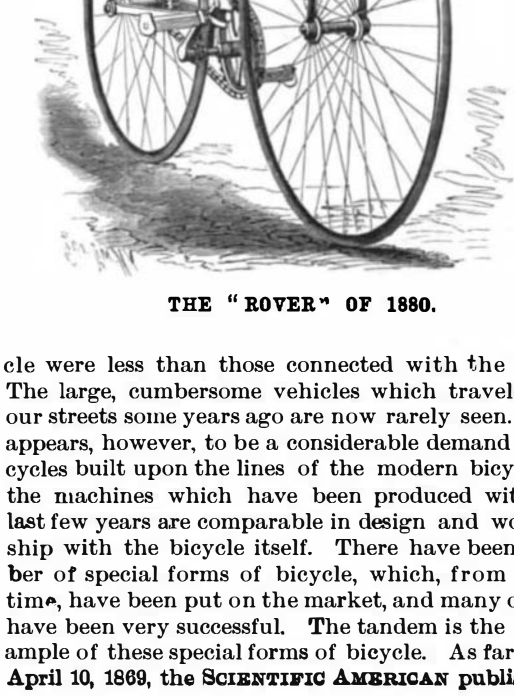
tests on the strength of the material used, the liability of breakage has been greatly reduced. The use of interchangeable parts and automatic machinery has also tended to standardize the product. Great advances have also been made in the rims, and at the present day in this country the heavy steel rim has given place to the wooden rim, which, as now constructed, has considerable strength.

Changes in the frame have been notable. The original Rover frame, which was not strong enough, was soon practically abandoned, and, after a time, the diamond frame took its place. At first, however, the frames were built on dissimilar lines, every manufacturer having a model of his own. Soon the frames of the wheels began to have a general resemblance, and at last the almost universal straight line pentagonal diamond was adopted. Gradually the top bar of this frame was raised until to-day, in the latest machines, it is parallel with the ground. In its frame the bicycle is now a veritable mechanical and engineering achievement. The bearings received more and more attention, until now a wheel with ball bearings will travel thousands of miles without showing any appreciable wear either to the balls or to the bearing cones. There has been a gradual improvement also in the sizes of the wheels; at first even in the modern safety the wheels were of different sizes, but now they are almost universally of the same size. In the old velocipedes, the frame was rigid, then springs were introduced into the saddle and the different parts of the frame, and rubber was introduced into the tires. Then the cushion tire was introduced, which made riding more enjoyable. Finally the pneumatic tire was resurrected from the old patent records, thus furnishing the ideal spring between the rider and the ground, minimizing the jar due to inequalities of the road and giving the maximum of ease and comfort to the rider. In 1845 R. W. Thompson patented in England the first pneumatic tire, but it was only in 1889 that it was adapted to the bicycle by an Irish veterinary surgeon named Dunlop. The cushion tire, in which there was a hollow space in the rubber, was known as far back as 1870, but it became very popular only when the pneumatic tire began to be introduced. It soon succumbed, however, to the pneumatic. It is to the pneumatic tire that we are indebted for a large part of the popularity which cycling now enjoys, and it may be regarded as one of the most important improvements. By these gradual steps the bicycle has been brought to its present state of perfection. An impressionable Italian has well defined the bicycle as "a poem in metal."

In connection with the bicycle, it is necessary to take notice of the tricycle, which was at one time very popular.

The mechanical difficulties connected with the tricycle were less than those connected with the bicycle. The large, cumbersome vehicles which traveled over our streets some years ago are now rarely seen. There appears, however, to be a considerable demand for tricycles built upon the lines of the modern bicycle, and the machines which have been produced within the last few years are comparable in design and workmanship with the bicycle itself. There have been a number of special forms of bicycle, which, from time to time, have been put on the market, and many of which have been very successful. The tandem is the best example of these special forms of bicycle. As far back as April 10, 1869, the SCIENTIFIC AMERICAN published an illustration of a tandem velocipede, which was probably the earliest known example of the tandem. The back seat was intended to be used either as a side saddle for women or a man's saddle. The inventor also had in view the placing of two side saddles over the rear wheel, thus foreshadowing a modern type of special machine. The advantages connected with a tandem are so great that it is little wonder they have achieved a wonderful popularity. Geared up to high speeds, they are able to cover the ground with great ease. Not only are the two riders able to carry on conversation, but the absence of vibration, and the power which it has against a head wind, have all conduced to make the tandem popular. Gradually came the demand for higher and higher speeds; so the number of riders was increased until now, for pacing and racing purposes, we have six or even seven riders mounted on a single pair of wheels. A sextuplette wheel truly represents an engineering achievement, as the truss may have to support a thousand pounds. Such a wheel is geared to 153, so that every revolution of the pedals carries the wheel 38¼ feet.

THE BICYCLE OF 1879.



THE "ROVER" OF 1880.

Ladies' wheels early attracted attention after the safety was in use, and to-day the lady riders are numbered by hundreds of thousands. The lady's wheel presented a more difficult problem than the ordinary bicycle, as the diamond frame was necessarily abandoned. A lady's wheel is now produced of strength equal to that of a man's wheel, with a slight increase of weight. As far back as 1875 we find the Starleys bringing out a high wheel for women. The rear wheel no longer tracked with the driver; it ran upon the end of an axletree which protruded twelve or fifteen inches to one side of the machine, so that a two-track bicycle was the result. This permitted the fair driver to ride side-saddle position. It seems almost impossible that the lady's wheel could be the outcome of this mechanical atrocity, and we may rather look for its origin in the "Rover." The first drop-frame or lady's machine was patented in the United States in 1887.

