(No Model.) 2 Sheets—Sheet 1

J. A. McCOY.

TELEPHONE EXCHANGE.

No. 432,547. Patented July 22, 1890.

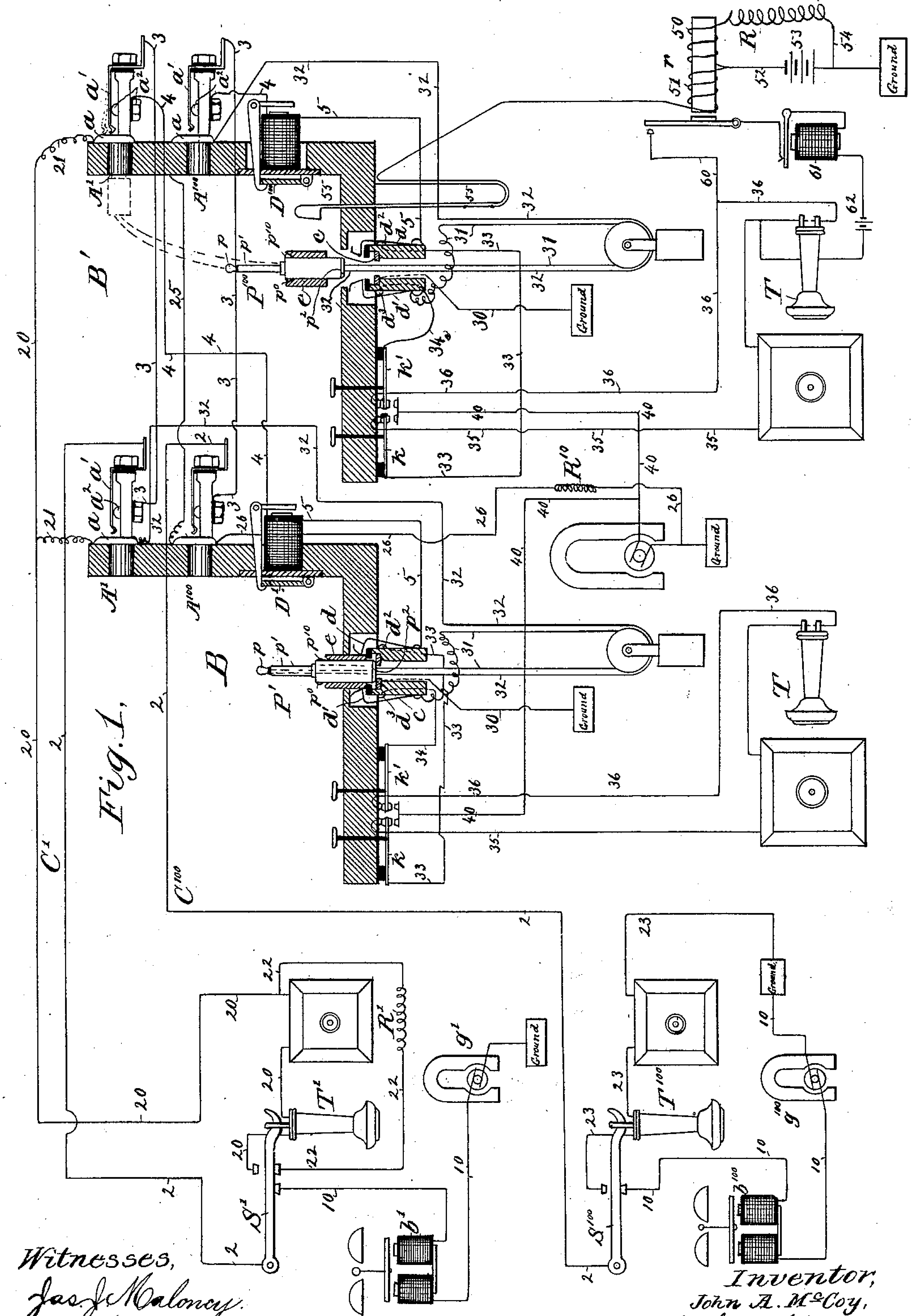

Fig. 1.

Witnesses,
Jas. J. Maloney.
M. E. Hill.

Inventor,
John A. McCoy,
by Jos. P. Livermore
Att'y.

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(No Model.)

