

EDISON'S TELEPHONIC RESEARCHES.

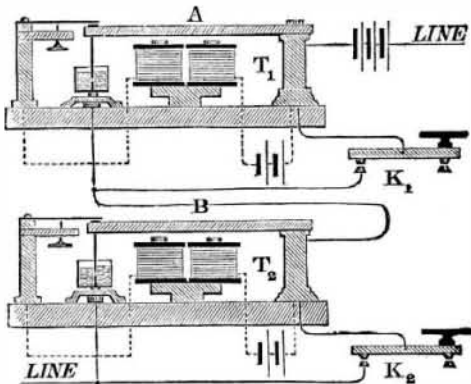
The following communication from Mr. Thomas A. Edison gives a detailed account of his researches in telephony, and is a valuable contribution to the history of the development of the speaking telephone.*

The investigations here detailed were made with a view to the perfection of a system of multiple telegraphy, which had for its basis the transmission of acoustic vibrations, with the view of producing an articulating telephone, carrying on both series simultaneously.

THE TUNING FORK SYSTEM.

In Mr. Edison's first system of acoustic transmission, which

Fig. 1.

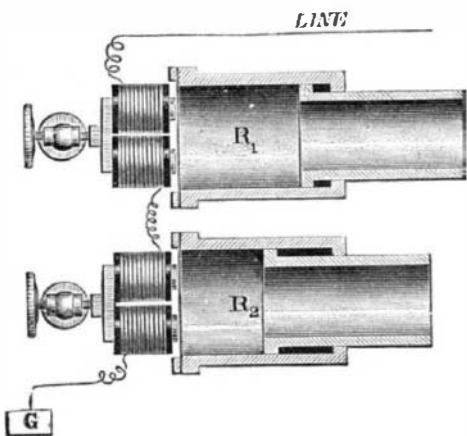


was devised in September, 1875, and is shown in Fig. 1, two tuning forks, A and B, vibrating from 100 to 500 times per second, were kept in continuous motion by a local magnet and battery, and the short circuiting was controlled by the signaling keys, K₁ and K₂. As will be seen on reference to the engraving, this system is dependent upon the varying resistance occasioned by employing a movable electrode in water, and which thus produces corresponding variations of the battery current in the line.

The receivers, R₁ and R₂, Fig. 2, were formed of telescopic tubes of metal, by lengthening or shortening of which the column of air in either could be adjusted to vibrate in unison with the proper tone of the fork, whose signals were to be received by each particular instrument. An iron diaphragm was soldered to one end of these tubes, and the latter placed in such a manner as to bring the diaphragm of each respectively just in front of an electro-magnet, which, in action, would cause them to vibrate. When the column of air in either receiver was properly adjusted to a given tone, the signals due to stopping and starting the vibrations by the distant key were very loud, as compared to other tones not in harmony with the column of air. Flexible rubber tubes, with ear pieces, were connected to the receivers, so that, in using the instruments, the head of the operator was not required to be held in an unnatural or strained position.

This system worked very well, but one defect in it was apparent from the first, and that was its continual tendency to give the operator what is termed the back stroke, which renders signals unintelligible.

Fig. 2.



While engaged in experimenting with his telephone Mr. Edison discovered that the sound waves could be transformed into electrical pulsations without the movement of any intervening mechanism.

THE INVENTION OF THE CARBON TELEPHONE.

The manner in which this result was reached is described by Mr. Edison as follows: "I first substituted a spiral spring of about a quarter inch in length, containing four turns of wire, for the rubber tube which connected the diaphragm with the disks. I found, however, that this spring gave out a musical tone, which interfered somewhat with the effects produced by the voice; but, in the hope of overcoming the defect, I kept on substituting spiral springs of thicker wire, and as I did so I found that the articulation became both clearer and louder. At last I substituted a solid substance for the springs that had gradually been made more and more inelastic, and then I obtained very marked improvements in the results. It then occurred to me that the whole question was one of pressure only, and that it was not necessary that the diaphragm should vibrate at all.

I consequently put in a heavy diaphragm, one and three quarter inches in diameter and one sixteenth inch thick, and fastened the carbon disk and plate tightly together, so that the latter showed no vibration with the loudest tones. Upon testing it I found my surmises verified; the articulation was perfect, and the volume of sound so great that conversation carried on in a whisper three feet from the telephone was clearly heard and understood at the other end of the line.

