house-owning experiment.

V. THE BANQUET.

It is customary for the directors of these societies, at their own expense, to celebrate the closing of a successful year, and have as their guests representatives from other societies.

“The banquet” includes officers from fully fifty companies, some being directors of four or five associations. At these gatherings experiences are related and subjects for the advancement of the cause are discussed. Every individual present on these occasions volunteers the information that he owed all he possessed to the building society and its teachings.

What the bottles on the table may have contained, it matters not now, for they are empty and are not capable of doing any harm.

Epoch-Makers Of The Century

By REV. A. LEFFINGWELL,
Rector of Trinity Church, Toledo, Ohio.

Every century has had its epoch-making characters,—men and women who dominated and directed the thoughts, purposes, activities, and achievements of their times. The nineteenth century is distinguished above all others by the number and quality of those who came to stand for the inception, advance, and culmination of the world's great movements and who highly exemplified in their careers the enterprise and genius of their day.

The object here is to designate, and make brief mention of, some of those who have fairly earned the title of epoch-maker, with the hope of providing a delightful historic study, and further enhancing the instructive value of a volume addressed to the triumphs and wonders of the century.

Statesmen, Orators, and Jurists.—Abraham Lincoln (b. February 12, 1809; d. April 14, 1865) sprang from the masses, and grew up with their institutions rather than with the learning of the schools. He grew into leadership because he was one of the "million," had hard sense and was true. As a forcible exponent of the sentiment of his party he was elected President in 1861. His election was the signal for secession and war. His mastery of the most delicate situation in the history of his country was superb. His patience, his perseverance amid hard trials, his wisdom of administration, his adaptation to the march of events, his striking and educative speech, his determination to preserve a union of States, all led grandly and inevitably to the crowning act of his noble career,—the abolition of slavery in the United States in 1863.

There is no sadder chapter in history, and no greater loss for any nation or time, than that of his taking off (after being a second time honored by the presidency) at the hands of an assassin, on the night of April 14, 1865.

Jefferson Davis (b. June 3, 1808; d. December 6, 1889) stood for the cause of the South against the Union, as it took concrete political form in the shape of the Confederacy, of which he became the only President. Though, perhaps, lacking the ability of such leaders as Calhoun and Stephens, he was a conscientious and persistent advocate of the doctrines which culminated in war, and as chief executive ruled with energy and firmness.

Henry Clay (b. April 12, 1777; d. July 29, 1852) was a born orator and natural party leader. In statesmanship he was intensely patriotic and always able, being highly informed and skillful in debate. He came to stand as the champion of those doctrines which the Whig party supported, such as protection to home industries, internal improvements, and reciprocity. Upon the question of slavery which agitated Congress during most of his career he generally assumed an attitude of compromise, and fathered so many measures of a pacifying nature that he was called "the great pacificator."

Daniel Webster (b. January 18, 1782; d. October 24, 1852) typifies the gigantic and imposing in New England intellect and physique. As early as 1820 he stood at the very head of American orators, a fame soon to be followed in the ranks of law and statesmanship. At first he opposed the doctrine of protection, but subsequently gave his support to Henry Clay's "American policy." In the United States Senate, he won the titles of "expounder of the

Constitution" and "supporter and defender of the Union," by his masterly denunciations of the doctrine of nullification.

James Monroe (b. April 28, 1758; d. July 4, 1831) reached the presidency twice, once in 1817, and again in 1820. His last administration was characterized as "the era of good feeling," during which new States were admitted, Florida was acquired, the Louisiana boundary defined, slavery prohibited north of certain lines, and many provoking controversies with England were settled. In 1823 he signalized his administration by promulgating the now famous "Monroe Doctrine," which was a warning to Europe that monarchical governments would not be allowed to interfere in the affairs of either North or South America.

John Quincy Adams (b. July 11, 1767; d. February 23, 1848) typed the Federalism of the early part of the nineteenth century, and won the highest place in scholarly statesmanship. In diplomacy he filled many prominent and difficult positions at home and abroad. As sixth President of the United States, he was opposed by a majority in Congress, and consequently failed to distinguish his administration. He was the forerunner of those sentiments which culminated in organized opposition to the doctrine of human slavery.

John C. Calhoun (b. March 18, 1782; d. March 31, 1850) was twice Vice-President of the United States, and as Senator became the leading exponent of the doctrine of States' rights and nullification of federal tariff laws. He ranked with Clay and Webster as a debater and constitutional expounder, and the three were known as "the Great Trio." In him the pro-slavery cause found its subtlest, ablest, and most logical defender. With a fully stored mind of highly metaphysical turn, a fearlessness and persistency that were matchless, and a character above reproach, he greatly endeared himself in the South, and his writings are held in high esteem by men of his school of politics.

Rufus Choate (b. October 1, 1799; d. July 13, 1859) was probably the best-equipped scholar of the public men of the century, and was unusually brilliant as orator, lawyer, and publicist. Next to Mr. Webster he was the greatest member of the Massachusetts bar. He may be called the American Lord Erskine.

Count Camillo Benso di Cavour, of Italy (b. August 10, 1810; d. June 6, 1861), found a life-work in the unification of the Italian States. By pursuing a masterly course in European diplomacy he brought the states of North Italy into unity, and finally, through the efforts of Garibaldi, those of Southern Italy became united with them in one kingdom under the rule of Victor Emmanuel in 1860. Though not a man of "blood and iron," like Bismarck, he was the equal of his great German contemporary in diplomacy.

William Ewart Gladstone (b. December 29, 1809; d. May 19, 1898) was four times premier of England. As orator, political leader and statesman, and critic in the immense range of subjects he covered, his genius was without parallel. It may be said that his was the mightiest personality and most catholic and powerful intellect of any Englishman. He championed the cause of Christianity among all nations, sounded the first trumpet call of Italian liberty, opposed Turkey as a Mohammedan power, raised England's commercial prosperity to the highest notch, unraveled the entanglements of Beaconsfield's ministry, inaugurated the most astonishing reforms in all directions, but especially in the church, education, army, and among the labor unions. It is almost impossible to name any matter of national or international importance in which his personality and genius were not felt for good.

Alexander Hamilton (b. January 11, 1757; d. July 11, 1804) was by all odds the ablest jurist and statesman of the early constitutional era of the United States. He became the first Secretary of the Treasury, and lifted the finances of the government from utter prostration to high prosperity. As fiscal organizer his success was unparalleled, and all after administrations of the Treasury have been practically along the lines he first laid down. He was easily the leader of that party which looked with disfavor on “States’ Rights,” and favored a strong central government.

Benjamin Disraeli, Earl of Beaconsfield (b. December 21, 1804; d. April 19, 1881), stood, as premier, for English “territorial aristocracy” and for that “territorial expansion” which fixed the wide boundaries of the Indian Empire, made Queen Victoria Empress of India, taught both Russia and India to refrain from meddling with England’s possessions, made the English voice preëminent in the disposition of Continental territory, and completely defeated the schemes of Russia against Turkey. Under him the middle classes lost, and the laboring classes gained, political power. His career greatly heightened the national institutions and character, as well as the international reputation and power, of his country.

Thomas Jefferson (b. April 2, 1743; d. July 4, 1826) stood in the past century as an able exponent of American rights, and his views were incorporated into the Declaration of Independence, of which he was the acknowledged author. He equally stood as the leading exponent of that political school of thought which favored decentralization, or limitation of the powers of the central government. After his election to the presidency in 1800, he signalized his administration by what is known as the Louisiana purchase, for $15,000,000. In thus enlarging the area of the country by boundaries of vast extent, he became one of the earliest and most enthusiastic of expansionists, and that without reference to the modernly mooted question of “government without the consent of the governed.”

Richard Cobden, of England (1804–1865), was a humanitarian of great native breadth and liberality, largely increased by travel and constant observation. He was a powerful leader in the famous Manchester School of English statesmen. His share in modern progress was fourfold; first, in securing the repeal of the odious tax on corn in 1846; second, in urging arbitration rather than arms as a final resort to settle international disputes; third, in negotiating with France the Commercial Treaty of 1860, which Mr. Gladstone said no other living man could have secured; fourth, in his vigorous and successful opposition of all efforts to enforce England’s recognition of the Southern Confederacy during the late civil war.

Prince Otto E. L. Bismarck, of Germany (b. April 1, 1815; d. July 30, 1898), blended the unerring instinct, great far-sightedness, fertility in invention and expedients, and adroit diplomacy of a statesman, with absolute fearlessness, inflexible purpose, indomitable energy, and resistless force. Thoroughly German, he was preëminently and always Prussian, and his great life-work was the accomplishment of German unity with Prussia at the head. This he achieved by the humiliation of Austria and France, and the gradual accession of all the distinctively German states.

