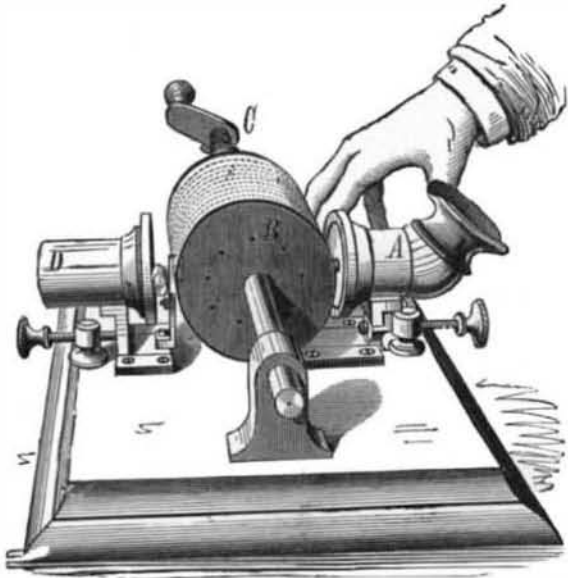


neous with the beginnings of the SCIENTIFIC AMERICAN.

New methods of attack have been applied. The electric furnace, in the hands of M. Moissan, has yielded remarkable results. Fluorine, the element which for so many decades resisted isolation, was isolated by him. By the utilization of electricity, rare metallic elements were also reduced from their compounds, and the electric current was applied by Classen with much success to the problems of analysis by electrolysis of aqueous solutions of the double oxalates. The synthesis of carbon and hydrogen has been effected on the large scale by the electric furnace, in which carbides decomposable



THE FIRST PHONOGRAPH.

by water are first produced. The decomposition of these by water gives acetylene gas, a veritable triumph of synthesis.

The every-day appliances of the laboratory have been improved beyond the dreams of old time chemists. Now special apparatus is procurable for all purposes. Rapid filtration, introduced originally by Bunsen, is really one of the notable improvements of the period we treat of, and in the hands of Gooch and others has been greatly developed and improved.

It may seem that the chemist's work is done, but it is not. The discovery of metallic carbonyls is an illustration of how great recent discovery may be. It was found by Mond that carbon monoxide gas had the wonderful power of combining with nickel, and also less freely with iron at ordinary temperatures, and could carry them off in the state of gas. This dates back only a few years. Had the discovery yielded the fruits expected, it would have fairly revolutionized some indus-

tries. The same is to be said for calcium carbide and acetylene gas, already alluded to.

THE PHONOGRAPH.

In December, 1877, a young man came into the office of the SCIENTIFIC AMERICAN, and placed before the editors a small, simple machine about which very few preliminary remarks were offered. The visitor without any ceremony whatever turned the crank, and to the astonishment of all present the machine said: "Good morning. How do you do? How do you like the phonograph?" The machine thus spoke for itself, and made known the fact that it was the phonograph, an instrument about which much was said and written, although little was known.

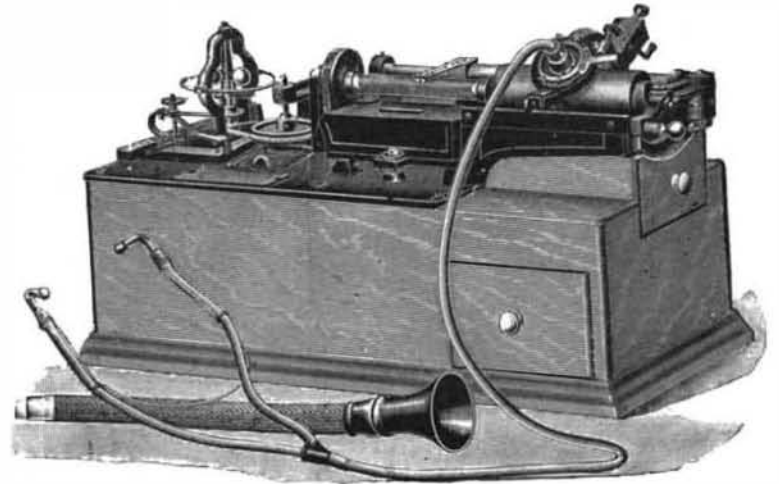
The young man was Edison, and the phonograph was his latest invention. The editors and employes of the SCIENTIFIC AMERICAN formed the first public audience to which it addressed itself. Edison, even then, was a well known and successful inventor. The invention was novel, original, and apparently destined to find immediate application to hundreds of uses. Every one wanted to hear the wonderful talking machine, and at once a modified form of the original phonograph was brought out and shown everywhere, amusing thousands upon thousands; but it did not by any means fulfill the requirements of the inventor. It was scarcely more than a scientific curiosity or an amusing toy. Edison, however, recognized the fact that it contained the elements of a successful talking

