THE TELEPHONE:

ITS

HISTORY, CONSTRUCTION, PRINCIPLES,

AND USES,

WITH

DEFINITE INSTRUCTIONS

ON THE

MAKING OF TELEPHONES,

(BY WHICH FAILURE IS IMPOSSIBLE),

AND TO WHICH IS ADDED A CHAPTER ON

THE PHONOGRAPH:

BY

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THE TELEPHONE.

INTRODUCTION.

The object of the following pages is to give such a clear and concise account of the History of the Telephone, as shall enable the general reader to understand and appreciate the difficulties that have been already overcome, and what is still required for the perfecting of this interesting instrument, and to give such a full and detailed description of its construction and of the principles involved therein, and in such a manner that even those who know little or nothing of the Sciences connected therewith may clearly understand its working, and that the careful reader may, without the possibility of failure, be able to make the instrument for his own amusement, and may reasonably aim, by patient and diligent work, to become a sharer in the perfecting of the Telephone.

HISTORY.

The word Telephone is derived from two Greek words—tele—distant, and phone—voice; and so may be applied to any instrument which enables us to hear the voice at a further distance than it can be heard by ordinary means.

The name is specially applicable to the instrument just invented by Dr. Bell, by means of which the voice is repeated at the distance of hundreds of miles.

With respect to this instrument, I find all sorts of errors afloat, some of which I thought impossible in this age of Schools and School Boards. It would be easy to practice on the credulity of a great many with it. Mr. Williams's speaking chip was not regarded with more superstitious reverence by the barbarous people among whom he laboured than is the Telephone by several educated people with whom I have come in contact. One lady fancied with one of these instruments in her pocket, she could at will hold converse with friends in distant countries, or with those who were dead! A great number believe the first part of this statement. Others, again, think it only a kind of speaking tube, and will scarcely believe when shewn that there is not some small tube through the wire, by which, in some mystical manner, the sound is conveyed to the other end. A far greater number, however, confound it with the toy Telephone now selling so much. In this toy Telephone ·e two chip or tin boxes, with one end in each,

covered with parchment, and connected with each other by a piece of thin string, or for longer distances, by thin wire. It will be evident that if one end is made to vibrate and the string held tight, the other membrane will be pulled by the string and vibrate in exactly the same way. If one person, therefore, speak through the open end of one box against the parchment, and another person place the open end of the other over his ear—keeping the string tight—the softest whisper may be heard, and so may be made the source of much amusement. This is one of the oldest Telephones, and was used among the Indians, it is said, some hundreds of years ago.

Wheatstone, in a similar manner, and knowing the readiness with which strings, &c., take up the vibrations which they themselves emit when sounding, managed to make several pianos in different rooms repeat the music of another. He had all the pianos tuned to exactly the same pitch, and then joined the piano played to the others by strips of wood, and the strings in these latter readily took up the vibrations of the instrument played, and thus fairly repeated the music.

Everyone, I dare say, has noticed how, when he has spoken into a piano, many of the strings have been caused to vibrate, and no doubt if there were sufficient strings of varying lengths to represent all the sounds made by the inflection of the voice when speaking, we should have a fair repetition of what was said.

Before commencing the history of the Telephone proper, or the Electric Telephone, it will be necessary to give a description of the different kinds of currents that have

been employed in these researches. These are of three kinds:—1st, the Intermittent; 2nd, the Pulsatory; 3rd, the Undulatory. In the first, the current is alternately broken and closed. In the second, there is a continuous flow of the current, but it is increased and diminished in regular pulses. In the third, there is a gradual increase and decrease of the current in a wave-like manner—the undulations increasing imperceptibly to their greatest amplitude, and then subsiding in the same way to their minimum. As in every circuit there is the direct or positive current, and the reversed or negative, we may say there are the three kinds of the positive current and three of the negative current. These currents may be rendered more clear, I think, by representing the positive current by the space above a line, and the negative by a similar space below a line. They would then stand as below—

POSITIVE CURRENTS.

Intermittent.

Pulsatory.

Undulatory.

Negative Currents.

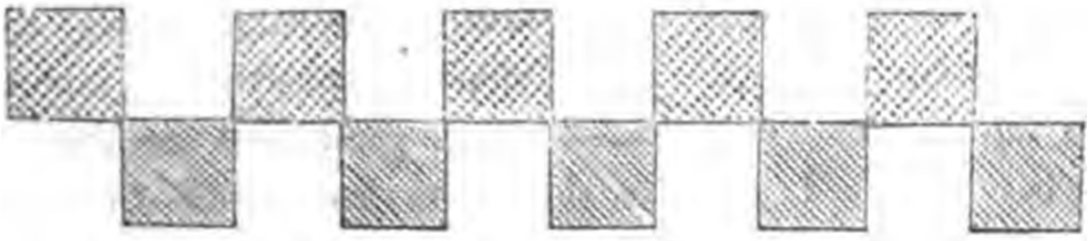
Intermittent.