When it is considered in its economic aspect, it will be seen the bicycle has wrought a veritable revolution, rehabilitating many industries and causing the downfall of others, while travel is diverted into new channels. It is estimated that at present there are 4,000,000 bicycle riders in the United States, while New York City alone possesses 200,000 riders. There are at least 250 reputable wheel manufacturers in the United States, besides a host of smaller concerns that cannot be strictly called manufacturers. Over $60,000,000 are invested in the plants, which give employment to more than 70,000 persons. It is estimated that the wheels turned out this season will exceed 1,000,000. A whole army of workmen are engaged in making bicycle sundries and in repairing. The wheel has brought prosperity to numberless country hotels and road houses which had become almost extinct since the decline of coaching. One great benefit conferred by wheeling is the agitation in favor of good roads. This has been of untold value to the country at large.

"The wheel took a holiday to join in the sport and recreation of men, but the yoke of business is upon it and it cannot escape the bondage. It took the race untold ages to capture the magic circle and harness it to human need, and it is too precious for man to give it a long tether." For many years the cycle has been a plaything of man, but the developments of the last few years have rendered it a valuable aid for business purposes. It makes the slow fast, and now telegraph messengers, postmen, lamplighters, building and street inspectors, "walking delegates," policemen, firemen, coast patrollers, express messengers, doctors, and others are all using the bicycle in their respective avocations. The experiments used to demonstrate the applicability of the bicycle for war purposes have been entirely successful, so that this opens up a new field of usefulness. Bicycles propelled by electricity or one of the petroleum products have been made, but are not in use to any extent.

An eminent physician has said that not within two hundred years has there been any one thing which has so benefited mankind as the invention of the bicycle. Thousands of men and women are now devoting half their time to this healthy recreation and are strengthening and developing their bodies and minds, and are not only reaping benefit themselves but are preparing the way for future generations which will be born of healthy parents; and in brief this epitomizes the hygienic side of the bicycle.

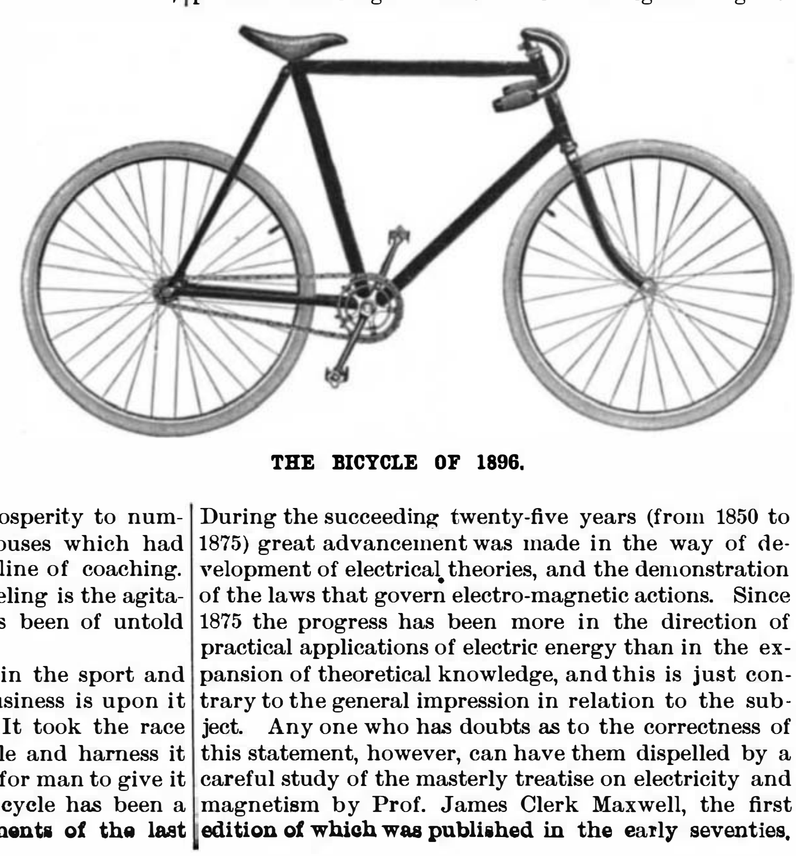
THE PROGRESS MADE IN THE GENERATION OF ELECTRIC ENERGY AND ITS APPLICATION TO THE OPERATION OF MOTORS DURING THE PAST FIFTY YEARS.

The advancement of science during the past fifty years has been so great that many are inclined to believe that we have found out more within this period than all that was known before. While this conclusion may not be strictly correct, there can be no doubt that the value of the principles, the truth of which has been conclusively demonstrated during this period, is greater than that of all discoveries previously made. This is true even of the purely theoretical development of science, but when we come to consider the question of the practical application of the knowlege thus acquired we can, without hesitation, say that the last half of the nineteenth century has not only produced greater advancement than any previous period of equal length, but more than all the centuries that have gone before it.

This may seem an extravagant statement, but any one who will consider the difference between the present state of advancement and the condition of the world fifty years ago will come to the conclusion that it is substantiated by the facts. The steamship, the railroad, the telephone, the telegraph, the electric light, the electric motor, electric railways, and all the numerous collateral industries that have been brought into existence thereby, have been developed within this period. It is true that the telegraph, the locomotive and the steamboat were invented previous to this time, but their reduction to a thoroughly successful form and their extensive practical application has taken place almost wholly since 1845.

Although progress in every department of science has been very great, that which overshadows everything else is the wonderful development of electricity, specially within the last twenty years.

Previous to 1850, this science was in a very crude state. Even the most eminent physicist of those days knew little about the fundamental laws of the subject, and some of them held views that in the light of our present knowledge were absurd in the highest degree.



THE BICYCLE OF 1896.