machine, and thoroughly believed it was destined to become far more useful than curious or amusing. He contended that it would be a faithful stenographer, reproducing not only the words of the speaker, but the quality and inflections of his voice; and that letters, instead of being written, would be talked. He believed that the words of great statesmen and divines would be handed down to future generations; that the voices of the world's prima donnas would be stored and preserved, so that, long after they had passed away, their songs could be heard. These and many other things were expected of the phonograph. It was, however, doomed to a period of silence. It remained a toy and nothing more for years.

The original instrument consists of three principal parts—the mouthpiece, into which speech is uttered; the spirally grooved cylinder, carrying a sheet of tinfoil which receives the record of the movements of the diaphragm in the mouthpiece; and a second mouth-

piece, by which the speech recorded on the cylinder is reproduced. In this instrument the shaft of the cylinder is provided with a thread of the same pitch as the spiral on the surface of the cylinder, so that the needle of the receiving mouthpiece is enabled to traverse the surface of the tinfoil opposite the groove of the cylinder. By careful adjustment this instrument was made to reproduce familiar words and sentences, so that they would be recognized and understood by the listener; but, in general, in the early phonographs, it was necessary that the listener should hear the sounds uttered into the receiving mouthpiece of the phonograph to positively understand the words uttered by the instrument.

In later instruments exhibited throughout the country and the world, the same difficulty obtained, and

