No. 778,569. PATENTED DEC. 27, 1904.

W. W. DEAN.

SUPERVISORY APPARATUS FOR TELEPHONE SYSTEMS.

APPLICATION FILED JULY 7, 1902.

2 SHEETS—SHEET 1.

Fig. 1.

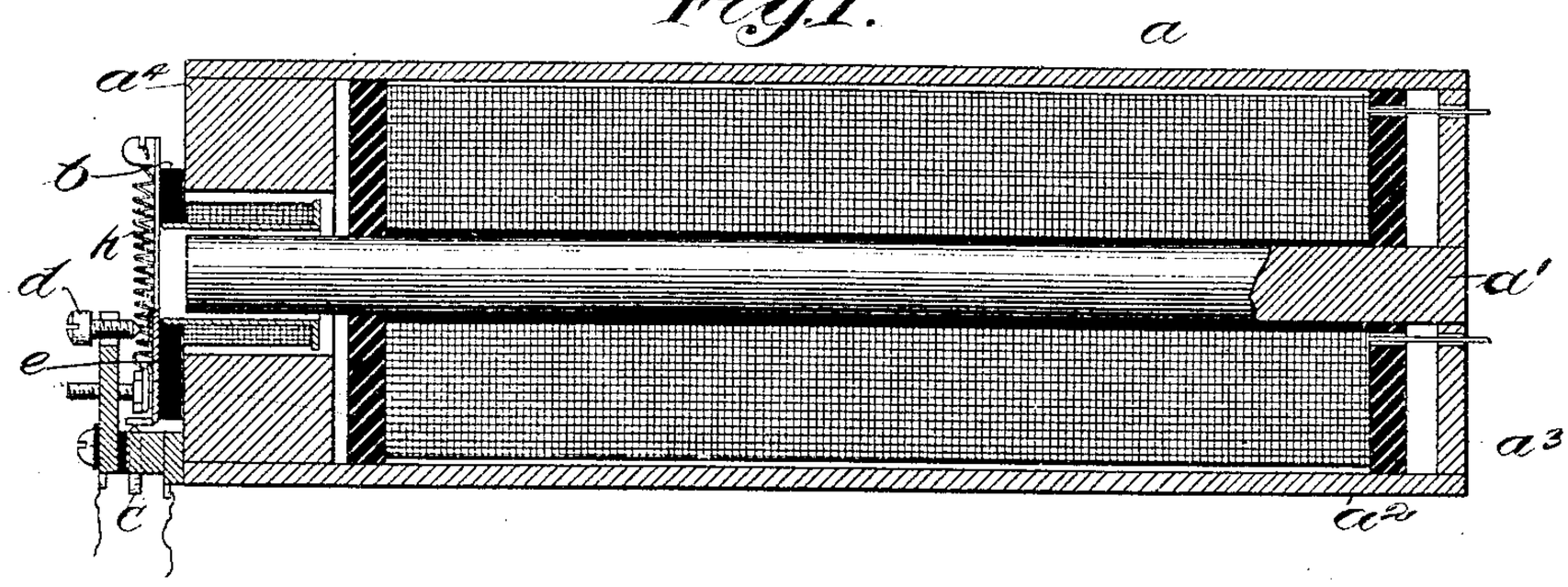


Fig. 2.

