F. W. DUNBAR.

TELEPHONE SYSTEM.

APPLICATION FILED MAY 9, 1904.

904,850.

Patented Nov. 24, 1908.

2 SHEETS—SHEET 1.

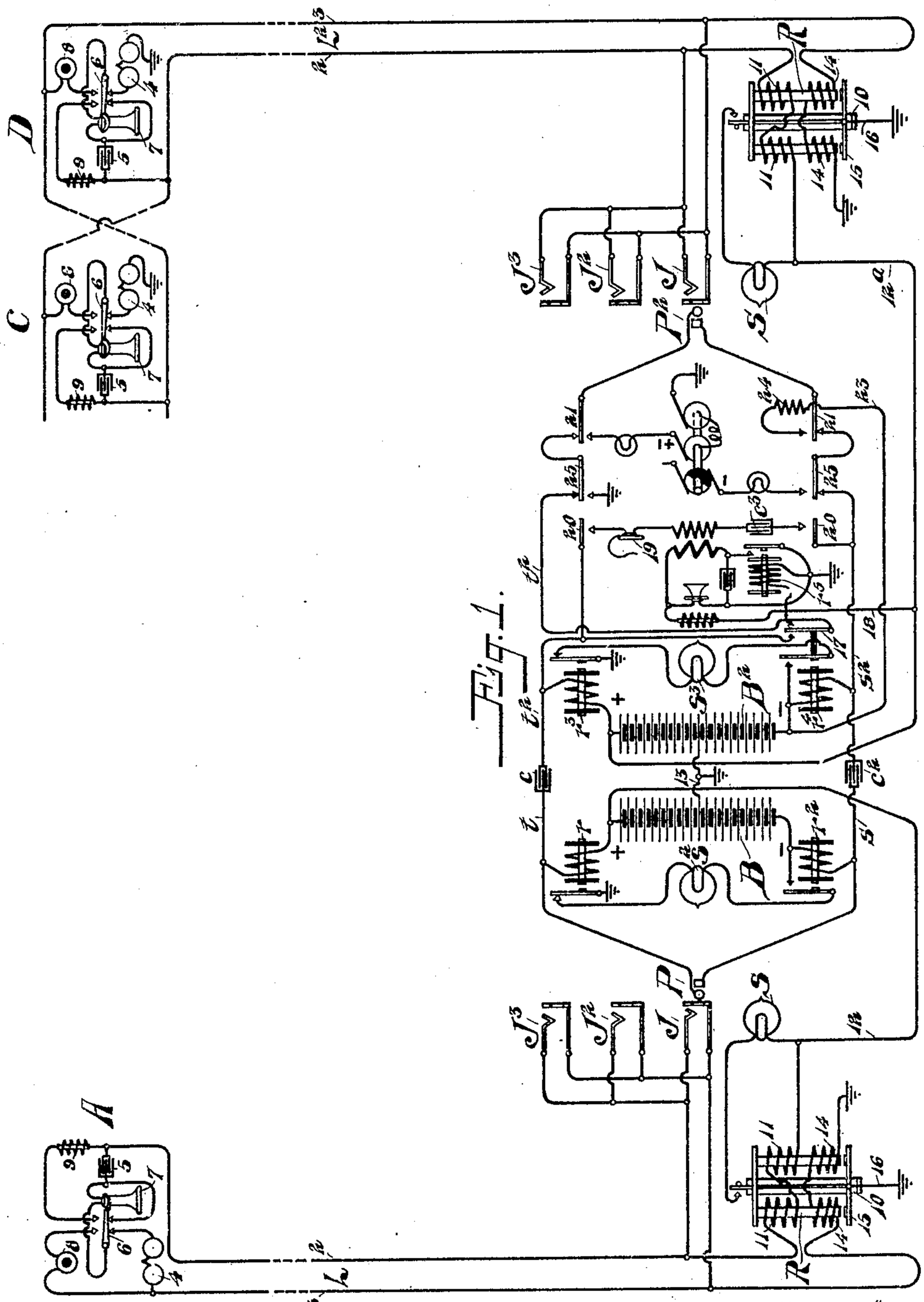

Fig. 1.