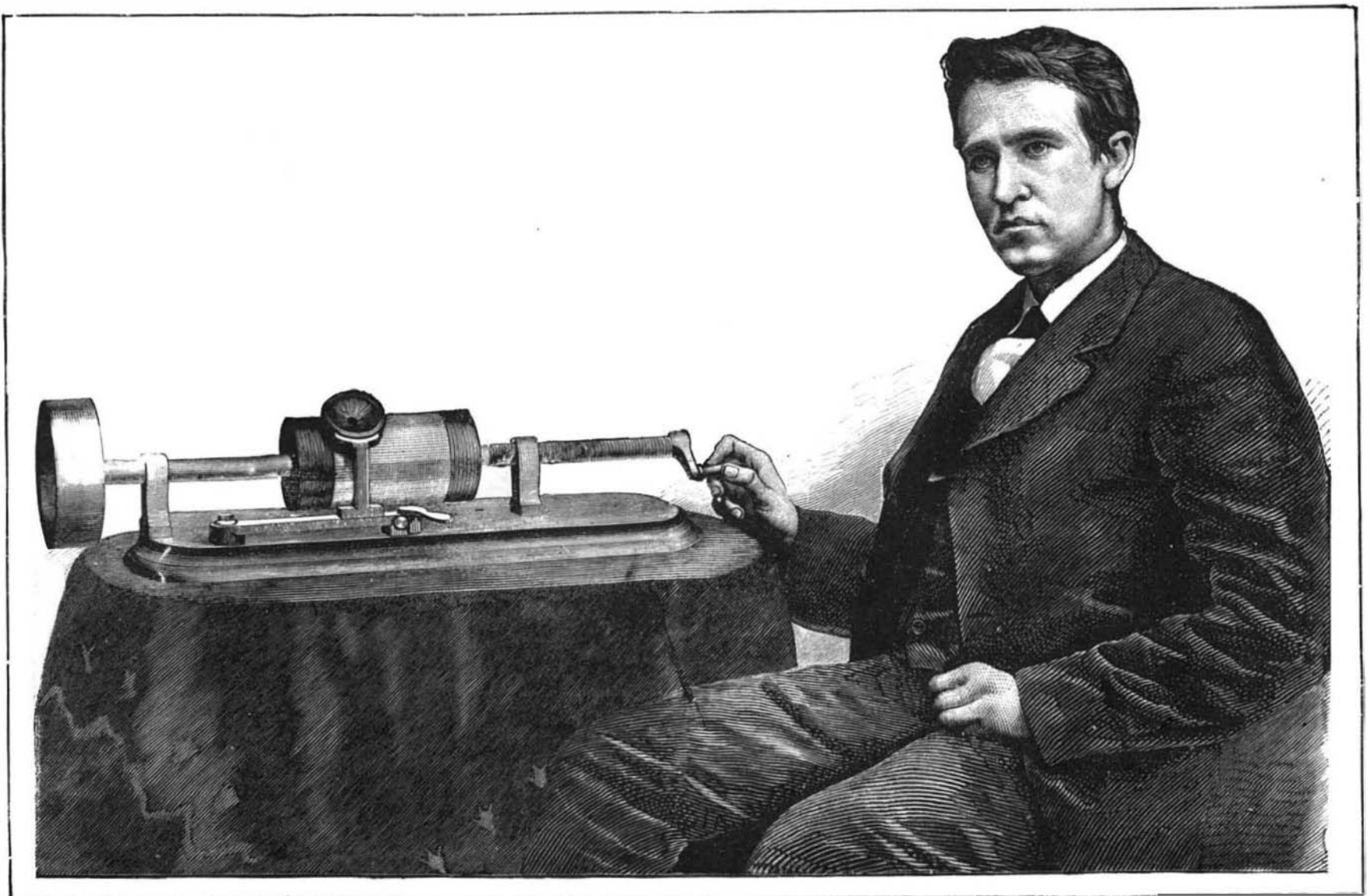


IMPROVED RECORDING AND REPRODUCING PHONOGRAPH OF 1896.

perfection of articulation was sacrificed to volume of sound. This was necessary, as the instruments were exhibited before large audiences, where, it goes without saying, the instrument, to be entertaining, had to be heard. These instruments had each one mouthpiece and one diaphragm, which answered the double purpose of receiving the sound and of giving it out again.

Finally it was made known to the public that the ideal phonograph had been constructed; that it was unmistakably a good talker; and that the machine, which most people believed to have reached its growth, had after all been refined and improved until it was capable of faithfully reproducing every word, syllable, vowel, consonant, aspirate and sounds of every kind.

During the dormancy of the phonograph, its inventor secured both world-wide fame and a colossal fortune by means of his electric light and other well known inventions. He devoted much time to the phonograph, and not only perfected the instrument



EDISON AND THE FIRST PERFECTED PHONOGRAPH.

itself, but established a large factory provided with special tools for its manufacture, in which phonographs are turned out in great numbers.

The improvements reduced the instrument to about the size of an ordinary sewing machine. In its construction it is something like a very small engine lathe; the main spindle is threaded between its bearings and is prolonged at one end and provided with a drum for receiving the wax cylinder, upon which the sound record is made. Behind the spindle and the drum is a rod upon which is arranged a slide, having at one end an arm adapted to engage the screw of the spindle, and at the opposite end an arm carrying a head provided with two glass diaphragms which may be interchanged when desirable. One of these diaphragms is used when it is desired to talk to the phonograph, and when the speech is to be reproduced the other diaphragm takes its place. The cutter by which the impressions are made in the wax is attached to the center of the diaphragm and pivotally connected to a gravity arm attached to the side of the diaphragm cell. The reproducing cell contains a delicate glass diaphragm, to the center of which is secured a stud connected with a small curved steel wire, one end of which is attached to the diaphragm cell. The recording and reproducing points are formed of chalcidony.