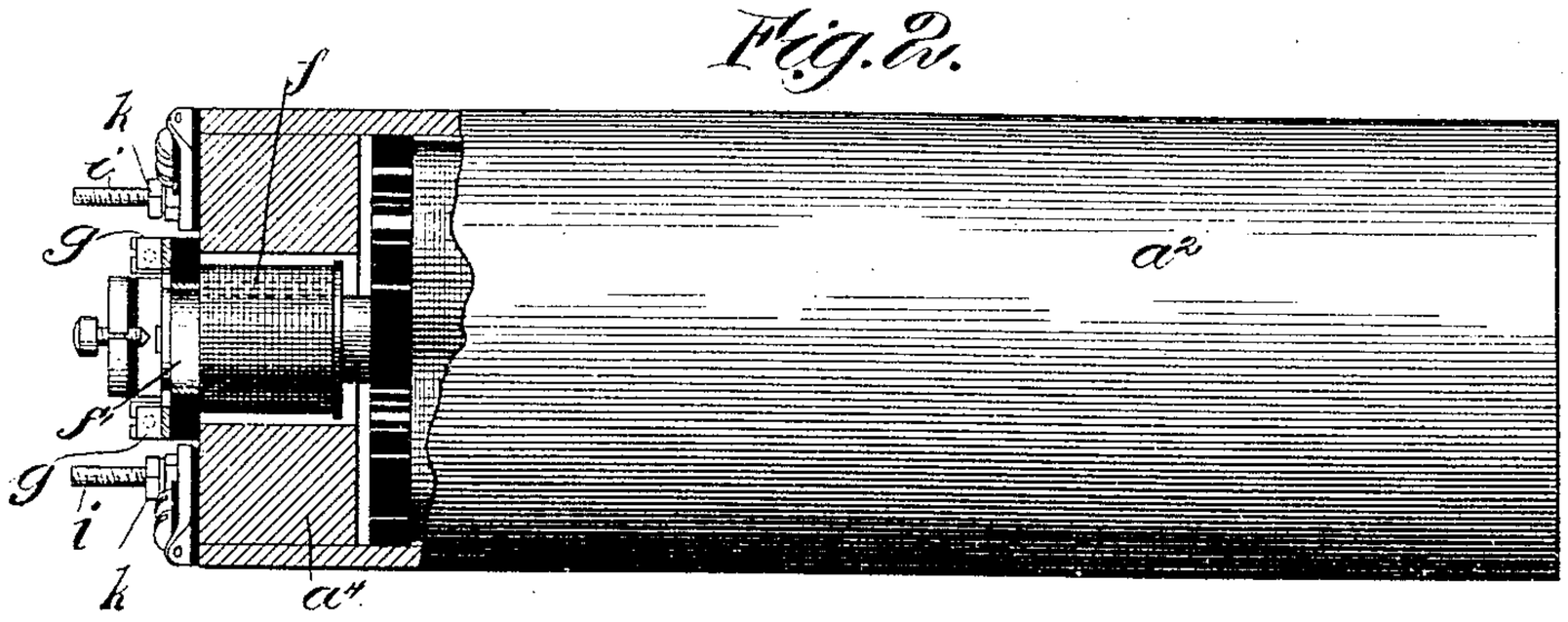


Fig. 4.

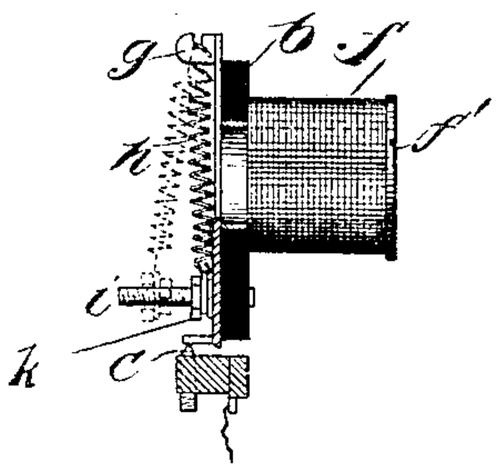


Fig. 3.