Witnesses.
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2 SHEETS—SHEET 2.

Fig. 2.

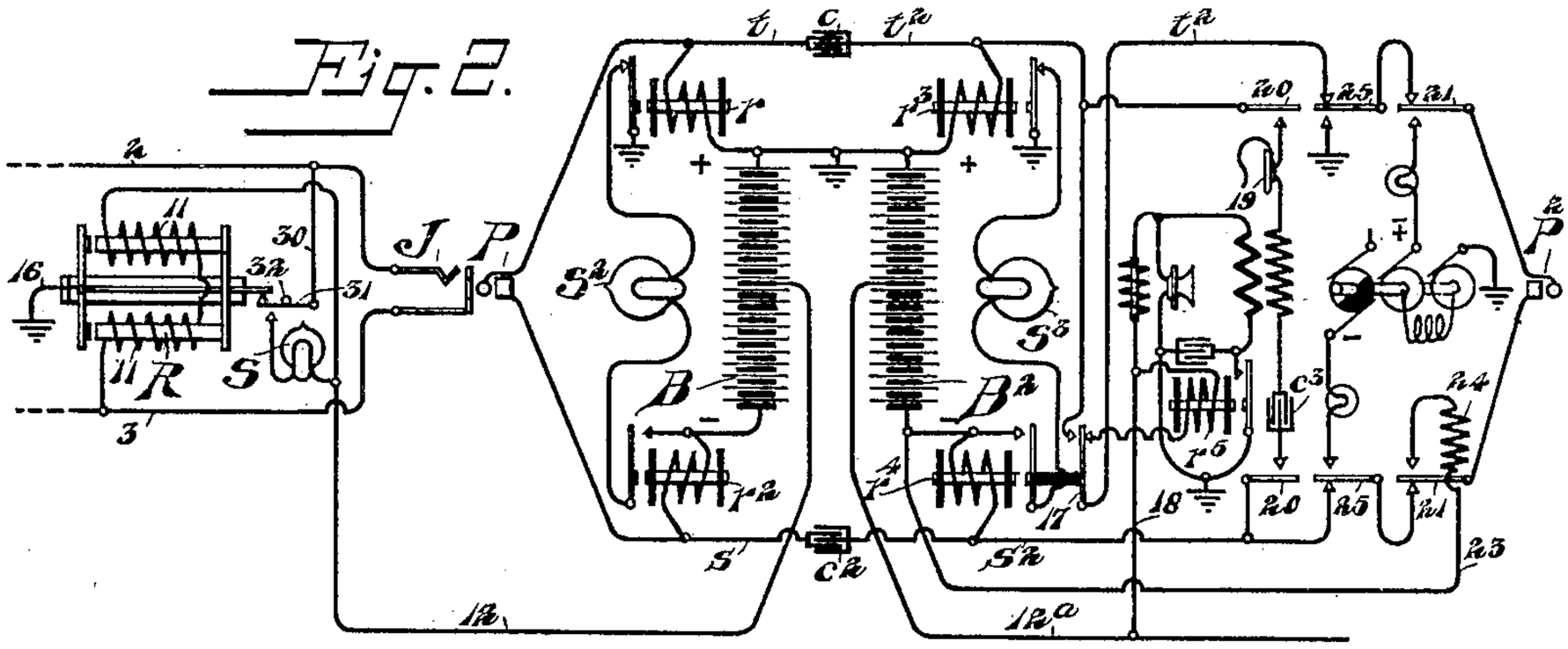


Fig. 3.

