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.

It was the latest invention of Edison, and the editors and employes of the *Scientific American* formed the first public audience to which it addressed itself. The young man was Mr. Thomas A. Edison, even then 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 their decease, 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. 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 has devoted much time to the phonograph, and has not only perfected the instrument itself, but has established a large factory provided with special tools for its manufacture, in which phonographs are to be turned out in great numbers.

The original instrument consists of three principal parts —the mouthpiece, into which speech is uttered; the spirally grooved cylinder, carrying a sheet of tin foil which receives the record of the movements of the diaphragm in the mouthpiece; and a second mouthpiece, 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 tin foil 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 the later instruments, such as were exhibited throughout the country and the world, the same difficulty obtained, and 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 but one mouthpiece and one diaphragm, which answered the double purpose of receiving the sound and of giving it out again. Strangely enough, the recently improved phonograph is more like the original one than any of the others. It is provided with two mouthpieces, one for receiving and one for reproducing.

The new phonograph, which is shown in Fig. 157, is of about the size of an ordinary sewing machine. In its con-

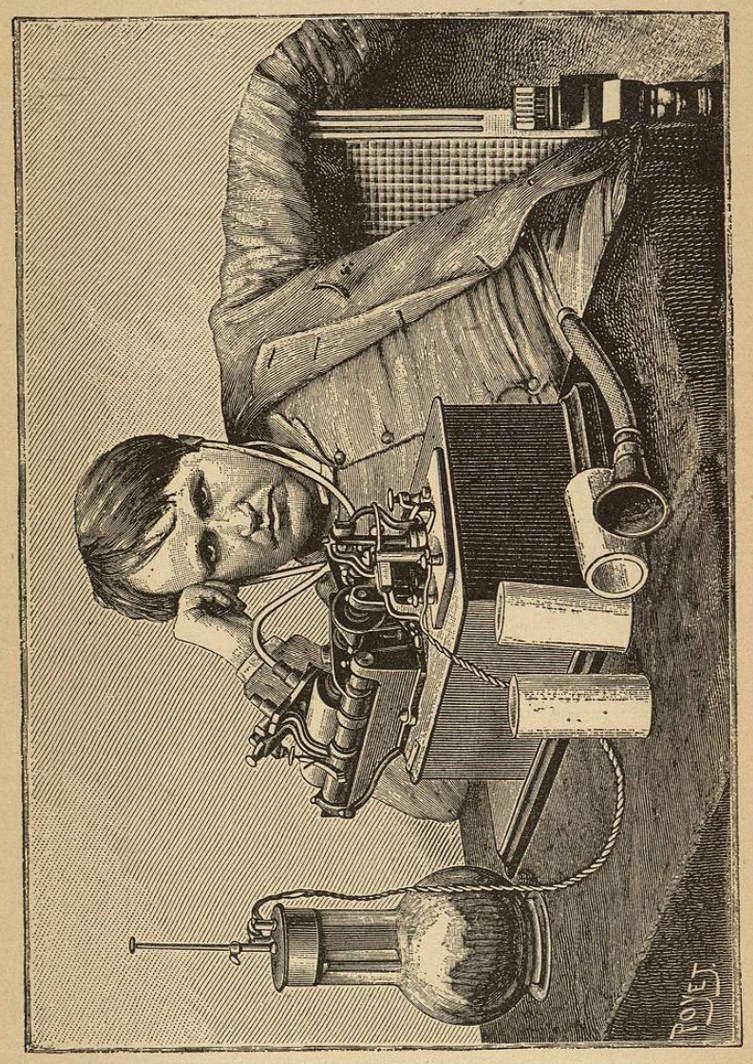


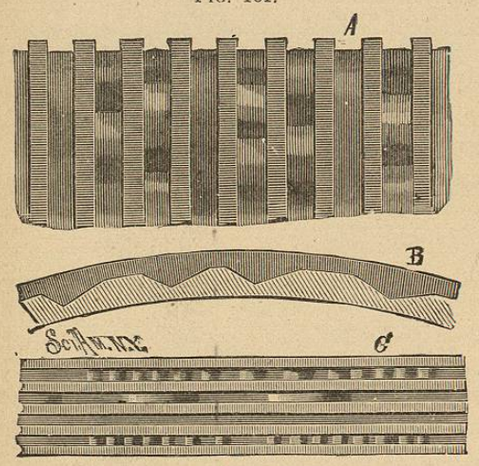
FIG. 158. Edison Listening to the first Phonogram sent from England.

struction, it is something like a very small engine lathe; the main spindle is threaded between its bearings, and is prolonged at one end to receive the hardened wax cylinder upon which the sound record is made. Behind the spindle and the cylinder 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 pivoted head, provided with two diaphragms, whose positions may be instantly interchanged when desirable. One of these diaphragms is turned into the position of use when it is desired to talk to the phonograph, and when the speech is to be reproduced, the other diaphragm takes its place. The glass diaphragm, which receives the speech and makes the impressions upon the cylinder, is shown in Fig. 159. The needle by which the impressions are made in the wax is attached to the center of the diaphragm, and pivotally connected to a spring arm attached to the side of the diaphragm cell. The device by which the speech is reproduced is shown in section in Fig. 160. The 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 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 diaphragms is returned to the position of starting, the receiving diaphragm is placed in the position of use, and as the wax cylinder revolves, the diaphragm is vibrated by the sound waves, thus moving the needle 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

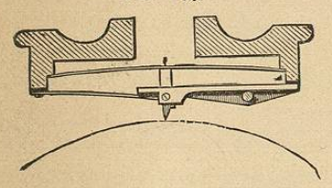
returned to the point of starting, the receiving diaphragm is replaced by the reproducing diaphragm, and the carriage is again moved forward by the screw, as the cylinder revolves, causing the point of the reproducing diaphragm to traverse the path made by the recording needle. As the point of the curved wire attached to the diaphragm follows

FIG. 161.