Pulsatory.

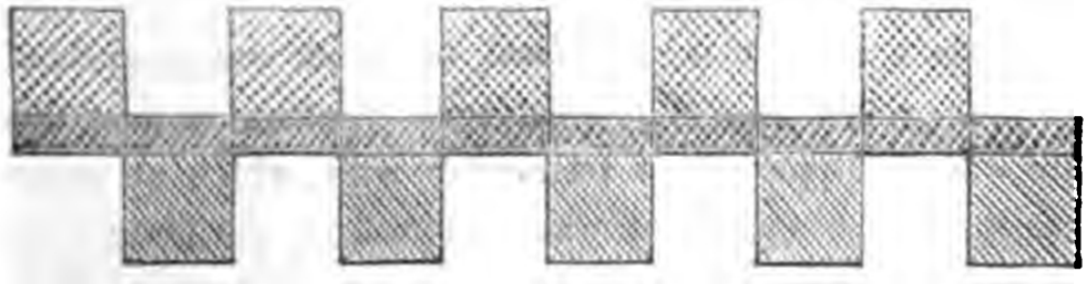
Undulatory.

Combined Positive and Negative Currents.

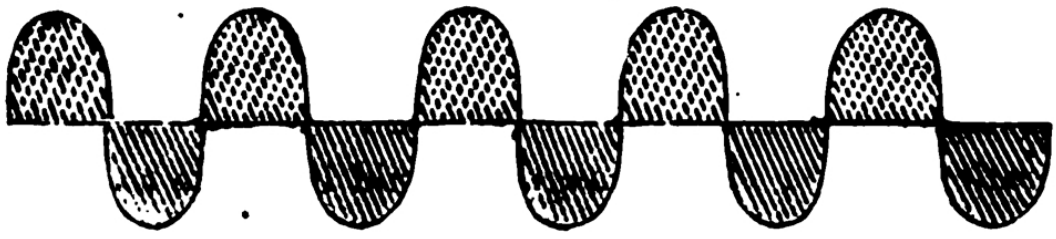
Intermittent.



Pulsatory.



Undulatory



I have been thus particular in dealing with these currents, as I think it is necessary thoroughly to understand them, in order to appreciate the merits due to Dr. Bell, in his successful efforts to invent an articulating Telephone. His great success is almost entirely owing to his using these undulatory currents, and his efforts have been directed to obtain them, though the means of producing a real undulatory current has still to be discovered. No doubt, before long, means will be found of greatly increasing the amplitude of these approaches to undulatory currents, and so producing greater amplitude in the vibrations of the plate at the receiving end, and consequently greater intensity of sound. Dr. Bell claims to have been the first to use undulatory currents in his investigations. Reiss succeeded, in 1861, in producing musical notes by intermittent currents. This Telephone consisted of a box, the top of which was covered with a parchment membrane tightly stretched. In the side there was a hole through which the sound to be transmitted entered the box and caused the membrane to vibrate. Attached to this membrane was a small plate of metal, to which was connected a wire from one pole of the battery. Resting against this plate was a hopper, *i e.*, a triangular wire, which at every vibration of the membrane was thrown from the plate. At the other end was an electro-magnet on a sounding box, and, as electro-magnets give out a tick at every break of a current sent round them, it will be seen that any sound entering the box would break the current at every vibration, so the electro-magnet would be made to tick in

the same manner, and thus faithfully reproduce the note entering the box, which would, by this means, be transmitted any distance. Helmholtz—the great German physicist—by similar means, combined with resinators, tuning forks, &c., succeeded in reproducing not only the pitch but the quality of sounds.

This is as far as Telephony had progressed until Dr. Bell commenced his successful researches. The first means he adopted to procure an approximately undulatory current was by using a harp made of steel rods, the ends of which were attached to the poles of a powerful permanent magnet. Between the rods at each end was an electro-magnet. If a magnet is moved in the vicinity of an electro-magnet, a current of electricity is generated in the coil surrounding the magnet, the direction of which changes as the magnet approaches or recedes from the magnet. Accordingly, when one of the steel rods is struck, induced currents are generated in the coil of the electro-magnet. These currents are transmitted to the electro-magnet at the other end of the circuit, where each rod of the harp selects the vibrations in unison with its own and commences to vibrate, and so exactly reproduces the sounds of the first harp. If the rods of the first harp be struck violently an intense current is induced in the wire, and a corresponding intensity of vibration in the rod of the second harp; and if two or more strings be struck simultaneously, currents are induced which cause the corresponding rods of the distant harp to vibrate in exactly the same manner. And if there could be sufficient rods of different lengths to represent the varying

