DOLBEAR'S NEW TELEPHONE SYSTEM.

Among the exhibits at the forthcoming International Electrical Exhibition at Paris, the new telephone we are about to describe will command attention as an original and important invention.

It embodies the most recent discoveries of Professor A. E. Dolbear, of Tuft's College, Massachusetts, who, as one of our most esteemed contributors, needs no introduction to the readers of "SCIENCE."

The advantages claimed by Professor Dolbear may be summarized as follows:

1. It is a *new* and independent system which has important advantages over the Bell and other Telephonic methods.
2. Its capability of transmitting speech over longer lines of wires than has been hitherto employed, and its freedom from the troubles of induction.
3. It is a silent instrument, the words coming out clear without the sputtering aud confused noises of the old system.
4. It is an absolute departure from the Bell system, and its principles of operation entirely independent.

We are enabled to place before our readers a description of this original telephone prepared by Professor Dolbear himself, illustrated by some excellent cuts loaned to us by Mr. H. C. Buck, who is leaving for Paris to represent Professor Dolbear at the forthcoming Electrical Exhibition.

Before describing Professor Dolbear's Telephone in detail, we may state that in order to receive messages by the Bell system it is necessary to use between the ear and the line wire an electrical machine, consisting of a magnet, a magneto-coil to influence the magnet, which coil is connected with the line wire and with the ground. Take out this machine, and we take out the Bell telephone system—this is substantially what Professor Dolbear claims to do—for to receive a message, he takes out the machine, and puts the end of the telegraph wire directly to the ear. For convenience of ordinary use Professor Dolbear provides the receiving end of his telegraph wire with a small handle, in which he arranges a couple of thin diaphragms, one of them attached to the wire—a contrivance that improves the vocal delivery of the line wire.

Professor Dolbear thus describes his invention:

RECEIVER.

This consists, in its simplest form, of two metallic disks about two inches in diameter, so mounted as not to be in metallic contact, and this is effected by turning a flange in a hard rubber case so they may be kept apart by it (see Fig. 1). A cap is screwed down upon each plate, one of them having a small hole in the middle of it to listen at; the other is a larger one, having a knob turned upon it for conveniently holding it in the hand. Through the middle of the knob a screw is sunk which touches the back plate and serves to adjust it to the best position relative to the front or vibrating plate. The back plate is thus fastened at both edge and middle, which prevents it from vibrating, while the front plate is only fast at its edge, leaving the middle free to vibrate.

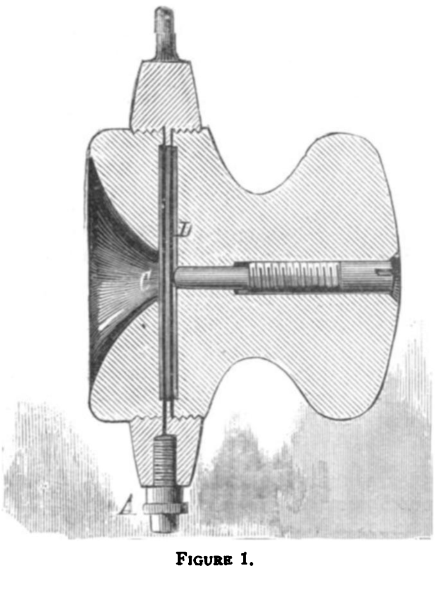

FIGURE 1.

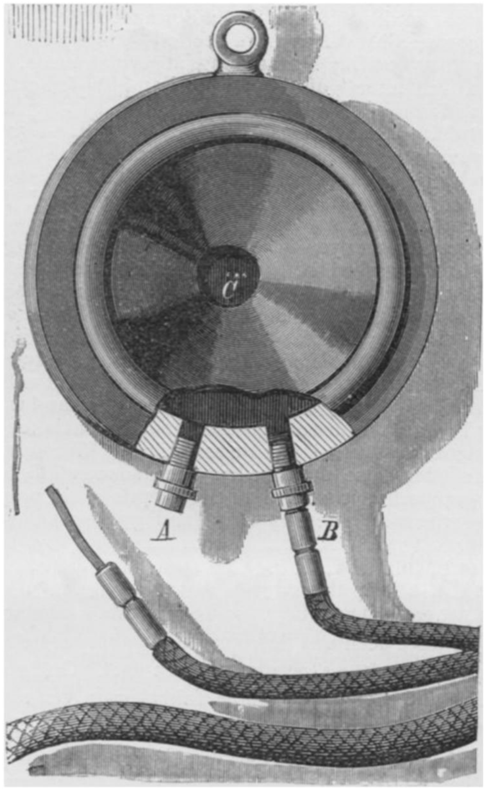

FIGURE 2.