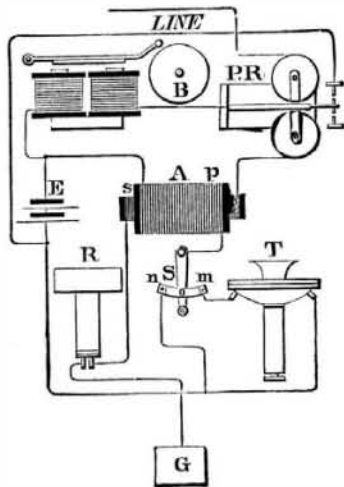
"This, therefore, is the arrangement I have adopted in my present form of apparatus, which I call the carbon telephone, to distinguish it from others. [In this way was made the discovery which Professor D. E. Hughes has lately claimed to have originated, and on which the so-called microphone is based.—Eds.]

"The accessories and connections of this apparatus for long circuits are shown in Fig. 3. A is an induction coil, whose primary wire, *p*, having a resistance of several ohms, is placed around the secondary, instead of within it as in the usual manner of construction. The secondary coil, *s*, of finer wire, has a resistance of from 150 to 200 ohms, according to the degree of tension required; and the receiving telephone, R, consists simply of a magnet, coil, and diaphragm. One pole of the magnet is connected to the outer edge of the diaphragm, and the other, which carries the wire bobbin of about 75 ohms resistance, and is included in the main line, is placed just opposite its center.

"P R is the signaling relay, the lever of which, when actuated by the current from a distant station on the line in which the instrument is included, closes a local circuit containing the vibrating call bell, B, and thus gives warning when speaking communication is desired.

"Besides serving to operate the call bell, the local battery, E, is also used for sending the call signal. S is a switch,

Fig. 3.



the lever of which, when placed at *o*, between *m* and *n*, disconnects the transmitter, T, and local battery, E, from the coil, A, and in this position leaves the polarized relay, P R, free to respond to currents from the distant station. When this station is wanted, however, the lever, S, is turned to the left on *n*, and depressed several times in rapid succession. The current from the local battery, by this means, is made to pass through the primary coil of A, and thus for each make and break of the circuit induces powerful currents in the secondary, *s*, which pass into the line and actuate the distant call bell.

"When the call signals have been exchanged, both terminal stations place their switches to the right on *m*, and thus introduce the carbon transmitter into their respective circuits. The changes of pressure, produced by speaking against the diaphragm of either transmitter, then serve, as already shown, to vary the resistance of the carbon, and thus produce corresponding variations in the induced currents, which, acting through the receiving instrument, reproduce at the distant station whatever has been spoken into the transmitting instrument.

TELEPHONE SIGNALING APPARATUS.

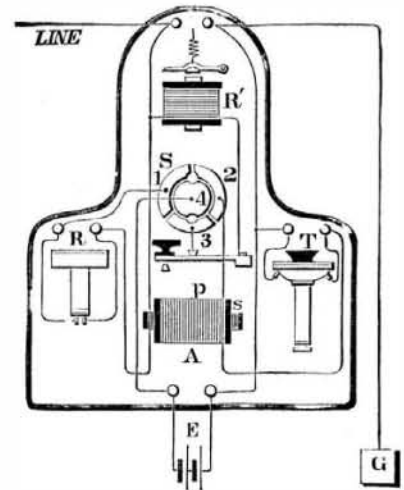
"For lines of moderate lengths, say from one to thirty miles, another arrangement, shown in Fig. 4, may be used advantageously. The induction coil, key, battery, and receiving and transmitting telephones, are lettered the same as in the previous engraving, and are similar in every respect to the apparatus there shown; the switch, S, however, differs somewhat in construction from the one already described, but is made to serve a similar purpose. When a plug is inserted between 3 and 4 the relay or sounder, R', battery, E, and key, K, only are included in the main line circuit, and this is the normal arrangement of the apparatus for signaling purposes. The battery, usually about three cells of the Daniell form, serves also both for a local and main battery. When a plug is inserted between 1, 2, and 4, the apparatus is available for telephonic communication.

