to 37 cents and feeling ready to abandon the whole subject indefinitely. Aid from the government was at hand, however, and a bill recommending the appropriation of $30,000 in aid of the telegraph was passed by Congress.

Soon after this work was begun on a line between Baltimore and Washington, and among those concerned in its erection was Ezra Cornell, the founder of the Cornell University. An attempt was made to lay the wire underground, and after an expenditure of nearly all the appropriation, this plan was abandoned and an aerial line was started. In seven weeks the work was completed, and the famous message was sent. It was written upon a strip of paper with an embossing point which simply indented the paper with dots and dashes.

Morse had conceived the idea of the relay circuit and had used in the early telegraphs a relay either as an extension of the line or as a local circuit. His great idea was to produce marks making a record of every message sent, and this idea seems to have been at the base of his work. One of his troubles consisted in accurately opening and closing the circuit in order to produce his alphabet. He used metallic type for the purpose with indented faces so shaped as to open and close the circuit at proper times and for proper periods, for the production of the desired markings. Each letter constituted a separate type, which was mounted on a portrule. When this was filled with type representing the message, it was drawn under the contact point. Then, as a simplification of this, two contact points close together were used, between which a wedge was thrust by hand, so as to open and close the circuit. Again, a keyboard was devised with a separate key like a piano, for each letter, but eventually, about 1844, the plain key, such as used to-day, was adopted. After the sending of the famous message in 1844, on April 1, 1845, the line between Baltimore and Washington was opened for public business under the auspices of the Post Office. One cent for every four characters was charged, and during the first four days one cent was received. After a week the receipts had risen to one dollar. Telegraph lines were slowly put up, but in 1846 the system was still experimental. In 1845 New York and Philadelphia were connected, in 1846 Philadelphia and Baltimore were connected. The government had rejected the purchasing of the Morse invention, so everything had to be done by private enterprise. The first ten years following 1846 were devoted to the exploitation of the new invention, and gradually more and more lines were added until, in 1856, what has been described as a straggling web of lines under the control of thirty or forty rival companies, working different apparatus under different patents, covered the more populous area of the country. Dividends were not paid except by one or two of the companies, and the prospects were anything but bright.

During these ten years inventors had not been idle. Morse's system required but little; the relay, the hand key and the alphabet and mechanism for reproducing the alphabet were all in existence in 1846, and since then little has been done with the Morse system proper in the way of addition. In the way of suppression the most important thing of all has been done. Various marking devices had been tried — pencil, embossing point, pen and inking wheel. Morse's apparatus was adapted for any of these devices, but after a while the clerks and attendants on instruments learned to read them by the sound made by the marking lever, and, in spite of threats of instant dismissal, they persisted in doing so when not watched. Morse was violently opposed to it, naturally regarding the recording device as the very soul of his instrument. Vail, who throughout figures as the entirely disinterested, self-sacrificing coadjutor of Morse, and who by many is considered as much the inventor of the Morse system as Morse himself, was the first to yield and devise, by simple suppression of parts, the well known sounder, converting the Morse telegraph into an acoustic one.

Other inventors took the subject in hand, all basing their work for the most part on the production of a record. Bain used chemical decomposition to produce a stain from a piece of paper, which, running in dots and dashes, would convey a message. To produce the dots and dashes he used a long strip of paper, previously perforated, which was drawn between two contact points. A short perforation produced a stain upon a corresponding strip of paper, giving a dot, while a long perforation produced a dash. Over and over again these devices have been applied in the most highly developed rapid transmission apparatus of the present day. Royal House devoted his energies to the development of a printing telegraph, but was estopped by Morse from the use of a relay. He performed the heavy work of his printing apparatus by pneumatic power, which was simply controlled by the telegraph line, and most curiously, in his attempt to produce a sensitive sounder, he described in one of his patents, long antedating Bell's invention, what is to all intents and purposes a Bell telephone, only he never imagined for a moment that it could be made to speak, and the microphone was still lacking to make it a practical invention.

We have seen that the early Baltimore and Washington line had Ezra Cornell as one of its constructors. In 1856 the amalgamation of the many companies then in existence was proposed and carried out through the agency of Hiram Sibley, the founder of the Sibley School of Science at Cornell University. Thus we find this great university intimately connected with the early days of the telegraph. The scheme was termed a crazy one; it was said to be like collecting all the paupers in the State and arranging them into a union so as to make rich men of them; but it was done.