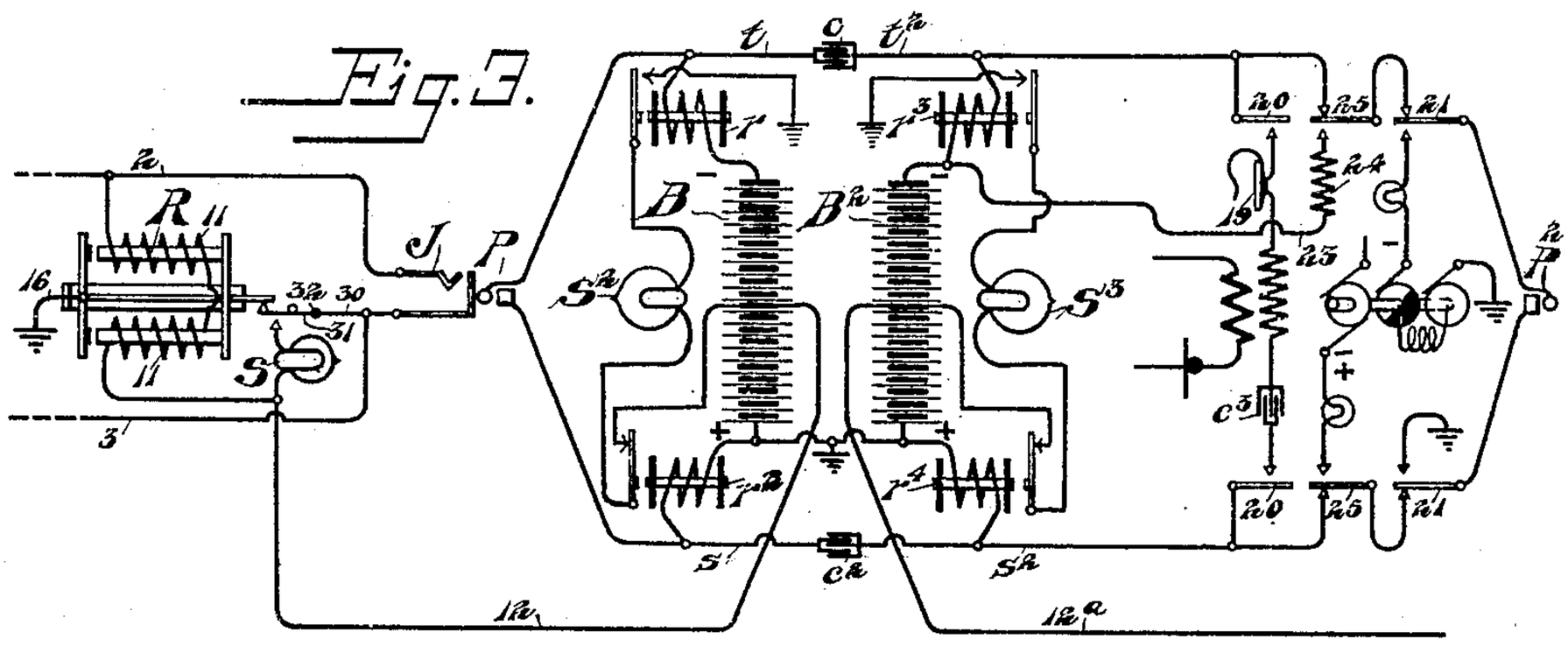
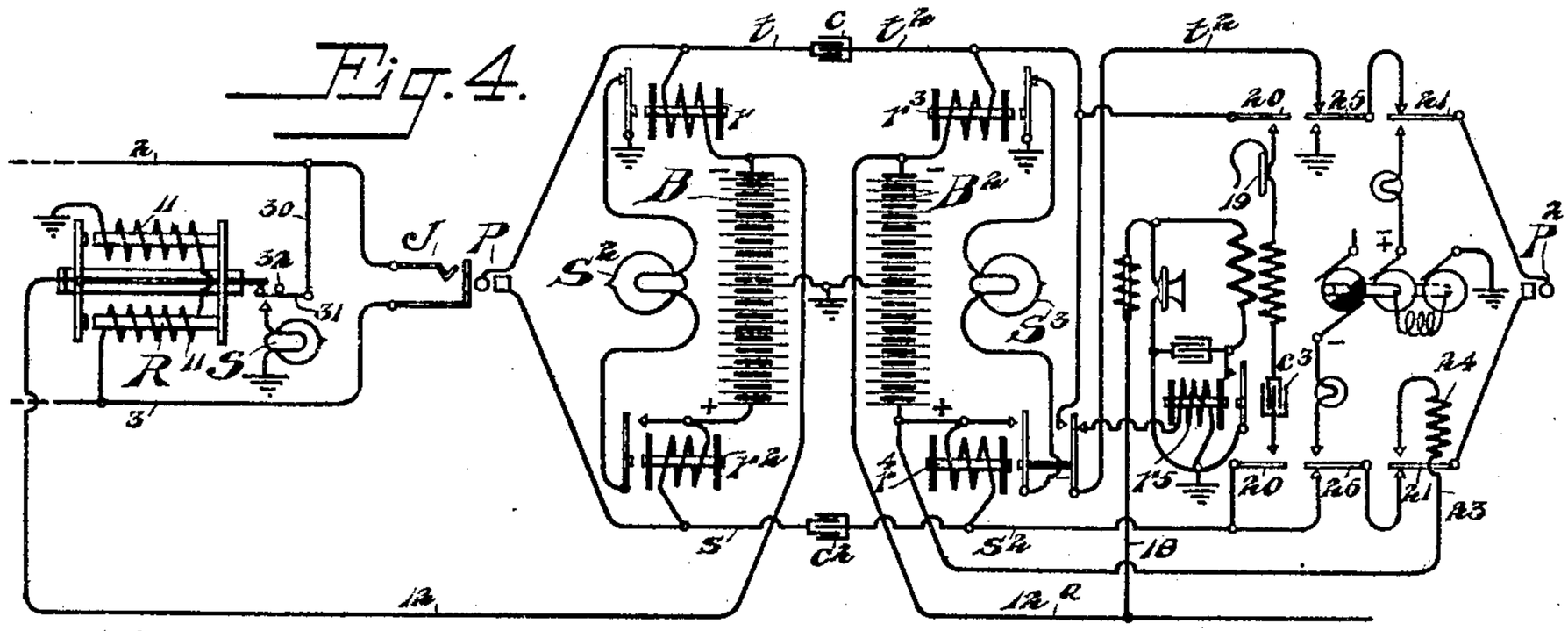