"I have also found, on lines of from one to twenty miles in length, that the ordinary call can be dispensed with, and a simplified arrangement substituted. This latter consists simply of the ordinary receiving telephone, upon the diaphragm of which a free lever, L, is made to rest, as shown in Fig. 5. When the induced currents from the distant station act upon the receiver, R, the diaphragm of the latter is thrown into vibration, but by itself is capable of giving only a comparatively weak sound; with the lever resting upon

its center, however, a sharp, penetrating noise is produced by the constant and rapid rebounds of the lever, which thus answers very well for calling purposes at stations where there is comparatively but little noise."

Mr. Edison has also used direct and induced currents to release clockwork, and thus operate a call, and by the further action of these currents on similar forks at a distant station, bells were caused to be rung, and signals given. Fig. 6, page 11, shows an arrangement of this kind. A and B are two magnetized tuning forks, having the same rate of vibration

Fig. 4.



and placed at two terminal stations. Electro-magnets, *m* and *m*₁, are placed opposite one of the prongs of the forks at each station, while a bell, C or D, stands opposite to the other. The coils of the magnet are connected respectively to the line wire and to earth. When one of the forks is set in vibration by a starting key provided for the purpose, the currents produced by the approach of one of its magnetized prongs towards the magnet, and its recession therefrom, pass into the line and to the further station, where their action soon causes the second fork to vibrate with constantly increasing amplitude, until the bell is struck and the signal given.

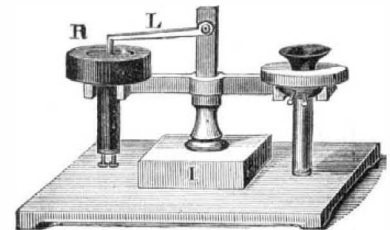
For telephonic calls the call bells are so arranged that the one opposite to the fork, which generates the currents, is thrown out of the way of the latter's vibrations.

THE ELECTRO-STATIC TELEPHONE.

Another call apparatus is represented in Fig. 7. In this arrangement two small magnetic pendulums, whose rates of vibration are the same, are placed in front of separate electro-magnets, the helices of which join in the main line circuit. When one of the pendulums is put in motion, the currents generated by its forward and backward swings in front of the electro-magnet pass into the line, and at the opposite terminal, acting through the helix there, cause the second pendulum to vibrate in unison with the former.

Fig. 8 shows a form of electrophorus telephone which acts by the approach of the diaphragm contained in A or B towards, or its recession from, a highly charged electrophorus, C or D. The vibrations of the transmitting diaphragm cause a disturbance of the charge at both ends of the line, and thus give rise to faint sounds. Perfect insulation, how-

Fig. 5.



ever, is necessary, and either apparatus can be used both for transmitting and receiving, but the results are necessarily very weak.

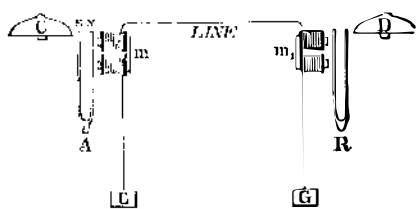
Another form of electro-static telephone is shown in Fig. 9. In this arrangement Deluc piles of some 20,000 disks each are contained in glass tubes, A and B, and conveniently mounted on glass, wood, or metal stands. The diaphragms, which are in electrical connection with the earth, are also placed opposite to one pole of each of the piles, while the opposite poles are joined together by the line conductor. Any vibration of either diaphragm is thus capable of disturbing the electrical condition of the neighboring disks, the same as in the electrophorus telephones; and consequently the vibrations, when produced by the voice in one instrument, will give rise to corresponding electrical changes in the other, and thereby reproduce in it what has been spoken into the mouthpiece of the former.

With this arrangement fair results may be obtained, and it is not necessary that the insulation should be so perfect as for the electrophorus apparatus. Fig. 10 shows a form of electro-mechanical telephone. Small resistance coils (1, 2, 3, etc.) were so arranged with connecting springs near a platinum faced lever, B, in connection with the diaphragm in A, that any movement of the latter caused one or more of the coils to be cut in or out of the primary circuit of an induction coil, C, the number, of course, varying with the

* Abridged from "The Speaking Telephone, Talking Phonograph, and other Novelties," by Geo. B. Prescott.

amplitude of the vibrating diaphragm. Induced currents corresponding in strength with the variations of resistance were thus sent into the line, and could then be made to act upon an ordinary receiving telephone. By arranging the

Fig. 6.

