(No Model.)

S. D. FIELD.
MAGNETO TELEPHONE.

No. 575,394. Patented Jan. 19, 1897.

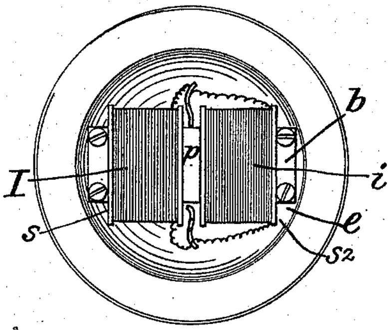


Fig. 3.

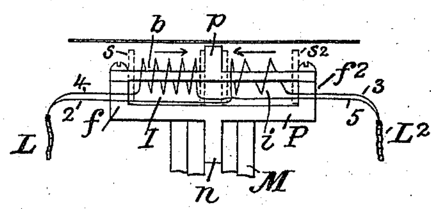


Fig. 2.

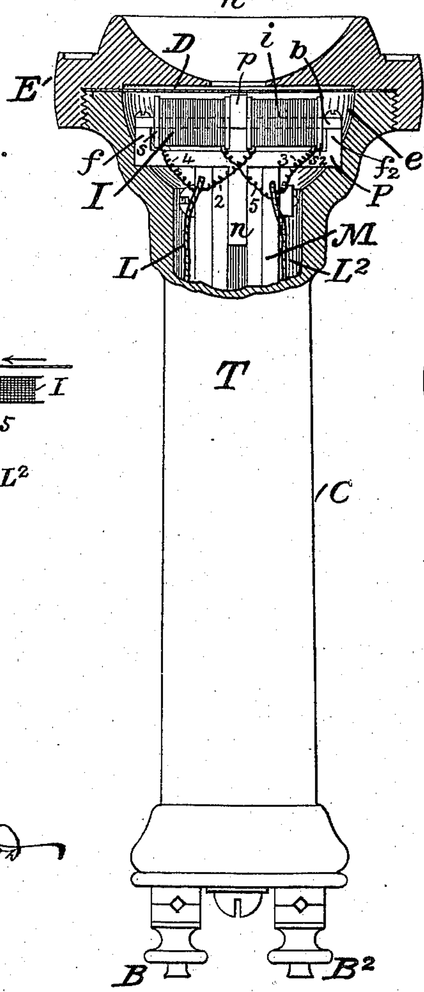


Fig. 1.

Fig. 4.

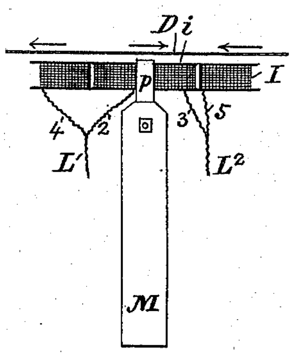
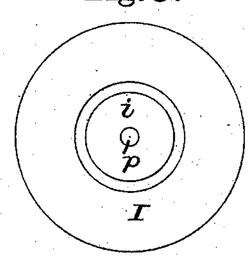


Fig. 5.



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MAGNETO-TELEPHONE.

SPECIFICATION forming part of Letters Patent No. 575,394, dated January 19, 1897.

Application filed August 11, 1896. Serial No. 602,387. (No model.)

To all whom it may concern:

Be it known that I, STEPHEN D. FIELD, residing at Stockbridge, in the county of Berkshire and State of Massachusetts, have invented certain Improvements in Magneto-Telephones, of which the following is a specification.

This invention relates to magneto-telephones such as are most generally now employed as receivers. Its object is to produce a receiving-telephone which shall be capable of responding to the rapid changes of voice-currents more promptly than has heretofore been found possible, and one whose reproduction of the transmitted sounds will therefore be extremely accurate and faithful without involving any counteracting loss in volume.

An application for patent filed of even date herewith for improvements in electromagnetic apparatus describes electromagnetic appliances and receiving instruments depending for their normal operation upon the difference in time required by exciting-coils of like magnetizing power, but diverse inductance, wound over or placed upon a common iron core, to reach, respectively, their maximum and zero magnetizing values under abrupt changes of a current traversing the said coils. The same underlying principles are involved in the present invention, wherein the iron core or pole-piece of the active pole of the telephone-magnet is associated with two controlling electromagnetic or exciting helices joined up between the binding-screw terminals of the instrument in parallel circuit or multiple arc with one another and adapted thereby to be connected in separate parallel branches of the same working circuit. These two helices are so constructed as to possess equal magnetizing powers when submitted to the action of the same steady current; or, in other words, when such a current divides between them both have the same number of ampere-turns. They are, however, likewise so relatively constructed and arranged that the inductance of one of them shall be much higher than that of the other, and by this means any rapidly-varying current, such as a telephone-current, passing through the circuit and through the two coils in parallel reaches its maximum when rising or appearing and its minimum when falling or disappearing with much greater celerity in the low-inductance helix than it can in the other. Moreover, the said helices are wound over or placed upon their core or connected up in opposition to each other, so that each tends to oppose the magnetizing effect of the other, and when a current, having passed its variable state, is steady or fully established through both, and both therefore exert their full magnetizing influence on the iron magnet-core, each neutralizes the effect of the other on said core, and the result is a zero of action. The spools or bobbins whereon the two helices are wound are preferably of the same or substantially the same mechanical dimensions; but the high-inductance helix is wound with fine insulated wire, while the wire of the low-inductance helix is relatively large, so that while the spool of the former requires to fill it a great number of convolutions that of the latter is filled by a much smaller number of turns. The appropriate size of spool having been selected, the size of wire for both and the relative number of turns for both required to substantially fill the said spools and at the same time to insure that the two shall be enabled to exercise a substantially equal magnetizing influence can readily be determined by the well-known rules of electrical engineering practice.