During the succeeding twenty-five years (from 1850 to 1875) great advancement was made in the way of development of electrical theories, and the demonstration of the laws that govern electro-magnetic actions. Since 1875 the progress has been more in the direction of practical applications of electric energy than in the expansion of theoretical knowledge, and this is just contrary to the general impression in relation to the subject. Any one who has doubts as to the correctness of this statement, however, can have them dispelled by a careful study of the masterly treatise on electricity and magnetism by Prof. James Clerk Maxwell, the first edition of which was published in the early seventies.

This work stands even to-day as one of the foremost upon the subject. There is not a known law or principle relating to electricity or magnetism that is not fully demonstrated therein, unless it may be some action of minor importance. Going back still further, we shall find that nearly all that we know of the theoretical part of the subject at the present time may be found described and in most cases explained in "Faraday's Researches" or the writings of our own immortal Joseph Henry.

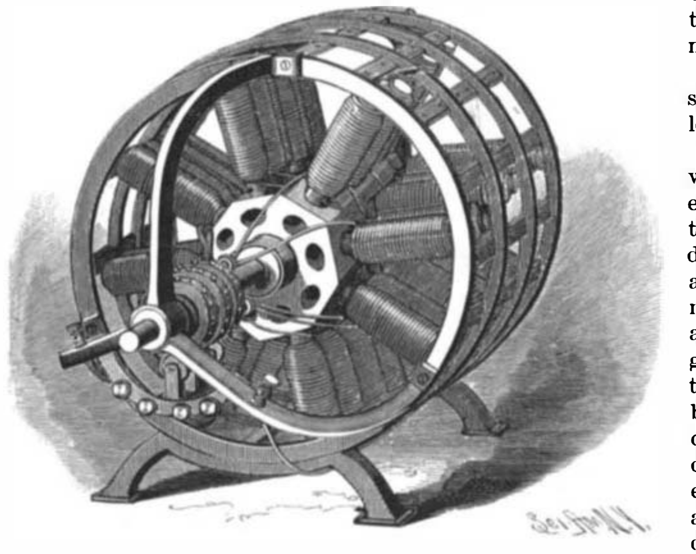
The numerous effects of electro-magnetic action were extensively investigated at an early date, but their true relation to each other and to the other forces of nature were not properly understood until the doctrine of the conservation of energy was established upon a firm foundation. Owing to this fact, some of the most distinguished men of fifty years ago advanced views that were decidedly at variance with the facts and only served to assist humbugs in their efforts to defraud investors. The natural result of this was that development was to a certain extent retarded; but considering the great progress that has been made, notwithstanding such drawbacks, we cannot feel that we have much cause for regretting the course that events have taken.

Many of the leading physicists of early days believed that the power of an electric motor could be increased almost without limit by simply reducing the distance between the rotating and stationary magnets. This belief was due to the fact that the weight that a magnet will hold with the armature in actual contact with the poles is very much greater than at a distance of but a small fraction of an inch. On this account it was assumed that accuracy of construction and rigidity of design would greatly increase the energy obtainable from a given amount of electric current. Charlatans at once took up this theory, and when they were unable to demonstrate to their victims that they had produced wonderful results, they restored confidence by saying that the force of the magnets was so great that the whole machine would spring and allow the poles to actually come in contact and thus absorb the power in friction; but that they thought that certain changes they had worked out would get around this difficulty. Such explanations with suitable modifications generally enabled them to obtain several additional subscriptions from the hopeful capitalists; but in the end confidence would be lost, and the plausible inventor would depart to other fields, where a new set of victims could be obtained.

In the course of time scientific men, who were experimenting in the electrical field, found out that the amount of energy that could be obtained from a battery was dependent upon the quantity of zinc decomposed, and that nothing of any account could be gained by reducing the clearance between the stationary and rotating parts of the motor or, in fact, by any change in the design. Having ascertained this much, they began to experiment with a view to discovering new and more economical means for generating the electric current. It was then known that a motor made with permanent steel magnets in the field would act as a generator of current, if driven at a sufficiently high velocity. Machines of this class were first made by Pixii in 1832, the principles of their action having been demonstrated by Faraday about a year previous.

Although J. S. Woolrich constructed a machine of this class of considerable size for those days in 1841, it was not until about 1862 that anything worthy of note was accomplished in this line. In that year Holmes brought out a large machine of sufficient capacity to be used for "arc" lighting, or, more properly speaking, for furnishing current for one "arc" light. This machine generated electric energy at a much lower cost than the electric batteries, but its size was very great in comparison with the work it would do, and its construction was of such a character as to be necessarily very expensive. Several other large machines of this type were designed and constructed during the next three or four years, but owing to their cost and bulkiness did not meet with much favor.

In 1866, Wilde developed a machine which was the stepping stone to the dynamo of the present day, and although the improvements it led to remained practically unused during the following ten years, it can justly be regarded as the step that marks the beginning of the present era of electrical development. Wilde discovered the fact that the current generated by a small magneto machine, if used to energize a powerful electro-magnet forming the field of a larger machine, would enable the latter to develop a current many times greater than that of the small machine. This discovery resulted in directing the attention of scientific men to the subject with renewed vigor. After a careful consideration of Wilde's work the conclusion was arrived at, that if a comparatively small machine could energize the field of a much larger one, that would



THE NEFF MOTOR, 1851.

generate a current many times greater, it ought to be possible to use a part of the current of the large machine to energize its own field, and thus dispense with the smaller machine. But it was also thought that the assistance of the small machine would be required to start the action. By actual trial it was soon found that the larger machine would start a current without the assistance of the small one. Then the conclusion was that all that was necessary was to pass a current through the machine from an external source, when started for the first time, and that the residual magnetism that would remain in the iron ever after would be sufficient to start the generation of current whenever the machine might be set in motion at any future time. It was soon found that initial magnetizing was unnecessary, and then it was concluded that locating the field in a north and south position would enable the machine to start the action by the aid of the earth's magnetism. Finally it was found that no such expedients were necessary; that all iron is magnetic in a slight degree, and that any machine, if properly constructed, would build up a current as soon as set in motion.