Fig. 4.



Witnesses.

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UNITED STATES PATENT OFFICE.

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TELEPHONE SYSTEM.

No. 904,850. Specification of Letters Patent. Patented Nov. 24, 1908.

Application filed May 9, 1904. Serial No. 206,995.

To all whom it may concern:

Be it known that I, FRANCIS W. DUNBAR, a citizen of the United States of America, and resident of Chicago, in the county of Cook and State of Illinois, have invented a new and useful Improvement in Telephone Systems, of which the following is a specification.

My invention relates to improvements in telephone systems, particularly of the two-wire type.

It consists in providing each telephone line with a single relay, which is preferably polarized and which is suitably actuated by calling current in the line when the subscriber is calling the central office, but which is rendered inoperative when the connection is established with the line to retire or prevent the operation of the calling signal.

Other features of the invention include improvements in the cord circuit to adapt it particularly for use with the line circuits.

My invention is illustrated in the accompanying drawings in which

Figure 1 is a diagram of one form or arrangement of the system, and Figs. 2, 3 and 4 are modifications thereof.

Referring particularly to Fig. 1, L and L^2 indicate subscribers' lines extending in two limbs 2 and 3 from their respective substations to the central office. At the substation A, a call bell 4 and condenser 5 are included in a bridge of the line conductors normally closed by the switch-hook 6; and a receiver 7, transmitter 8 and retardation coil 9 are adapted to be suitably connected in the circuit when the receiver is removed therefrom. This apparatus is intended to typify any usual or desired common battery substation outfit. At the central office each of the lines is provided with an answering jack J and with a suitable number of multiple jacks such as J^2 and J^3, all preferably permanently connected with the telephone lines, and with a line relay R which is polarized as by permanent magnet 10. This relay is provided with windings 11 connected between the tip conductor 2 of the line and conductor 12 leading to the positive pole of a battery B which is grounded at the center as shown by the branch 13. The said relay is also provided with windings 14 legged to ground from the sleeve side of the line. The windings 11 are so wound that current flowing through them serves to assist the permanent magnet 10 in polarizing the vibrating armature 15 of the relay, while the windings 14 are wound so as to produce a north pole upon the free end of one core and a south pole at the free end of the other. These latter windings are therefore the active windings of the relay, while the other windings are merely balancing windings for the line and might be replaced by any suitable windings for that purpose. The armature is grounded by branch conductor 16 and serves when suitably actuated to close the normally open circuit of the line signal S; it is preferably so adjusted as to restore itself so that when uninfluenced by the magnets of the coils, it returns to normal position.