Wendell Phillips (1811–1884) exemplified the wonderful power of the skillfully colloquial in public speech, and is a type of the American orator who devotes his ability to correct public abuses, right public wrongs, and educate the public mind and taste. Chiefly as an avowed abolitionist, as advocate of the temperance cause, as champion of the Indians and of woman’s rights to the ballot, and as untiring mover in improving the nation’s penal institutions, Mr. Phillips most largely contributed to public weal and progress.

James Gillespie Blaine (b. June 31, 1830; d. January 27, 1893), whether serving in the House, Senate, or Cabinet, had few equals as a statesman, debater, parliamentarian, or enthusiastic political leader. Though often disappointed in his aspirations for the presidency, he lost none of that wonderful power which he had acquired by reason of his energy, tact, skill, personal magnetism, and knowledge of public men and measures. He became the special champion of the doctrine of reciprocity, and by its practical application during Mr. Harrison's administration proved its benefits to commerce and international trade relations.

By his splendid series of decisions and opinions, Joseph Story (September 18, 1779; September 10, 1845) shares with John Marshall the merit of determining and of developing towards its fullest capacity the power of the United States Supreme Court, as set forth in the Constitution, over state courts and state legislation. He also practically constructed the United States Admiralty Law and, even to-day, his "Commentaries on the American Constitution," in connection with both of his foregoing services, is a standard work. He represents the broad and powerful American judicial mind, which has contributed so largely to the integrity of the Union.

James Kent (b. July 31, 1763; d. December 12, 1847) was professor, judge of chancery, justice and chief justice of the N. Y. Supreme Court, and chancellor of New York. He possessed immense legal learning, and to him is primarily due the creation of New York courts of equity. His exhaustive "Commentaries upon American Law" is accepted at home and abroad as one of the great classics of American law literature.

Francis Wharton was born March 7, 1820, and died February 21, 1884. Although at the age of forty-three he exchanged law for the ministry, he still showed the legal tendency of his mind in a long career as professor of ecclesiastical and international law in Boston institutions. He enriched the literature of his profession by many valuable and standard works on law, municipal, state, national, and international, and, under Mr. Cleveland, was of great service to the administration as United States Examiner of International Claims in the Department of State.

Louis Adolphe Thiers, of France (b. April 16, 1797; d. September 3, 1877), was editor, historian, and statesman, and in the latter role became a distinguished leader of French thought and polity. His greatest service to his country was after the Franco-Prussian war, when the Assembly elected him chief of the executive, with the title of "President of the Republic." In this capacity he was particularly successful in negotiating the terms of peace with Germany, and in fulfilling all the conditions of peace.

William McKinley (b. January 29, 1843) became a leading champion of the doctrine of industrial protection at an early period in his congressional career. In 1883 Hon. W. D. Kelley said of him: "He has distanced all his colleagues in mastering the details of the tariff." The Tariff Act of 1890 came to be popularly known as the "McKinley Bill." Elected President in 1896, his administration was signalized by that humanitarian interference in behalf of struggling Cuban patriots, which culminated in the Spanish-American war, and the most unprecedented triumph of modern times. It had the added distinction of rounding out the nineteenth and introducing the twentieth century.

Warriors.—Napoleon Bonaparte (Napoleon I.), soldier, statesman, and Emperor of the French (b. August 15, 1769; d. May 5, 1821), was the greatest of the world's masters in the art of war. His numerous campaigns, conducted with a brilliancy never before equaled, had for their object the humiliation of the countries of Europe, and the establishment of an imperial policy in which France should be supreme. This he came very near to effecting, in spite of closely combined and persistent opposition. None of the frequent coalitions formed to thwart his ambitions and stay his martial progress proved absolutely effective till that of March 25, 1815, was formed, which put an army of 700,000 men in the field against him. It was a part of this army that he met at Waterloo, June 18, 1815, where defeat awaited him, together with the eclipse of his gigantic influence and phenomenal genius.

Ulysses Simpson Grant (b. April 27, 1822; d. July 23, 1885), graduated at West Point and had a brief military experience in the Mexican war. On the breaking out of the Civil War he reëntered the Federal service from civil life, and by exceptional fertility of resource achieved a series of victories in the West which led to his command of all the Union forces, with the specially conferred title of lieutenant-general, a title subsequently raised to that of general. By the brilliant, persistent, and simultaneous campaigns he carried through in the East and West, he further clinched his title as one of the world's greatest generals, and ended the conflict with honorable peace. He was honored twice with the presidency of the nation, and through the trying period of reconstruction his wise statesmanship cemented the Union his sword had preserved.

Arthur Wellesley Wellington of England (b. May 1, 1769; d. September 22, 1852), attained his first real military distinction in the campaigns of the English in India. He further added to his fame in the campaign against France in the Spanish peninsula. But his greatest glory as a warrior was reached in 1814, when, with the aid of the Prussian marshal Blücher, he defeated Napoleon at the decisive battle of Waterloo. He was afterwards honored with a seat in the House of Lords, and as Prime Minister of the Tory party, but his statesmanship proved to be of an inferior and unpopular order.

Helmuth Karl Bernhard von Moltke, of Germany (b. October 26, 1800; d. April 24, 1891), was the world's greatest exponent of strictly scientific warfare. He made the Prussian army a most powerful and dangerous machine, and led it triumphantly against Denmark and Austria. By dint of strict organization and drill he made the armies of the German Confederation equally effective, as was shown in the Franco-German war (1870–71), which was a series of brilliant victories, ending with the capitulation of Paris and the downfall of Napoleon III. and his empire. His greatness lay in the fact that cool, sober calculation always dominated his greatest audacity of plan.

Simon Bolivar, or Bolivar y Ponte (b. July 25, 1785; d. December 17, 1830), justly earned the surname of "The Liberator." The first and greatest of those South American patriots who struck against the tyrannical colonial system of Spain, he achieved the independence of the three States of Colombia, Bolivia, and Peru, secured their recognition by the civilized world, and lived to govern them with the wisdom and moderation of a wise executive.

Robert E. Lee (b. January 19, 1807; d. October 12, 1870), graduated at West Point, and was in the constant military service of the United States till the breaking out of the Civil War. He then transferred his services to the Confederacy, and speedily became the highest exponent of its military powers. Honorable, just, energetic, persistent, skillful in offensive or defensive warfare, schooled in strategy, full of devices and combinations to overcome desperate situations, he prolonged a hopeless struggle to an astounding degree, and met defeat and surrender without dishonor. He readily ranks as one of the world's greatest generals.

Lajos (Louis) Kossuth of Hungary (b. April 27, 1802; d. March 20, 1894), as writer, lawyer, and statesman, came to stand for Hungarian freedom. After the declaration of independence of his country in 1849, he became its military and political ruler, but was forced by Russian intervention and domestic rivalry from his high place, and escaped to foreign lands to pass the balance of his life in eloquent but fruitless appeals in behalf of his cause and people.

Giuseppe Garibaldi, of Italy (b. July 4, 1807; d. June 2, 1882), typed the restless, daring soldier, the impulsive statesman, and the energetic defender of freedom. He shared Count Cavour's desire for a free and united Italy, and grew to be a great popular hero. Upon his capture of the two Sicilies, he presented them to Victor Emmanuel, thus consummating his life dream of unification, and his desire for a government in which the wishes of the people were, to some extent, recognized.

Naval Heroes.—Stephen Decatur (b. January 5, 1771; d. March 22, 1820) attained the rank of captain in the U. S. Navy for his gallant exploit of burning the frigate Philadelphia in the harbor of Tripoli, after she had been captured by the Tripolitans. He won further fame as commodore in the war of 1812, and again in the war with Algiers, Tunis, and Tripoli. Quick to comprehend emergencies and prompt in action, he was a type of the dashing and absolutely fearless American seaman. True to his fiery nature, he found his death in a duel with Commodore Barron.

Oliver Hazard Perry (b. August 23, 1785; d. August 23, 1819) was rewarded with the rank of captain in the U. S. Navy for the remarkable courage and dash which eventuated in the memorable victory over the British fleet in Lake Erie, September 10, 1813. This victory gave the Americans control of the Great Lakes and hastened, more than any single event, the conquest of the Northwest and the end of the War of 1812. He saw further honorable service as commander of the Mediterranean squadron, and died at Port Spain, on the island of Trinidad, of yellow fever.

David Dixon Porter (b. June 8, 1813; d. February 13, 1891) grew and ripened gradually into one of the great naval captains of the nineteenth century. His courage and energy, large experience, and intimate knowledge of the rivers and seacoasts of the country fitted him for the great emergencies of the Civil War. Many of the victories of the Union armies in the West were due to his cöoperation with gunboats. He greatly aided in the initial success of Farragut's expedition up the Mississippi, the reduction of Vicksburg, and other strongholds upon Western waters. The greatest victory of his life was the capture of Fort Fisher. He wrote a history of the U. S. Navy during the war, a work commended by all naval nations. On the death of Farragut, 1870, he reached the high rank of admiral.