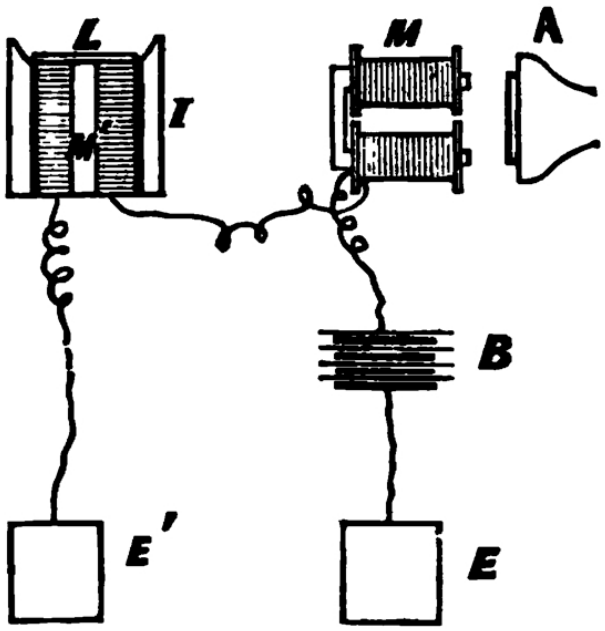
inflections of the human voice, no doubt the quality of the voice could in this way be faithfully represented as the resultant of a number of simultaneous vibrations slightly differing from each other in pitch. The motion of a particle of air in the immediate neighbourhood of two vibrating bodies differing in pitch is different when they vibrate simultaneously from what it is when they are sounded separately. The particle moves with neither the one nor the other, but takes up a motion which is the resultant of these vibrations, just as a ball struck simultaneously by two persons, at different angles, obeys neither the one force nor the other, but moves in a direction which is the resultant of the two forces. In the same way, if any number of bodies be simultaneously set vibrating, a particle of air in their vicinity accommodates itself, so to speak, to the different rates of the vibrating bodies, and takes up a motion, not of any one of the vibrating bodies, but one which is the *resultant* of the forces acting upon it.

The harp of steel rods did not supply Dr. Bell with the means of transmitting this resultant, but he set to work heartily to endeavour to discover it, and how it might be transmitted in the simplest manner. While investigating this subject with an improved form of the Phonautograph, the happy thought occurred to him that it would be better to use a piece of iron possessing no particular musical note like the rods of the harp, but the resultant of a vowel sound, and which would take up any vibration, and by means of which an undulatory current could be produced that would correspond to the motion of the air when set in vibration

by a sounding body. I may just mention that the Phonautograph is an instrument for registering the vibrations of sounds. It usually consists of a box like the one described when speaking of Reiss' Telephone. A style, or hog's hair bristle, is inserted in the parchment. Just touching this style is a piece of smoked glass, which can be moved while the membrane is vibrating, and thus is traced the curve of the vibration on the glass. Dr. Bell made use of the human ear itself for this purpose, and while experimenting with it was particularly struck with the effect the tympanic membrane had on the bones of the mid-ear. This led him to the construction of a Telephone composed of a stretch membrane having a piece of iron attached to it, and placed over one of the poles of an electro-magnet, which was kept magnetised by a current from a battery. Here we have the membrane taking up the vibrations and carrying the piece of iron with it, which, by its motion, produces an undulatory current in the wire, just in the same way as the rods previously mentioned, and so at the distant end the current strengthens and diminishes the magnet according to its direction, and attracts the iron on the membrane and produces vibrations of the membrane corresponding to those of the first one. This did not succeed to his satisfaction but encouraged him to persevere, as it emitted some faint sound. You see here the piece of iron and membrane at each end interfere with the action of each other—the iron interfering with the vibrations, and the membrane with the attractions. Still it was a great step in the accomplishment of the object to be attained, and after various modifications,

particularly in the size and thickness of the iron attached to the membrane, articulate speech was obtained—the vowel sounds being very fairly produced, but the consonants were all alike.

Other methods of producing undulatory currents were next tried. As water offers considerable resistance to the passage of electricity, a cork with a thin platinum wire passing through it was attached to the membrane. The wire dipped into a cup of water, and the current passing through the wire and the water was continued through another wire, which dipped into the water to the battery to complete the circuit. At every vibration of the membrane the wire on it approaches and recedes from the other, by means of which a greater or less amount of electricity is passed along the circuit, and thus is produced a kind of undulatory current. Dr. Bell experimented with other liquids, and afterwards with plumbago dipping into mercury. In this way he managed to get a fair undulatory current and succeeded in producing articulate speech. Perhaps the best form of apparatus for producing undulatory currents was that exhibited at the Centennial Exposition, at Philadelphia, and concerning which Sir Wm. Thompson exclaimed, "This is the greatest by far of all the marvels of the Electric Telegraph." This, however, did not act well as a receiving instrument, but necessitated for this purpose the use of the iron box and thin vibrating lid. The membrane in this instrument was stretched over a brass ring (A) with the armiture attached to it as in figure.