Each of these plates, A B, Fig. 2, is in metallic connection with the induction coil so as to be its terminals. When thus connected and one makes and breaks connection in the primary circuit, a click may be heard by one holding the receiver near to the ear. If a Helmholtz interrupter be employed to make and break the primary circuit, the pitch of the fork can easily be heard, and with a *Reiss transmitter* or other suitable one in the same place, any kind of a sound will be reproduced.

The explanation of this is easily understood from the foregoing description of the conditions present. The electromotive force generated by induction in the coil changes the two terminals in the receiver, one positively, the other negatively; they therefore attract each other.

One of them is free to move, while the other is rigid. The middle of the freer plate consequently moves slightly toward the other whenever they are electrified, and *in so doing spends the energy of the electricity*, while its elasticity brings it back to its place. It is not essential, however, that both of these terminal plates should be connected to the induction coil, for if only one is connected, the recurring charges will cause the free plate to vibrate, for a charged body will attract any other body, so if the connection be to the back plate it will attract the front one and make it move, and if the connection be to the front plate it will attract the back plate and approach it. The effect will be increased by putting the finger upon the terminal that is free ; not because it *makes a ground*, as it is termed in electrical science, or completes an electrical circuit, for if the individual listening be as perfectly insulated as glass or hard rubber can make him, the sound is as loud as if he stood on the ground ; but the individual becomes electrified by induction, it is the same as enlarging the terminal would be. Consequently receivers are

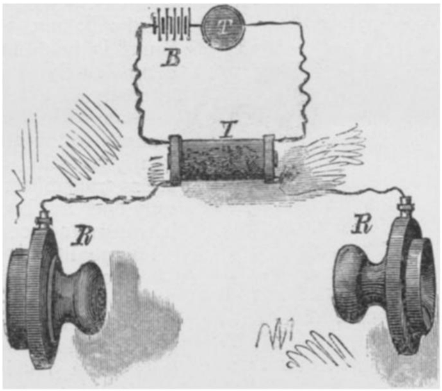

FIGURE 3.

made having only one wire terminal (see Fig. 3), the other plate being connected by a conductor to a metallic ring upon the knob, and this receiver is as efficient as the other.

Electricians will recognize in this structure what is technically known as the *air condenser*, and the mutual attraction of the two plates has been employed as a means of measuring electrical potential. In this case one of the plates is suspended from one arm of a balance, while the other is fixed underneath it at a short distance. The attraction of the plates when they are electrified requires an extra weight to keep them apart, and the weight needed is the measure of the attractive force. But the plates will attract each other when glass or mica or any other non-conducting substance is placed between them in the place of the air ; and one might expect that if such an air condenser would give sonorous results, other forms of condensers, would do so likewise, and this is so. Indeed, whoever has charged a Leyden jar has probably noticed the sounds coming from it when it is nearly saturated. In 1863 Sir Wm. Thompson had his attention directed to the sounds produced by discharge in an air condenser.*

When the two plates of Epinus's condenser are in metallic contact no sounds whatever can be produced by it, but if they are separated by a thin film of air they will

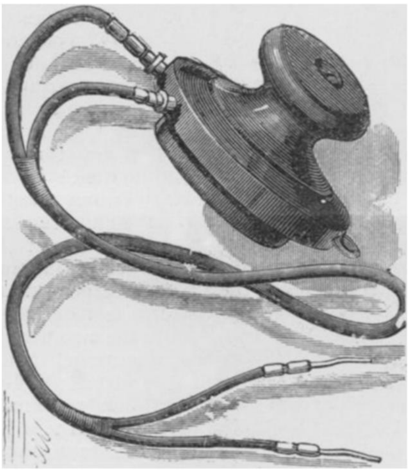

FIGURE 4.