David Glascoe Farragut (b. July 5, 1801; d. August 14, 1870) supplies the highest type of the skillful, cautious American naval commander, backed up by extraordinary dash and boldness. His signal achievements during the Civil War were the destruction of the Confederate fleet in the Mississippi, the capture of New Orleans, the passage of the forts at Port Hudson and the batteries at Vicksburg, and the capture of Mobile. For his brilliant and successful services the rank of vice-admiral was especially created for him by the government, and afterwards that of admiral.

John Adolf Dahlgren (b. November 13, 1809; d. July 12, 1870) was a prime agent in developing the Naval Ordnance Department and its works at Washington. He invented and made the well-known Dahlgren guns. During the Civil War he commanded the South Atlantic blockading squadron, of some ninety vessels, and did splendid service for the Union cause. He was author of many naval articles and books, some of the latter being used as text books by the government.

Raphael Semmes (b. September 27, 1809; d. August 30, 1877) types more fully than any other the naval dash and efficiency of the Confederacy. In him, as commander of the Sumter and Alabama, the merchant marine of the United States found its direst enemy, and his exploits upon the ocean won for him a fame which overshadowed those of even higher rank, but whose services were limited to narrower fields of naval activity.

Admiral George Dewey (b. December 26, 1837) acquired considerable naval experience in the Civil War. At the breaking out of hostilities with Spain (1898) he was in command of the U. S. squadron in Eastern waters, and was ordered to destroy the Spanish fleet in the harbor of Manila. His attack was prompt and daring, and it ended in one of the most notable victories in the history of naval warfare. In a few hours the entire fleet of Spain in the Orient was swept away, together with her power, and the United States was placed in possession of a new and magnificent island empire whose maintenance and government may change the whole history of the Orient, if not of the world.

Admiral Sampson's contribution to the century's progress lies in the line of skillful preparation for emergencies, and promptitude in meeting them. He became an epoch-maker in the history of the United States by means of the great and decisive victory over the Spaniards, won by the fleet under his command in the waters off Santiago.

Preachers and Teachers.—The Rev. James McCosh (b. April 1, 1811; d. November 6, 1894) was an able leader of that great school of literary men, scholars, educators, and aggesssive practical thinkers which this century chiefly seems to have produced.

His contribution to modern progress lies mainly along three lines:—

First, in his efforts to obtain the Free Church of Scotland, and establish it.

Second, in his most successful administration of the affairs of Princeton College while he was president of that institution.

Third, by his numerous, original, and powerful writings, chiefly controversial and philosophical.

The Rev. Charles Hodge (b. December 28, 1797; d. June 19, 1878) was a fine example of the modern expositor of the dogmas of Calvinism. Strong in conviction and persistent in purpose, a clear, logical thinker and writer, he naturally became a very powerful leader, his influence being particularly felt in establishing the present exalted position of the Presbyterians, especially of the old school division. This influence was wielded partly from his chair as Professor of Didactic, Exegetic, and Polemic Theology, and especially in the famous Princeton Review, which owes its greatness chiefly to his editorship and contributions.

Philip Schaff (b. 1819; d. October 20, 1893) is a type of the scholar who, through profound research and interpretation, has created an epoch in theology by his contributions to the nineteenth century, mainly in historical and exegetical branches.

Henry Ward Beecher (b. June 24, 1813; d. March 8, 1887) easily earned the reputation of the greatest pulpit orator of his day. As pastor of Plymouth (Congregational) Church in New York, his genius and remarkable eloquence attracted and held one of the largest congregations in the United States. Spontaneity, tact, emotion were elements of his oratory, and these were always supplemented by force, depth, subtilty, and quick grasp of intellect and heart. His versatility was phenomenal. Journalism, literature, politics, social life, philanthropy, parochial organization, and even agriculture and many other branches were touched upon by him, and all with results varying from excellent to extraordinary.

Ralph Waldo Emerson (b. May 25, 1803; d. April 27, 1882) passed through the career of teacher and preacher to that of general writer, lecturer, and poet. He should probably be classed with the metaphysicians or philosophers. His publication of "Nature" in 1835 marked a new era in American thought. From subsequent addresses and works may be dated the intellectual movement which was called *Transcendentalism*, and which was a reaction against formalism and tradition. He lacked the method essential to the foundation of a new philosophy, but his works form a permanent addition to the highest literature of the human race.

Phillips Brooks (b. December 13, 1835; d. January 23, 1893) was one of those phenomenal preachers of the century who won the hearing and hearts of his auditors by largeness and liberality of thought; spirituality, earnestness, self-sacrifice, and great love; and by beauty and poise of character. He seldom preached doctrine, but relied on the efficacy of ardent exhortation, and the finding and kindling of the good in each auditor.

Charles H. Spurgeon (b. June 19, 1834; d. January 31, 1892) stands as a type of the great popular preacher and leader in charitable work. With Baptist view's, he revived his own denomination and exerted a helpful influence on all others. No divine of his time swayed so resistlessly the immense audiences he attracted. His plain sermons were always lightened with happy illustrations and delivered with rare power and personal magnetism, and they had the exceptional quality of retaining much of their charm and persuasiveness when in print.

Friedrich Froebel of Thuringia, Germany (b. April 21, 1782; d. June 2, 1852), was a born educator, and his great life-work lay wholly in that direction. He studied not so much to get knowledge of particular branches as to discover their natural unity and hidden connection. He was the advocate of the new education, and pushed the system of Pestalozzi far beyond its author's dreams. According to Froebel, man and nature are governed by the same laws; and, by his observation of both, he reached his idea of what man's development should be, and how to accomplish it. True development must of course proceed from within, from self activity. And as every age of man is complete in itself, its perfect development can come from only such development in the preceding age. Hence, the necessity of properly training and educating young children. This course of reasoning resulted in his invention of the kindergarten system, together with his self-sacrificing devotion in training teachers, and in his heroic perseverance notwithstanding bitter opposition, or indifference.

Victor Cousin, of France (b. November 28, 1792; d. June 15, 1867), was a renowned epoch-maker of the century in founding the school of systematic eclecticism in philosophy. His system sets forth a doctrine of catholic comprehension and toleration of others. Few men did more in official and private life to advance the cause of general education in France.

William Wilberforce, of England (b. August 24, 1759; d. July 29, 1833), with Pitt and Clarkson, led in the cause of freeing the slaves, being himself the greatest type of the English abolitionist. For forty-six years he maintained unceasing and relentless warfare against slavery, and his priceless gift to the present century was the final and complete extinction of slavery and of the slave-trade in the British possessions.

Historians.—William H. Prescott (b. May 14, 1796; d. January 27, 1859) proved himself to be an epoch-maker in the sense that he combined the worth of history with the brilliance and fascination of the novel, and developed the entirely new field of Spain's career at home and in her colonies. His "Ferdinand and Isabella," "Conquest of Mexico," "Conquest of Peru," and "History of Philip II," all obtained a world-wide circulation, and both placed and kept their author in the highest rank of modern American historians.

François P. G. Guizot, of France (b. October 4, 1784; d. September 13, 1874), was both statesman and historian. In the former capacity he held several important public positions, and from 1840 to 1847 was, as Minister of Foreign Affairs, really at the head of the government. His many proposed reforms brought on the revolution of 1848 and the dethronement of Louis Philippe. Though ranking as one of the greatest of French statesmen, his highest and most enduring reputation rests on his historical writings, which are very numerous, and the chief of which is his "General History of Civilization in Europe." His works are classics of historical research, and inspiring forerunners of the modern method of treating history.

James Anthony Froude (b. October 23, 1818; d. October 20, 1894) ranks as one of the brightest of England's writers and historians, though not one of the most reliable. His writings are characterized, in the main, by ultra-Protestantism; and in his two most important works, “The English in Ireland in the 18th Century,” and “The History of England,” he endeavors to justify his country’s severe treatment of the Irish Romanists, to establish Henry VIII. as the chief champion of English independence, and also to bestow upon her ministers much of the credit popularly supposed to belong to Queen Elizabeth.

John L. Motley (b. Massachusetts, April 15, 1814; d. England, May 29, 1877) typifies the patient and painstaking searcher for truth in the development of national history; and also the sympathetic, graphic, and spirited painter of the scenes, events, and characters which he presents. His “Rise of the Dutch Republic,” “History of the United Netherlands,” and “Life and Death of John of Barneveld” are all undeniably great contributions to the historical literature of the present century, besides being monuments to the exacting toil and research of years.

Henry Thomas Buckle, of England (b. November 24, 1822; d. May 29, 1862) is a conspicuous type of the patient and learned historian. His principal donation to modern progress is “The History of Civilization in England,” a work whose novel theories created an epoch in the philosophy of history, and called forth much controversy. According to him, civilization was due not so much to moral or religious influence as to material causes,—soil, climate, food, atmosphere, etc.