The records of the business of the Western Union, originally so named because it was intended to be a union of Western telegraph companies, have been tabulated since 1867. It had, in that year, 46,270 miles of poles and cables and 85,291 miles of wire were in use; and 5,879,282 messages were transmitted. The receipts were $6,568,925.36. Its profits were $2,624,919.73. In 1895, with 189,714 miles of poles and cables, and 802,651 miles of wire, with 58,307,315 messages sent, receipts of $22,218,019.18 were shown, with a profit of $6,141,389.21. Since 1868 the average tolls per message had fallen from $1.047 to $0.307 per message. The Western Union represents about seven-eighths of the business of the United States, and by its wires, cables and connections any part of the world can be reached. Next to it in importance comes the other great American company—the Postal Telegraph. This and the Western Union do almost all the telegraphic business of the United States.

It would be too great a task to attempt to catalogue, much less describe, the many inventions in telegraphy. The genius of Edison, Delaney, Stearns and others has made it possible to send a number of messages simultaneously in both directions on the same wire. The British Postmaster-General states in a recent report that on a line on which in 1870 the highest speed by Wheatstone automatic was 60 to 80 words a minute, 600 words a minute is now possible. The old Bain principle of electric decomposition and the use of a perforated ribbon drawn between contact points to produce the dot and dash making contacts have reappeared in various instruments. Even the old Morse pendulum, giving its zigzag line, is the prototype of the siphon recorder used in ocean telegraphy.

Construction is receiving more and more attention. The Western Union Company are putting in hard drawn copper wire in place of iron on trunk lines, with the most satisfactory results. Over 10,000 miles of such wire is now in use. It relieves the strain on the poles, owing to its lightness, and its electrical superiority makes it work under very adverse meteorological conditions.

In the production of current, dynamos have been in some cases substituted for batteries with the best results. Time service is carried on throughout the United States from the Washington Naval Observatory. The telegraph business in this country, in spite of the sparsely settled districts and long distances of transmission, is made to show a profit. In England, where it is run by the government, and where it is calculated that of 70,000,000 messages per annum, some two-thirds are sent from or to London, a large annual deficit is shown.

PHYSICS.

Fifty years ago the science of physics was in a very peculiar condition. Mayer, about 1842, and Joule, 1843–1845, had given to the world their determinations of the mechanical equivalent of heat, laying the corner stone of the entire structure of modern physics. An immense amount of other data had been determined by methods which were hampered by inevitable inaccuracies, but which were accepted and utilized to the utmost by scientists of those days. In one point of theory hopeless confusion existed, on account of the want of an adequate distinction between force and energy. Physicists had gradually acquired the doctrine of the indestructibility of energy, and it was expressed in the so-called doctrine of the conservation of force. This supposed law was promulgated as one of the great triumphs of science, but it was not satisfactory. The comments of scientists upon it and their troubles in trying to reconcile facts with it make curious reading to-day when we know that force can be created and annihilated at will, and when we have learned to distinguish definitely between force and energy. After years of work the distinction was formulated and a threefold system of units was established for physics; the members of the system were force, work and energy. They were definitely distinguished, one from the other, and at once the great doctrine of the conservation of energy, unproved as it may be, obtained universal acceptance by men of science, and to-day is universally used as a working hypothesis. Faraday was one of those who had trouble with the doctrine of the conservation of force. He was an intimate friend of Clerk Maxwell, and utilized the mathematical genius of his friend in his work, and it was Maxwell who, working on the theory of dimensions, did much to definitely fix the relations of force, work and energy in all the formulæ of physical units which have sprung from the theory in question. It is impossible to dwell too strongly on this point in the development of physics during the last fifty years. Until force was accurately distinguished from energy the doctrine of the conservation of energy could not be utilized, and it is precisely on this doctrine that the whole of modern physics is constructed. It would be fair to term the theory the greatest discovery of the century in physics. The theory of dimensions is a necessary comment upon it, putting it into precise shape with due results.