One of the most extraordinary facts in connection

SIEMENS ELECTRIC LOCOMOTIVE OF 1879.

with the dynamo is that it was in existence and was used by the greatest physicist of all countries for thirty years or more before its properties were discovered. As far back as 1834, Jacobi constructed an electric motor with electro-magnets in both the field and armature. This machine was a dynamo, and if driven in the opposite direction to that in which it ran as a motor, it would have generated a current. The action would have been very feeble, because the commutator was so arranged that it would not allow a continuous current to circulate through the machine. Nevertheless, the action would have been sufficient to have been detected. But all the motors with electro-magnetic fields made between 1834 and 1866 were not of this class. In all probability more than half of them reversed the current through the armature coils. Such was the arrangement used by Davenport, who constructed, in 1837, the first experimental electric railway.

Any of the electro-magnet motors in which the current was reversed would have generated a current so strong, if they been rotated backward, that its presence could not have escaped notice. Yet hundreds of theses machines were experimented with for more than a quarter of a century, and the fact was never discovered.

Facts like this only serve to show how short-sighted the human intellect is, even that which is located in the brains of the most eminent men.

Between 1866 and 1876 very little was done in the way of practical development, but quite considerable in the way of improving the dynamo. In the machine of Wilde and several others that immediately followed it an armature was used that gave a pulsatory current. Gramme made an improvement in this direction by adopting a ring-shaped armature, upon which the wire was wound in a great many sections, the ends of which were attached to a commutator of a corresponding number of sections. As a result of this construction the current was rendered far more uniform, and the destructive sparking of the brushes was practically eliminated. Siemens, also, worked in this line, and accomplished the same results by the use of a drum-shaped armature. A few machines of both these types were introduced for the operation of "arc" lights, but their introduction was at a very slow pace.

In 1876 and the two or three following years, storekeepers in the large American cities began to realize that the electric "arc" light was very valuable for advertising purposes. This at once increased the demand for lights, and resulted in the establishment of central lighting stations. In the early eighties [these stations had become very numerous, and the electric lighting industry had attained considerable inportance. In the mean time the incandescent light had been reduced to a commercial success, and was being rapidly introduced.

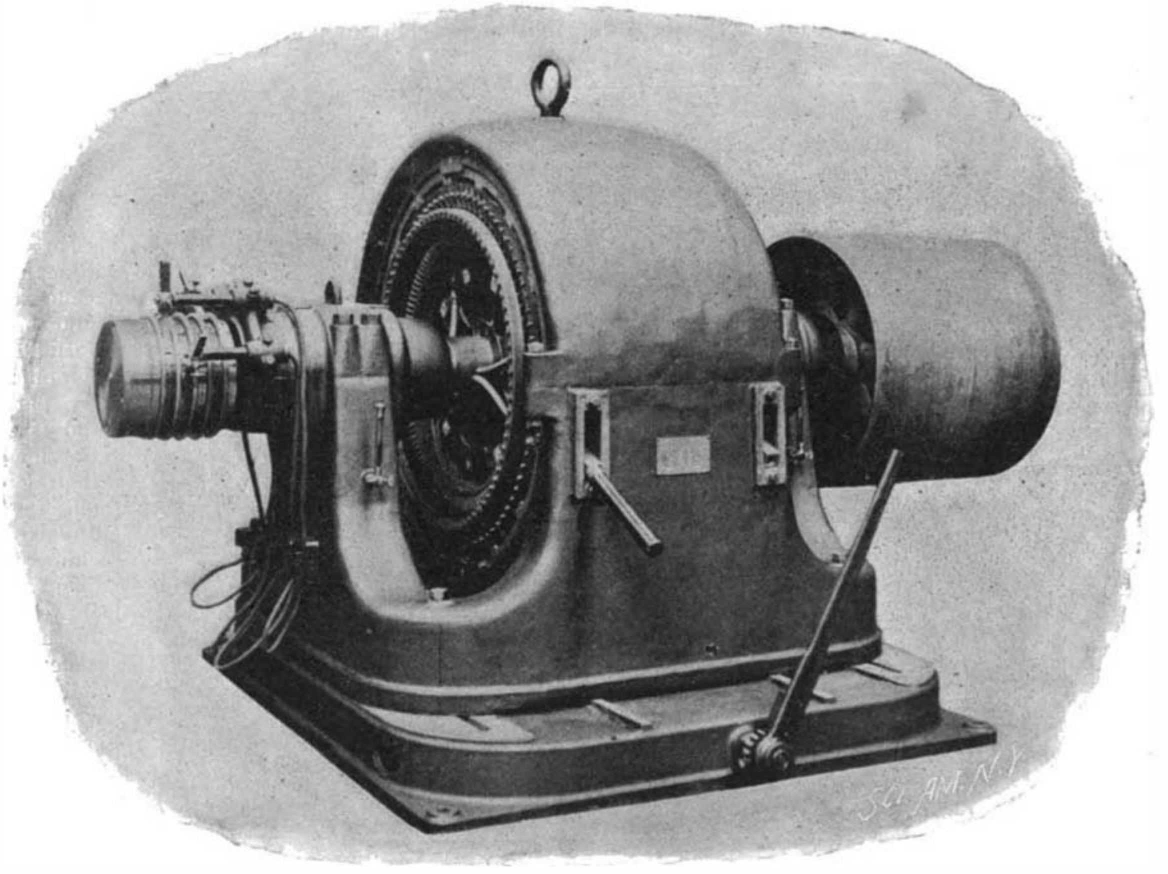
Up to this time very little was done in the way of utilizing electricity for the transmission of power. This was due principally to the fact that it was not believed that electric motors could compete successfully with steam engines, inasmuch as they would have to be operated by currents generated by the energy of the latter, and therefore would cost much more to run, not only on account of the loss in the conversion and reconversion of mechanical into electrical energy, but also on account of the profit that the central stations would have to make to yield a fair return upon the capital invested in the generating and distributing plant. As at that time it was very generally believed that the dynamo could not be made very efficient (some placing the theoretical limit at fifty per cent), this belief was almost universal. But at about this time it was beginning to be clearly demonstrated that the efficiency of the dynamo could be made very high. It was shown theoretically that those who claimed fifty per cent as the limit of efficiency were misled by mixing the law of maximum work with that of maximum efficiency. The truth of these theoretical arguments was demonstrated by the actual performance of the best machines that were then being made, in some of which an efficiency approximating ninety per cent was obtained.