(A) Membrane with Arm.

(B) Battery.

(M M') Electro Magnets.

(E & E') Lines to Earth.

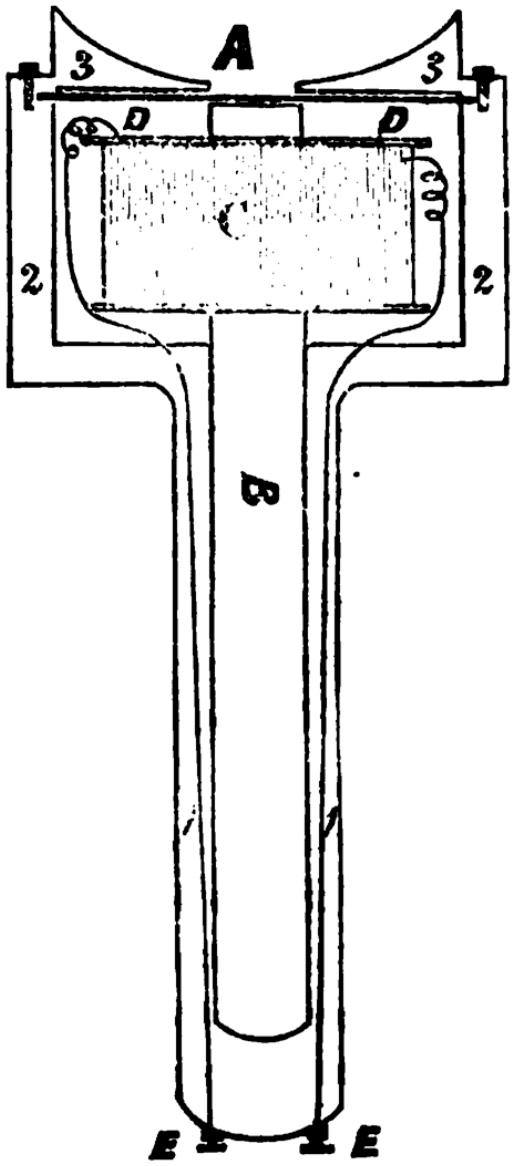
(I) Iron Box Lid.

(L) Receiver.

Articulate sounds were distinctly heard on placing the ear close to the receiver (L), but still Dr. Bell felt certain of producing something better. Various modifications were tried. He found that diminishing the size of the coils gave more intense sounds at the receiving end, and that every turn of the wire beyond what was sufficient for the induction of the current only added to its resistance. Then the strength and size of the magnet was varied in all ways till at last it was found that the battery could be dispensed with. With regard to the armiture, it was found that increasing its size also increased the sounds, and then it was discovered that the membrane could be done away with altogether. And here was left the instrument as we now

have it—an instrument which, for simplicity and effectiveness, stands unequalled in all branches of Science; and every one is asking why such a simple thing was not thought of before, while others, for this very reason, seem to regard it with superstitious dread. But here is the instrument in the midst of us, the instrument which will make both the year 1877 and the name of Dr. Bell memorable while time shall last.

CONSTRUCTION.



The instrument, as now used, consists of a permanent magnet, around one end of which is a coil of very thin insulated wire. In front of this and nearly touching the magnet is a thin soft iron plate about the thickness of a threepenny piece, and the whole is enclosed in a wooden case. At the thin end of the case are placed two binding screws, from which two pieces of copper wire run inside the case to the coil, and are soldered to the two ends of the coil. The two wires which connect it with the distant instrument are also joined to the same two binding screws and thus complete the circuit. For long distances only, one wire is used, the other being put to earth, and the circuit is completed through the earth, thus saving the expense and trouble of a second wire. Above the ferrotype disc, or iron plate, is a piece of wood which fits on the other part of the case and to which it is screwed. This also rests on the disc or diaphragm and holds it in its place. There is a cone-shaped hole in the centre of the head piece through which you speak against the plate. These are the parts of this simple instrument which is destined to become a portion of every business establishment, if not of every household.