The battle between the undulatory and the corpuscular theories of light had waged hotly, Newton and Young being the rival authorities appealed to, but the last fifty years have seen the undulatory theory universally accepted, and, in connection therewith, have seen the theory of electricity based on the luminiferous ether and its disturbances also accepted. Light and electricity thus were brought into near relations with each other, and a sort of conviction was established that no substance transparent to light could be a conductor of the electric current—something remarkably verified by the allotropic forms of carbon. Again we find the name of Clerk Maxwell, the developer of the electro-magnetic theory of light, foremost in the work of establishing the unity of natural science.

In 1850 Fizeau announced the success of his determination of the velocity of light by a physical test, using his rotating mirror to displace the apparent reflection of an electric spark. His results were close to the truth, and subsequent determinations by astronomical as well as by physical methods have but slightly affected them.

Mayer and Joule had developed the modern theory of heat, so that during the last fifty years comparatively little of basic work was possible. Melloni's work on what was called radiant heat, which comes nearly within our period, is an interesting example of old methods. The identification of this "radiant heat" with light phenomena is a direct growth of a recent period. Now it is treated as a particular phase of ether waves and the term itself is rejected. If the ether waves are long enough, they produce "obscure light," if the expression may be allowed, the old radiant heat. If of a certain range of length, the optic nerve is affected and light is produced. If still shorter, they cease to affect it again. Light becomes a subjective phenomenon, treated under the subject of ether waves. Chevreul's monumental work on color phenomena belongs to the light-producing division of ether waves, largely in the order of subjective phenomena.

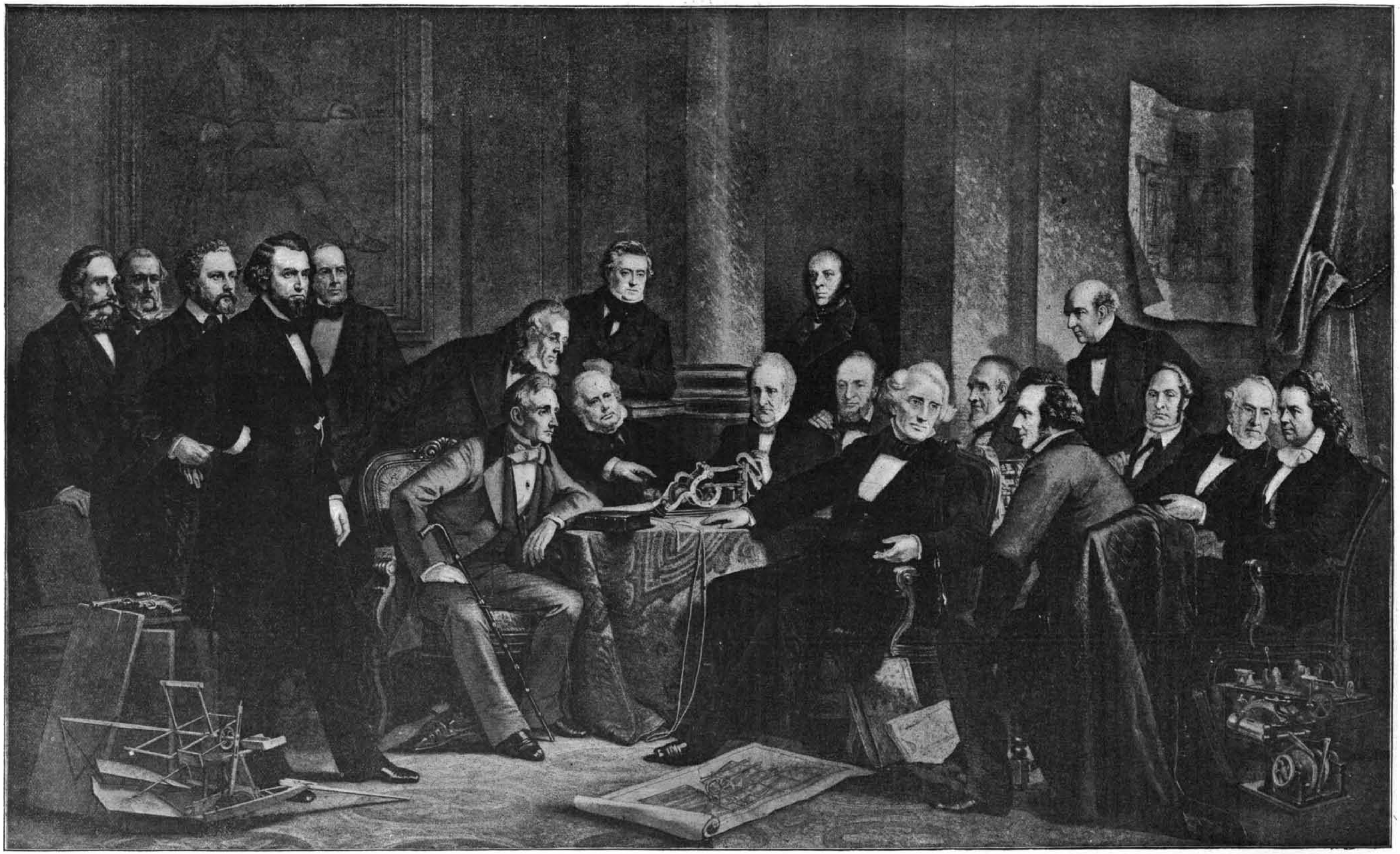
Sound has been the subject of extensive research, Helmholtz's analysis of the physiological basis of music, published in 1862, marking perhaps the greatest epoch in the recent development of the subject. Mathematics, physiology and experiment were all devoted to the accomplishment of his great task, and the effect of overtones in giving its distinguishing quality to a note was formulated. By the use of a telescoping resonator Helmholtz succeeded in determining precisely what overtones existed in any given sound, and then by producing simultaneously the fundamental and overtones previously determined he reproduced mechanically the sound in question. This gave the analysis and synthesis of a sound. Koenig may be cited as a developer of apparatus for such study, some of his acoustic apparatus being a true scientific triumph.

