(No Model.)

J. A. BARRETT.

REPEATING INDUCTION COIL.

No. 382,856. Patented May 15, 1888.

Fig. 1.

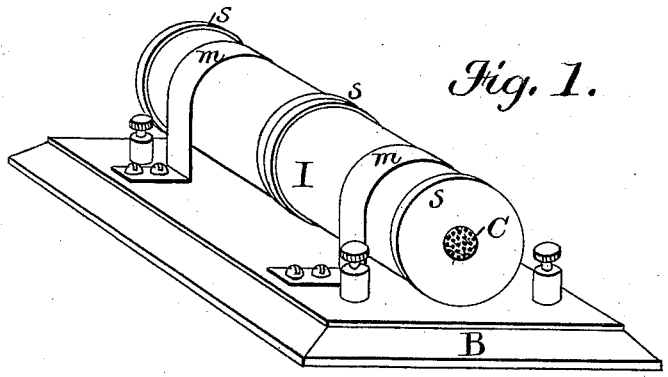


Fig. 2.

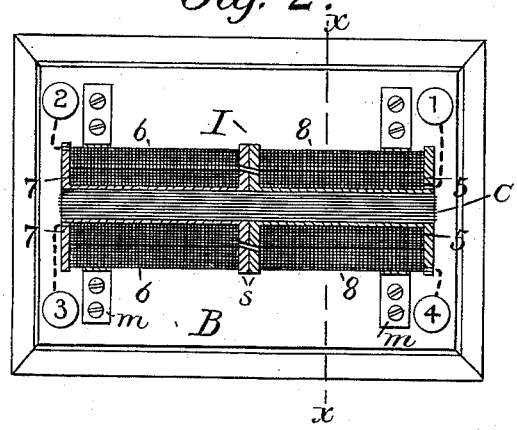


Fig. 3.

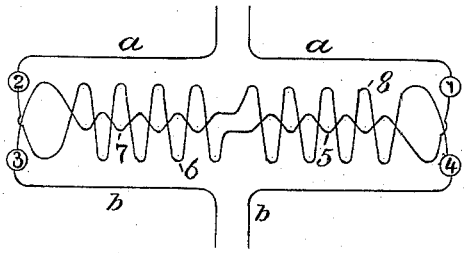


Fig. 4.

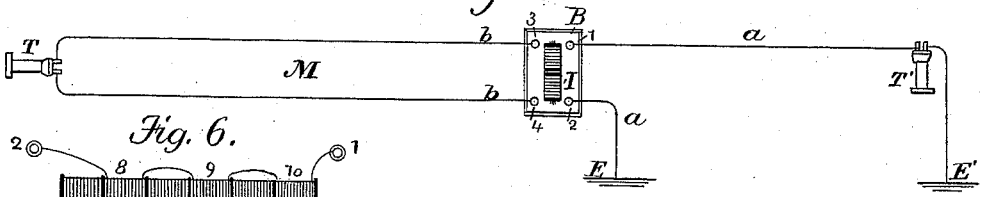


Fig. 6.

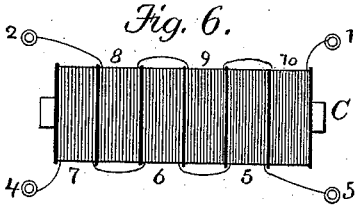
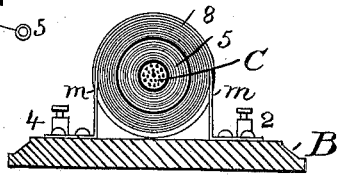


Fig. 5.



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UNITED STATES PATENT OFFICE.

JOHN A. BARRETT, OF BROOKLYN, NEW YORK.

REPEATING INDUCTION-COIL.

SPECIFICATION forming part of Letters Patent No. 382,856, dated May 15, 1888.

Application filed January 14, 1888. Serial No. 260,746. (No model.)

To all whom it may concern:

Be it known that I, JOHN A. BARRETT, residing at Brooklyn, in the county of Queens and State of New York, have invented certain Improvements in Repeating Induction-Coils, of which the following is a specification.

This invention is an improvement in repeating-coils for telephonic circuits. The repeating-coil or inductorium is a species of induction-coil peculiarly constructed for the special purpose of utilizing electrical induction as a means of reproducing in a given circuit the voice-currents originating in another circuit.

The main use of this inductive repetition is the mutual and automatic exchange of telephonic messages between metallic and earth return-circuits, although the same principle may be with equal ease applied to a similar use, as between two metallic or two grounded circuits; but it is found necessary in long telephone-lines in order to relieve such lines from external inductive interference and to better provide for the avoidance of earth-currents and leakage through earth-terminals from other wires to furnish complete metallic circuits, the direct and return wires thereof being substantially parallel to one another and equidistant from other lines. When such a metallic-circuit trunk line is to be connected at one or both ends with an ordinary grounded or earth return-circuit, it is clear that this union cannot be directly effected without again destroying the neutrality gained by the double wire, and that the said union between the single and double wire at the point of junction must be otherwise effected. The only feasible mode of connection which up to the present time has presented itself is to provide at the connecting-station a repeating-coil with two electrical circuits in inductive proximity to one another, and to introduce one of the said circuits into the metallic-circuit line and the other into the earth-circuit line, whereby the voice currents traversing either line are enabled to propagate fac-simile currents in the circuit of and adapted to traverse the other. Heretofore and prior to my invention the form of coil which has been found best adapted to this class of work has been constructed with two silk-covered wires of approximately equal size and resistance wound together as closely as possible upon a single core. The two wires have been wound at once and were in fact parallel to one another at every part of the winding.