It has been found that variations in the size, diameter, and thickness of the iron plate, as well as in the size and thickness of the permanent magnet, make but little difference in the distinctness of the articulations. Distinct articulation can be produced by using plates from 1in. to 24in. in diameter, and from $\frac{1}{64}$ to $\frac{3}{8}$in. in thickness. Dr. Bell states that even a Morse Sounder may be made to utter articulate sounds. From these facts many believe that the action is molecular, and that the vibration of the

plate itself mars the effect. There is not, at present, however, sufficient data respecting the action to enable one to venture an opinion, but no doubt as the investigation has been taken up by many of the most noted physicists of the day, this and other processes, of which we still know little or nothing, will soon be satisfactorily explained. Size of plate affects quality of sound, but not the distinctness of the articulations. For instance, a plate only about an inch in diameter, speaks as a man with a cold in his head. If we increase the diameter of the plate, but not its thickness, we gradually lose the nasal twang till a fairly clear and pleasant articulation is attained. Still increasing the diameter only, we get a throaty and drum-like sound. If now we increase the thickness of the plate, without altering the diameter, the above effects are reversed, and we gradually lose the drum-like sound till we get clear utterance, and still increasing the thickness, we again get the disagreeable nasal twang. So we see that to obtain the best effects it is necessary to have a proper proportion of diameter to thickness in the plate, and, knowing the above results, it is easy by trial to find out whether our plate is duly proportioned in these respects. It seems, therefore, that the fundamental pitch of the plate itself has much to do with the pleasantness and clearness of the electric articulations.

ACTION AND THE PRINCIPLES INVOLVED THEREIN.

Having thus given a description of the instrument itself, I will endeavour to show the use and action of each of its parts, and how sound can be reproduced by this wonderful invention at the distance, it is said, of 12,000 miles. And not only the pitch of the sound, but every particular of its quality or timbre is faithfully reproduced, so that we can without the least difficulty recognize the voice of those we know, and it would require an excellent mimic to be able to deceive us with regard to the voice of those intimately known to us. I must premise that on some of these questions very different opinions are at present entertained, but it is probable that most of them will soon be definitely settled by the investigations that are now being made.

The following is what I believe to be the *rationale* of the working of the instrument. Sound impinging as vibrations on the sending plate, as in speaking, &c., causes it to vibrate. At each approach and recession of the plate to the magnet, the condition of the magnetism in the magnet is varied. When the plate approaches the magnet its free magnetism is diminished, as part of it is required for more completely magnetising the plate, and is held by the inductive action of the plate on the magnet. When this change in the magnetism is made, a momentary current of electricity is induced in the coil surrounding the magnet, the direction of which depends on the way the wire is coiled.

When the plate recedes the free magnetism for acting on the coil is increased, and a momentary current of electricity is again induced, but in the opposite direction of the former. That a magnet does generate a current of electricity may easily be shown in the following manner. Coil a small quantity of covered wire round a piece of paper—or if not covered take care that the different coils do not touch each other—and join the two ends, passing them over a delicately-poised magnetic needle. Now thrust a magnet into the coil, and you see the needle moved from its position just at the instant the magnet enters the coil. Then sharply withdraw the magnet, and you will find the needle move in the contrary direction. So in the magneto-electric machine we have electric currents generated each time the coils approach and leave the poles of the magnet, because the iron core of the coils changes its magnetism at those times. The converse also of this is true, viz., that an electric current induces magnetism or varies the magnetism of a magnet, which is well seen in the electro-magnet. So in this way as has been said are currents produced in the coil surrounding the magnet at the receiving end of the Telephone by the vibrations of the iron plate. When the plate approaches the magnet the current is in one direction, and when it recedes in the contrary direction. These currents are transmitted by the wires attached to the binding screws to the receiving instrument, and there passing through the coil a reverse process to that just described takes place, viz.: the current passing through the coil round the magnet varies the strength of the magnet according to the direction in which it passes.

When the magnetism is increased the iron plate is attracted, when it is diminished it recedes by its own elasticity, and as these approaches and recessions are made every time, the current, and, therefore, the magnetism, is changed, they become vibrations exactly like those in the sending plate, whose motion, as we have seen, originated the current. So you see sound does not really travel in this process beyond the sending-plate, on which it impinges, but is expended in making the plate vibrate, which varies the magnetism, and this in its turn generates electric currents, which are transmitted by the wires to the receiving end, where they vary the strength of the magnet, which then attracts the iron plate, and it again recedes by its own elasticity, and in this way the original vibrations are reproduced. And not only is the pitch of the sound reproduced, but every particular of quality and timbre, and, we believe, in this way. Every sound has besides its fundamental or pitch sound, a large number of higher sounds related to it, called harmonics, or overtones, and the quality of a sound depends upon the predominance of particular harmonics. When the tone is pleasant there is a predominance of harmonics nearly related to the fundamental, but in harsh or disagreeable sounds harmonics predominate which are not so nearly related to the fundamental note. Now, not only does the plate vibrate with the fundamental sound, but it breaks up into small segments for every one of these numerous overtones, so that each harmonic is represented by its own vibrating segment. These small segments affect the magnet, and the magnet the currents, and in this way the smallest difference in quality is exactly reproduced.