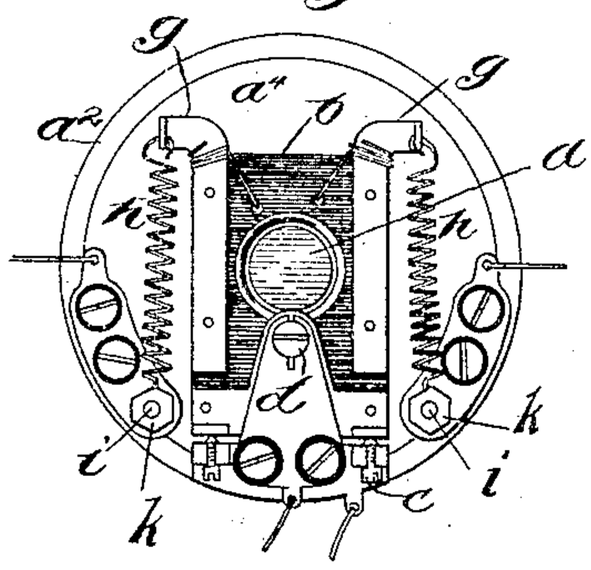
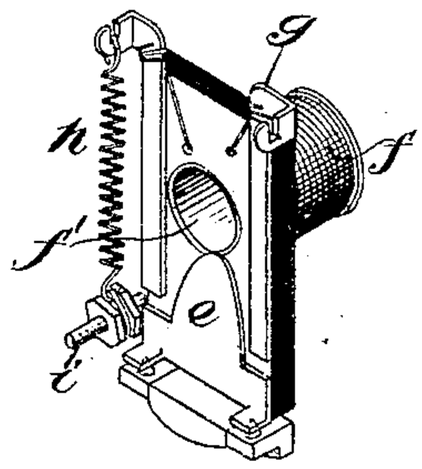


Fig. 5.



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SUPERVISORY APPARATUS FOR TELEPHONE SYSTEMS.

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2 SHEETS—SHEET 2.