George Bancroft (b. October 3, 1800; d. January 17, 1891) was equally renowned as statesman and historian. As a member of President Polk’s cabinet, he was instrumental in founding the Naval Academy at Annapolis and the Naval Observatory at Washington. As minister to Prussia he negotiated several foreign treaties, and ably conducted the settlement of the “Northwest Boundary” question. But his great life-work was his “History of the United States,” on which he labored untiringly till his death. It is the most exhaustive, philosophic, and inspiring of our national histories.

Richard Hildreth (b. June 28, 1807; d. June 11, 1865) was one of the century’s valuable contributors to the welfare of the United States by his “History of Banks,” his many works on morals and politics, and chiefly by his great life-work, “The History of the United States,” a production of great labor and masterly detail, but somewhat heavily written.

Thomas Babington Macaulay, of England (b. October 25, 1800; d. December 28, 1859), was noted as essayist and statesman. But his genius lay especially in history, in which line he was enabled to furnish the world with his great life-work, that most remarkable and valuable “History of England,” which quickly attained a circulation never before equaled by any similar publication. Though at times partisan and partial, he was still fortunate in throwing his great strength on the side of right.

Editors.—Horace Greeley (b. February 3, 1811; d. November 29, 1872) was founder of the “New York Tribune.” He took rank as one of the ablest editors of his day, and stood the foremost political advocate and controversialist of his time in America. He made of his paper a splendid property, and through it exercised an influence that reached far down among the masses. He lost much of his popularity by his advocacy of universal amnesty and impartial suffrage, after the close of the Civil War, and gradually drifted into the Liberal Republican party. This party, in alliance with the Democrats, placed him on the presidential ticket in 1872. He was disastrously defeated, and died from the effects of hard campaign work and grief.

James Gordon Bennett (b. September 1, 1795; d. June 1, 1872), founder of the “New York Herald,” was the most spirited and daring of those pioneers who revolutionized the journalism of the century. In his paper he broke away from high prices and prosaic methods, and inaugurated the era of cheap prices, racy news, and independent expression. He practically developed the present organization of newsboys, the use of the telegraph in securing news, and the American system of European and war correspondence.

William Cullen Bryant (b. November 3, 1794; d. June 12, 1878) united the scholarship of the general literature and the grace of a poet with the genius of a high-toned and brilliant editor. He gave to his paper, the “New York Evening Post,” a rank and influence seldom attained in journalism, especially when it is considered that its patrons were chiefly of the educated and higher business classes. He represented the cleanest and most intellectual journalism of the century.

John W. Forney (b. September 20, 1817; d. December 9, 1881) was founder and owner of “The Philadelphia Press.” The journalism of the century can boast no more indefatigable and brilliant pen than his, nor did any journal of his day occupy a more commanding place amid the discussions incident to the Civil War and subsequent periods of reconstruction. He was also editor and owner of the Washington, D. C., “Chronicle.”

Charles Anderson Dana (b. August 8, 1819; d. October 17, 1897) is an instance of a scholar and publicist who found a true, though late, outlet for his genius in the realm of independent journalism. Under his editorship and management the “New York Sun” became the model news medium of the country, and its editorial, financial, and other departments were conducted with an ability and conscientiousness that commanded the widest confidence. He was associate editor of “The New American Cyclopædia,” and compiler of the admirable “Household Book of Poetry.”

Joseph Medill (b. April 6, 1823; d. March 16, 1899) rose to the high rank of editor-in-chief and principal owner of “The Chicago Tribune,” through the schooling afforded by connection with several minor papers. No man of the century was more thoroughly imbued with the true editorial instinct. Of dignified and prudent expression, broad and keen thought, ever alive to the privileges and power of the press, he made his journal a model of excellence in all its varied departments as well as a colossal property.

Joseph Pulitzer (b. 1847) was founder and editor of “The St. Louis Post-Dispatch,” and afterwards became owner and editor of “The New York World.” Like the elder Bennett he ranks as one of the dashing, daring editors of the century, whose aim is to gain notoriety and extraordinary circulation for his journal by strong, and often vituperative, attack upon public men and things, and by tireless efforts to secure general news of a unique and sensational character, at whatever cost.

Murat Halstead (b. 1829) rose to editorial distinction, and became a strong factor in the life of the middle West, through his connection with the “Cincinnati Commercial,” which he raised to a flourishing financial condition, with immense power in municipal, state, and national politics. In 1890 he became editor of “The Standard-Union,” Brooklyn, N. Y.

Whitelaw Reid (b. October 27, 1837) is a type of the highest class of American political editors, and represents the best in that kind of American journalism which aims to be both alert and catholic in its efforts, without the sensationalism of personality, exaggeration, or the horrible. Next to Mr. Greeley, whom he succeeded as editor, he will best be remembered in connection with “The New York Tribune,” and has made his journal a great power along nearly all lines, particularly those political.

Scientists.—Sir Charles Bell, of Scotland (b. November 17, 1774; d. April 29, 1842), is a shining example of patience and genius for investigation, discovery, and deduction in medical science. The nervous system was his particular forte; and he discovered the most important principle that the brain is divided into two parts, each having its corresponding division in the spinal marrow, and that one set of nerves conveys sensations from the body to the brain, another carrying back to the body and its muscles the command of the brain, and finally that nerves conveying different sensations are connected with different parts of the brain. He was a remarkable surgeon, a brilliant lecturer, and a medical author of universal fame.

Samuel D. Gross (b. July 8, 1805; d. May 6, 1884) ranked as one of the epoch-makers in his profession. As physician, surgeon, and medical author he showed a lofty aim, strict devotion, marked originality, and powerful intellect. His numerous works commanded world-wide attention and became accepted standards. Two of them, at least, were the first of their kind ever published in America.

George C. L. F. D. Cuvier, of France (b. August 23, 1769; d. May 13, 1832), exhibited in his career the immense reformation and advance in natural history during the first three decades of the nineteenth century. He expanded the system of comparative anatomy as the only true basis of natural history, and from an utterly chaotic and unintelligible heap of dry facts concerning animal structures he finally deduced the underlying, natural principles of unity, in their classification and division. He also established many positive laws of geology and paleontology and, by his vast discoveries and daring conceptions therein, developed the comparatively new science of fossil animal-life to an extent hitherto undreamed of.

Charles Robert Darwin, of England (b. February 13, 1809; d. April 18, 1893), was one of those well-equipped and persistent scientists whose investigations led to the modern doctrine of the origin and evolution of species by means of natural selection and preservation of favored races in the struggle for life. His conclusions were at first bitterly rejected, especially by religious scientists, but ere the end of the century came they met with wide acceptance. Only such a genius and patience as his could have collected, arranged, and interpreted the gigantic mass of facts out of which he slowly deduced his conclusions.

Louis J. R. Agassiz (b. May 28, 1807; d. December 14, 1873), was the premier of his day as a scientist and naturalist. Of wonderful physical and mental power, vast enthusiasm, untiring industry, and exceptional propensity for research and orderly arrangement, he developed the modern science of ichthyology, propounded new and accepted theories of geology and of glacial systems, and established the magnificent Museum of Natural History at Cambridge, Mass. Astonishingly prolific as a writer, he remains a constant source of inspiration to naturalists and scientists.

Samuel C. F. Hahnemann, of Germany (b. April 11, 1755; d. July 2, 1843), was an epoch-maker in the field of medicine. By 1820 his theories and publications had awakened universal interest, and the homœopathic system had become an established school. Despite the long and bitter war between allopathy and homœopathy, it is certain that the latter has contributed largely to render medicine free from many old-time methods of an indefensible, if not actually harmful or dangerous kind.

Horace Wells, of Hartford, Conn. (b. January 21, 1815; d. January 14, 1848), was a dentist. His use of nitrous oxide (laughing gas) to render the extraction of teeth painless led to its fuller application as an anæsthetic in surgery, and hence to the discovery of modern anæsthesia by ether and chloroform. Though robbed of the honor of his discovery by others, the dentist Wells is no less a contributor to mankind of one of the greatest boons of the century.

Louis Pasteur, of France (b. December 17, 1822; d. September 28, 1895), gave new direction and impulse to chemistry and pathology by the discovery that fermentation arose from micro-organisms, and also that disease was, in many instances, due to the presence of bacilli in blood or tissue. He followed this with his system of culture and inoculation, by means of which he performed most miraculous cures of even such a vicious disease as hydrophobia. The Pasteur Institute in Paris stands a monument to his genius and philanthropy.

Philanthropists.—Stephen Girard (b. May 24, 1750; d. December 26, 1831) was crabbed, unapproachable, penurious, irreligious, yet strangely liberal in large public or charitable affairs. Twice he helped the government with large loans. Public charities and improvements, hospitals, and paradoxically enough, even churches, were indebted to him for munificent gifts. The greatest monument to his philanthropy is Girard College, founded by a bequest of $8,000,000, for the education of poor white male orphans.