* See papers on Electro-Statics and Magnetism, page 236.

reproduce speech (see Fig. 6, at E). In the first case the electricity passes from one plate to the other without doing work or changing its form ; while in the latter, its form is changed and work is done, and between the best conductors, such as silver and copper and the perfect non-conductor air there are all degrees of conductibility, and whenever electricity spends its energy upon an imperfect conductor it results in heating it; that is, in molecular and atomic vibrations. Consequently an undulatory current from an ordinary transmitter, when sent through an imperfect conductor, will set up sound vibrations in it which may be appreciated by the ear. Let, then, any poor conductor, like a disk of carbon, a sheet of paper or of gelatin, or such chemical substances as ammonium chloride, be placed between the terminal plates, and an undulatory current sent through them will result in sound, and speech may be reproduced.

Now, the phenomena observed in Geissler's tubes and Crooke's tubes show that the residual gaseous molecules are violently impelled from the electrified terminals, not simply because they are electrified, but because they are heated, for the same phenomena are witnessed when the terminals are heated in other ways ; so it is probable that between the plates of the air condenser there is an actual impulsion of the air particles from one to the other, and that the phenomenon of attraction is not isolated from molecular impact. Receivers have been made in which a vacuum could be produced between the plates, but no great difference could be observed in their performance ; and when one reflects upon the immense number of

FIGURE 5.

molecules left in the best vacuum yet produced, it is not a matter for much surprise.

When a non-conductor, such as air, or vulcanite, or mica, separates the two plates, there is a complete transformation of the electricity at the limiting surfaces, and with small condensers the efficiency depends upon the electromotive force employed. For low electromotive forces, such as common batteries of a few cells can give, the effect is almost inappreciable, and for this reason such a receiver as this is quite free from the disturbance known as induction, and which is so troublesome in the magneto-telephone, such induced currents being generally of low electromotive force.

Among the earliest of my experiments, made while developing this method, was to attach one terminal wire from an induction coil to the outer coating of a Leyden jar, taking the other wire from the coil in one hand, and applying one ear to the knob of the jar. Every word spoken at the transmitter was distinctly heard, but the prickly sensation due to the electricity was too disagreeable. Another receiver, not less curious than the Leyden jar, was found in the pair of insulating handles made for the medical application of electricity. When these were connected to the coil wires, and one held in each hand by the wooden part, while the metallic ends were placed at the ears, any kind of a sound at the transmitter was heard without any difficulty, but of course the same sensation was felt as with the jar. Many forms of condensers have been employed with capacities too small to measure up to two micro-farads, and these in all sorts of relations, charging the plates from batteries, from Holtz machines, charging the line as in cable works, etc., all of which give results that differ only in degree.

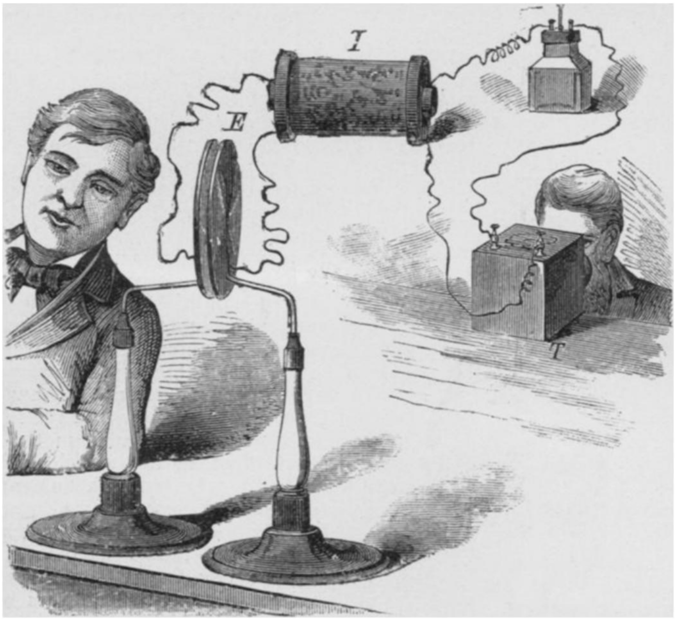

FIGURE 6.