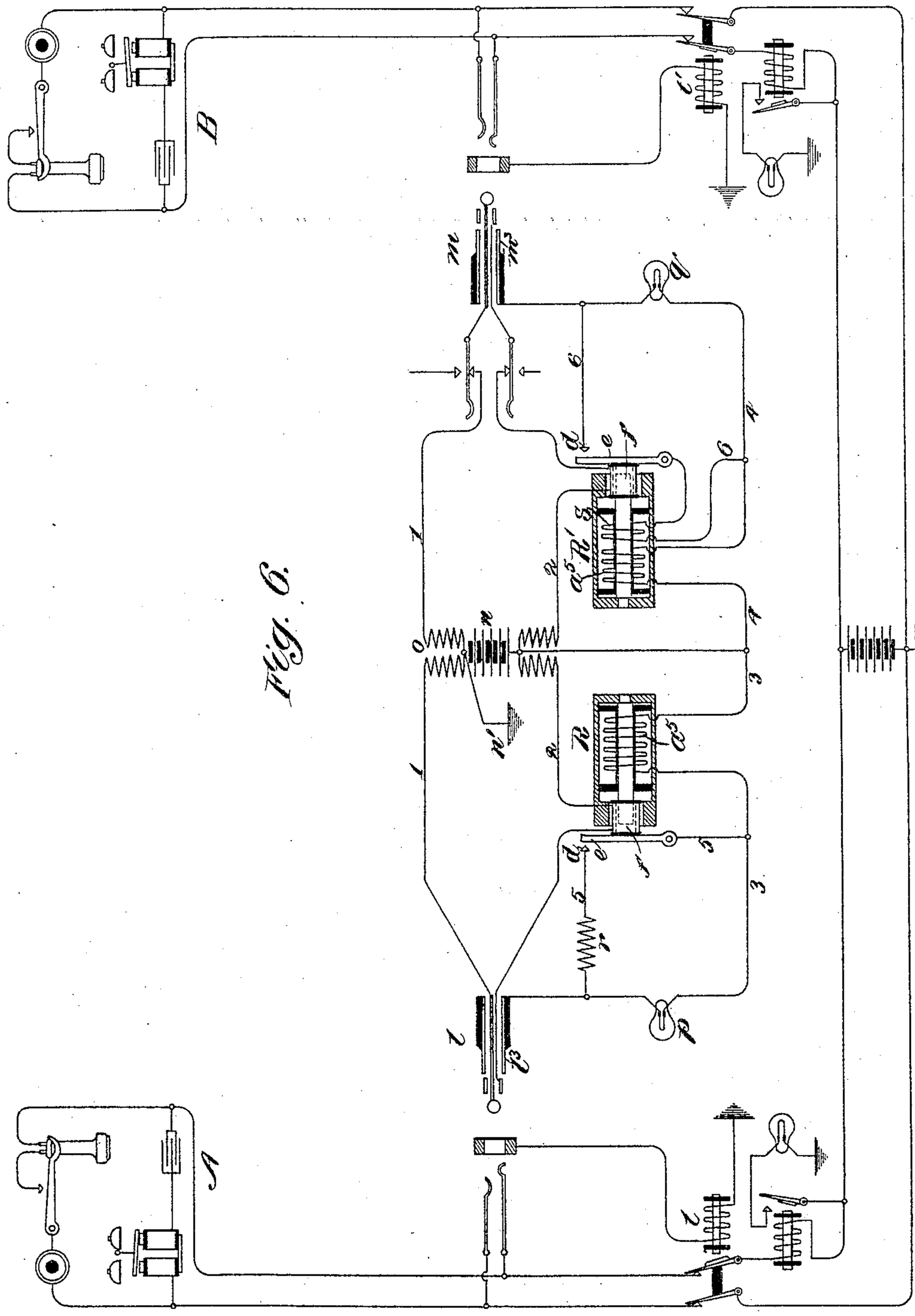

FIG. 1.

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UNITED STATES PATENT OFFICE.

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SUPERVISORY APPARATUS FOR TELEPHONE SYSTEMS.

SPECIFICATION forming part of Letters Patent No. 778,569, dated December 27, 1904.

Application filed July 7, 1902. Serial No. 114,535.

To all whom it may concern:

Be it known that I, WILLIAM W. DEAN, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented a certain new and useful Improvement in Supervisory Apparatus for Telephone Systems, of which the following is a full, clear, concise, and exact description.

My invention relates to supervisory apparatus for telephone-exchange systems; and its object is particularly to produce a supervisory relay which will be extremely sensitive and which will have very little resistance and very little self-induction, so that it will be perfectly adapted for use in telephone-circuits and will not interfere with the proper transmission of the delicate voice-currents. A relay having these characteristics would have a very wide range of usefulness; but my attention has been directed particularly toward the improvement of supervisory signaling apparatus for telephone-switchboards, and the relay of my invention was designed particularly to form a part of such apparatus.

In accordance with this invention a coil or conductor of low resistance and self-induction is included in the telephone-circuit, being also in the path of direct current controlled by the substation-switch. This coil or conductor is mounted in the field of force of a strong magnet, so as to move to and fro, according to the direction of current flowing through said coil, and an indicator or signal is arranged to be controlled by the movement of said coil. The magnet is preferably an electromagnet and may be included in a local circuit which is established in closing the plug-and-socket switch, by which connection is made with the telephone-line.

I will describe my invention more particularly by reference to the accompanying drawings, in which—

Figure 1 is a vertical sectional view of a relay constructed in accordance with my invention. Fig. 2 is a plan view thereof, partially in section. Fig. 3 is an end view. Fig. 4 is a detail illustrating in elevation the movable coil and its mounting. Fig. 5 is a perspective view of the same, and Fig. 6 is a diagram illustrating a telephone system and supervisory signal apparatus therefor constructed and operating in accordance with my invention.

Similar characters of reference are used to designate the same parts wherever they are shown.

The core of the magnet a, as shown most clearly in Figs. 1, 3, and 6, is constructed in the form of a central rod a', surrounded by an inclosing shell a^2, the two being joined at the rear by a circular heel-piece a^3. The magnetizing helix or winding occupies a space between the inner core or rod a' and the inclosing shell a^2. An annular pole-piece a^4 is fitted within the shell a^2, at the forward end thereof, and an annular space is left between the core a' and the outer pole-piece a^4. In other words, the magnet a is provided with two concentric pole-pieces a' a^4, whereby an annular magnetic field is produced in the space between the inner and outer pole-pieces. The lines of force, that is to say, radiate from the central core to the annular inclosing pole-piece a^4, and an annular magnetic field of great intensity is produced. A plate b, of non-magnetic material, is pivoted at the bottom upon two screw-points c c, upon which it is adapted to oscillate toward or away from the end of the magnet. The outward movement of this plate b is limited by a stop d, against which a conducting-plate e is adapted to strike when the plate swings outwardly. The plate e and the stop d are adapted to be connected with an electric circuit and to constitute terminal contacts therefor. A hole is cut in the plate b slightly larger than the end of the core-piece a' and registering therewith, and a cylindrical drum f', of copper, is fitted into this hole, extending inwardly and inclosing the end of the core-piece a'. Around this copper drum f' are wound a few turns of fine insulated copper wire f, the ends whereof are led out through the plate b and attached, respectively, to two metal strips g g, fastened to the front of the plate b. Springs h h are fastened at the upper ends of these strips g g and are fastened