The spindle of the phonograph is rotated regularly by an electric motor in the base of the machine, which is driven by a current from one or two cells of battery. The motor is provided with a sensitive governor which causes it to maintain a very uniform speed. The arm which carries the diaphragms is provided with a turning tool for smoothing the wax cylinder preparatory to receiving the sound record.

The first operation in the use of the machine is to bring the turning tool into action and cause it to traverse the cylinder. The turning tool is then thrown out, the carriage bearing the recording diaphragm is returned to the position of use, and as the wax cylinder revolves the diaphragm is vibrated by the sound waves, thus moving the cutter so as to cause it to cut into the wax cylinder and produce indentations which correspond to the movements of the diaphragm. After the record is made, the carriage is again returned to the point of starting, the receiving diaphragm is replaced by the reproducing diaphragm, and the carriage is again moved forward by the screw as the cylinder revolves, causing the point carried by the reproducing diaphragm to traverse the path made by the recording cutter. As the point follows the indentations of the wax cylinder the reproducing diaphragm is made to vibrate in a manner similar to that of the receiving diaphragm, thereby faithfully reproducing the sounds uttered into the receiving mouthpiece.

The perfect performance of the phonograph depends upon its mechanical perfection—upon the regularity of its speed, the susceptibility of the wax cylinder to the impressions of the needle, and to the delicacy of the

speaking diaphragm. No attempt is made in this instrument to secure loud speaking—distinct articulation and perfect intonation having been the principal ends sought.

The phonograph may be now used for taking dictation of any kind, for the reproduction of vocal music, for teaching languages, for correspondence, and for various other purposes too numerous to mention.

The wax cylinder upon which the record is made is provided with a rigid backing. It is very light and a mailing case is provided for safely mailing it. The recipient of the cylinder places it on his own phonograph

within a few years—the graphophone, which is similar to the phonograph, operating on practically the same principle, and the gramophone, which has a flat disk instead of a cylinder and makes a record which is a sinuous groove, by means of a laterally vibrating needle. It reproduces sound by the lateral vibrations caused by the following of the reproducing needle in the groove of the record.

THE AMERICAN LOCOMOTIVE.

The first practical locomotive to turn its wheels upon

a track in America was the Stourbridge Lion, an imported English engine. This notable event took place August 9, 1829. The first engineer to run a locomotive in America was Horatio Allen, who handled the throttle on this occasion. It is claimed that the first American-built locomotive to be put into active service was the Best Friend, which was constructed by Mr. E. L. Miller, for the South Carolina Railroad Company. This occurred in November, 1830.

In the earliest days of American locomotive building the influence

of the original English models is traceable in the designs; but it was not long before the American mechanic began to strike out for himself, and build a machine specially adapted to local conditions. Various original and radical features were introduced, and with such rapidity, that in the brief interval of sixteen years between the trial trip of the Best Friend and the year 1846, which marks the opening of the half century with which we are dealing, the most important elements of the typical American eight-wheel engine, as we know it to-day, may be said to have been substantially established.

A comparative study of the cuts of early engines of this period will enable the reader to identify, in one design or another, those characteristic features which are distinctively American. He will find the leading truck, the four-coupled drivers, with the fire box between the axles, the bar frame, the outside cylinders, the equalizing levers, the "cow catcher," and the bell, and last, and perhaps as characteristic as any, the cab. In saying that the main features of the eight-wheel American engine were to be found represented in the locomotives of 1846, it is not to be understood that this was by any means, at that time, the accepted type, although it was destined shortly to become

and listens to the phonogram—in which he not only gets the sense of the words of the sender, but recognizes his expression, which will, of course, have much to do with the interpretation of the true meaning of the sender of the phonogram.