When it became fully demonstrated that the efficiency of dynamos could be made very high, the future of the electric motor ceased to be so hopeless It was then realized that the difference in coal consumption between large and small engines would go far toward offsetting the losses in the generation and transmission of the electric energy and in paying the profits of the central station, and that the small excess in cost of electric power would be largely if not wholly compensated for by the convenience, compactness, and many other advantages of the electric motor. On this account the introduction of these machines began to be pushed with greater vigor than previously. Unfortunately most of the first inventors who entered the motor field were not very well informed in electrical science, and as a result nearly all the early machines were defective electrically as wel as crude mechanically. This circumstance served only to retard the development of the electric motor.

In 1884 and 1885, more able men began to turn their attention to this field, and from that time up to the present day, the growth of the electric motor has been very rapid.

At first these machines were used for the operation of small printing offices and for driving coffee mills, ventilating fans, sewing machines, etc. Soon after they were used to operate pumps and also freight elevators in warehouses. This led to the development of regular electric elevator machines, which came about in 1888. Although an electric pump, in the truest sense of the word, cannot be said to have been developed so far, there are many combinations of motor and pump now that are a great improvement on those used ten years ago.

One of the greatest triumphs of the electric motor has been in the street railway field. As every one knows, a substitute for animal power on these roads had been looked for for many years. Steam, compressed air, gas, hot water, and other systems were tried. but without success. The cable proved satisfactory on large roads with heavy traffic, but was not regarded as a complete solution of the problem, because it was too expensive for small roads.



THREE HUNDRED HORSE POWER TWO-PHASE ELECTRIC MOTOR.

The possibilities of the electric motor in this field were realized even before its practicability in other directions became demonstrated. In 1879 Siemens constructed an experimental electric railway which actually carried passengers. Several others worked in this field during the following years, but it was not until about 1888 that complete success on a commercial scale was attained. The electrical equipment of all the street railways of Richmond in that year, and the complete success of the installation, was the real beginning of the introduction of electricity for the operation of railways. From that time up to the present day, horse roads, in towns and cities throughout the United States, have been changing over to the trolley system as fast as the apparatus could be obtained from the manufacturers.

The electric railway motor has found its way into almost every quarter of the civilized world, but nowhere to such an extent as in this country; in fact, the development of electricity in every line has been carried much further here than in any other part of the world.

When electricity began to invade the railway field, it was believed by many that the storage battery would become an important adjunct; but those who had such hopes have been doomed to disappointment so far, and it is probable that such will continue to be their fate. The storage battery of to-day is not adapted to railway work. Future improvements may, and probably will, enable it to compete successfully with the trolley in isolated cases, under certain conditions, but it is safe to say that it is impossible for it to ever become a formidable rival.

One direction in which electric motors have made great headway, and about which the general public knows little or nothing, is in mining, especially coal mining. Coal-cutting machines operated by compressed air have been used for many years; these are now being equipped very generally with electric motors. Mining pumps, hoisting machines, and ventilating plants are operated electrically. In addition to these may be mentioned mine locomotives, of which a large number are in use.

The extent to which electricity is used in mining may be judged when it is said that it is estimated that the capital invested in such apparatus aggregates over one hundred million dollars.