2 Sheets—Sheet 2.

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Fig. 2,

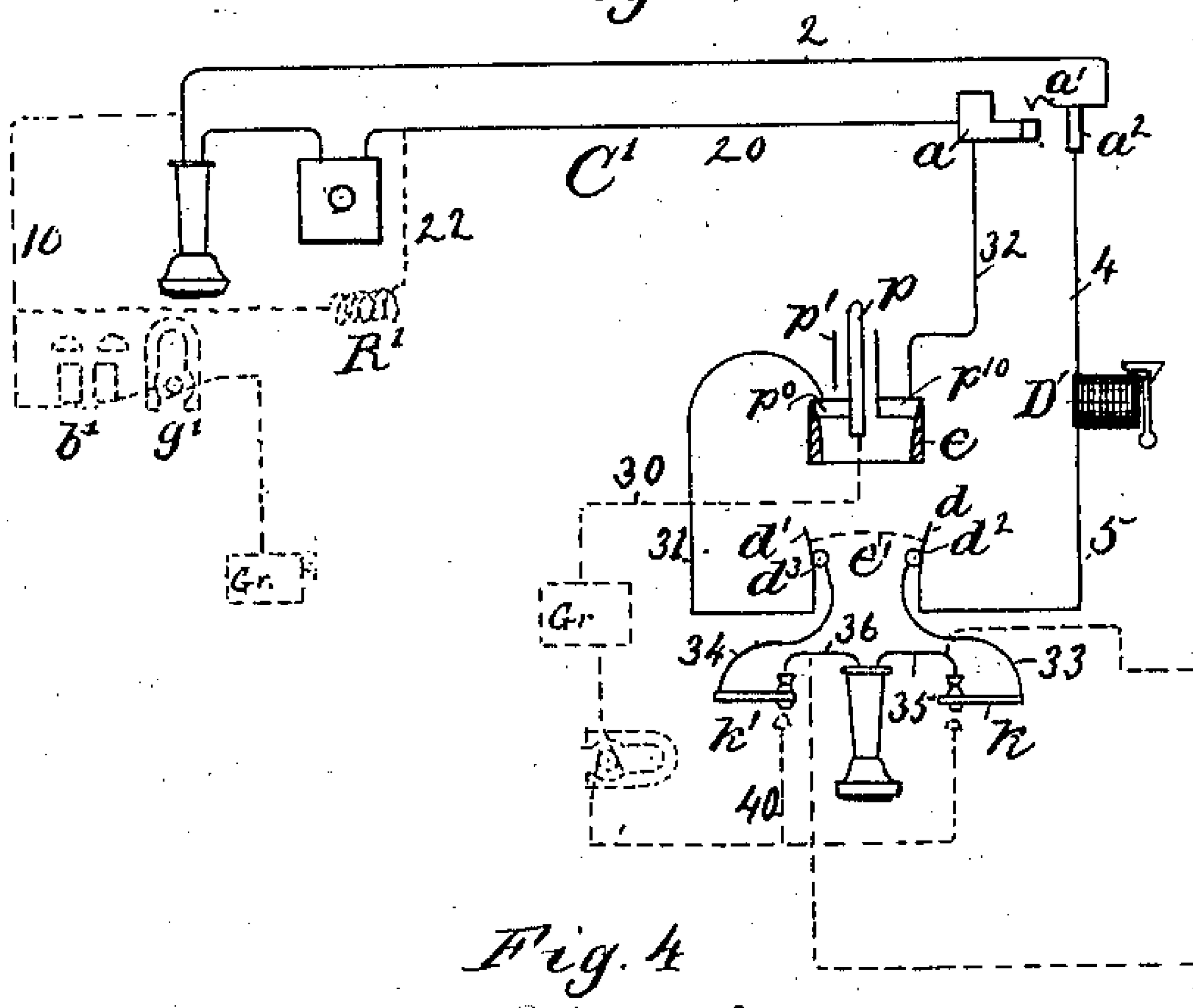


Fig. 3

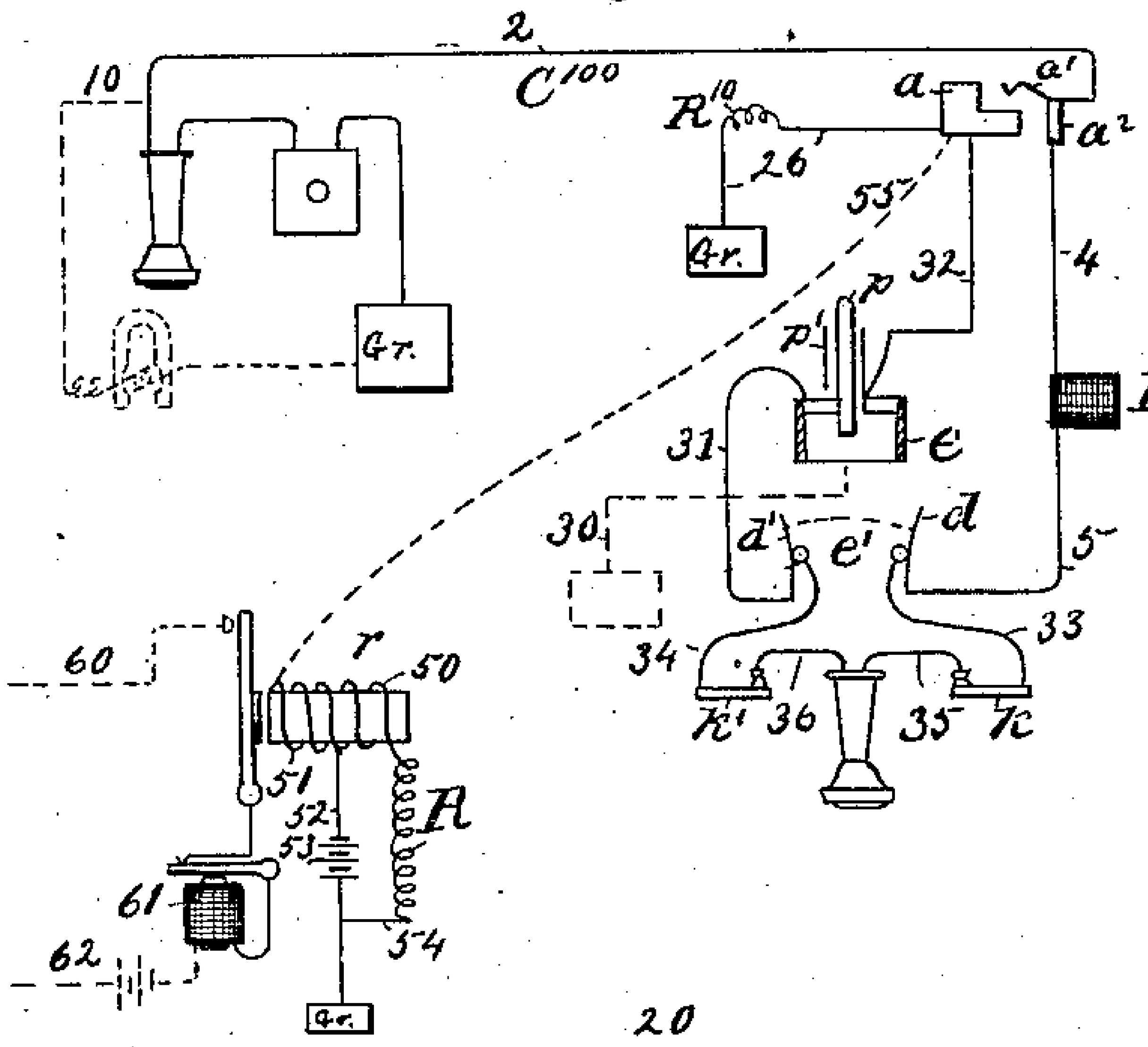


Fig. 4

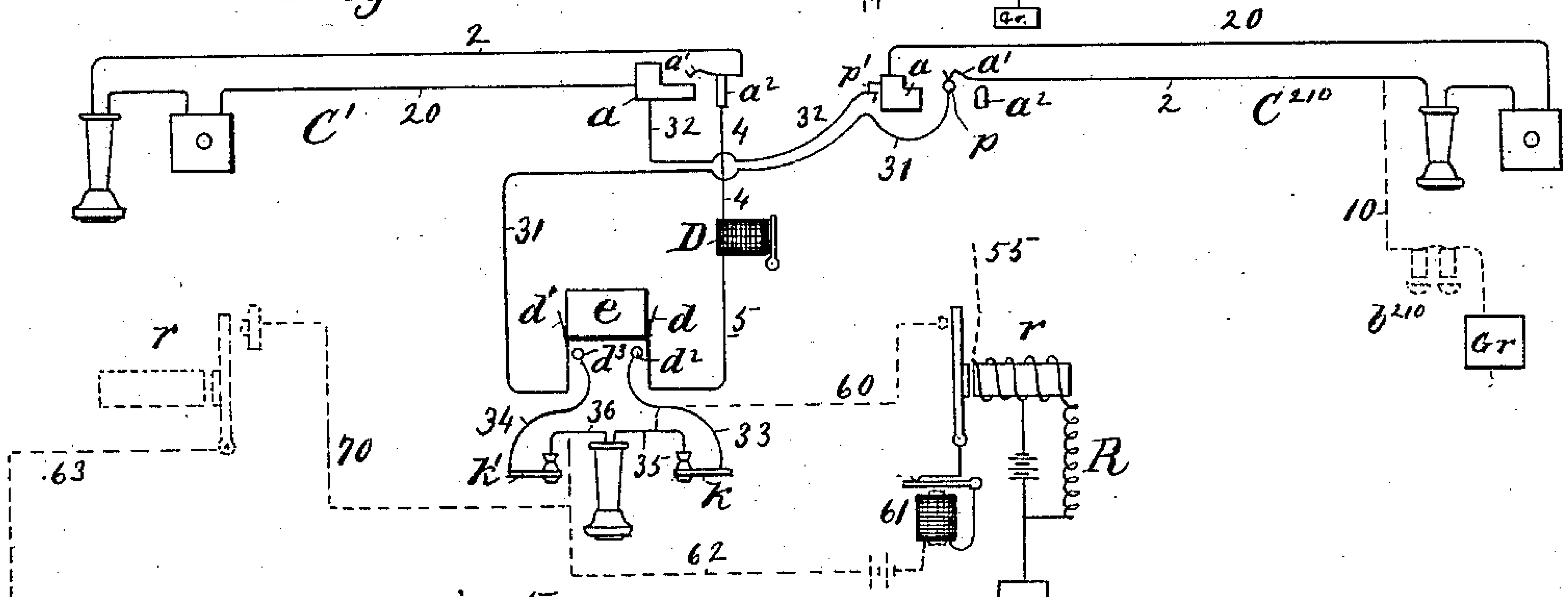


Fig. 5,

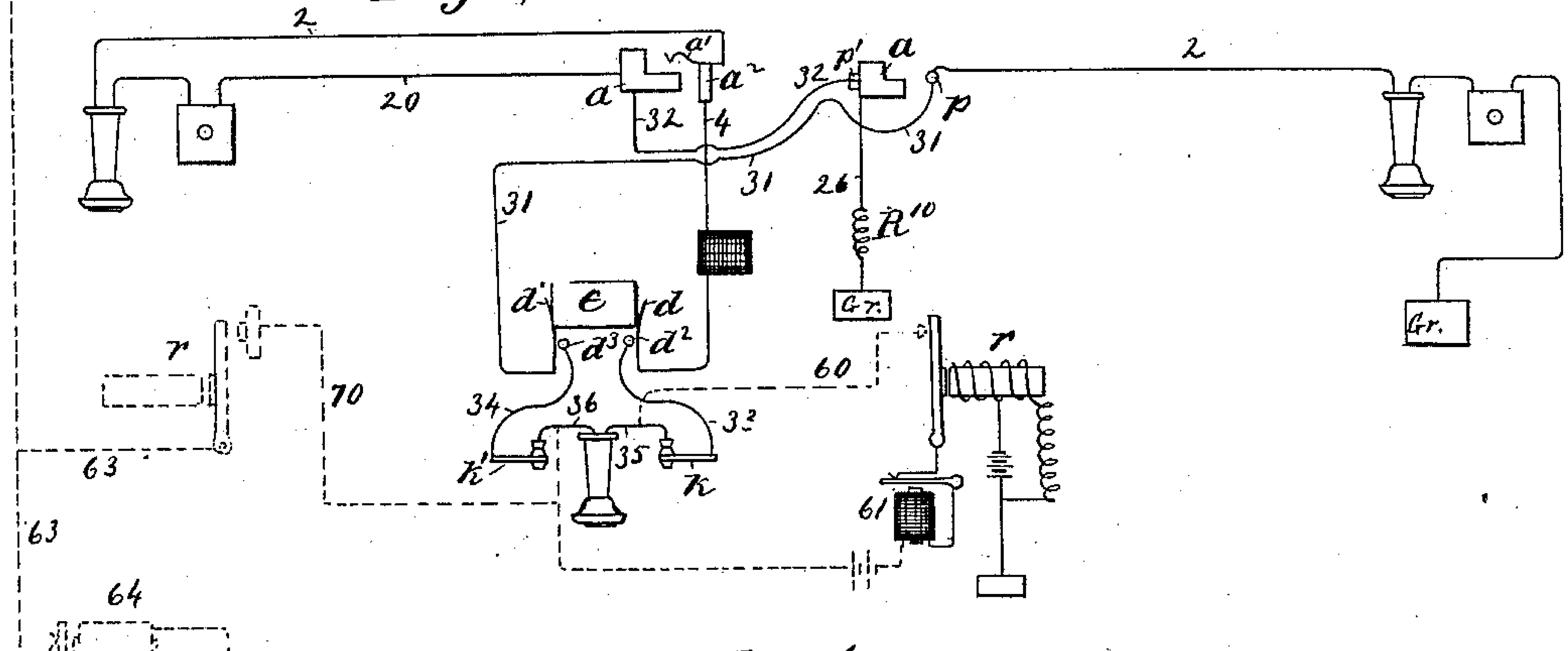
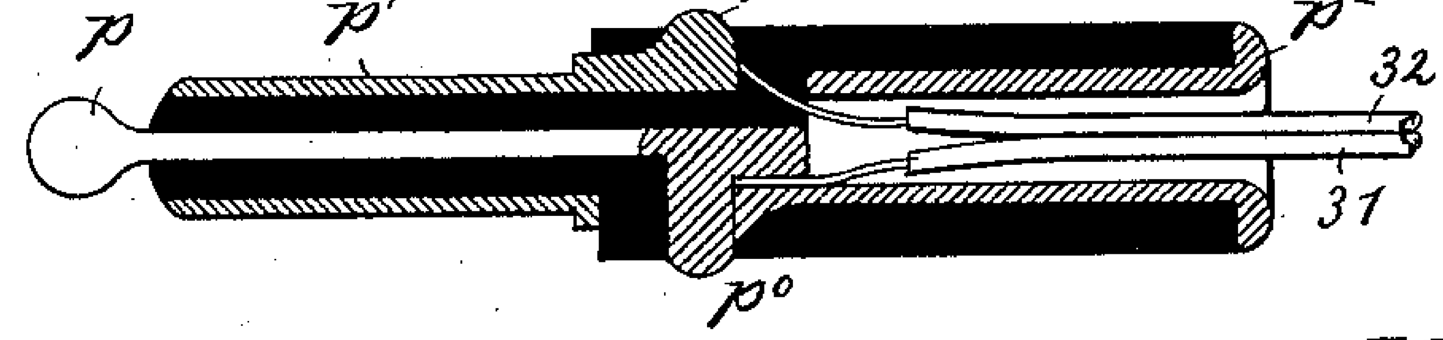


Fig. 6,



Witnesses,
Jas. J. Maloney.
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Att'y.

UNITED STATES PATENT OFFICE.