James Smithson, of England (b. about 1765; d. June 27, 1829), was possibly the first philanthropist to bestow a large endowment upon the United States. With the sum of $500,000 to $600,000, which came to it from this benevolent foreigner, the young republic founded and endowed the splendid Smithsonian Institute at Washington for the spread and increase of knowledge, thus putting Mr. Smithson in the highest rank of the world's benefactors, and erecting an imperishable monument at another turning-point in the progress of civilization.

George Peabody (b. February 18, 1795; d. November 14, 1869) ranks as one of the century's greatest philanthropists. Among his noblest gifts were $3,500,000 for free education and the training of teachers in the Southern States, $1,000,000 for a scientific institute at Baltimore, large sums to Harvard University, and a great amount to his native town, Danvers, Mass., for educational purposes. Dying in England, he left $2,500,000 to London, to found workingmen's homes.

John Jacob Astor (b. July 17, 1763; d. March 29, 1848) used much of his colossal fortune in philanthropy. Perhaps his largest single gift, at least that by which he is best known as a benefactor, was the sum of $400,000 to found the Astor Library of New York city. This noble institution is conducted on the public plan, and contains nearly 300,000 volumes.

James Lick (b. August 25, 1796; d. October 1, 1876) amassed a fortune in California, out of which he provided a trust fund for certain public and charitable purposes. This fund amounted to $5,000,000 at the time of his death. To him is due the famous Lick Telescope in the University of California, which cost $700,000; the California School of Mechanic Arts, costing $540,000; the free public baths of San Francisco, costing $150,000; and numerous other charities and benefactions.

Leland Stanford (b. March 9, 1824; d. June 20, 1893) acquired a great fortune in California. Inspired by a dream at the time of his little son's death, he determined to found and endow an institution of learning in his State. The result was the Leland Stanford Junior University, whose direct endowment was princely, and whose indirect endowment is expected to amount to $20,000,000 or more.

Florence Nightingale was born, May, 1823, in Florence, Italy, of English parents, and, prompted by philanthropic instincts, turned her attention to the relief of humanity. After study in various nursing schools, she was sent at the head of a corps of trained nurses to care for the sick and wounded soldiers of the Crimean war, in which position she displayed marvelous energy and ability. A grateful public subscribed for her a testimonial of $250,000, which she devoted to the founding of a training-school for nurses.

Clara Barton (b. about 1830) left a clerkship in Washington to engage in the work of alleviating the sufferings of the soldiers of the Civil War, on the battlefields and in hospitals, a work she performed with rare energy and self-sacrifice. She afterwards aided the Grand Duchess of Baden in establishing her hospitals during the Franco-Prussian war, and was decorated with the Golden Cross of Baden and the Iron Cross of Germany. In 1881 she organized the American Red Cross Society, for which she secured an international treaty giving it protection. She performed splendid service in camp and field during the Spanish-American war.

John D. Rockefeller (b. 1839) is a splendid example of those many and noble American millionaires who have responded with astonishing liberality to the promptings of their philanthropic natures. The reconstruction of the Chicago University, the founding or endowment of other public institutions, and of numerous charitable benefactions, together embracing the expenditure of many millions, are magnificent monuments to Mr. Rockefeller's share in promoting the progress of his country during the last quarter of the nineteenth century.

Matthew Vassar (b. April 29, 1792; d. June 23, 1868) founded Vassar College, N. Y., in 1861. A brewer of large fortune, he conceived the idea of erecting and endowing a college for women, wherein education could be obtained either moderately or gratuitously, and which should be undenominational. To this end he gave land and $428,000 for buildings and equipment. Again he gave $360,000. Other members of his family added to his gifts, till $1,000,000 and more were expended in buildings, apparatus, etc., and the endowment amounted to over $1,000,000.

Inventors.—George Stephenson, of England (b. June 9, 1781; d. August 12, 1848), was the first (1814) to construct a satisfactory locomotive steam engine. In 1815 he introduced the steam blast into his second locomotive. In 1822 he built and operated his first railway, eight miles long. In 1829 his engine, named the Rocket, was driven at the rate of twenty-nine miles an hour. He invented a safety lamp, which is still in use in English collieries. A natural genius and self-taught mechanic, he refused knighthood, but has received by common consent the title of the father of railways.

Richard M. Hoe (b. September 12, 1812; d. June 7, 1886) completely revolutionized the art of printing by the invention of his "lightning" rotary press, in 1846. This marvel was capable of printing 20,000 impressions an hour. After many costly experiments, with a view to printing both sides of a sheet at once, he evolved his web-perfecting press, which drew the paper from a roll, perhaps miles in length, at the rate of 1000 feet a minute, printed both sides simultaneously, and cut and folded the sheets at the rate of 20,000 per hour. Subsequent improvements have given his machines a much larger hourly capacity.

Elias Howe (b. June 9, 1819; d. October 3, 1867) contributed the sewing-machine to the century's triumphs and wonders, though it is alleged that the honor of inventing both the eye-pointed needle and the lock-stitch belongs to Walter Hunt, between whom and Howe long litigation prevailed, finally resulting in the recognition of the 1846 patent of the latter. Modifications and improvements by more recent inventors have made the sewing-machine the household boon of to-day.

Cyrus W. Field (b. November 30, 1819; d. July 12, 1892) made the problem of a telegraphic cable across the Atlantic an aim of his life. For thirteen years he labored with wonderful faith and perseverance, and at last, after a series of defeats and mortifying failures, succeeded (1866) in laying a cable that thoroughly solved the problem. Since then submarine telegraphy has become one of the most useful and powerful factors in the private and public life of the world.

Samuel F. B. Morse (b. April 27, 1791; d. April 2, 1872) contributed to the century's triumphs and world's civilization by that brilliant and persistent series of investigations, which resulted in the first practical telegraph. He brought his invention before the world in 1844, and with the aid of the government set up a line of forty miles between Washington and

Baltimore, over which dispatches successfully passed, May 24, 1844. From this moment his triumph was complete, and he became the recipient of many flattering distinctions at home and abroad.

John Ericsson (b. July 31, 1803; d. March 8, 1899) either invented, or first made practical, the steam fire-engine, the artificial draught for locomotives, the reversible locomotive, the "link-motion," the caloric engine, and the screw propeller. Discouraged in England, he came to the United States in 1839, where he revolutionized naval warfare by applying the screw propeller to the U. S. S. Princeton, and employing a range finder. In 1854 he invented the Monitor iron-clad on principles first applied in the Monitor which defeated the Merrimac in Hampton Roads, Virginia, March 9, 1862. His career was signalized by many other valuable inventions.

Alexander Graham Bell, born March 3, 1846, besides exploiting in America his father's valuable system of instruction to deaf mutes, typifies the inventive spirit of his age by his contribution to public progress through the material side, as exemplified in that indispensable aid to modern life, the telephone, with the invention of which he is generally, but by no means undisputedly, credited.

Thomas Alva Edison (b. February 11, 1847) is a splendid example of the tireless, acute, and practical scientific inventor, and is well named the electrical "wizard." Among the triumphs of his skill and genius are the automatic telegraphic repeater; the duplex telegraph, afterwards developed into the quadruplex and sextuplex transmitter; the printing telegraph for stock quotations; the carbon telephone transmitter; the aerophone; the megaphone and microphone; the phonograph and photometer; the incandescent lamp; and many other devices for electric lighting.

Nicola Tesla (born 1858), a former pupil and assistant of Edison, shares with his master the honor of representing the world's greatest and most practical of scientific inventors and discoverers. His most noted investigations and discoveries have been along the line of arousing luminous vibrations in matter, without, at the same time, setting in action heat-vibrations. He has made the remarkable discovery that 200,000 volts may pass harmlessly through that body which 2000 would kill, and is experimenting to produce 3,000,000 vibrations a minute in matter. He has also shown that both motors and lights can be operated on one wire without a circuit. His rotary motor is used in conveying power from the great plant at Niagara Falls.

Novelists.—Sir Walter Scott, of Scotland (b. August 15, 1771; d. September 21, 1832), exerted a powerful influence on the literature of the century through the medium of his stirring poetry and delightful fiction, in both of which he was most ready and prolific. His numerous works, teeming with striking situations, strong and noble in style, are models of literary excellence, and are as captivating to readers of to-day as they were half a century ago.

Charles Dickens, of England (b. February 7, 1812; d. June 9, 1870), ably exemplified that school of novelists who paint homely social life with all its innocent, clumsy efforts at humor; its sorrows, vanities, and weaknesses; its selfishness, malice, and vice; its wrongs, sufferings, and goodnesses. Though faulty in plot and style and ridiculous in their exaggerations, his novels marked a new era in literature, and no books ever so appealed to the sympathies and good impulses of readers.

James Fenimore Cooper (b. September 15, 1789; d. September 14, 1851) typifies a large and apparently enduring class of fiction writers of which he was a remarkable forerunner; that school of novelists who deal with stirring, bold, and healthful adventure, in which the Anglo-Saxon mind particularly seems to find unfailing delight. Both at home and abroad, his novels attained a wide, sudden, and well-deserved popularity. And to this day no library of fiction is complete without them.