THE TRANSMITTER.

As with other systems in common use, there is a transmitter as well as a receiver. One form of the transmitter is attached to the door of a box containing battery and coil. This transmitter is substantially the same as the one invented by Reiss in 1861. His consisted of a cubical box (see Fig. 6) about five inches on a side, having an opening on one side to talk into, and another one on top, across which the diaphragm was fastened. A pin of platinum was glued to the middle of the membrane, and connected by a wire to a binding screw. A V-shaped wire with platinum point touched upon the platinum of the membrane, and with its binding screw served to complete a galvanic circuit. This one (see Fig. 10) differs from this of Reiss only in making the chamber smaller, making the connecting wire on top T-shaped, and substituting carbon or other suitable substance for the platinum; but the platinum does very well. It is a matter of some surprise that the old transmitter is still spoken of as a *make and break* circuit, and that it can only transmit pitch, whereas, whether it breaks or not when a sound is made in it depends solely upon the intensity of that sound, just as with the Blake transmitter, if one talks gently to the original Reiss transmitter, it not only does not break, but it transmits speech with all its qualities.

Accompanying the transmitter an induction coil is shown at I, Fig. 6, and as the working of the receiver depends upon electromotive force and not upon current, it is necessary, if a coil be used to raise the electromotive force, to have one with many more turns than is needed with the magneto receiver, and the best results have been obtained with a coil having a resistance of four or five thousand ohms, but it is probable that this will be reduced.

On account of the high electromotive force a better insulation is needed than ordinary telegraph lines give, when the induction coil is at the further end of the line, but if it is at the receiving end, and a low electromotive force is employed in the primary, then ordinary insulation will answer. Again, the electromotive force being high, inserted resistances do not so markedly decrease the efficiency of the instrument, as in the case with the magneto-telephone. For instance, the articulation is perfect and loud enough with a resistance of fifty thousand ohms, a resistance equal to five thousand miles of common telegraph wire, and it may be heard through a resistance of a million ohms, practically an infinite resistance.

If one of the terminals of a receiver be charged in any way, the reaction between the two plates will be stronger than it will be without. Let, then, one terminal be attached to a knob of a Holtz machine that is kept charged by rota-

FIGURE 7.

tion. The sounds will be heard much louder, and any other source of electricity with high potential will answer the same purpose. Hence a battery of a large number of cells may be substituted for the Holtz machine, and one of the terminals of the battery may go to the ground, though this is not essential. This arrangement will keep the terminal plate charged to the potential due to the chemical relations and number of cells in the battery. If the battery be placed in the line wire it will keep both ends of the line charged. A Volta's pile may be substituted for the battery in either place, and so may a charged condenser of any capacity, the electrically

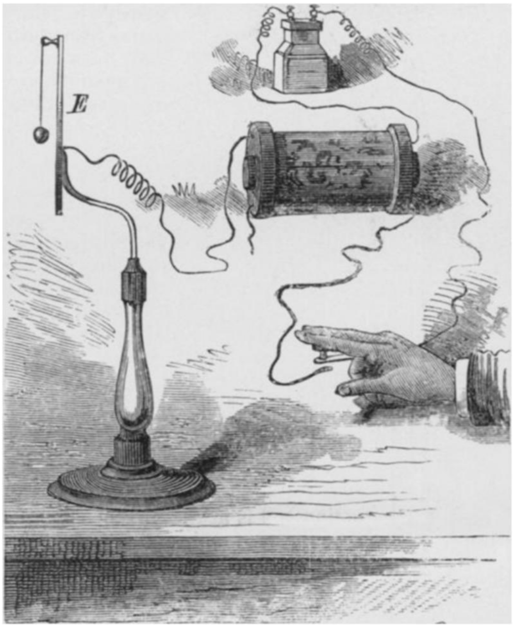

FIGURE 8.

charged terminals in this system acting in a way analogous to the permanent magnets in the magnetic system.