Faraday's work has done much to elucidate the physics of electricity, and the magneto-generator of currents and the electric motor were natural sequences thereof. Physicists developed the subject and constructed motors with electro-magnetic fields, until gradually the conception of a self-exciting dynamo arose, and soon currents of high intensity began to be produced by self-contained generators. Then came the greatest discovery of all, that a machine adequate in its revolutions to generate a current would, if a current were passed into it from an outside source, generate mechanical energy. This convertibility of the dynamo into a motor was a beautiful sequence of the doctrine of the conservation of energy, and at once enabled us to convert mechanical energy into electrical energy and vice versa.

Spectrum analysis is justly considered an achievement in physics, and in the hands of astronomers it has led to the discovery of double stars and the determination of the velocity of the motions of stars receding from or approaching to the earth. Helium was, in 1872, announced as a probable constituent of the sun from lines in its spectrum. Recently Ramsay has identified it in the gas given off with argon from the mineral cleveite.

The discovery of argon, as the result of a physical investigation, is one of the triumphs of modern science. It was found by Rayleigh and Ramsay that nitrogen gas from the atmosphere was of higher specific gravity than that from chemical compounds. The hitherto unknown constituent of the air, argon, was discovered and a new element was added to the list, an element which mankind had been breathing unsuspectedly for all time. The acuteness of the millionaire scientist of the last century, Cavendish, is shown in his paper on nitrogen, in which it is almost certain that he describes the discovery of argon. He only dared to suggest the existence of any such gas; his suggestions slumbered for over a century.

The work done by the different scientists in physics during the last years is too vast to bear repetition. Every branch of the subject has been worked up to the highest state of development; throughout every phase of investigation the definite mathematical relations of physical units, of time, space, force, work, energy and others, appear as the guides. The physicist has worked



The orig. Picture by C. Schussele. Phil. 1861.

Entered according to Act of Congress in the year 1863 by John Sartain, in the Clerk's Office of the District Court for the Eastern District of Pennsylvania.
Published by Munn & Co. N. Y.

Eng. on steel by John Sartain. Phil. 1862.

Dr. MORTON, Etherization. BOGARDUS, Iron Architecture. COLT, Revolvers. McCORMICK, Reapers. SAXTON, Mint & Coast Surv. Machinery. PETER COOPER, Gelatine &c. GOODYEAR, Vulcanizing Gum Elastic. MOTT, Works in Iron Fuel &c. PROF. HENRY, Electricity as a Motor. Dr. MOTT, Management of Heat &c. ERICSSON, Caloric Engine Monitor &c. SICKLES, Steam Cut off &c. MORSE, Electric Telegraph. BURDEN, Horse Shoe Machine. HOE, Rotary Press &c. BIGELOW, Carpet Looms &c. JENNINGS, Friction Matches &c. BLANCHARD, Eccentric Lathe &c. HOWE, Sewing Machine.