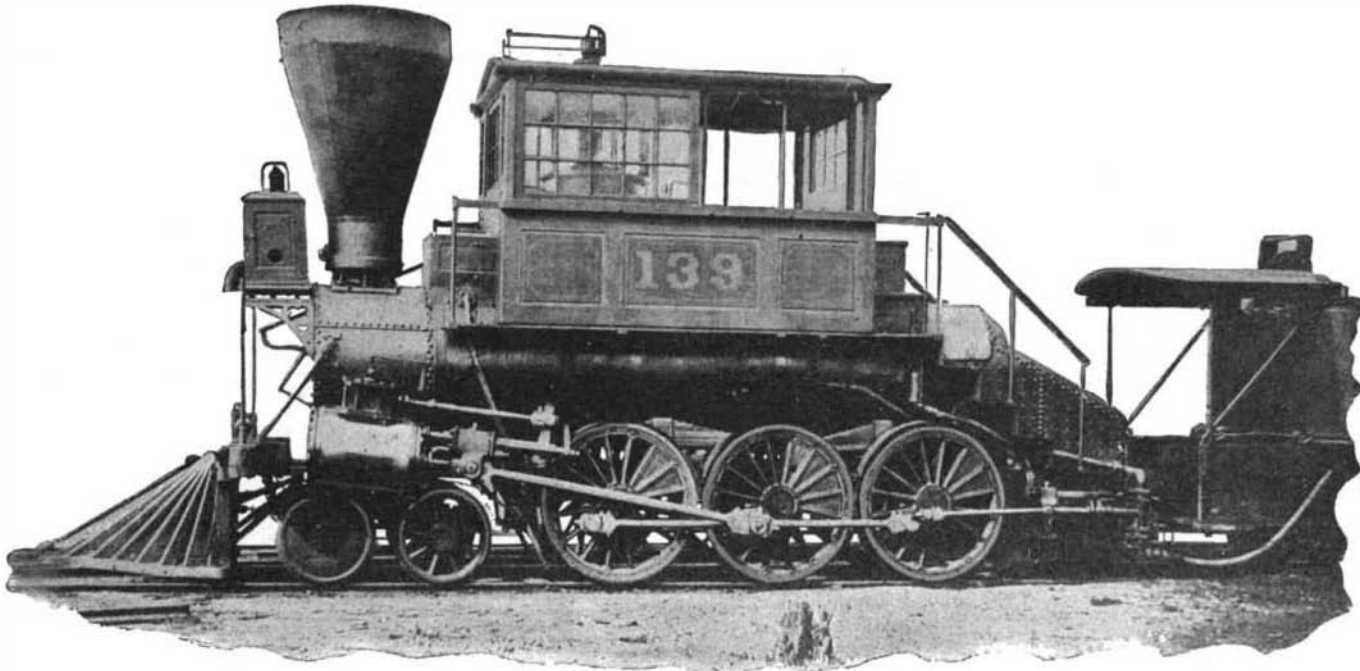
A very interesting and popular use of the phonograph is the distribution of the songs of great singers, sermons and speeches, recitations, the words of great men and women, music of many parts, the voices of animals etc., so that the owner of a phonograph may enjoy these things with little expense.

Passing over the application of the phonograph to dolls, we will refer briefly to the latest developments of the instrument. It has recently been determined to

furnish a perfect phonograph for a moderate price which will reproduce any record with great fidelity. Purchasers will be able to provide themselves with records of any desired character, so that the most interesting of entertainments may be had at a moment's notice. This phonograph is driven by a spring motor in a manner similar to a music box. It is light, compact, and readily operated. Although it is designed for reproducing only, it may for a small additional cost be made to record or to both record and reproduce. The records are made on the recording phonograph, which is now so perfect as to leave nothing to be desired.