Nathaniel Hawthorne (b. July 4, 1804; d. May 18, 1864) exhibits in his numerous fictional works a man's breadth and strength of imagination and a woman's quick perception and spiritual insight. Almost gloomy in color, overhung with impending fate, and often uncanny, his stories are yet always fascinating. As has been well said, one catches in them "gleaming wit, tender satire, exquisite natural description, subtle and strange analysis of human life, darkly passionate and weird."

Count Leo (or Lyoff) Alekseevich Tolstoi (b. August 28, 1828) is a Russian aristocrat by birth, but has assumed the dress and life of a peasant, the better to exploit his doctrines respecting non-resistance, communism, labor, religion, politics, government, and society. His numerous writings show a combination of keenness of realistic insight and wealth of poetical imagination, of a wonderful breadth of view with perfect handling of minute detail, seldom rivaled in all literature. Whether or not he will prove to be the forerunner of a great revolution in the world's national and social life, there is no disputing his genius and pertinacity.

Edward George Earle Bulwer (Baron Lytton), of England (b. May 25, 1803; d. January 18, 1873), was novelist, poet, dramatist, and essayist, and ranked as one of the most versatile and classical authors of the century. Through his plays, poetry, and novels he introduced a new literary era, and was the leader, if not actual founder, of the school of melodramatic romance.

Harriet Elizabeth Beecher Stowe (b. June 14, 1811; d. July 1, 1896) acquired great fame as authoress of the epoch-making book, "Uncle Tom's Cabin." It proved to be a powerful contribution to the anti-slavery cause, and served to electrify readers in twenty different languages. In dramatized form it has delighted millions of auditors. The authoress represents woman's efforts for the overthrow of slavery; efforts she put forth modestly, completely unconscious of their great power and future influence.

George Eliot, pseudonym of Marian Evans, afterwards Mrs. Lewes, then Mrs. Cross, of England (b. November 22, 1819; d. December 22, 1880), was one of the ablest of the world's female novelists, and had but few equals among men. She was a leading epoch-maker in that introspective school which always with astonishing skill uses the "plot" in all its events, environments, and circumstances to develop each character in strict logical accord, whether for good or evil.

Victor Hugo, of France (b. February 20, 1802; d. May 22, 1885), was, in his day, the most popular author who has ever lived. Few poems, no drama, and absolutely no novel have ever produced the immediate and tremendous effect of his earlier poems, his "Hernani," and his "Les Misérables." Through "Hernani" he completely defeated the classic school and became the leader of the romantic school of revolutionary individualists, thus creating a new epoch in literature. He invented novelties in poetry and prose which produced strength, variety, delicacy, harmony, and richness of imagery and coloring, absolutely unparalleled and original.

Poets.—Lord George Gordon Byron, of England (b. January 22, 1788; d. April 19, 1824), is a remarkable instance of a poet of marvelous natural powers, mingling good and evil in accordance with the whim that took him; yet exhibiting distinctly, through it all, evidences of a great soul and genius. He created an epoch in the world's poetic literature. Skeptical, cynical, melancholy even to sentimentality, and skillfully manipulating the public side of his affairs to keep up a most fascinating air of romantic mystery about them all, he succeeded in affecting public thought with these characteristics to a wonderful extent. As a result, "Byronism," for a time, was the absorbing rage in all prominent circles, literary and even social.

Henry W. Longfellow (b. February 27, 1807; d. March 24, 1882) is possibly the century's finest type of the people's poet. Though by no means a poet of great imaginative or creative powers, yet few reached his perfect skill as a painstaking and unerring artist; while none have ever surpassed him in creating that atmosphere of subtile beauty which always seems to surround and penetrate his verse. As an epoch-maker his influence extended even to Europe, and especially to England, securing him a fame wider and greater than that of any other American poet, and rarely failing to win the enduring affection of all kinds of readers.

John Greenleaf Whittier (b. December 17, 1807; d. September 7, 1892), as an editor and poet contributed no little to the cause of the abolitionists. Together with Longfellow, Holmes, Lowell, Hawthorne, and Emerson, he may be considered an epoch-maker in the development of American literature as guided by the spirit of New England. He types the sweet, simple, and absolutely sincere poet whose verse breathes forth a strong patriotism, and is redolent of the healthful home life of the Eastern States.

Sir Alfred Tennyson, of England (b. August 6, 1809; d. October 6, 1892), was by far the leading representative of those English poets who, while not wanting in the fire and spontaneity of true genius, nevertheless wrote carefully, after long reflection, with calculation and toil, as to diction, polish, and arrangement of sentences and thoughts. His highly-wrought "In Memoriam" and his exquisite, though somewhat sensuous "Idylls of the King" were absolutely novel, and mark an epoch in the history of the world's poetry.

Elizabeth Barrett Browning (b. 1809; d. June 29, 1861) is, without doubt, the greatest poetess of the present century and probably of any other. She presents an extraordinary instance of the grasp, comprehensiveness, and logic of man's intellect, united with the intuitions, deep emotions, impulses, and visions of woman. Her especial contribution to the progress of this century is not only to the wealth of its poetry, but also to the careful and discriminating consideration of many of its social problems.

Robert Browning (b. in London, May 7, 1812; d. in Venice, December 12, 1889) was the foremost of psychological poets. Belonging to "The Romantic School," he created an epoch in literature by carrying his high ideals and wonderful efforts of genius over into what became known as "The Spasmodic School."

Actors.—Edmund Keene, of England (b. 1787; d. May 15, 1833), was one of the greatest and most popular actors of all time. He typified, and greatly contributed to the success of, that school of actors who rely almost solely on their own native genius and acquired powers, rather than on the aid of externals. He has been called both the "Byron" and the "Napoleon" of actors, and seemed to have the most extraordinary power both of catching and revealing the meaning of Shakespeare, with the quickness and vividness of the lightning flash.

Edwin Forrest (b. March 9, 1806; d. December 12, 1872) was a tragedian of the robust type. His success upon the stage was signal, owing to natural genius, superb form, and noble presence. For more than a generation he rendered effective and kept popular the leading tragedies of Shakespeare, and others suited to his powers. The Actors' Home at Philadelphia was endowed by him, and stands as his monument.

Edwin Booth (b. November 13, 1833; d. June 7, 1893) stood as the exponent of the refined and lofty in drama. Through his rare histrionic powers he became a recognized interpreter of such characters as Richard III., Shylock, Lear, Iago, Othello, Brutus, etc., but he never appeared to better advantage than in Hamlet. His ability was as fully recognized abroad as at home. He expended $175,000 in establishing the Players' House and Club in New York.

Charlotte S. Cushman (b. July 23, 1816; d. February 18, 1876) first won her histrionic honors in opera. Her voice failed, and then she began her memorable career as actress, her most famous personations being Lady Macbeth, Bianca, Julia, Beatrice, Lady Teazle, Queen Katharine, and Meg Merrilies. She readily ranked with the great dramatic artists of the century, and her skill, native and acquired, divided with her own splendid character the admiration of the general public.

Tommaso Salvini (b. January, 1830) demonstrates that now very rare and severely tragic school of the stage in which the actor appeals to the public through his genius and art, rather than through his environments and accessories. He thus belongs to an apparently closing era in the history of the stage. Powerful, passionate yet self-controlled, magnificent in physique, in elocution, in reading and in deportment, as an actor he really belongs to the world, although Italian in both spirit and training.

Sir Henry Irving (or really John Henry Broadrib), of England, was born in 1838, and is the leader of that modern school of actors, who depend not so much on good reading, acting and general elocution as upon careful attention to details in stage-setting and presentation. As an epoch-maker in the history of the modern drama, he marks that point where the actor begins to look away from his own personal art to that displayed in his surroundings and accessories.

Lyric Dramatists.—Ludwig van Beethoven, of Germany (b. December 17, 1770; d. March 26, 1827), is widely held to be the most colossal of musical geniuses, in breadth and grasp of intellect, in vastness and boldness of imagination, and in depth and tenderness of emotion. His one opera, "Fidelio," is by many considered to be unrivaled in the realm of pure dramatic music. His sonatas and chamber music are generally conceded easily to lead in those two departments, while his symphonies are universally believed to have reached the utmost limit of development which is possible in the field of orchestral composition.

Charles F. Gounod, of France (b. June 17, 1818; d. October 18, 1893), is an instance of a composer whose permanent fame must rest on but one work, the opera of "Faust," in which he reached the utmost height of his powers and success. No opera has ever had such instant, universal, and constant popularity. Eclectic in style, and faithful and enthusiastic in his art, he did much to advance the progress of religious and operatic music in France.

Robert Schumann, of Saxony (b. June 8, 1810; d. July 29, 1856) was one of the creators of the romantic school of music. He was not a piano player, but a teacher and composer. His symphonies have been accorded a rank next to those of Beethoven, and for their deep pathos, fine, intense passion and wild, mournful beauty many of his compositions are almost peerless.