MEN OF PROGRESS — AMERICAN INVENTORS.

on spectroscopic analysis with most brilliant results. Langley's classic results with the bolometer in the in visible infra-red spectrum being worthy of citation as an example of the requirements of modern physical tests. In the same line Michelson worked in the obtaining of a scientific unit of length by using the wave length of specified light, and this is a wonderful illustration of the refinement of physical methods. The old time distinction of vapor and permanent gas has ceased to exist, as all the gases have yielded to the experimenter and have been liquefied, and, in many cases, solidified. Crookes discovering peculiar phenomena in gases at very high degrees of exhaustion endeavored to prove the existence of a fourth state of matter, adding one to the long accepted division. While his researches have not definitely established this fact, they have led the way to the most recent of the discoveries of physics, "last of all the greatest," the X ray phenomenon discovered by Roentgen, a name that will go down to posterity with that of Newton, Faraday and Maxwell.

MEN OF PROGRESS.

On the opposite page we present a reproduction of the large engraving, "Men of Progress—American Inventors," a fine steel engraving which was published by Munn & Company. The original oil painting from which the engraving was made was painted by C. Schussele in Philadelphia, in 1861. It was engraved on steel by John Sartain, a Nestor of American engravers. It is a fine example of the perfection to which steel engraving has been brought at the period in which it attained its highest development. In thousands of homes to-day this superb engraving still ornaments the walls.

On the left of the engraving is Dr. Morton (1819–1868), a dentist, who first used ether as an anæsthetic in 1846. From this dates the introduction into surgery of ethereal anæsthesia; next to him is James Bogardus (1800–1874), whose numerous inventions include a ring spinner, an engraving machine and the first dry gas meter. He was also interested in building iron buildings, and was one of the fathers of the modern system of iron construction. Col. Colt (1814–1862), the inventor of the Colt revolver, who is next to him, is referred to elsewhere in the more extended biographical notices, as is also Cyrus McCormick, the father of the reaper, who is at his right. Behind is Joseph Saxton (1799–1873), who devised ingenious mint machinery and coast survey and meteorological instruments.

Charles Goodyear (1800–1860), who is seated at the table, immortalized himself as the inventor of the process of vulcanization of rubber, which he patented in 1844. Behind him stands Peter Cooper (1791–1883), who is widely known for his varied talents and many inventions and for the success he met with in the development of the glue industry in this country. He was interested also in various iron works which he successfully exploited. His name will always be remembered as a philanthropist, for he founded and endowed Cooper Union in New York. Seated at the table is Jordan L. Mott, who will be remembered for his works in iron, fuel, etc. Leaning on one side of the pillar is Prof. Joseph Henry (1797–1878). He was an American physicist, especially noted for his investigations in electro-magnetism. On the right of the center is Dr. Eliphalet Nott, who made important researches on the management of heat. Behind is Capt. John Ericsson, of whom a more extended account is given on another page. In front is Sickles, who invented a steam cut-off. Seated in a chair is Prof. Morse, who is perhaps the most imposing figure in this unique collection of American inventors. His portrait and a biographical sketch may be found in another page. Behind is Henry Burden (1791–1871), a Scotch-American inventor. His inventions include a cultivator (1820), the hook-headed railroad spike, and a machine for making horseshoes. This machine produced from the iron bars sixty horseshoes per minute. In 1833 he built a cigar-shaped steamboat 300 feet long, which was afterward lost.

Richard Hoe, who is at the left of Morse (1812–1886), perfected, in 1846, a rotary printing press, which received the name of Hoe's lightning press, and he subsequently invented the Hoe web perfecting press. These inventions are described on another page. Next to him is Erastus Brigham Bigelow, who will be remembered for his inventions in relation to the carpet loom. In 1838 he patented a remarkable loom for weaving knotted counterpanes. In front of him is Jennings, who made important discoveries and inventions regarding the manufacture of matches. Thomas Blanchard (1788–1864), is chiefly known for his eccentric lathe for turning irregular forms, such as lasts, spokes, gunstocks, etc. He also invented a tack machine in 1806, and a steam carriage in 1825; he also built a stern-wheel boat for shallow waters, which is now largely in use in Western rivers. Howe, on the extreme right, is referred to in the article on the sewing machine and also in the brief biographical note which will be found on another page. The group is one of extreme interest as representing those inventors who were especially distinguished about the time of the breaking out of the civil war. It is to be hoped that some artist will come forward and portray the inventors of the last decade of the nineteenth century as faithfully as has the painter of these "Men of Progress."