Each of the lines is provided with similar apparatus but some of them are connected by a common conductor 12^a with a second battery B^2 similar to the battery B. The operator's outfit comprises a number of cord circuits of the type shown in the drawing, each having an answering plug P and a calling plug P^2 provided with tip and sleeve contact surfaces adapted to register with the corresponding contacts of the spring jacks of the lines when inserted therein. The tip contacts of the two plugs are united by the flexible strands t and t^2 and the condenser c, while the sleeve contacts are connected with flexible strands s and s^2 and condenser c^2.

The battery B is bridged across the answering end of the cord circuit and includes upon either side, the supervisory relays r and r^2 controlling, the former through its normally closed contacts and the latter through its normally open contacts, the local circuit of the supervisory signal S^2 associated with the answering plug P. The battery B^2 is likewise bridged across the calling end of the cord circuit and includes upon either side of the supervisory relays r^3 and r^4 controlling in a similar manner the local circuit of the supervisory signal S^3 associated with the calling plug P^2. The supervisory relay r^4 is provided with an additional contact 17, adapted in its forward position to complete the talking strand t^2 for conversation, and in its normal position to connect with a grounded high resistance and high impedance test relay r^5, which serves when energized to complete a path for current through the primary of the operator's induction coil and the conductors 18 and 12^a from the battery B^2. The operator's

outfit, comprising the usual receiver 19, the secondary of her induction coil and the condenser c^3, is adapted to be bridged across the cord circuit by any suitable listening key 20. A ringing generator is adapted to be connected between ground and the tip side of the line by means of ringing key springs 21 while at the same time the sleeve of the cord circuit is connected with the battery lead 23 containing the resistance coil 24. The said generator may be connected with the sleeve side of the line by ringing key springs 25, the tip side of the line being at the same time grounded. Upon the line L^2 two stations are shown with the signaling bells 4 grounded from the opposite sides of the line. Otherwise the arrangement is the same as that shown at station A.

In the operation of the system the subscriber A removes his receiver and closes circuit for a portion of the battery B from the positive pole thereof over conductor 12, through windings 11 of the line relay R, line conductor 2, through substation instruments back to the central office over line conductor 3 and thence through windings 14 of relay R to ground and back to the center of the battery. The current through the coils 14 is now of the proper direction to tip the armature 15 of relay R from its normal position and to close the local circuit of the line signal S which is lighted to indicate the fact of the call. In response to the call the operator inserts the answering plug P of her cord circuit in the jack of the line which permits current from the battery B to circulate in the metallic line. Current from the positive pole of said battery now flows through the supervisory relay r and the windings 11 of the line relay R in parallel and thence over the line conductor 2 to the substation, returning over line conductor 3. Current also flows from the grounded pole of said battery through the ground and thence through the windings 14 of said line relay R to the line conductor 3 where it joins the returning current over the telephone line, and flows over the sleeve strand s and through the sleeve relay r^2 to the negative pole of said battery. This current is therefore in the opposite direction through windings 14 of relay R than when the subscriber was calling the central office so that the tongue of said relay is restored to normal position and the signal S is extinguished. At the same time sleeve supervisory relay r^2 is actuated to close the local circuit of supervisory signal S^2 but owing to the fact that tip supervisory relay r is also now actuated the local circuit of said signal is opened and the signal remains inert.

Connecting her instrument with the line the operator receives the order and proceeds to test the condition of the wanted line. Normally the test rings of the jacks of the lines are grounded through the windings 14 of relays R and since the tip strand of the cord circuit is grounded through the test relay r^5 no flow of current results when the tip of the plug is touched to one of the test rings, and no click is received by the operator. In case of a connection, however, the said test rings are connected through the sleeve strand of the cord circuit with the negative pole of either the battery B or B^2, whereby when the grounded tip of a testing plug is touched to one of the test rings, a flow of current results through the test relay and the same is actuated to inductively cause a click in the operator's receiver. It will be understood that the said test relay is of sufficient resistance and impedance to prevent a large or sudden variation of current upon the tested lines so that the subscribers are not annoyed. Any other test receptive device may, of course, be substituted for the apparatus shown.