In the telephone an initial magnetization is, as usual, imparted to the soft-iron core or pole-piece by a permanent or temporary magnet. When a working-current impulse of given polarity or direction is transmitted through the main line, it circulates through both windings. In one—say the low-inductance coil—it first passes round the core in a direction to decrease or weaken the original polarity, while its direction round the core in the other is such as to tend to strengthen the initial polarity; but since in the coil of low inductance the current reaches its normal value much quicker than it does in the other the polarity of the core is acted upon practically in the first place by that coil alone, and since, also, the main-line working current of a telephone system is either one of most rapid alternation or, as in rare instances, of rapid strength variation it becomes evident that the said first impulse of current in the quick-acting coil is swiftly reversed or begins to change, and that such reversal or change is necessarily assisted by the more sluggish action of the high-inductance coil, which allows its portion of the first impulse of the current to reach its normal value and to act upon the core in opposition to that of the other coil, but an instant later. Thus the action on the core of each reversal or change of current in the quick helix of low inductance is facilitated by the slower action upon the said core of the more sluggish coil, which operates as a kind of curb to shorten up and sharpen the said reversals or changes, enabling them to be fully accomplished much quicker than otherwise would be the case.

I have attained good results with a differential-inductance telephone, in which I associated with the ordinary bar-magnet and diaphragm a fork-shaped soft-iron core having a bridge of iron extending between the two prong ends of the fork, the whole forming a soft-iron parallelogram provided at its center, which was located immediately behind the middle of the diaphragm, with a polar projection or pole-piece. In this instrument the two coils surrounded, respectively, the two portions of the iron bridge between the said central pole and the prong ends, and I prefer this or a similar arrangement.

The invention may, however, be readily embodied in a telephone of standard construction, to which is added the high-inductance helix in the form of a flat coil surrounding the inner or low-inductance helix and concentric with that and with an ordinary cylindrical core.

In the drawings accompanying and illustrating this specification, Figure 1 represents a hand or receiving telephone broken away near the earpiece to show a preferred pole-piece construction and coil arrangement in which my invention may be embodied. Fig. 2 is a diagrammatic detail indicating more clearly the said form of pole-piece and mode of winding the two electromagnetic helices. Fig. 3 is a front view of the helices and pole-piece, the cap-piece and diaphragm being removed. Fig. 4 represents in elevation the arrangement of the working parts of a modification; and Fig. 5 is a front view of the coils and polar end of the magnet thereof, the diaphragm being removed.

Referring in the first place to Figs. 1, 2, and 3, T is a hand-telephone in which my invention is incorporated, C being the usual case thereof, provided at one end with an expansion-chamber *e* for the pole-piece and coils and at the other with binding-screw terminals B and B^2, whereby the instrument and its internal connections may be united through the external circuit and a transmitter.

M is the usual permanent magnet, D the diaphragm, and E the cap or ear piece, which is screwed over the expansion-chamber and secures the edge of the diaphragm. A forked pole-piece P, of soft iron, having two prongs $f f^2$, is attached to the magnet by a projecting piece *n*, which is bolted between the ends of the bars composing the magnet, and a bridge-piece *b*, also of soft iron, unites the prongs f and f^2 magnetically, forming a soft-iron parallelogram. A central polar projection *p* extends outwardly from the middle of the bridge-piece to a point in close proximity to the middle of the rear side of the diaphragm.

I is a magnetizing, exciting, or actuating helix made of many turns of fine magnet-wire, placed on or wound over the bridge-piece between the central pole *p* and one of the fork-prongs, (in this instance the prong *f*,) and *i* is another actuating-helix formed of a much smaller number of turns of a larger size of magnet-wire. By reason of this construction, regardless of their relative resistance or magnetizing power, the inductance of the helix I is very much higher than that of the coil *i*, so that when both are being operated by the same rapidly-varying current that portion of the current which traverses the coil I is slower both in rising to its maximum or in falling to its minimum value than the portion which passes through the coil *i*, and it follows, of course, that the magnetizing or demagnetizing action of I is much more sluggish than that of *i* upon the central pole *p*, which is common to both.