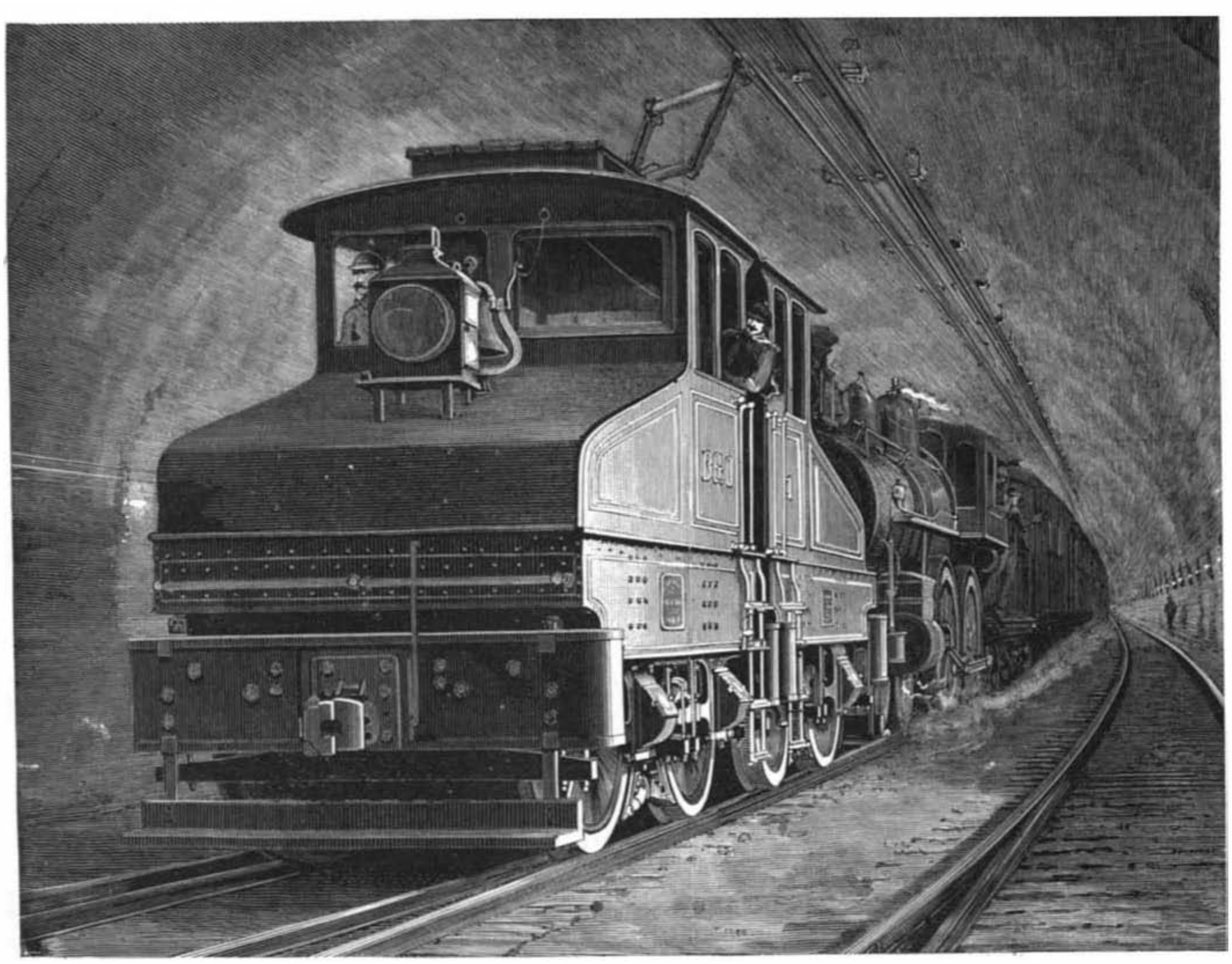
In considering the development of the electrical industry, we are accustomed to say that it has been brought about within the last twenty years; but as a matter of fact nearly nine-tenths of it is the outgrowth of the last fifteen years, and the development of the electric motor branch has occurred within the last ten years. At the convention of the National Electric Light Association held in Detroit, in August, 1886, a paper was read on the subject of electric motors; and to show the extraordinary growth of the industry, it was stated that at that time fully five thousand were in use. To-day it is estimated that over five hundred thousand are used, or a hundred times as many as ten years ago. But this difference in numbers does not represent the full difference; for of the five thousand motors in use in 1886, at least four thousand were of the size used for driving small fans and sewing machines. At that time a ten horse power motor was considered very large, and it is doubtful if there were more than fifty in operation throughout the entire country. To-day there are numerous machines of over one hundred horse power, and some even five or six times that capacity. There are several large manufacturing establishments where over three hundred motors are in use, their aggregate power running in some cases beyond four thousand horse power. Concerns that use one hundred or more motors, requiring for their operation from one thousand horse power upward, are quite numerous.

Some idea of the difference between the machines of to-day and the efforts of the early experimenters, in design as well as magnitude, may be obtained by comparing the illustrations of the earlier motors and locomotives with the later ones. The motor invented by Jacob Neff, of Philadelphia, is a fair representation of the electric motor of forty and fifty years ago. The armatures, which were plain bars of iron, were held by the frame of the motor while the electro-magnets were carried by a hub on the shaft journaled in the center of the frame and carrying a commutator for directing the current through the several magnets in succession as their poles approached their armatures. The two-phase electric motor here illustrated is a machine of to-day. This is a Westinghouse 300 horse power motor of the self-starting induction type, designed to operate at a speed of five hundred revolutions per minute when supplied with two-phase currents of 3,000 alternations per minute and 2,000 volts pressure. This machine affords an example of the latest development in electric motors. The Siemens locomotive of 1879, under guidance of the motorman, is here figured and one of the one hundred ton locomotives now in use in the Belt line tunnel of the Baltimore and Ohio road at Baltimore is shown. These locomotives are more powerful than the largest steam locomotives.

A few figures will show the extent of the electrical industry in the United States at the present time.

In the mining industry it is estimated that the investment in electric apparatus amounts to over one hundred millions.

The estimated number of motors



ONE HUNDRED TON ELECTRIC LOCOMOTIVE, 1895.

Used in the Belt Line Tunnel of the Baltimore and Ohio Railroad at Baltimore.

in use is five hundred thousand; placing the average value of these at one hundred and fifty dollars, the aggregate represents seventy-five millions. The number of electric elevators in use is not known, but as there are over six hundred in New York City alone, it is evident that the total must run up into thousands, and represent an investment of ten or fifteen millions.

There are over twelve thousand miles of electric railroads, using over twenty-five thousand trolley cars. This represents more than ninety per cent of all the street railways in the country. The combined capital of these roads is over seven hundred millions. There are over twenty-seven hundred central stations, from which light and power are furnished. The investment is this line is over three hundred millions. There are nearly eight thousand isolated plants, valued at more than two hundred millions.