Upon finding the line idle the calling plug P^2 is inserted and the ringing generator actuated. Closing the springs 21 of the ringing key serves to connect the generator with the tip side of the line and rings the bell at station D. At the same time current from the lower portion of the battery B^2 flows from ground over conductor 23, sleeve strand s^2, sleeve conductor of the line jacks and through the coils 14 of the line relay R of the called line, and is in the proper direction to prevent its operation. Operating springs 25 of the ringing key would serve to connect the ringing generator with the sleeve side of the line which would operate the call bell at station C; this ringing current is negative pulsating in character, and the portion flowing through the windings 14 of relay R serves to maintain the same inoperative.

It will be noted that during ringing, current flows over the conductor 12^a, through windings 11 of relay R and thence over the tip strand of the cord circuit and either through the generator when springs 21 are operated or directly to ground when springs 25 are operated. In either case, however, this current assists the permanent magnet so that the said relay is not operated thereby, while the retardation of coils 11 prevents the passage of the ringing current therethrough.

After calling the subscriber and before his response relay r^4 is actuated by current from the negative pole of battery B^2 through said relay and over the sleeve strand s of the cord circuit and thence through windings 14 of relay R to ground. This current is of suitable direction to prevent the actuation of relay R while serving to energize relay r^4 to close the local circuit of signal S^3, which is now lighted owing to the fact that the subscriber has not yet responded.

Spring 17 of relay 7^4 serves now to disconnect the test relay 7^5 and to complete the tip strand of the cord circuit for talking.

Upon the response of the called subscriber current flows over the line L^2 in the same manner as described for the line L so that the relay 7^3 is actuated to open the local circuit of signal S^3 and extinguish the same.

During conversation it is necessary that the direction of the current in the sleeve winding of the polarized relay should be from ground to the sleeve side of the circuit; in other words, should be the reverse of the direction of the current when a call is made by a subscriber. If a line and instrument were of zero resistance, and if the resistance of the sleeve relay in the cord circuit were 90–9/10 ohms, the windings 11 and 14 of the relay R of 1000 ohms each, and the battery 40 volts, then no current would flow through the sleeve winding of the polarized relay because under these conditions the sleeve side of the line circuit and the ground at the center of the battery would be at the same potential. As, however, the sleeve relay has a resistance higher than 90–9/10 ohms, current will flow from ground through the sleeve winding to the negative side of the battery in the cord circuit. This is true even if the line and instrument have zero resistance, and the greater the resistance of the line and instrument the greater will be the current flowing over this path.

This system is of course applicable to one battery in the cord circuit and in practice is perhaps better adapted for such use due to the fact that variations between the voltages of the two sets of batteries may decrease the margin of operation of the system.

At the termination of the conversation the subscribers return their receivers to the hooks and open the line circuits so that the same conditions prevail as was described for line L^2 after the subscriber was called and before his response. As then pointed out, these relays are prevented from operation so that the line lamps S do not light and since the supervisory relays 7 and 7^3 are deprived of operating current the local circuits of signals S^2 and S^3 are closed and the said lamps are lighted. Upon observing this the operator withdraws the plug and takes down the connection, thus restoring all parts to normal condition.

In Figs. 2, 3 and 4 the polarized line relay has but one winding, the balancing winding being replaced by a spring contact legged from either the tip or sleeve side of the circuit. The polarized relay has thus three contacts instead of one pair.