USES.

In speaking of the uses of the Telephone, there is no need to say anything about the many and various purposes for which it may be employed commercially, but I may just ask what we would not sometimes give to hold converse with dear ones who have been long absent from us, and to hear their own sweet voice (the latter, but not the former, I may say can now, it is said, be accomplished by Mr. Edison's last invention—the phonograph—described afterwards). On the Continent and in America the Telephone is becoming very common for commercial and domestic purposes, and no doubt it will rapidly spread in this country now that Her Majesty the Queen has had it laid on to Osborne and is so pleased with the results. It possesses many advantages over the ordinary telegraph. No signs have to be learnt, so that any one can manage it, and as signs however well defined are apt to be sometimes mistaken, messages would be likely to be transmitted by it with greater correctness. The great advantage of the Telephone, however, is the rapidity with which we are able to transmit messages by it. If at the receiving end we have a shorthand writer at the desk with an instrument against his ear, he will be able to copy a message as quickly as it is spoken. The great disadvantage is the faintness of the sounds, which prevents it being heard without placing the instrument *close* to the ear. This

defect will, no doubt, be somewhat remedied before long, as many of our greatest men are taking up the subject earnestly. Sir W. Thompson has already made many interesting experiments with it in acoustics. The effect of beats can be well illustrated with it. Place two Telephones against the two ears, and let two sounds slightly differing in pitch be sent through them. The effect of the beats will become very marked though each ear hears only one sound. The interference of sound, too, is perhaps more beautifully illustrated by means of the two Telephones. The augmentation of the sound is distinctly heard when the phase of vibration in each is the same, and silence—or "dead spot" is perceived at regular intervals when the phases of vibration are opposite. Just in the same way have we often seen waves on a lake or the sea augmented when their swells have coalesced, and been destroyed, when the swell of the one has happened to come exactly in the trough of the other.

I have thus endeavoured to give as clear and concise an account of this most interesting invention as I was able in the time I could devote to the work and with the materials at my disposal, feeling certain from the numerous questions addressed to me on the subject, that some such explanation would prove most acceptable to a large number of persons, who take great interest in this invention, and are very anxious to have the means of gaining all the information they possibly can respecting it.

DEFINITE INSTRUCTIONS ON MAKING TELEPHONES.

The Telephone is so simple an instrument, and the materials so inexpensive, that hundreds are trying to make their own Telephones, and not a few of these would-be-telephone-makers "have gone wrong," and have spent as much time, and wasted as much material, as would, if properly estimated, have gone far towards purchasing a pair of Dr. Bell's—though £20 is rather a high price for a pair of instruments which intrinsically are worth only about as many shillings—the material and workmanship all considered. Yet, we must remember that Dr. Bell has probably spent hundreds of pounds in apparatus, besides years of patient persevering labour, before discovering that such simple and inexpensive materials only were requisite, and he certainly deserves to be well repaid for his outlay of time and money, and we ought not to refuse him any reasonable remuneration. I think, therefore, that those who would like to use the Telephone, and can well afford to pay the £20 for it, are not shewing due appreciation of Dr. Bell and his great invention, if, instead of purchasing his instrument, they should endeavour to make their own.

Before giving more definite instructions on the making of Telephones, I would like to say a few words by way of

caution as to the infringement of the patent. I don't think there ever has been an invention where the temptation to the infringement of the patent was so great as in the present instance. The parts of the instrument are being sold everywhere at a small cost, and they are easily put together, and there is small chance of failing to get "excellent voice out of this little organ." I anticipate that many prosecutions will very soon be made under the patent both for the sale and use of Telephones. It seems to me that if persons sell the whole, though not put together, or even parts prepared for that purpose alone, they are infringing on the patent; and that if persons use it not for direct profit only, but to save labour, or, as they would say, for convenience either in the house or business, they would be liable to prosecution for infringement. I doubt not, however, we shall soon know more exactly than at present the intention of the law on the subject.

THINGS REQUIRED FOR MAKING A TELEPHONE.

I., The Case; II., The Magnet; III., The Coil; IV., The Disc, Diaphragm, Ferrotype, or Vibrating Plate; and V., Binding Screws.

I.—The Case should be made of wood, as it readily takes up vibrations, and thus increases the sound. It is better made in three parts:—1, the cylindrical part for holding the bottom of the magnet; 2, the shorter but wider part for enclosing top of magnet and coil. This should fit tightly on the other, or the two may be made in one. This last should reach just beyond the magnet, so that the disc may be laid on it, and be as near as possible to the magnet without touching it. 3, The mouthpiece. This should fit on the top of No. 2 and hold the disc in its place. A cone-shaped hole is cut in the top that the sounds in speaking may fall on the middle of the disc.