The state of the art up to this point appears to be exemplified by the patents issued to Thomas A. Watson, No. 232,788, of September 28, 1880, and to Thomas D. Lockwood, No. 290,898, of December 25, 1883. This form of repeating-coil is in most cases all that can be desired; but circumstances have arisen in which it has been found to introduce certain noises into the otherwise perfectly quiet metallic telephone-circuit, whereby the advantages gained by the use of the parallel metallic circuit were again lost to a considerable extent. Experiment seems to have demonstrated that this phenomenon is due in the first place to the prevalence of disturbing earth-currents or currents leaking from the earth in the sirgle or earth terminal line, these being especially intense in certain parts of the country, and being probably a concomitant of some peculiar geological development; and, secondly, to a very considerable amount of electrostatic capacity in the peculiar repeating-coil when constructed in the before-described manner, whereby such a coil, in addition to its electrodynamic properties, was made to possess in some degree the properties of a condenser. The result of this was that while the legitimate telephonic current carrying the desired message traversed the two sides or wires of the metallic circuit in opposite directions, as it should, a great portion of the disturbances originating in the single wire were propagated through both wires of the metallic circuit in the same direction, using the two wires thereof simply as a split path. To remedy this defect, and to avoid as far as possible the conditions causing them, the repeating-coil, which is the subject of this specification, has been devised.

My invention dispenses with winding the two insulated wires together throughout, and consists in so winding them that while both as a whole are equally near to the core the two wires are wound in two or more separate helices, each of which is placed into close inductive relations to a helix or helices of the other, so that while in the former coils it was

sought to increase the telephonic induction between the two circuits by keeping them as intimately parallel with each other as possible throughout the entire coil, in the type constituting my present invention the principle solely employed is the mutual induction occurring between separate and independent helices included in different circuits both direct and through the medium of an electro-magnetic core.

In the drawings, which are a part of this specification, Figure 1 is a perspective view, in outline, of a repeating-coil embodying my invention in its most preferred form. Fig. 2 is a plan view of the same, the coil being in horizontal section. Fig. 3 is a diagram of the several circuits of the same repeating-coil. Fig. 4 shows the said repeating-coil in operative connection with metallic and earth circuit main lines at the junction of said lines. Fig. 5 is a cross-section on line *x x* of Fig. 2, and Fig. 6 symbolizes a modified construction.

In the form of coil I, which I prefer, a double spool, *s*, (indicated clearly in Fig. 2,) is provided, upon which the four portions of the coil proper are wound. These four portions (marked, respectively, 5, 6, 7, and 8) each have approximately an equal number of convolutions of wire. The inside portions, 5 and 7, of the coil I are first wound up to one-half the depth of the wire-space. Then the outside ends of these inside portions are passed over and spliced to the wire, which is wound in the diagonally-opposite space until the spool is full. Thus the inside helix, 5, at one end of the repeating-coil is connected in circuit with the outer helix, 6, at the other end, and the inside helix, 7, is in like manner connected in circuit with the outer helix, 8. Each circuit of the repeating-coil then comprises an inner portion close to the iron core and surrounded externally by a portion of the other circuit, and an outer portion surrounding the inner portion of the said other circuit. All the winding is done in one direction of revolution. The two circuits thus formed in the repeating-coil I have approximately an equal resistance and an equal number of convolutions about the core, and, furthermore, occupy symmetrical relations between themselves and the core.

The core C is made, as usual, of soft iron, and occupies the cylindrical space in the center of the spool *s*, which may be secured to its base-board B by metal straps *m*, which embrace the said coil and are attached by screws to said base-board. Binding-screws 1, 2, 3, and 4 may also be mounted upon the base-board B and connect with the four ends of the circuits. The arrangement of the two coils at any given point in the appliance is made clear by Fig. 5, in which the helix 5 of one circuit is shown as surrounding the core C and as being itself surrounded by the helix 8 of the other circuit.

The diagram, Fig. 3, is also intended to show clearly the final connections. One of the circuits enters at binding-screw 1 and passes through the inner helix, 5, at the right-hand end of the coil and the outer helix, 6, at the left-hand end of the coil, terminating at the binding-screw 2. The other circuit enters at binding-screw 3, passes through the inner helix, 7, at the left-hand end of the coil, then through the outer helix at the right-hand end, terminating at binding-screw 4. The size and total resistance of the wire used in these coils may vary with the length and character of the line-wires with which they are associated; but I have found that in a coil which meets the average conditions each of the two wires may be twenty-thousandths of an inch in diameter, and that the entire resistance of each of the wires may be approximately one hundred and twenty-five ohms.