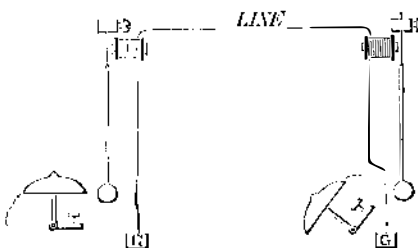


springs in a sunflower pattern about a circular lever, articulate sentences have been transmitted by this method, but the results were very harsh and disagreeable.

THE WATER TELEPHONE.

Fig. 11 shows a form of the water telephone, in which a double cell was used so as to afford considerable variation of resistance for the very slight movements of the dia-

Fig. 7.

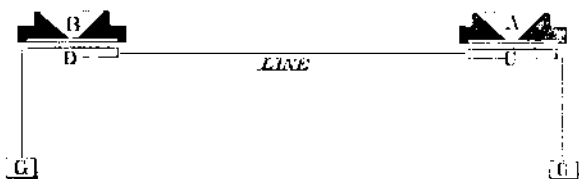


phragm. The action of the apparatus will readily be understood from the engraving, where a wire in the form of the letter U is shown, with the bend attached to the diaphragm, and its ends dipping into the separate cells, and thus made to form part of the circuit when the line is joined to the instrument at *a* and *c*.

THE THERMO-ELECTRIC TELEPHONE.

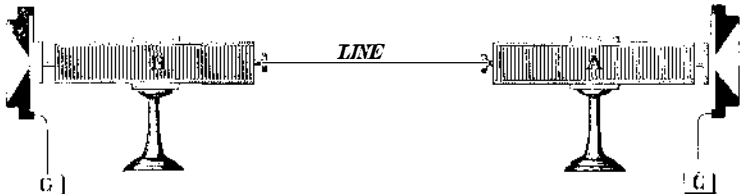
Mr. Edison is now conducting experiments with a thermo-electric telephone, which gives some promise of becoming

Fig. 8.



ing serviceable. In this arrangement a sensitive thermopile is placed in front of a diaphragm of vulcanite at each end of a line wire, in the circuit of which are included low resistance receiving instruments. The principle upon which the apparatus works depends upon the change of tempera-

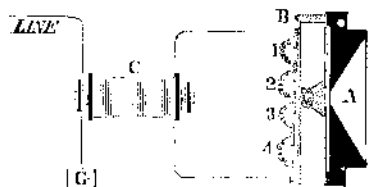
Fig. 9.



ture produced in the vibrating diaphragm, which he has found is much lower as the latter moves forward, and is also correspondingly increased on the return movement.

Sound waves are thus converted into heat waves of similar characteristic variations, and the inventor hopes to be able, by the use of more sensitive thermo-piles, to trans-

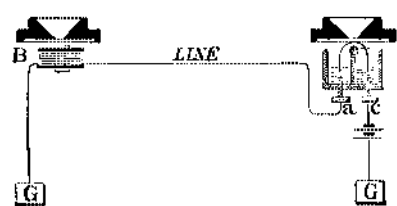
Fig. 10.



form these heat waves into electrical currents of sufficient strength to produce a practical telephone on this novel principle.

An interesting fact connected with telephonic transmission was discovered during some of his experiments with the magneto-telephone, which is that a copper

Fig. 11.



disk may be substituted for the iron diaphragm now universally used. If a piece of copper, say one sixteenth of an inch thick and three fourths of an inch in diameter, is secured to the center of a vulcanite diaphragm, the effect

becomes quite marked, and the apparatus is even more sensitive than when the entire diaphragm is of copper. The cause of the sound is due, no doubt, to the production of very weak electrical currents in the copper disk.

New Inventions.

Mr. W. B. Austin, of New York city, is the inventor of an improved Chimney Ventilator, consisting of segmental spiral plates arranged upon a pivoted vertical rod, placed in a pipe at the top of the chimney, revolving in bearings in supporting cross bars. A downward current is prevented by a chimney cap of peculiar shape which deflects the wind upward.

Mr. Z. N. Morrell, of Luling, Tex., has patented a Fire Extinguisher for Lint Rooms, consisting of a tank provided with a valve in its bottom, placed on the roof of a lint room, and connected by a pipe to a perforated tank or sprinkler secured to the ceiling. The sprinkler is provided with a short pipe to which a hose can be attached.