II.—The Magnet should be a round well magnetised piece of steel, say 4in. long and $\frac{3}{8}$in. in diameter for small Telephones. A pair can be purchased for 2s. 6d. or 3s.

III.—The Coil. This consists of about 2oz. of No. 36 covered wire wound carefully, without bends or "kinks," on a bobbin, with a hole through it for fixing on the magnet, about $\frac{1}{8}$ of an inch from the end. These also can be bought for about the same price as the magnets.

IV.—The Disc. This consists of a thin plate of soft iron, about 3in. in diameter, placed as described above. A pair may be purchased for 1s.

V. The Binding Screws. These are peculiar screws going through the case for fastening the wires to. The most convenient place for them is the bottom of the case farthest from the speaking end. In that case a wire should be fastened to each screw, and brought up each side of the case before the magnet and coil are inserted. Then one end of the coil is carefully fastened to one wire and the other end

to the other wire. Now the disc is laid on and kept in its place by fastening the mouth piece over it to the other part of the case, and then the instrument which cost so much labour and accomplishes such wonders is complete. It is then placed in circuit with another exactly corresponding instrument by joining them together by two wires, and they are ready to transmit your voice from one to the other.

EXPERIMENTS WITH THE TELEPHONE.

As I think the Telephone is likely to become very general, not for business matters alone, but also for instruction and amusement, and for these latter purposes self-made ones may undoubtedly be used by those who are unable to purchase the dearer and better ones of Dr. Bell. I propose to mention a few suggestive experiments which may be performed with it for testing the powers of the instrument, and for affording profitable entertainments. I know that ladies have already issued invitations for "Tea and Telephone," and I have no doubt that these parties will become popular and fashionable if proper experiments are devised. These are so numerous that only a few can be mentioned here, but every one will be able to think of others suitable to the moment.

Different kinds of sounds are reproduced in different degrees of intensity and distinctness. Musical sounds seem to be heard further from the Telephone than any others, and those, like the tuning fork, which give out a clear metallic ring, are heard at the greatest distance. I believe a large tuning fork could be heard in any part of a good sized room if there were two or more instruments placed on a wooden box. I have heard a kind of screech at the distance of about thirty feet. In the same way we can have the music of a piano, harmonium, organ, or orchestral repeated to an audience miles away from the place of actual performance. The music of the latter, however, cannot be so easily transmitted as that of the others, unless there be a large number of Telephones in circuit that each performer may sing or play near the plate of one of them. In the case of the piano, &c., the Telephone can be placed on it, and so the vibrations can readily be communicated to the disc without much loss of intensity. Dr. Bell has succeeded several times in repeating, to tolerably large audiences, the music performed some distance away. Music, through the Telephone, seems peculiarly sweet, and produces a strange and fairy-like effect on the mind. Does it not seem wonderful that not only single sounds, with their overtones, but all the various notes of the different performers of a large orchestra can be each represented on the plate of the Telephone by its own vibrating segment, and in the wire by its own particular electric current, and that each should be simultaneously reproduced in the disc of the receiving instrument?

We can listen to our friends playing the piano, or they

can accompany our singing when far asunder, the song may be sung in Paris and the accompaniment played in London. *Punch*, therefore, in his Almanack of this year, has not much over-stepped the bounds of probability when he makes Mamma and Matilda in South Kensington to play the accompaniment for Jack in the Bush.

"Speaking through the human body," and "through water," &c., may sound to many still more wonderful. But these experiments may be readily accomplished by making the body, &c., a part of the circuit. This is done by detaching the wire from one of the binding screws of the Telephone, and then letting the person, through whom you wish to speak, take hold of the detached wire with one hand and the binding screw with the other. As the body is a conductor, the electric currents will pass through the body in the same manner as they do through the wire and produce the same effects. Wetting the fingers with acidulated water and standing on an insulator will make the experiment succeed better, the first, because it renders the conduction more perfect, and the second, because it prevents the currents passing to the earth. If water be used as part of the circuit through which the electric currents, and, therefore, as may be said, the voice is to be passed, care must be taken to properly insulate it, *i.e.*, to prevent its being connected with the earth by conductors. Then break the wire, and insert the two ends in the insulating or insulated pitcher containing the water, and keep them some distance from each other in it. The currents must then pass through the water. When two persons are speaking, you can easily interrupt their communication by lifting one end of the wire

out of the water. Any other conducting body may be made the vehicle for transmitting the voice if it be carefully insulated.

Then different intensities of sounds may be tried. It will be found that the faintest sounds can be plainly heard; indeed, low speaking is more distinct than shouting. The softest whisper can be heard, if it is uttered distinctly and forcibly. Breathing and sighing too are experiments which are easily tried, and which can be distinctly heard.