L and L^2 are the conducting-wires, connecting both helices in circuit between the screw-terminals B B^2, and at any convenient point between the binding-screws and the coils the said conductors divide into two parallel branches, in which are respectively connected the helices I *i*. One branch is traceable between conductors L and L^2 by way of connecting-wire 2, helix *i*, and wire 3, while the other may be traced through wire 4, helix I, and wire 5.

As indicated in Fig. 2, the two windings are reversely connected, so that when a current impulse of given direction is sent through the circuit and instrument the magnetic action of each on the central pole *p* tends to oppose that of the other. The magnetizing force of the helices I and *i* are equal, and as *i* is the quicker in reaching its maximum and also its minimum value the influence upon the pole *p* of *i* alone is at first manifested, but is checked and its following change made more expeditious by the more-slowly-exercised opposing influence of I. Since the same phenomenon occurs with every current variation, it is obvious that the magnetic changes, which by their action on the diaphragm are transformed into mechanical motion, are enabled to more faithfully copy the form of the voice-currents developed in the circuit by the distant transmitter. Hence the reproduction of the transmitter-sounds is effectuated with great accuracy.

In the telephone to which I have hereinbefore referred as having been made by me the high-inductance helix I was made by employing such a size of wire that its spool s was properly filled when the resistance measured three hundred ohms, and the low-inductance coil i was made by winding with wire of such size that its spool s^2 was filled when the measured resistance was seventy-five ohms. Roughly, therefore, it may be said that the magnetizing power of the coils is equal and their inductances sufficiently dissimilar when with spools of the same size both filled with wire the resistance of the winding of the high-inductance coil is four times that of the low-inductance coil, which according to standard practice may be seventy-five ohms or thereabout. More generally we may consider that under average conditions the two helices have suitable relative proportions when the resistance of I is approximately four times that of i and when in both the product of the number of turns into the strength of the current circulating in the helix is the same.

In the modification illustrated by Figs. 4 and 5 the two helices are placed concentric with one another, the high-inductance coil I occupying the outermost position and both encircling the soft-iron core p of the telephone-magnet, the said core and the low-inductance coil i being of ordinary dimensions and form. In this modification, M is the magnet; p, its soft-iron pole-piece or core; i, an actuating-helix immediately surrounding the said core and connected in a branch 2 3 of the circuit L L^2; I, a second helix of much higher inductance than the former placed so as to surround the said former helix and core and connected in parallel with the former in the branch 4 5 of the same working circuit L L^2, and D is the diaphragm.

In Figs. 2 and 4 the arrows indicate that at any given moment the currents in the two coils have opposite magnetizing direction.

In the modification of Figs. 4 and 5 the inner coil may, as usual, have a resistance of seventy-five ohms, and may be formed of seven hundred and fifty convolutions, and in that case the coil I may have six thousand convolutions and a resistance of six hundred ohms.

It is apparent that my invention is not restricted to either of the particular forms of telephone herein specifically shown and described, and that the spirit of the said invention would also find embodiment in a form having its two coil-wires wound on the same spool or in any analogous arrangement, provided that the magnetizing forces of the said two wires were alike, their inductances unlike, and their winding or connection reciprocally reversed with respect to their action on the magnet-core.

Having described my invention, I claim—

1. A magneto-telephone comprising in combination a diaphragm, a magnet, a pole-piece therefor, as described, and two oppositely wound or connected magnetizing or exciting helices of equal magnetizing power, but dissimilar inductance, associated with the said pole-piece, the said helices being in parallel or multiple arc with one another between the instrument-terminals, and adapted thereby to be connected in parallel in the same working circuit.

2. A differential-inductance magneto-telephone having its magnet pole-piece or core associated with two oppositely wound or connected exciting or actuating coils connected in parallel with each other, one of the said coils being formed of a relatively short and coarse wire, and the other of a relatively long and fine wire, and both having such proportions that when the current of the working circuit divides between them, their ampere-turns shall be the same; substantially as and for the purposes specified.

3. The combination in a magneto-telephone, of the magnetized soft-iron core or pole-piece, with two independent electromagnetic helices of equal and opposite magnetizing power, but unequal inductance, surrounding the said core, in such manner as to excite opposite magnetizations therein, under the influence of the said working current, and thereby facilitate the required magnetic changes thereof, the said helices being in separate parallel branches of the same circuit.

4. In a magneto-telephone, the combination substantially as described, of the vibratory diaphragm and inducing-magnet, with a forked pole-piece for the said magnet having an iron bridge-piece uniting its ends, and forming therewith a soft-iron parallelogram, having a central pole projecting close to the diaphragm center, and two oppositely wound or connected exciting or actuating helices in parallel circuit with each other, surrounding the said bridge-piece one on each side of the central polar projection; the said helices being of similar magnetizing power when submitted to the same steady current, but of dissimilar inductance.

In testimony whereof I have signed my name to this specification, in the presence of two subscribing witnesses, this 28th day of July, 1896.

STEPHEN D. FIELD.

Witnesses:
THOMAS D. LOCKWOOD,
JOSEPH A. GATELY.