at the bottom to threaded projections *i i*, which are mounted upon but insulated from the end of the pole-piece a^4. Threaded nuts *k k* engage these threaded extensions *i i*, whereby the lower end of the springs *h h* may be moved in or out along the rods *i i* to adjust the tension or to change the position of the lower ends of the springs so that they may lie to one side or the other of the fulcrums or pivotal points *c c*, upon which the plate *b* is adapted to oscillate—that is to say, the springs may be adjusted so that the contact between the plate *e* and the contact-point *d* is held either normally open or normally closed, as may be desired. The coil *f* being disposed within the annular magnetic field between the two conducting pole-pieces a' a^4 will tend to move in the line of its axis—that is, in the line of the core a'—when traversed by an electric current, the direction of such motion being dependent upon the direction in which the current flows through the coil—that is to say, assuming that the pole-piece a' is a north pole and, looking at the front end of the coil, as in Fig. 3, assuming that the current flows in the coil in a clockwise direction the coil will tend to move outwardly—that is, will tend to close the contact between the plate *e* and the contact-point *d*. The springs *h h* are shown as adjusted in position to oppose this outward movement and tend to keep the contact broken.

The operation of my improved relay will be understood by referring to Fig. 6, which shows two such relays for controlling the supervisory signal apparatus of a pair of connecting-plugs at the central office of a telephone-exchange system. Two subscribers' stations A B are shown, the telephone-lines whereof extend to spring-jacks and the usual line-indicating apparatus at the central office. The operator is provided with a pair of plugs *l m* and their cord-circuit for insertion in the spring-jacks of any two lines to connect such lines together for conversation. A centralized battery *n* is bridged across the tip and ring strands 1 2, respectively, of the plug-circuit between the windings of the usual repeating-coil *o*. The side of the battery *n* which is connected with the tip-strand 1 is grounded at *n'*. The movable coil *f* of relay R is included serially in the cord-strand 2 between the battery *n* and the ring of the plug *l*, and similarly the coil *f* of relay R' is included serially in the strand 2 of the plug-circuit between the battery *n* and the ring of plug *m*. A conductor 3, including serially the helix a^5 of relay R and the supervisory signal-lamp *p*, extends from that side of battery *n* which is not grounded to the third contact l^3 of plug *l*. Similarly a conductor 4 connects the same side of the battery *n* with the third contact m^3 of plug *m* through the helix a^5 of relay R' and the supervisory signal-lamp *q*. The movable coil *f* of relay R operates the contacts *e d*, which control a shunt 5 around the supervisory signal *p*, and similarly the contacts *e d* of relay R', which are operated by the movement of the coil *f* thereof, control a shunt-circuit 6 about the supervisory signal-lamp *q*. A resistance-coil *r* is included in the shunt-circuit 5 between the contact-point *d* and the sleeve l^3 of the plug *l*, and the relay R' is provided with a supplemental helix *s*, which is included in the shunt-circuit 6, taking the place of the mere dead resistance *r* of the shunt 5. When the plugs *l m* are inserted in the spring-jacks of the lines to stations A B, respectively, the circuit of battery *n* is completed from ground *n'* through the windings a^5 of relays R R', respectively, to the sleeve-contacts l^3 m^3 of plugs *l m* to the test-rings of the jacks and to ground through the usual cut-off relays *t t'* of the subscribers' lines. The relays R and R' are thus rendered responsive to the flow of current in the lines to substations A and B, respectively. The operation of these relays can best be understood by tracing the progress of a connection made between two subscribers' lines in response to a call from one of them. For this purpose let us assume that the subscriber at substation A desires communication with the subscriber at substation B. He signals the central-office operator in the usual way by apparatus which is well known in the art and need not be particularly described, and the operator in response to his call inserts the plug *l* in the spring-jack of his line. The circuit of battery *n* through the magnet-coil a^5 of relay R is thus completed to ground through the cut-off relay *t* of subscriber A's line, and the relay R is rendered responsive to the flow of current in that line. The telephone at station A being off the hook, the circuit between the two limbs of the telephone-line is thus completed at that substation in a manner well understood, and current from battery *n* flows out over the strand 2 of the plug-circuit to one side of the line, through the subscriber's apparatus at the substation, and back over the other side of the line to the other pole of the battery by way of the cord-strand 1. The movable coil *f* of relay R is wound and connected in such a way that the current from battery *n* flowing through it will be of suitable direction to cause an outward movement of the coil. This will cause contacts *d* and *e* to be closed together, completing the shunt-circuit 5 about the signal-lamp *p*, so that current will be diverted from the lamp through this shunt-path and the lamp will remain darkened. The operator of course would be provided with the usual telephone set and listening-key associated with her cord-circuit for communicating with the calling subscriber. When the operator learns the number of the subscriber called for, she inserts the connecting-plug *m* in the spring-jack of the called line and signals the called subscriber