Many other experiments of a like nature will readily suggest themselves to every one, and in this way the Telephone may be made the source of much useful information and amusement to all parties.

THE PHONOGRAPH.

"Wonders will never cease." When just finishing this brief account of the Telephone, we were astonished by the announcement of another invention almost as wonderful but not likely to become so useful as the Telephone; and, as it is in some degree connected with this subject, and may, perhaps, by many be confounded with it, I thought it would be interesting and instructive to give a short description of this last invention, that every reader might be able to compare the two and see the great difference between them.

The Phonograph is a machine by which, it is said, the voice of a person can be taken, stored up, and reproduced at will over and over again as often as it is wished.

A message of any length can be spoken on a metal plate, and the plate sent to any part of the world, and there respoken by pure mechanical means in the exact tones of the speaker. So, too, we can keep copies of words spoken by our friends, and after they are taken from us can have them, as it were, speaking those same words to us as often as we wish.

This ingenious machine, by which such wonderful effects are accomplished, is the invention of Mr. Edison, and he has given it the name of Phonograph, or Sound-writer.

It is composed of three principal parts, viz.: 1, The Receiver; 2, The Recorder; 3, The Transmitter.

1.—The Receiver. This consists of a curved tube, one end of which is fitted with a mouth-piece, and the other end covered with a very thin metal plate, capable of being made to vibrate by every wave of sound. Attached to the centre of this plate—which forms a right angle with the horizon—is a small steel pin, which, of course, will vibrate with the plate. By means of a set screw and table, the pin can be adjusted to the groove in the cylinder of the next part of the machine—the Recorder.

This consists of a brass cylinder, with a continuous V groove from one end to the other, giving it the appearance of a large screw. This cylinder is mounted on a horizontal shaft, carried in bearings at each end, and having its face towards the steel point of the receiver. The shaft is prolonged beyond the ends of the cylinder, and one of the ends is cut with a screw thread and works in a screw bearing. At this end is a handle, and as it is turned round the cylinder is not only revolved, but is made to travel its whole length in front of the steel point backward or forward. We now see that if a strip of soft inelastic metal, such as tinfoil, be carefully placed in the groove, and the steel pin of the receiving-plate adjusted to the tinfoil, then vibrations of the plate will cause the pin to make indentations in the tinfoil, and these indentations will be more or less marked, according to the intensity of the vibrations.

If the handle be turned at the same time a person is speaking down the tube, it will be seen that the words spoken will be, as it were, visibly impressed on the strip in the shape of indentations, more or less marked, and the next process is to reconvert them into sound.

This is done by the Transmitter, which consists of a conical metal box or drum, with its larger end open and its smaller end covered with paper tightly stretched. Just in front of this stretched paper is a very light flat steel spring fastened in a vertical position and terminating in a blunt steel pin, corresponding exactly to the pin on the receiver. The spring is connected with the stretched paper of the transmitter by a silk thread, just kept tight so that when the spring moves the paper diaphragm is made to vibrate.

Now it will be easy to see how this apparatus reproduces the sounds impressed on the tinfoil. The cylinder, with the foil in it, is turned back to the position in which it was before commencing to speak, and the point in the transmitter placed in the first indentation made by the receiver. If now the handle be turned at the same speed as it was when the words were being recorded, the steel point will follow the line of impressions made on the foil by the point of the receiver, and there will thus be communicated to the paper diaphragm vibrations of exactly the same number and depth as those which produced the impressions in the foil. In this way the words of the speaker may be made to issue from the conical box in his own voice tinged with a metallic ring. But you see that it is necessary to turn the handle at exactly the same rate in each case, *i.e.*,

in recording and transmitting. For if turned faster in the latter case, the voice will have a shriller tone than that in which it was spoken, and if slower a lower tone. Mr. Edison is now making a machine to turn by clockwork, so that its speed may be exactly registered.

Any nnmber of copies of the "speaking strip" can be made by taking a plaster of Paris cast of the original strip, and rubbing off impressions from it on clean sheets of tin foil.

This machine must be considered as a great scientific wonder, but I much question whether it will ever be of any practical utility. It certainly would be very nice to be able to have our friends speaking to us whenever we wished it, but I do not think it at all probable that we shall ever be able to recognise their voices by this machine. It will, no doubt, reproduce the pitch and force, and therefore the modulations of the voice, and in this way some of the peculiarities of the speaker may be reproduced. But I do not think it possible by this means to reproduce the quality of the sound by which we more especially distinguish one voice from another. The most important use, as far as I can see, of this wonderful invention will be the reproduction of musical sounds. A celebrated singer, therefore, if unable to fulfil his engagement through loss of voice, or from any other cause, can keep "strips sung off" and forward by post, and they may be "turned off" and encored as many times as the audience wish.