Felix Mendelssohn-Bartholdy (b. February 5, 1809; d. November 4, 1847) was as lovely in character as in works. In symphony, song, piano-forte, organ, or oratorio, he showed himself worthy of being classed with the great musical masters. His compositions suffered eclipse for a time by those of a stronger school, but his true position in the musical world is once more becoming recognized.

Franz Schubert, of Austria (b. January 31, 1797; d. November 10, 1829), has been called "the immortal melodist." His fecundity was marvelous, and he is best known by his songs, several hundred in number, and nearly half of which have immortal quality. He also composed many charming symphonies and operas. His chief characteristics are the freshness of his delightful melodies supported by harmonies of equal interest.

Anton Gregor Rubinstein, of Russia (b. November 30, 1830; d. November 20, 1894), combined the brilliant pianist with the composer of genius. Had he not been preceded by

Liszt as an epoch maker, he would undoubtedly have had the honor of being first of all great pianists.

Frederic F. Chopin, of Poland (b. March 1, 1809; d. October 17, 1849), was one of the first of pianists and musical composers. His playing, like his music, was marked by a strange and ravishing grace, and he was the great interpreter of the music of his native country. He composed concertos, waltzes, nocturnes, preludes, and mazurkas abounding in poetic fancy and subtle harmonic effects.

Jacques Offenbach, of France (b. June 21, 1819; d. October 4, 1880), was the chief creator of the opera bouffe, and was an astonishingly prolific composer. He stands for the clever, tactful musician, shrewd to perceive and quick to seize what catches the public ear for the time being.

Franz Liszt, of Hungary (b. October 22, 1811; d. July 31, 1886), ranks as one of the world's phenomenal pianists. His strength and technique were prodigious, his magnetism irresistible, and his power over audiences unequaled. By his free, fantastic compositions he created a new school of composers. He gave extraordinary aid and inspiration to other musicians, and in reality brought Richard Wagner into prominence before the musical world.

Richard Wagner, of Germany (b. May 22, 1813; d. February 13, 1883), early abandoned Beethoven as an operatic model, and felt that a new era in music was about to dawn. His musical theories first found full swing in his famous opera of the "Nibelungen Ring," with which, and kindred productions, he practically created the modern music-drama. In his operas he was sole author of their wonderful wealth of true poetry, stage effects, dramatic action, and endless melody. No musician has ever made such bitter foes and warm friends, and none ever had to fight his way so stubbornly to recognition.

Giuseppe Verdi, of Italy (b. October 9, 1813), is one of the most remarkable musical composers of the century, in the respect that his talent has not failed with age, but has kept pace with the great changes which have affected the dramatic stage since his youth. In the beauty of his melodies and the intensity of his dramatic powers he is unsurpassed. Very few, indeed, of his numerous productions have failed to hold exalted place in public estimation. His best-known works are "Il Trovatore," "La Traviata," "Rigoletto," "Ballo in Maschera," "Aïda," "Otello," and "Falstaff," the latter written in 1893, when the author had reached the age of eighty.

Sovereigns.—William I., King of Prussia and Emperor of Germany, was the epoch-maker of the 19th century for his realm. He was son of Frederick William III., and born March 22, 1797. In 1849 he was made commander-in-chief of the Prussian army. He succeeded to the throne of Prussia in 1861, and immediately under the guidance of Bismarck set about those measures which were to end in the unification of the German states. These involved the war of 1866 with Austria, after which, in 1867 he became head of the powerful North German confederation, comprising 22 states, and a population of 29,000,000. Then followed the successful war with France, in 1871, which resulted in the complete realization of his idea of a united Germany, and on January 28, 1871, King William of Prussia was proclaimed Emperor of Germany, in the palace of the French kings, at Marseilles. He died March 9, 1888.

Victor Emmanuel. At the birth of Victor Emmanuel in 1820, Italy was a segregation of states or provinces, owned and played against one another by the chess-players of Europe. The policy of ambitious sovereigns to the north was to keep it divided and discordant. Victor Emmanuel became king of Sardinia at a time when Austria's power was well-nigh supreme in the belligerent Italian states. His plea with Austria that the Sardinian constitution should be protected, and its success, aroused for him the confidence of the Italian people, and paved his way to the Italian crown. In 1852 he secured the services of the masterly Count Cavour, the Bismarck and Gladstone of Italy, for his premier and guide. Through Cavour's influence France united with Sardinia against Austria. The war which followed and the peace of Villafranca completed Emmanuel's task, and made him king of a united Italy, over which he reigned successfully for eight years, dying on January 9, 1878.

Czar Alexander II. The epoch-maker of Russia during the 19th century was Alexander II., born April 29, 1818. Of the many important events of his reign, which began in 1855, the most illustrious was the abolition of serfdom in his dominions, which gave freedom to 23,000,000 subjects. He was killed by anarchists in 1881.

Francis Joseph. This emperor of Austria-Hungary was born August 18, 1830, and succeeded to the throne of Austria in 1848, and of Hungary in 1867. Though defeated in wars with France, by which he lost Italian provinces, and with Germany by which he lost Schleswig-Holstein, he managed through an unprecedently long reign, in some part of which he was both emperor and legislature, to hold together an empire composed of heterogeneous Germans and Slavs, a task that would have proved impossible with a less wise and respected ruler. He survived the century, and the question also lived, what of the empire after his death?

Victoria, Queen and Empress. Alexandrina Victoria Guelph, whose reign was the longest in English annals, and covered the epoch-making time of Great Britain during the nineteenth century, was born in London, May 24, 1819. She was the daughter of the Duke of Kent, fourth son of George III. She became next in succession to the throne on the death of her uncle, King William IV., which occurred June 20, 1837. Her ancestry dated back to Egbert, A. D. 827. To the wisdom of her mother she owed a well-ordered, peaceful, and happy childhood, with a view to the possibility of the English throne. Special teachers were employed as her instructors, and she became proficient in music and drawing, as well as in the classic and modern languages. She became equally proficient in the English constitution and general history. In 1831, when, at the age of twelve, it was deemed necessary to acquaint her with the fact that she was heir presumptive to the throne, the genealogical table of the royal family was placed in her book of history. After a study of it, she remarked that she was nearer the throne than she had thought, and that the reasons for her course of mental training had become obvious.

About this time the young princess made her first appearance at court, and Parliament voted her an additional appropriation of $50,000 a year for her expenses. But as a rule her mother made use of the fast vanishing possibility of the birth of other heirs who would take precedence of her, to keep the child, as long as propriety would permit, out of the whirl of court life, and to allow her education to proceed without interruption. The consequence of this maternal discretion was that Victoria came to the throne in excellent physical and mental health.

She attained her legal majority—eighteen years—on May 24, 1837, and her birthday was celebrated throughout the country. On June 20, 1837, King William died childless. It became the immediate duty of the Archbishop of Canterbury and Lord Conyngham to inform the young princess of her uncle's death and her own right of accession. She held out her hand to the Archbishop to be kissed, and said, "I ask your prayers on my behalf." A meeting of the privy council was called for eleven o'clock. The princess was known to but few of the members, and there was a universal desire to ascertain what manner of person she might be. She appeared before this august body of a hundred leading nobles and statesmen with modest composure, bowed to the lords, took her seat, and read her declaration. The members of the council were then sworn to allegiance, kneeling and kissing her hand. The foreign ambassadors were then received one by one. All were captivated by the easy dignity of their girl-queen. Her speech was generally remarked upon for its perfect elocution. Of her speech a few months after, upon the dissolution of Parliament, Charles Sumner, who heard it, said, “I was astonished and delighted. I think I never heard anything better read.” And of the same speech Fanny Kemble said: “I think it is impossible to hear a more excellent utterance than that of the Queen’s English by the English queen.”

Victoria promptly reformed her court, which was sadly in need of correction, and removed the royal residence to Windsor Castle. Public admiration for her ability and grace of manner grew into enthusiasm, so that on the day of her coronation at Westminster Abbey, June 28, 1838, the pageant was not only one of unsurpassed splendor, but the populace were described as “coronation mad.” This was the manifestation of a radically changed public sentiment as to royalty, for the eclipse of monarchy under the four Georges had long been accepted as a humiliating fact, and respect for the throne had been well-nigh lost during William’s reign. Altogether it was a bad time for a girlish queen to assume power; yet her guiding hand was soon favorably and powerfully felt, and it has been said by more than one good authority that her accession at that special crisis was the salvation of monarchy in Great Britain.