THE TEXTILE INDUSTRIES OF THE UNITED STATES SINCE 1846.

Modern methods of textile manufacturing had their beginning in the forties, or about fifty years ago. The inventions that have contributed to make the textile industry in the United States what it is to-day first made their appearance at about that time. The modern system of textile manufacturing, therefore, has had an existence of almost exactly half a century. Before then, the various processes of manufacturing were in a sort of transitory or equivocal state of existence—inharmonious one with another. For a hundred years a struggle had been going on for the establishment of an equilibrium between them, which was not fully effected and realized till 1851, when systems, mechanical methods and comparative perfection of product became known to the world at the London international exhibition. The manufacturing world then, for the first time, became cognizant of the fact that there was before it the beginning of a new era of existence. American and foreign inventions had brought about this improved condition of affairs. The great inventions of the eighteenth century had served their purpose and been superseded by those that allowed more continuous and automatic operations. The spinning mule had been made successfully self-acting; the jenny had been thrown aside, while its coadjutor, the billy, was made to serve a new purpose in wool spinning as a more important auxiliary to the carding machine; and the latter for wool had been modified and new devices attached to it for the purpose of s[illegible]plifying processes and improving the quality of work done. The cotton manufacturing industry had attained development or made more rapid progress to maturity than had been the case with the woolen industry. But at that period both, it may be said, began a new life, regenerated, and started upon their present career. The Crompton fancy cassimere loom, which first appeared in the forties, and John Goulding's inventions affecting carding and spinning, which began to be appreciated at that time, did more to modernize the woolen industry than anything else. The worsted industry, as it is known to-day, had its beginning at that period in the perfection of the combing machine, more, however, as an English than an American industry, the latter appearing later. The silk manufacturing industry, also, began about this time with its centralizing at Paterson, N. J.

At the beginning of the 1850–60 decade, the three textile industries that will be considered in this article, cotton, woolen and silk, were well established, and have remained important factors in the industrial development of the country. Their relative growth may be seen in the following census statistics showing the comparative value of products:

	Cotton.	Per cent.	Woolen.	Per cent.	Silk.	Per cent.
1850	$61,869,184	54·6	$49,636,881	43·8	$1,809,476	1·6
1860	115,681,774	57·0	80,734,606	40·0	6,607,771	3·0
1870	177,489,739	43·6	217,668,826	53·4	12,210,662	3·0
1880	192,090,110	38·4	267,252,913	53·4	41,033,045	8·2
1890	267,981,724	38·7	337,768,524	48·8	87,298,454	12·5

As will be observed, measured by the value of their products, the cotton manufacturing industry was preeminent over that of wool in 1850 and 1860, but occupied second place in 1870, 1880 and 1890. Abnormal conditions existed in the sixties, favorable to the woolen and detrimental to the cotton industry, giving the former an impetus that put it first in rank, which it has since retained, though its relative position has been somewhat diminished since 1890, based on the productive capacity of machinery, product values not being obtainable. Since 1890 the productive capacity of the cotton manufacturing industry has increased about 13 per cent, while that of the wool manufacturing industry has increased only about 8 per cent. There is no doubt, however, that the woolen industry still holds its first position in the textile line in the value of products. The silk industry has been steadily gaining, as will be seen, since 1850, till it occupies a relative position of no mean proportions.

The silk manufacturing industry of the United States, in the diversity and excellence of its product, has made commendable progress within the last forty, and even ten or fifteen years. The Chicago Exposition of 1893 revealed an elegance of American silk manufacture that the general public scarcely dreamed of as having an existence. In 1850 the silk manufacturers of this country were confined almost wholly to sewing silk, and no marked progress was made till after 1870, when, by the census of 1880, it was seen that considerable advances had been made in the manufacture of dress goods, which by 1890 became of the first importance with that of ribbons. In color, design and finish, American silk dress goods compare favorably to-day with the best made abroad. The silk industry is chiefly (91 per cent) confined to the four States of New Jersey, New York, Pennsylvania and Connecticut, centralized in certain localities, Paterson, N. J., being first in importance. The status of the silk industry in the United States may be seen from the following statistics, taken from the 1890 census:

VALUE OF PRODUCTS.