In Fig. 2 the batteries B and B^2 are grounded at the tip end of the battery, while their centers are connected by the conductors 12 and 12^a with the actuating windings of line relays R which are connected with the sleeve sides of the line circuits. The test relay is therefore connected to conductor 18 leading to the center of the battery instead of to ground as in the former instance. The method of testing, however, is obvious. The tip side of the line is normally grounded through conductor 30, spring 31 of line relay R, the tongue of said relay and ground conductor 16. Normally when a subscriber calls, current flows from the battery B over conductor 12, through the windings of relay R and out over the line of the substation and thence back to the central office and through conductor 30, spring 31 and branch 16 to ground. This current is of a suitable direction to actuate the relay R which causes spring 31 to close the local circuit of the line signal S to light the same. Upon the insertion of the plug into the jack of the line, the winding of said relay R is inclosed in a local circuit with the lower portion of battery B and is therefore actuated in the reverse direction so as to not only permit spring 31 to return to normal position to open the circuit of lamp S but to also lift said tongue out of contact with said spring 31, whereby the ground connection from the tip side of the line is opened. This condition is not altered throughout the connection, so that the line signal remains inoperative. Otherwise the operation is similar to that described with reference to Fig. 1 and will be readily understood.

Fig. 3 shows the line relay permanently connected with the tip side of the line, while the sleeve side of the line is normally grounded through the tongue of the line relay. The sleeve ends of the batteries B and B^2 are grounded instead of the tip side as in Fig. 2. This necessitates ringing with negative pulsating current over the tip side of the telephone line and with alternating current over the sleeve side of the line. When alternating current is sent over the sleeve side of the line, negative battery is thrown upon the tip side of the line so as to throw the armature of the polarized relay away from the spring contact. The operation is thought to be obvious.

In Fig. 4 the tip side of the circuit is normally connected through the spring contact of the polarized line relay with the negative side of the battery B^2. When a call is made negative current flows over the tip side of the circuit through the subscribers' instruments and back through the sleeve windings of the polarized relay to ground. This establishes a north pole on one core of the relay and a south pole on the other core so that the armature will be suitably attracted to close the line lamp to ground, thus lighting it. When the call is answered positive current will be sent through the sleeve relay in the cord circuit

and through the winding of the polarized relay to ground. This will attract the armature of the polarized relay in the opposite direction, first opening the line circuit and then the tap from the tip side of the line to the armature of the relay. The spring contact is prevented from following the armature by the dead stop 32 as shown in this figure as well as in Figs. 2 and 3. In the case of Fig. 4, if the line and instrument were of zero resistance, no current would flow through the line relay, but as the line and instrument always have some resistance positive current will flow through the winding of the polarized relay to ground in all cases. It is obvious that in plugging into a called for line the polarized relay will be operated in a direction to cut-off the tap from the tip side of the cord circuit. In this instance again the batteries are grounded at the center.

It will be understood that the several grounds mentioned may be and in practice usually are one and the same or they may be the common office return and that the ringing and listening keys mentioned may be any of the usual types.

Having thus described my invention, what I claim and desire to secure by Letters Patent is:—

1. In a telephone system, the combination with a telephone line, of a polarized line signaling device connected therewith at the central office, a source of current connected with the line at the central office and adapted to send current through said device in the proper direction to operate the same when the subscriber is calling, a cord circuit at the central office to establish connections with the line for conversation, a pair of electro-magnets one associated with each limb of the cord circuit, a supervisory signal controlled by said magnets, one of said magnets being included in a local circuit with the actuating windings of said device when a connection is established with the line, the current in said local circuit being in the proper direction to render said device inoperative and sufficient to energize the magnet to cause said supervisory signal to operate and the other magnet being placed under the control of the subscriber and serving when energized to render the supervisory signal inoperative, substantially as described.

2. In a telephone system, the combination with a telephone line, of a polarized line signaling device connected therewith at the central office, a central source of current in said line adapted to send current through the said device in the proper direction to operate the same when the subscriber is calling, a cord circuit at the central office to establish connection with the line for conversation, a pair of electro-magnets associated with said cord circuit, a supervisory signal controlled thereby one of said magnets being connected in a local circuit with said device and including a portion of one of the talking strands of the cord circuit when a connection is established with the line, the current in said local circuit being the proper direction to render said device inoperative and of sufficient strength to cause said supervisory signal to operate, and the other electromagnet being in the path of current over a portion of the other talking strand of the cord circuit and the metallic telephone line and therefore under the control of the subscriber, said electromagnet serving when energized to render said supervisory signal inoperative, substantially as described.