Mr. Harvey Maranville, of Akron, Ohio, has invented Scales for testing coin and weighing small articles, more especially coin and mail matter. A beam is provided at one end with a graduated rotating disk, which carries the counterpoise, and at the other end with a scale for measuring the diameter and thickness of coin, and a pivoted platform for receiving the coin or packages to be weighed.

Mr. Joseph Dufour, of Racine, Wis., has patented a new Thill Coupling, which can be easily constructed of wrought iron. The improvement consists in constructing the axle clips, or axle irons, to which the thill irons are attached, with lateral curved arms, which serve to prevent detachment of the thills when in their normal position, but not when elevated vertically.

Mr. John Senn, of Evansville, Ill., has patented a new Remedy for Hog Cholera, which is also claimed to be efficacious in diseases of the lungs with which hogs are often affected.

Messrs. Austin Dollason and Charles L. Leonard, of Factoryville, N. Y., have improved the construction of the Front Gear for Carriages patented by C. L. Leonard, May 14, 1872, so as to prevent it from sagging or settling in the center. This is effected by means whereby more or less arch may be given to the center and side bars.

Mr. Joseph E. Chenette, of Hillsborough, Oregon, has patented a new Last. The object of the invention is to facilitate the removal of the last from the shoe and to avoid injury to the last by nailing to it pieces of leather for enlarging it at the instep and toe, and at the ball of the last.

An improved Cake Cutter and Nutmeg Grater, devised by Mr. Herbert M. Avers, of Chicago, Ill., consists of a block having at one end an interior cavity and lid for the nutmegs, and at the opposite end a handle for taking hold of the same. On the sides are cake, doughnut and biscuit cutting devices and a nutmeg grater.

Mr. David F. Hartford, of Boston, Mass., has patented a new Shears for Cutting Sheet Metal. The machine has one fixed and one movable cutter. The latter is attached to a pivoted arm, which is connected with a hand lever by means of a link, so that when the lever is vibrated the said arm is vibrated correspondingly. The lever and link enable great force to be applied to the movable knife.

A novel Hand Stamp has been patented by Mr. Sydney W. Garrison, of Memphis, Shelby county, Tenn. It consists in combining a spring-seated receding case, containing an inking pad, with a pivoted and reversible type plate sustained upon arms, so that when the housing is drawn back the platen may be reversed and its type turned outwardly from contact with the inking pad into position for pressing.

Mr. William Fenstermacher, of Shippenburg, Pa., has patented a new Side Bar Wagon, in which the body of the vehicle is supported by springs midway between the side bars and the axle. This is claimed to make the wagon very easy riding.

A new Cheek Piece for Headstalls has been patented by Mr. James W. Weed, of Prescott, Iowa, which is so made as to render unnecessary a great amount of the stitching heretofore required in making headstalls.

Mr. Alexander Waldron, of New York city, has patented an improved mode of Weighting the Seats of Waterclosets in such a manner as to cause the seat to assume a vertical position immediately after use.

A new Lamp has been invented by Mr. Nicholas L. Rigby, of Winfield, Kansas, which consists of a bowl having one or more straight arms with burner cups, the bowl being made with a horizontal top and circumferential flange, to form a detachable fountain. A center valve is provided which is automatically opened when the fountain is seated on the bowl.

A new Wagon Tongue Support, adapted to relieve the necks of horses from the weight, and which is easily adjustable, has been patented by Messrs. Daniel B. Hart and William P. Webster, of West Mentor, Ohio.

Messrs. Edward Christman and John Caldwell, of Louisville, Ky., have invented an ingenious Adjustable Chair for infants, whereby accidents to the child consequent upon its own pushing, kicking, or attempting to rise or slip down are prevented.

Mr. Howard M. Moffett, of Cleveland, Ohio, has patented a new Door Bolt. It consists of guided locking bolts that are pivoted at their slotted inner ends to an eccentric cam,

which is revolved by a wing-shaped key, while a raised center portion of the cam serves, in connection with the recessed inner ends, for retaining the bolts in locked position.

A new Valve Attachment for the pipes of washbasins has been devised by Mr. Francis E. Kernochan, of Pittsfield, Mass., which is so constructed as to prevent escape of sewer gas and to guard against any accidental overflow of water.