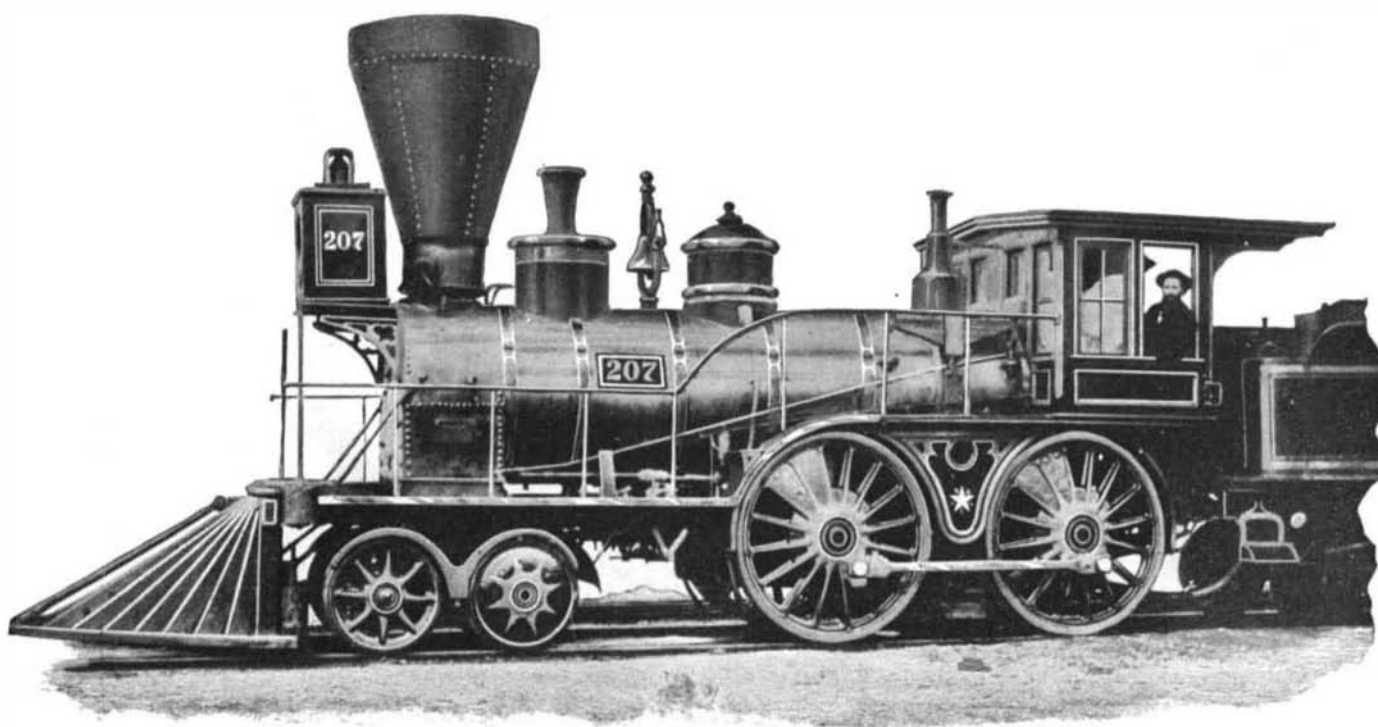
Other instruments of this class have been devised

so. That was an age of investigation, and the student of American locomotive history is impressed with the number and variety of experimental engines which figured in the twenty years from 1841 to 1860. In the first place, the inside cylinders and the single driving wheel, which have been so very largely retained in English practice, were tried and found wanting for the requirements of those days. The celebrated Globe eight-wheeled inside connected engines were for many years a familiar feature on many New England roads, and it is but a few years since the last of them was consigned to the scrap heap. An engine of this type, with 15 by 22 inch cylinders, built for the Baltimore and



CAMEL-BACK LOCOMOTIVE BUILT FOR THE B. & O. RAILROAD IN 1853.

Cylinders, 19 by 22 inches; drivers, 50 inches; weight, 71,000 pounds; steam pressure, 120 pounds.



INSIDE-CONNECTED EIGHT-WHEELED LOCOMOTIVE BUILT FOR THE B. & O. RAILROAD IN 1854.

Cylinders, 15 by 22 inches; drivers, 60 inches; boiler, 44 inches diameter; weight, 56,000 pounds.