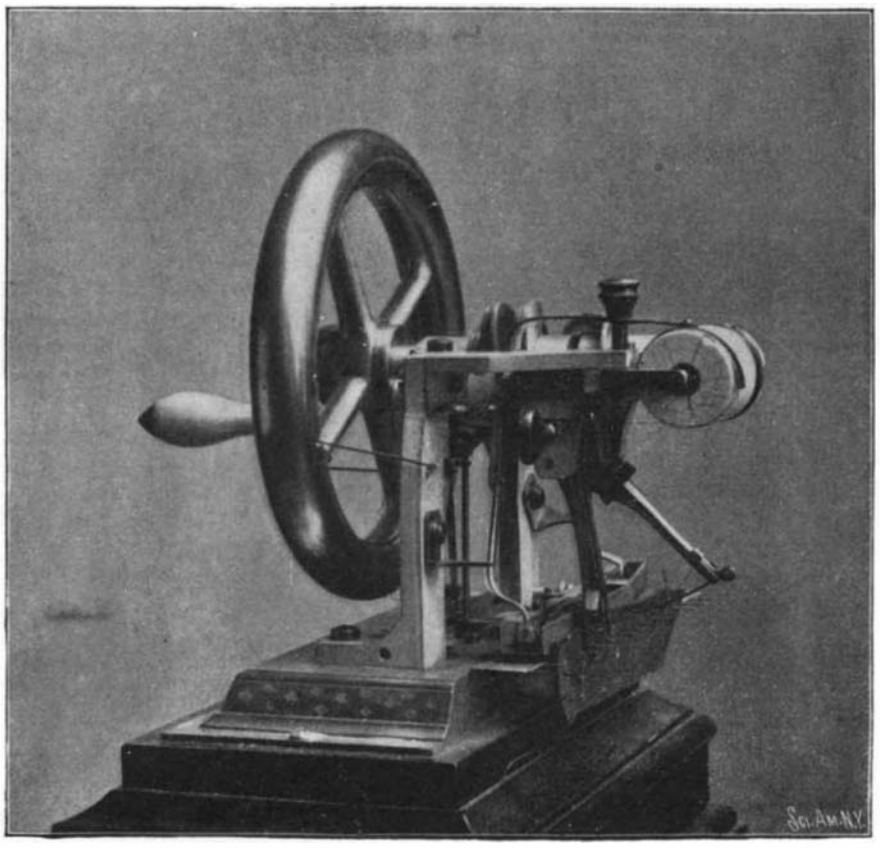
These several industries represent a total investment of nearly fourteen hundred millions, of which nearly two-thirds is invested in those branches in which the electric motor, in one form or another, is used. This two-thirds of the industry has been developed within the last ten years.

It is estimated that nearly four per cent of all the people in the United States make their living in one way or another out of the electric industry.

As an indication of the manner in which we have outstripped European countries in the electric field, we may mention the fact that there are over eight times as many electric railways in this country as in all the rest of the world combined.

THE SEWING MACHINE.

Fifty years have passed since Elias Howe applied at Washington for a patent on his sewing machine, and placed on file the working model which is herewith illustrated. On the tenth day of September, 1846, the patent was granted. That day may justly be written down as the birthday of the sewing machine—the practical modern machine as we know it to-day—and the year 1896 is therefore the semi-centennial anniversary of one of the greatest labor-saving devices of modern times.



THE ELIAS HOWE MACHINE, SEPTEMBER 10, 1846.

Earliest model filed in Patent Office.

In according to Elias Howe the title of father of the sewing machine, one is not unmindful of the earlier attempts of other inventors, whose devices, more or less crude and impractical, contained a suggestion of the future combination of parts, which was to make possible mechanical sewing. The records of the English Patent Office show that on July 17, 1790, Thomas Saint patented a sewing machine, which had a horizontal cloth plate, a vertical reciprocating needle, a continuous thread fed from a spool, an automatic feed and means for tightening the thread. It sewed with a chain stitch, an awl forming the hole, and a needle with a notch in its lower end pushing the thread through the cloth, and forming the loop. Thimonnier, in 1830, patented a machine in France, in which a barbed needle, shaped like a crochet needle, was carried through the material from above, and caught a thread which was on the lower side, bringing it up through the cloth, and forming a chain stitch on the upper side.

Walter Hunt, of New York, applied for a patent in 1854, and showed that in 1834 he had made and sold sewing machines which embodied an eye-pointed needle and a shuttle. Whatever success Hunt may have had with these designs, it is certain that it was not until Howe had independently invented his own machine, and proved its utility to the public satisfaction, that Hunt thought his device of sufficient importance to cover it with a patent. His application was rejected "on the ground of abandonment," the courts holding that the patent law is framed for the protection and reward of such inventors as disclose their inventions for the public benefit. If Hunt's machine was practical, as he claimed, we have here a notable instance of the folly of allowing a useful invention to lie dormant until some independent inventor has achieved the same result, and demonstrated its commercial value. Similar cases to this of Hunt and Howe are not far to seek. They all teach us that, if the first inventor believes his device to be practical and valuable, he should hasten to place himself beneath the protection of the patent law; but that if he loses faith in its possibilities and value, and gives up his search, he should be content to leave the field to others and "for ever hold his peace."

Whatever credit may be due to the early machines above mentioned, and to the later experiments of Hunt, the fact remains that Elias Howe did independently invent a practical sewing machine, which contained the three essential features of a needle with the eye at the point, a shuttle operating beneath the cloth to form the lock stitch, and an automatic feed; that he had sufficient faith in his machine to cover it with a patent; and that his unconquerable perseverance enabled him to convince the world of its commercial utility and establish its reputation as one of the most beneficial inventions of the age.