3. In a telephone system, the combination with a telephone line, of a polarized line signaling device connected therewith at the central office, a source of current connected with the line at the central office and adapted to send current through said device in the proper direction to operate the same when the subscriber is calling the central office, a cord circuit to establish connections with the line for conversation, a pair of relays associated with the cord circuit, a supervisory signal controlled by said relays, one of said relays being included in a local circuit with said device completed over a strand of the cord circuit when a connection is established with the line, the current in said local circuit being in the proper direction to render said device inoperative and of sufficient strength to operate said relay to cause said supervisory signal to operate, and the other being in the path of current completed over another strand of the cord circuit and over the metallic line whereby it is under the control of the subscriber, said latter relay serving when actuated to render said supervisory signal inoperative, substantially as described.

4. In a telephone system, the combination with a telephone line, of a polarized line signaling device connected in the metallic circuit thereof at the central office, a source of current connected with the line at the central office and adapted to send current over the metallic line and through said device in the proper direction to operate the same when the subscriber is calling, a cord circuit to establish connection with the line for conversation, a pair of signal controlling electro-magnets associated with the cord circuit, a supervisory signal controlled thereby, one of said magnets being included in a local circuit with the said device completed over a strand of the cord circuit when a connection is established with the line, the current in said local circuit being in the proper direction to render said device inoperative and of sufficient strength to operate said magnet to cause said supervisory signal to operate, and the other magnet being included in the path of current over another strand of the cord circuit and

the metallic line and placed under the control of the subscriber, said latter magnet serving when energized to render said signal inoperative, substantially as described.

5. In a telephone system, the combination with a telephone line, of a signaling device therefor at the central office having a coil in each limb of the telephone line and normally under the control of the subscriber, a cord circuit to establish connections with the line for conversational purposes, a source of current associated with the cord circuit, and supervisory apparatus connected with the cord circuit, said signaling device being actuated by current in one direction when the subscriber is calling, and being rendered inert by current in the opposite direction when a connection is established with the line for conversation, substantially as described.

6. In a telephone system, the combination with a telephone line, of a polarized line signaling device at the central office, a cord circuit to connect with said line, a pair of supervisory relays and a source of current in a bridge of the cord circuit, one of said relays being adapted to be actuated over a local circuit including the polarized line signaling device when the cord is connected with a line, the other of said relays being under the control of the subscriber, and a supervisory signal controlled by the conjoint action of said relays, substantially as described.

7. In a telephone system, the combination with a telephone line, of a polarized line signaling device therefor at the central office actuated to display its signal when a calling line is closed at the substation, a cord circuit to connect with the line, a pair of supervisory relays in a bridge of said cord circuit, one of said relays being placed in a local circuit including a coil of said line signaling device when the cord is connected with the line, whereby said line signaling device is differently actuated to efface its signal, the other of said relays being placed in a circuit under the control of the subscriber and completed through the contacts of the subscriber's instrument, and a supervisory signal controlled by the conjoint action of said relays, substantially as described.

8. In a telephone system, the combination with a telephone line, of a cord circuit to connect therewith for conversation, a pair of supervisory relays, and a source of current in a bridge of said cord circuit, a conductor connected with an intermediate point of said source, a line signaling device for the line, said line signaling device and one of said supervisory relays being actuated over a circuit including said conductor when the cord is connected with a line open at the substation without displaying the line signal, a supervisory signal displayed by the actuation of said latter relay, the other of said supervisory relays being actuated over the telephone line when the line is closed at the substation, said latter relay being adapted to efface said supervisory signal, substantially as described.

9. In a telephone system, the combination with a telephone line, of a polarized line signal therefor having a coil in each strand of the telephone line, a central source of current, a portion of said source being adapted to furnish current to the telephone line through the coils of said line signaling device, current from said portion of the source being adapted to energize said polarized line signaling device in the proper manner to display the signal when the line is closed at the substation, a cord circuit, means to reverse the current through a portion of said polarized line signaling device when the cord is connected with the line, whereby the device is differently actuated to efface the line signal, substantially as described.

Signed by me at Chicago, county of Cook, State of Illinois, this second day of May 1904.

FRANCIS W. DUNBAR.

Witnesses:

GAZELLE BEDER,

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