United States, gross value				$87,298,454
New Jersey,	Paterson	$22,058,624		
	Elsewhere	8,701,747	$30,760,371	
New York,	New York City	13,579,462		
	Elsewhere	5,838,334	19,417,796	
Pennsylvania,	Philadelphia	8,059,604		
	Elsewhere	11,297,942	19,357,546	
Connecticut			9,788,951	79,324,664
In other States				$7,973,790

The silk industry is centered chiefly about Paterson, New York and Philadelphia. Not far from 60 per cent of it is so situated.

Industries.	Capital.							Value of Products.
	Aggregate.	Value of Plant.				Live Assets.		
		Total.	Land.	Buildings.	Machinery, Tools, and Implements.			
Lumber and other mill products from logs and bolts	$496,339,968	$294,325,888	$156,539,097	$31,273,534	$106,513,257	$202,014,080		$403,667,575
Iron and steel	373,478,018	210,830,316	31,553,087	42,766,656	136,510,573	162,647,702		430,954,348
Cotton goods	354,020,843	230,993,567	23,225,097	69,742,664	138,025,806	123,027,276		267,981,724
Woolen goods	$130,989,940	$57,820,243	$6,534,819	$19,332,575	$31,952,847	$73,169,697		$133,577,977
Worsted goods	68,085,116	27,890,810	2,842,769	7,962,865	17,085,176	41,194,306		79,194,652
Carpets	38,208,842	17,375,384	2,884,139	5,559,458	8,931,787	20,833,458		47,770,193
Felts	4,460,621	1,865,984	276,780	714,453	874,751	2,594,637		4,654,768
Wool hats	4,142,224	1,194,389	144,350	381,105	668,934	2,947,835		5,329,921
Hosiery and knit goods	50,607,738	23,574,761	2,271,466	6,194,088	15,109,207	27,032,977		67,241,013
Total	$296,494,481	$129,721,571	$14,954,323	$40,144,544	$74,622,704	$166,772,910		$337,768,524

The relative status of the cotton and woolen industries, as it existed in 1890, and which is preserved to-day, or nearly so, may be seen in the foregoing table. The four leading manufacturing industries of the United States are here given, the lumber manufacturing interest holding the commanding position in the amount of capital employed, without including planing mill products and the more advanced articles of wood manufacture. Iron and steel rank next, without including anything manufactured therefrom. The manufacture of cotton goods occupies the third, and of woolens, the fourth position. In the value of products the relative positions are somewhat changed. But taking the two great textile industries—cotton and woolen—together, and, in amount of capital and value of products, they stand supreme over all others. Taking all the six New England States together, where these manufactures mainly exist, 34 per cent of the capital invested in all kinds of manufactures is represented in the cotton (21 per cent) and wool (13 per cent) manufacturing industries. The importance of these industries to that section are thus seen, and the effect their prosperity has upon the communities in which they are located.

The cotton manufactures of the United States, as noted above, advanced in the value of their products from $62,000,000 in 1850 to $268,000,000 in 1890, or 332 per cent. In number of spinning spindles the advance was from 3,600,000 to 14,200,000, or about 300 per cent. The increase in value of product and in number of spindles was about the same for this period. The number of spindles in 1846 was about 2,400,000; in 1895 it was 16,100,000, an increase of 570 per cent, and the annual consumption of cotton, per spindle, was 73·4 and 80·5 pounds respectively. The consumption, per spindle, it would thus appear, has increased but slightly within the past fifty years. But important factors have to be considered in this connection; as consumption per spindle is, after all, no more than a statistical curiosity, meaning much or little, according as it is used. Speed of spindle and count of yarn must be taken into calculation. The productive capacity of a spindle to-day is about 44 per cent greater (some are inclined to put it more) than it was fifty years ago, so that measured by this standard the cotton manufacturing industry has advanced within the past fifty years not 570 per cent, but 866 per cent. That this is not shown in the consumption of cotton is due to two causes: less running time and finer counts.

The progress that has been made in the mechanical