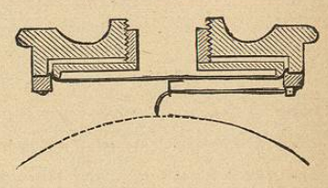
Phonographic Record Magnified.

FIG. 159.



Receiving Diaphragm.

FIG. 160.



Speaking Diaphragm.

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.

A crucial test of the capabilities of this machine was recently made in our presence, at Edison's laboratory, near

Llewellyn Park, Orange, N. J. A paragraph from the morning newspaper was read to the machine in our absence, and when upon our return to the instrument it was reproduced phonographically, every word was distinctly understood, although the names, localities, and the circumstances mentioned in the article were entirely new and strange to us. Another test of the perfection of the machine was the perfect reproduction of whistling and whispering, all the imperfections of tone, the half tones and modulations even, being faithfully reproduced. The perfect performance of the new instrument 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 have been the principal ends sought.

A highly magnified section of the phonograph cylinder, showing the indentations, is illustrated in Fig. 161; A representing a section of the face of the cylinder, B a transverse section of a portion of the cylindrical wax shell, and C showing a less magnified face view of a small portion of the cylinder.

The new phonograph is to be used for taking dictation for taking testimony in court, for reporting speeches, for the reproduction of vocal music, for teaching languages, for correspondence, for civil and military orders, for reading to the sick in hospitals, and for various other purposes too numerous to mention.

Imagine a lawyer dictating his brief to one of these little machines; he may talk as rapidly as he chooses, every word and syllable will be caught upon the delicate wax cylinder, and after his brief is complete he may transfer the wax cylinder to the phonograph of a copyist, who may listen to the words of the phonograph and write out the manuscript. The instrument may be stopped and started at pleasure, and if any portion of the speech is not understood by the transcriber, it may be repeated as often as necessary.

In a similar manner a compositor may set his type directly from the dictation of the machine, without the necessity of

"copy," as it is now known. Mr. Edison says that the whole of "Nicholas Nickleby" could be recorded upon four cylinders, each 4 inches in diameter and 8 inches long, so that one of these instruments in a private circle or in a hospital could be made to read a book to a number of persons. This is accomplished by means of a multiple earpiece.

The little wax cylinders upon which the record is made are provided with a rigid backing, and the cylinders are made in different lengths; the shortest—one inch long—having a capacity of 200 words, the next in size 400 words, and so on. These cylinders are very light, and a mailing case has been devised which will admit of mailing the cylinders as readily as letters are now mailed. The recipient of the cylinder will place it on his own phonograph and listen to the phonogram—in which he will not only get the sense of the words of the sender, but will recognize his expression, which will, of course, have much to do with the interpretation of the true meaning of the sender of the phonogram.

Fig. 158 is a life-like picture of Mr. Edison photographed while he listened to his first phonogram from abroad.

A very interesting and popular use of the phonograph will be the distribution of the songs of great singers, sermons and speeches, 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.

It may even be pressed into the detective service and used as an unimpeachable witness. It will have but one story to tell, and cross examination cannot confuse it.

REFLECTION AND CONCENTRATION OF SOUND.

The particular action of sound to be dealt with here is that of reflection, examples of which are presented in every echo; and whispering galleries are but the exhibition of the same thing, although more rare. A few of them have a world-wide reputation.

In his article on sound in the "Encyclopædia Metropolitana," Sir John Herschel mentions the abbey church of St.

Albans, where the tick of a watch may be heard from one end of the edifice to the other. In Gloucester Cathedral a gallery of octagonal form conveys a whisper 75 feet across the nave. In the whispering gallery of St. Paul's the faintest sound is conveyed from one side of the dome to the other, but is not heard at any intermediate point. The dome of the capitol at Washington is an excellent whispering gallery. These effects are due to an accidental arrangement of the walls.

Sails of ships are sometimes inflated by the wind so that they act as concentrating reflectors of sound. Arnott says that in coasting off Brazil he heard the bells of San Salvador from a distance of 110 miles, by standing before the mainsail, which happened at the time to assume the form of a concave reflector, focusing at his ear.

Sounds may be received and reflected by means of metallic parabolic reflectors, so that many times the volume of sound that naturally strikes the ear will be concentrated, rendering sounds audible that might otherwise be too distant or too faint to be heard. Such reflectors of necessity have a fixed form, and are available under certain conditions only. The accompanying engraving (Fig. 162) represents a sound reflector that may be focused as readily and directed as easily as a telescope. It is, in fact, a portable and adjustable whispering gallery, having many useful applications.

The instrument is very simple, consisting essentially of an airtight drum, one head of which is rigid, the other elastic. This drum, or more properly reflector, is mounted on pivots in a swiveled support, and is provided with a flexible tube having a mouthpiece and stop cock at its free end. Two wires are stretched across the face of the reflector at right angles to each other, and support at their intersection a small plane mirror, the office of which is to determine the position of the reflector in relation to the direction of the sound. A small ear trumpet or funnel, which is shown on the table, is used in connection with the reflector, to increase its effect by gathering portions of the sound that might escape the unaided ear.

The reflector is adjusted by looking through the ear