in a well-known manner. Immediately upon the insertion of the connecting-plug into the jack of the called line the magnet of relay R′ is energized, as previously explained; but until the called subscriber responds no current passes through the coil *f* of the relay R′, so that the shunt-circuit 6 is not closed and the supervisory signal-lamp *q* remains lighted by current from battery *n* in the circuit 4 until the shunt 6 is closed by the movement of the coil *f* in response to the flow of current therethrough—that is, until the called subscriber removes his telephone from its hook. When the called subscriber responds, current flows through the coil *f* of relay R′, which causes the coil to move outwardly, closing contacts *d* and *e* together and establishing the shunt-circuit 6 about the signal-lamp *q*. The establishment of this shunt-circuit diverts the current through the lamp *q*, so that the lamp is extinguished and remains dark until the subscriber at station B replaces his telephone upon the hook, whereupon the lamp will be lighted, as before explained, to indicate to the operator that subscriber B has finished using his telephone and desires a disconnection.

It will be observed that the shunt-circuit 6 differs from shunt-circuit 5 in that the resistance *s*, which is interposed in the circuit 6 to prevent the short circuit of the battery *n*, is wound about the magnet-core of relay R instead of being in a separate coil of mere dead resistance, as is the case with the resistance *r* in the shunt-circuit 5. The winding *s* is connected so that the current flowing therein will magnetize the core in the same way as the current flowing in winding a^5. In other words, the effects of the two windings are accumulative. When the shunt-circuit 6 is closed, therefore, the effect will be to strengthen the annular field of force and cause the contacts *d* and *e* to press more tightly together; otherwise the relay R′ is constructed in the same manner as the relay R and the connections are the same. The relay R′ is merely a modification.

I claim—

1. The combination with an electric circuit, a source of current therein, means for determining the flow of current in said circuit, instruments in said circuit responsive to rapidly-varying currents and means for producing such rapidly-varying currents in the circuit, to operate said instruments, a coil *f* included in said circuit, the self-induction of said coil being very small so as not to impede the proper transmission of the rapidly-varying currents, a magnet *a* within the field whereof said coil is placed, a mounting for said coil permitting the same to swing to and fro, whereby said coil is caused to move relatively to said magnet, under the influence of current flowing therein, a local circuit, and relay-contacts, operated by the movement of said coil, for controlling said local circuit, whereby the condition of said local circuit is determined by the flow of current in the first-mentioned circuit, substantially as set forth.

2. The combination with a telephone-line extending from a substation to a central office, of a source of direct current and means at the substation for controlling the flow of current in the line, a coil *f* of low resistance and self-induction at the central office, included in the main telephone-circuit, in the path of the direct current aforesaid, a magnet within the field of force of which said coil is disposed, a mounting for said coil permitting the same to move relatively to the magnet-pole, whereby the coil is moved in response to the flow of current in the telephone-circuit, an indicator or signal, and means, controlled by the movement of said coil, for effecting the display or concealment of said signal, substantially as described.