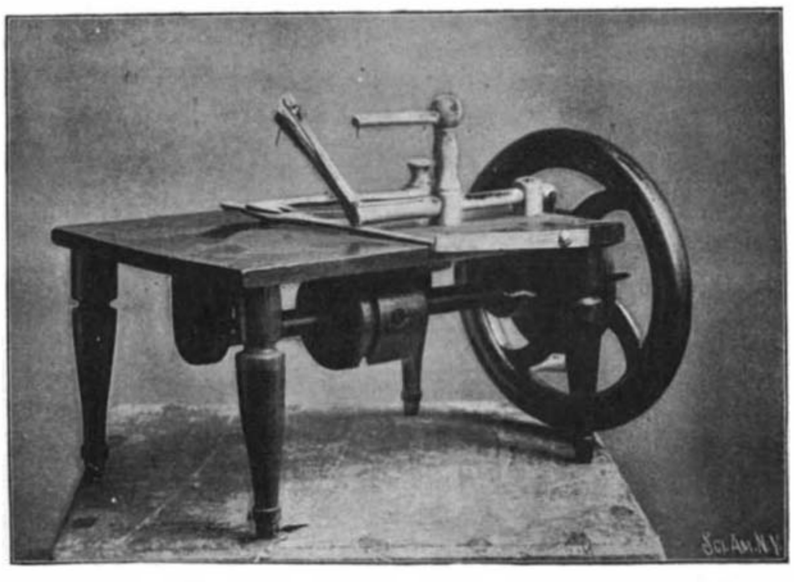
The inventor of the sewing machine was born in 1819 at Spencer, Mass. His father was a farmer and miller, whose means were so small that Howe was put to work at bread winning when he was yet a mere child. At twenty we find him a machinist in the shop of a Mr. Davis, of Boston, Mass., where he was first started on his investigation of the possibilities of mechanical sewing by hearing a capitalist remark to his employer that a large fortune awaited the man who could invent a sewing machine. At the outset he lost much valuable time in the endeavor to copy the motions of sewing by hand. If young Howe had known something of the early attempts of Saint, Thimonnier and others, he would have given his sewing machine to the world some years earlier than he did; but he had to go over the road that others had traversed before him, trying in vain to sew successfully with a needle pointed at both ends, and having the eye at the center. It was in 1844 that he abandoned the attempt to imitate the hand stitch, and conceived the idea of using two separate threads, on either side of the cloth, and forming the stitch by the co-operation of a shuttle. He was on the right track at last, and it was a natural step to shift the eye from the center to the point of the needle, so as to more readily form the loop for the passage of the shuttle. He did this, and in October, 1844, by means of a rough model, he had satisfied himself that his device would sew. Howe was very poor, and in spite of the priceless secret which lay hidden in his brain, he found himself quite unable to purchase even the material to build a working machine. Fortunately for him and the world at large, he was able to induce a former schoolmate, George Fisher, to provide $500 for the expenses of constructing a machine, and to board Howe and his family while it was being built, in consideration of which he was to acquire a half interest in the patent when it should be taken out. The work was finished by April, 1845, and in July he sewed two complete suits of clothes for himself and Fisher.

Then came the heartache and disappointment. The tailors were suspicious of the machine; and even after a public exhibition, in which the machine easily beat five of the swiftest sewers of a clothing manufactory, he received not a word of encouragement.

Howe went back to the garret of George Fisher's house and built another machine, for deposit in the Patent Office, this being his second machine and the one shown in our illustration.

In all the annals of the Patent Office it would be difficult to find a "stronger" patent than this. So completely did it embody the essential features, that it carried its author safely through such a tempest of litigation as never fell upon a patentee before or since. Judged by comparison with later machines, the product of skilled and intelligent mechanics, this early effort of Howe's, with its piece of cloth stuck on the pins of a "baster plate," is a somewhat clumsy affair; but it sewed, and it did so according to principles which will probably continue to govern the construction of sewing machines to the end of time.

By a study of the cut it will be seen that a curved, eye-pointed needle was carried at the end of a vertical vibrating lever, and that it took its thread from a spool situated above the lever. The tension on the thread was secured by means of a spring brake, whose semicircular ends bore upon the spool, the pressure being regulated by a vertical thumb screw. The work was held in a vertical plane by means of pins projecting from the edge of a thin metal "baster plate," to which an intermittent motion was given by the teeth of a pinion. Above the "baster plate" was the shuttle race, through which the shuttle, carrying the second thread, was driven by means of two strikers, which were operated by two arms, and cams located on the horizontal main shaft.



THE WILSON MACHINE OF NOVEMBER 12, 1850.

Earliest model filed in Patent Office.

After securing his patent, Howe, discouraged by his reception in America, determined to introduce his machine in England, and sent one over by his brother, Amasa B. Howe, to London, where a Cheapside manufacturer of corsets agreed to furnish money to promote the new venture. The following year, 1847, we find Howe in London trying, as part of the bargain, to adapt his machine to the sewing of corsets. Then followed two years of heartbreaking failure, in the course of which the inventor sank steadily into poverty. From three small rooms, he moves into one in the poorest part of Surrey. He borrows from a chance friend the means for bare existence, and the money to send his sick wife to America. Then he finishes a machine worth $250, which he sells for $25; and finally he pawns his first machine and his patent for money to carry him back to America, where he arrives, practically penniless, in April, 1849.

From this time on the tide of fortune sets steadily in his favor. He discovers that in his absence his shuttle machine has been built and sold freely in America, and that the mechanical world is waking up to its great possibilities. With the assistance of his father he commenced an infringement suit against those parties who were making his machine, or machines embodying his claims, and after a bitter fight he came off completely victorious. A vigorous attempt was made by I. M. Singer & Company to break the Howe patent, on the ground that an earlier machine (as already mentioned) had been made by Walter Hunt; but while the parts of the Hunt machine of 1834, which were recovered and produced in court, showed that he was "upon the track of the invention," the evidence showed that he had finally given up in despair of any practical results. In 1854, Judge Sprague, of Massachusetts, in giving a verdict for Howe, observed that "there is no evidence in this case that leaves a shadow of doubt that, for all the benefit conferred upon the public by the introduction of a sewing machine, the public are indebted to Mr. Howe." His success in the Singer suit was followed by