Her prime minister, Lord Melbourne, received at an early date a touch of her quality, when, after vainly urging her to sign a certain document, he testily withdrew it with the remark that it was not of paramount importance. “Sir,” replied the queen instantly, “it is with me a matter of the most paramount importance whether or not I attach my signature to a document with which I am not thoroughly acquainted.” And on another occasion, when her signature was asked to a document on the ground of “expediency,” she replied, “I have been taught, My Lord, to judge between what is right and what is wrong, but expediency is a word I neither wish to hear nor to understand.” The beginning of her reign was coincident with the inauguration of transatlantic steam navigation. In the second year of her reign the Whig ministry, at whose head stood Lord Melbourne, lost its working majority in Parliament. The queen immediately summoned the Tory leader, Duke of Wellington, to form a new government. Wellington suggested Sir Robert Peel as better qualified for the task. He accepted, but when the queen found that the change would affect all the ladies of her Bedchamber and household she repudiated Peel, and recommissioned Melbourne. For this she and her premier were taunted as being at the head of what was called the “Bedchamber Plot.” Subsequently, when Peel succeeded Melbourne, the queen found in him and Wellington warm friends and trusted advisers. Among the other notable events of this year (1839) of her reign, were the formation of the Anti-Corn Law League, and the occupation of Cabul and Aden by the British forces.

The queen’s hand was sought in marriage by many kings, dukes, and princes of Europe. Her choice fell upon her cousin, Prince Albert of Saxe-Coburg and Gotha. It was a love-match, mingled with not a little diplomacy on the part of her aunt, the Duchess of Gloucester, and Albert’s uncle, King Leopold. The wedding was celebrated with stately splendor at the Chapel Royal in St. James’s Palace, on February 10, 1840. The marriage proved a happy one. All that the most affectionate and unselfish wife could be, she was to her husband. And the Prince Consort not only returned her affection in full, but became her faithful, laborious, vigilant, discreet adviser and helper, lifting from her shoulders the crushing load of state affairs, and opening a new era in her life. Careful and well informed observers have ranked Prince Albert among the statesmen of his day, and some have said that for the greater part of his twenty-one years of married life he was practically King of England.

On November 21, 1840, their first child, afterwards Empress Frederick of Germany, was born. An economic triumph of the year was the introduction of cheap postage in England. In

1841 Sir Robert Peel succeeded Lord Melbourne as premier. British arms greatly extended political and commercial influence in the Orient by the taking of Canton and Amoy. On November 9 the Prince of Wales, who, January 23, 1901, succeeded to his mother's throne, was born. In 1842 two attempts were made to assassinate the queen. It became the foreign policy of the government not to further complicate the Indian question by pushing conquest in Afghanistan, so the British forces were withdrawn. The commercial prestige of England was greatly advanced in the Orient by the acquisition of Hong Kong as a port, and the general opening of all the Chinese ports to foreign trade. This year also witnessed the permanent foothold of Great Britain in South Africa, by absorbing the Boer republic of Natal.

On April 25, 1843, Princess Alice was born. British possessions in India were enlarged by the annexation of Scinde. The queen and her husband paid a friendly visit to Louis Philippe of France, and received a return visit. In 1845 Mr. Gladstone became premier. England and France joined in war against the Argentine republic. The year witnessed the outbreak of the formidable Sikh rebellion. In the following year, 1846, this rebellion was suppressed and the Sikh territory was ceded to the East India Company. The aggravated question of the Northwest boundary of the United States was settled by treaty. The great famine in Ireland, and a somewhat indignant public sentiment in England, conduced to the repeal of the Corn-laws. For several years the Irish situation was serious, famine and insurrection going hand in hand. In 1848 Princess Louise was born. The Sikh rebellion was renewed. The Boer territory in South Africa was further trenched upon, and the farmers trekt across the Vaal River to establish the Transvaal republic. In 1849 the queen paid her first visit to Ireland, the Sikh rebellion was suppressed, and the Punjaub was annexed to British India. 1850 witnessed the conclusion of the Clayton-Bulwer treaty with the United States. In 1851 the queen opened the great Exposition in London. In 1852 the first Derby ministry came into power. In 1854 Great Britain participated with France in the Crimean War against Russia. For several years the vigorous foreign policy of the government led to serious complications. In 1860 the Prince of Wales visited America. During the Civil War in the United States, the queen's sympathies were with the Union cause, and the very last public act of the Prince Consort was to sign in the name of the queen the paper which modified the demand of the ministry upon the United States with reference to seizure of the Confederate envoys Mason and Slidell. The paper in its unmodified form would have been equivalent to a declaration of war by England.

Toward the end of 1861 Prince Albert's strength began to fail, and on December 14 he passed away. His death was a severe blow to the queen and to the nation. Two years afterwards she wrote in a letter to Dean Stanley, "I can never be sufficiently thankful that I passed safely through those two years [the two first years of her reign] to my marriage. Then I was in a safe haven, and there I remained for twenty years. Now, that is over, and I am again at sea, always wishing to consult one who is not here, groping by myself, with a constant sense of desolation."

In 1863 the Prince of Wales was married. For several years the government had serious trouble with the Fenian uprisings in Ireland and America. In 1867 the Dominion of Canada was constituted. 1868 witnessed a cabinet change from Derby to Disraeli, and from him to Gladstone; and the passage of a reform act for Scotland and Ireland. In 1874 Disraeli succeeded Gladstone as premier. In 1875 Great Britain acquired control of the Suez canal, and in 1876 the queen was proclaimed Empress of India. In 1879 Great Britain was carrying on war in India against revolting tribes, and in South Africa against the Zulus. Two years later (1881) she attacked the Boers of the Transvaal, but met with defeat. In 1885 there was a further loss of military prestige by withdrawal from the Soudan campaign. In 1887 the queen celebrated her semi-centennial jubilee, and ten years later (1897) her diamond jubilee. In 1900 she witnessed the consolidation of her Australasian colonies, and in 1901 the establishment of the Commonwealth of Australia. The closing years of her life were clouded by the attitude of her country in South Africa, and the losses of life and treasure entailed by the war with the Boers. It was said by many that her anxiety and grief over this situation hastened her death. Her last illness was brief and painless, and her death took place at Osborne, Isle of Wight, surrounded by her family, at 6.55 P.M. on January 22, 1901, in the eighty-second year of her age, and sixty-fourth of her reign.

Her death occasioned sincere mourning throughout the civilized world. She was succeeded by her oldest son, the Prince of Wales, who ascended the throne on January 23, 1901, and assumed the title of Edward VII. The queen and Prince Consort were ever anxious as to the education of their children. They were trained to industry and economy. The daughters were taught accomplishments as well as sewing and cooking, and were given to understand that they were not to marry without affection, nor for mere money or reasons of state. Victoria was herself a careful manager in pecuniary affairs. By thirty she had saved enough from her income to provide for the whole expense of her new place at Osborne, where she died,—about $1,000,000,—while for the Prince she had already saved from the revenues of her Cornwall estate, $500,000. The Prince left her a valuable estate which at her death had come to be estimated at $25,000,000. This, added to her own judicious investments through the sixty-four years of her reign, gave her rank as one of the wealthiest of sovereigns, as well as of the world's persons.

Already the "Victorian era" is being celebrated as the greatest period of progress that Britain ever knew, as the golden age of England. And this with much propriety and truth, for her reign teemed with instances of the exercise of power in the form of moral influence, with results important and far reaching.

Some of these instances showed statesmanship of a high order. She never took sides in partisan politics, nor antagonized the policy of her responsible ministers, though often advising them and even at times correcting their serious mistakes, never cheapening her advice by offering it in affairs of little moment, always straightforward, self-reliant, vigilant for the rights of the people, yet strenuous of law, neither misled by flattery, nor coerced by fear, a hater of evil, a maker of peace. More than once, in hours of crisis, did she exercise a moral influence whose weight turned the course of events in both Europe and America. As an instance of this, the modification of Lord Palmerston's action in the Trent affair, already mentioned, may be referred to. And when Bismarck, surprised at the rapid recovery of France from the effects of the Franco-Prussian War, had resolved on a second invasion and humiliation, it was through Victoria's intervention that the aged German emperor was influenced to refuse a renewal of hostilities.

If her reign pass into history as the "Victorian Era," then it will truly have many interesting chapters, some grandly inspiring, others—for such there must be—widely open to the criticism and judgment of posterity. It witnessed the greatest achievement in invention, the greatest advancement in science and art, and the most remarkable evolution in the relations of capital and labor that the world has ever seen.

No equal period of world-history has seen such unparalleled growth of a people, and such unexampled expansion of national territory. At the beginning of her reign the population of the Empire was 127,000,000. At her death it embraced 11,334,000 square miles and 384,000,000 people. The United Kingdom itself grew from 16,000,000 to 40,000,000 besides sending out its swarms of emigrants to people continents and isles. Commerce kept even pace with this advancement. British ships sailed every sea. England's flag was known in every port of the world. During Victoria's reign the foreign trade of Great Britain increased 420 per cent. The great cloud on the Victorian era was England's wars,—the questionable Crimean

War of 1853–55; the Indian mutiny of 1857, which ran a frightful course of rapine and bloodshed; the Soudanese campaign; the Boer War in South Africa.

THE END

****