The repeating-coil I is connected for use as shown in Fig. 4, the two wires *a* of one telephone-line (say that having earth terminals E and E') being united with the binding-screws 1 and 2 of one of the compound helices, while the two wires *b* of the other circuit—viz., the metallic circuit M—are in like manner united with the remaining binding-screws, 3 and 4. When so connected, the telephones T and T' can be reciprocally used. In the repeating-coil so made it will be observed that each of the two circuits comprises one section nearest to the core and another portion separated from the core by an interposed portion of the other circuit.

I have stated that the two circuits of the repeating-coil I should be of approximately equal resistance and have about the same number of convolutions as one another. This equality between the said two circuits is desirable from the fact that the repeating-coils are required to meet a great variety of conditions and a great diversity of line-circuits, and that they are required to operate reciprocally, each circuit in turn being the transmitting and receiving circuit. The electrostatic capacity of a repeating-coil so made is very much less, and hence its condenser effect is diminished, and it has little or no tendency to transfer undesirable or disturbing currents in the manner hereinbefore stated.

I show in Fig. 6 a modification, which for some cases might be desirable, a central core of soft iron, C, having its length divided into a number of short sections by transverse partitions. Each of these sections is wound full of insulated wire, and the two circuits are connected through alternate sections, the circuit terminating at binding-screws 1 and 2, for example, with sections 8, 9, and 10, and the other circuit with sections 5, 6, and 7.

I do not restrict myself in either of the forms I have described to any specific number of alternately-placed helices, as each circuit of the repeating-coil may be made up of two or more helices connected so as to coincide in operation; or, if I so elect, I may construct two or more separate repeating-coils, each having a central soft-iron core and an outer and inner helix of insulated wire, the same size being used for both helices, and combine for use in

a single repeater the said coils, the inner helix of one being connected in circuit with the outer helix of the next, and so on *ad libitum*.

I claim—

1. A repeating-coil consisting of two insulated wires of approximately equal length and size, and a magnetic core, said wires being each wound into two or more helices, each of which is placed in close inductive relation to a helix or helices of the other wire, and both wires as a whole being equally near to the core, whereby each wire is equally exposed to reciprocal inductive action, and to magneto-electric induction from the magnetic core, substantially as described.

2. A repeating-coil having two wires of approximately equal length and size, and a spool divided longitudinally into sections, said wires being each wound into two or more separate helices disposed in the sections of said spool in such manner that each helix is adjacent to one in the other circuit, substantially as described.

3. A repeating-coil for telephone-circuits, comprising a soft-iron core, and two separate insulated conducting-wires wound thereon, equal portions of both of the said wires being wound in a helix next to the core, and the remaining portions of each being wound externally to and surrounding that portion of the other which immediately surrounds the said core, whereby both are equally exposed to magnetic induction from the said core, and whereby each is enabled to act inductively with equal power upon the other.

4. A repeating-coil for telephone-circuits, comprising a soft-iron core, and two separate and independent insulated conducting-wires of equal size and approximately equal length and resistance surrounding the same, equal portions of both of said wires being wound in separate helices next to the core, each being wound to an equal thickness from one end to the center of the said core, and the remaining portions of each being wound externally to and surrounding that portion of the other which immediately surrounds the said core, whereby both are alike exposed to the inductive action of the core, and whereby each is enabled to reciprocally induce currents in the other.

5. In a repeating induction-coil, a containing reel or spool divided at its longitudinal center into two equal portions or compartments, an inside helix of insulated wire wound in each compartment of the said reel and filling up one-half of the depth of the wire-spaces, each inside helix being of substantially equal length and resistance, an external helix of insulated wire wound in each reel-compartment surrounding the inner helix thereof, and filling the remaining wire-space of the reel, the external wires also being of uniform length and resistance, one end of each external helix being united to one end of the internal helix of the other compartment, so that two separate circuits are constituted in the complete repeating-coil, each formed, respectively, of one inside and one outside helix, the outer helix of each surrounding the inner helix of the other, and a soft-iron core passing through the center of the reel and surrounded by the said helices, substantially as and for the purposes described.

6. In a repeating induction-coil, the combination, substantially as hereinbefore described, of a soft-iron core, a wire-spool surrounding the same and divided into longitudinal compartments, two helices of insulated wire of uniform size wound in each compartment, the inner helix being wound to fill one-half the depth of the wire-space, the outer helix wound thereover until the remaining wire-space is filled up, and the inner helix of each compartment being connected with the outer helix of the next, whereby each of the two circuits of the repeating-coil are caused to consist of an inner helix and an outer helix in series, the outer helix surrounding the inner helix of the other circuit, and terminal screws or connections for each of the said circuits, whereby they may be united with independent telephone-circuits, for the purpose specified.

In testimony whereof I have signed my name to this specification, in the presence of two subscribing witnesses, this 6th day of January, 1888.

JOHN A. BARRETT.

Witnesses:
F. A. PICKERNELL,
F. DE LYSLE SMITH.