There are various other ways of employing condensers, and as one would infer from the preceding descriptions of the phenomena, these condensers will talk, that is, they will reproduce in sound the varying electrical conditions to which that may be subjected, as will also either a battery or a Volta's pile.

I have often heard them talk, and have made many experiments with such receivers.

By this system telephonic communication can be secured through ordinary medical electrodes.

In perfecting this new telephone Professor Dolbear has given long and constant study to the scientific problems involved, while the mechanical construction has been prosecuted by Mr. H. C. Buck, aided by skilled machinists and competent assistants. The above concise description in the inventor's own words will give our readers a clear understanding of the principles that underlie his interesting invention, and it only remains for us to describe in brief the several figures in our front page engraving.

Fig. 7 shows the telephone in actual use, the transmitter being secured to the wall, the battery and induction coil being placed in a box on the floor, or in a convenient closet. Fig. 4 is a perspective view of the new receiver; Fig. 2 a face view of the same, with a portion of the casing broken away to show the connection of the two binding posts, A B, with the diaphragms, C D, and the adjusting screws by which the distance between the diaphragms is regulated are shown in the sectional view Fig. 1.

Fig. 8 illustrates the principle of electrical attraction upon which the action of the new receiver is based; the electrostatic charge received by the plate, E, from the induction coil attracts the pith ball suspended in front of the plate.

Fig. 6 shows the two plates, E, of an Epinus condenser, placed near together and connected with the terminals of the secondary wire of the induction coil, I, and used as a telephone receiver.

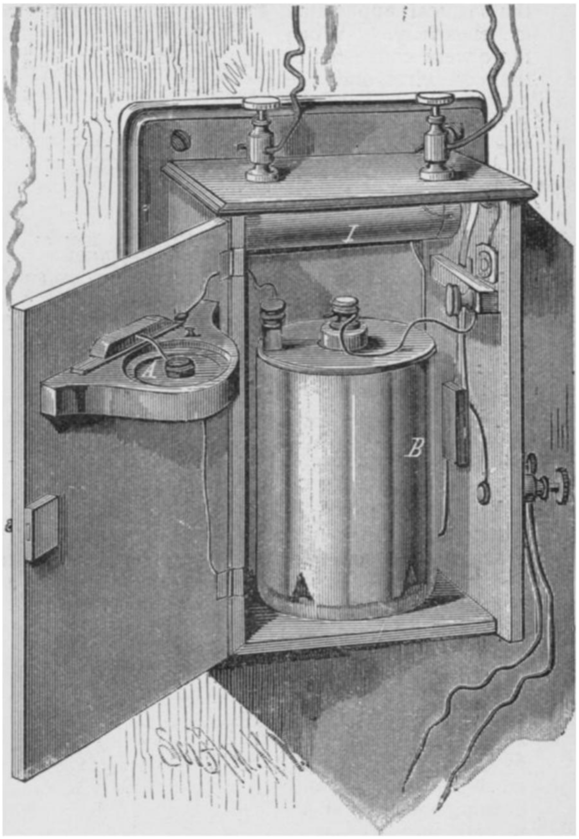

FIGURE 9.

Fig. 5 illustrates the essential features of the new telephonic system. I being the induction coil whose primary is in circuit with the battery, B, and transmitter, T, the receivers, R, are each connected with a single terminal of the secondary wire of the coil, I.

Fig. 9 shows Professor Dolbear's experimental telephone transmitter. In this instrument the diaphragm, A, is horizontal, and carries a carbon electrode, upon which rests a moveable carbon electrode connected by an arm with a delicately pivoted bar supported by the diaphragm cell. The local circuit is from the battery, B, through the carbon electrodes, and through the primary of the induction coil, I.

EXTRACTION OF SILVER.—To extract the silver from silvered objects, these should be plunged into a bath composed of a mixture of 100 grammes of finely pulverised saltpetre and 1000 grammes of sulphuric acid. If the acid is weak, the copper and the other metals except the silver will be attacked; if the acid is concentrated the silver alone will be dissolved.