Mr. James Goodwin, of Montreal, Canada, has patented an ingenious Invalid Bedstead, which is an improvement upon that for which the same party has received letters patent, dated March 9, 1875, No. 160,667. The improvements relate to improved adjustments; to means whereby the stretcher frame may be elevated at both ends simultaneously, or at the foot only; to devices for bracing and strengthening the bedstead frame; and for stretching the ticking.

Mr. John M. Lescale, of Painscourtville, La., has patented a new Fire Escape, in which there is employed, in connection with the double grooved drum, a pendulum having an adjustable radius, so that it may be changed in position to regulate the rapidity of the descent of persons to the pavement.

A new Coffee Roaster has been patented by Mr. Jonathan Miller, of Trenton, N. J., which consists in a rotating cylinder having an inner lining of gauze wire. The sheet metal body of the cylinder and the inner gauze wire lining are held between two cast iron heads grooved concentrically to receive the same, the heads being clamped together by a nut upon a central axis, which latter is extended and bent to form the crank.

A novel Mailing Package has been patented by Mr. Wm. B. Pittman, of Vicksburg, Miss., which may be readily opened and inspected by the postmaster and as readily and securely closed against any sifting of pulverulent contents into the mail bag.

Mr. Joseph B. Underwood, of Fayetteville, N. C., has lately patented a new Coffee Roaster, in which the charge of coffee in the roasting cylinder is transferred to the cooling cylinder without exposure to the air and in an automatic manner, by the simple rotation of the same without raising the cylinders into a vertical position.

Mr. James Gainey, of Augusta, Ga., has patented a combined Filtering, Cooling, and Water Forcing Apparatus, which consists in combining a filtering apparatus and an air pressure water reservoir with the distributing pipes of the building, the said filtering apparatus being connected with the main water supply and discharging clear water into a tank having an air cushion in the top, which tank at the same time serves as a reservoir for a larger and more expeditious supply of water than could be drawn direct from the filter.

Mr. Newton J. Alexander, of Austin, Tex., has patented a Paper Bag of ordinary or any preferred construction, with a flap or apron of such form and dimensions that the powder or other substance to be put up may be deposited thereon and transferred to the bag proper by suitable manipulation of the flap and bag.

Mr. Henry Monk, of Troy, N. Y., has patented a novel Ironing Machine, which consists in providing an ironing table with a movable bosom board which may be adjusted to adapt it for properly supporting the fronts of shirts of different sizes, so that the upper portion of the fronts may be ironed in the desired manner by the ordinary heated rolls used in ironing machines. This avoids the frequent necessity of finishing them off by hand. The polishing rolls are constructed in a peculiar way to adapt them to polish shirt fronts which have not a uniform thickness of cloth.

The same inventor has also patented a pocket device, which, besides serving as a Match Safe, is adapted for igniting a match and protecting the flame thereof, thus enabling a cigar to be lighted in the street or wherever else an air blast or current would otherwise tend to prevent it.

Mr. George Banister, of Columbus, O., has patented an improved process of Tempering Steel, whereby one step of the old or ordinary process is avoided, and the cost of tempering is correspondingly reduced.

New Electric Light.

A new electric lamp, with incandescence acting in free air, has been described to the French Academy by M. Regnier. A thin rod of carbon, pressed laterally by an electric contact, and forced in the direction of its axis on a fixed contact, is traversed between these two contacts by a pretty powerful current, and becomes incandescent in this part, burning and thinning towards the extremity. As the end gets used up, the rod, continually pushed on, slips in the elastic contact, and is thus kept up against the fixed contact. The heat developed by passage of the current in the rod is greatly increased by the combustion of the carbon. An apparatus made on this principle is said to give a clear white light with four Bunsen elements. With a more powerful battery, several lamps on this system may be lit.

Quick Freight Time.

A special flour train, consisting of 25 cars and carrying 2,500 barrels, left Minneapolis, Minn., May 16, and arrived at Jersey City on the 20th. Barges and men were in waiting, and the flour was delivered to the steamer Alexandria early the next morning for exportation to London. The entire train load was shipped within four and a half days from the time of leaving the mills. It is intended to dispatch such a train weekly from Minneapolis, to make direct connection with the steamers for Liverpool and London.