3. The combination with two telephone-lines extending from substations to a central office, of spring-jacks for the lines at the central office, a pair of plugs and their plug-circuit for connecting the lines together, a source of current in the plug-circuit and means at the substation of one of the lines for determining the flow of current therein, a coil *f* of low resistance and self-induction included in the plug-circuit, in the path of current from the aforesaid source, a magnet within the field whereof said coil is mounted and means for exciting the same, a mounting for said coil, whereby it is permitted to move to and fro under the influence of current flowing therein, relay-contacts *d e* operated by the movement of said coil, and a local circuit including an indicator or signal, controlled by said relay-contacts, substantially as set forth.

4. The combination with two telephone-lines extending from substations to a central office, of spring-jacks for the lines at the central office, a pair of plugs and their plug-circuit for connecting the lines together, a source of current connected with the plug-circuit and means at the substation of one of the lines for determining the flow of current therein, a coil *f* of low resistance and self-induction included in the plug-circuit, in the path of current from the aforesaid source, a magnet within the field whereof said coil is mounted, means, controlled by connection of the plug-circuit with a line, for exciting the said magnet, a mounting for said coil permitting the same to move relatively to the pole-piece of said magnet, under the influence of current traversing said coil, and a supervisory signal controlled by the movement of said coil.

5. The combination with a telephone-line extending from a substation to a central office, of a spring-jack for the line at the central office, a plug and its plug-circuit, adapted to make connection with the line, a source of current connected with the plug-circuit, and means at the substation for determining the

flow of current in the line, a coil *f* of low resistance and self-induction included in said plug-circuit, in the path of the current controlled at the substation, a magnet within the field whereof said coil is mounted, a mounting for said coil permitting the same to swing to and fro under the influence of current flowing therein, an energizing-helix a^5 for said magnet, a supervisory signal *p* and a circuit 3 including said supervisory signal and the helix a^5 of the magnet with a source of current, said circuit being completed by connection of the plug-circuit with the telephone-line, a shunt 5 about the supervisory signal *p*, and relay-contacts *d e*, operated by the movement of said coil *f*, controlling said shunt-circuit, substantially as described.

6. The combination with a telephone-circuit and means for producing varying telephone-currents therein, of a source of direct current and means for controlling the flow of such current in said telephone-circuit, a responsive device comprising an electromagnet having concentric pole-pieces adapted to produce an annular field of force, and a coil of small self-induction included in said telephone-circuit and movably supported in the annular field of force of said electromagnet, a circuit for the magnet including a source of current and a switch for controlling said circuit, whereby a movement of said coil may be produced by a change in the flow of direct current in either circuit, the flow of telephone-current being unimpeded.

7. The combination with an electric circuit and means for changing the flow of current therein, of an electromagnet in said circuit, a coil of small self-induction movably supported in the field of force of said magnet, a second circuit including telephone apparatus together with said coil, a source of direct current and means for controlling the flow of direct current in the circuit of said coil; whereby said electromagnet and movable coil constitute a responsive device sensitive to changes in the flow of direct current in either of said circuits, the flow of telephone-current in the second circuit being unimpeded thereby.

8. The combination with a telephone-line, of a switch for making connection therewith, a local circuit controlled by said switch, an electromagnet with concentric pole-pieces having a winding included with a source of current in said local circuit, a coil of small self-induction movably supported in the annular field of force produced between said concentric pole-pieces when the local circuit is completed, said coil being included with a source of current in the circuit of said telephone-line, a switch included in the telephone-line circuit adapted to control the flow of current therein, and a signal actuated in the movement of said coil, whereby the signal is jointly controlled by both of the aforesaid switches.

In witness whereof I hereunto subscribe my name this 28th day of May, A. D. 1902.

WILLIAM W. DEAN.

Witnesses:
EDWIN H. SMYTHE,
GERTRUDE EYSTER.