JOHN A. McCOY, OF MEDFORD, ASSIGNOR TO THE NEW ENGLAND TELEPHONE AND TELEGRAPH COMPANY, OF BOSTON, MASSACHUSETTS.

TELEPHONE-EXCHANGE.

SPECIFICATION forming part of Letters Patent No. 432,547, dated July 22, 1890.

Application filed January 23, 1888. Serial No. 261,560. (No model.)

To all whom it may concern:

Be it known that I, JOHN A. McCOY, of Medford, county of Middlesex, State of Massachusetts, have invented an Improvement in Telephone-Exchanges, of which the following description, in connection with the accompanying drawings, is a specification, like letters on the drawings representing like parts.

My invention relates, mainly, to the appliances for signaling and connecting together the various circuits of a telephone-exchange, the said appliances being adapted to signal over and to connect either grounded or metallic circuits.

In another application, Serial No. 257,663, filed December 12, 1887, I have shown and described a telephone-exchange comprising both grounded and metallic circuits; but in the construction there shown it was desirable, if not essential, to separate the grounded and metallic circuits at the central-office switch-board, certain sections of which were devoted wholly to one kind of circuits and other sections to the other kind, and the operation of testing and making the connection was somewhat different in the said different sections of the switch-board.

In the present invention the operations performed by the central-office attendant are the same for both kinds of circuits, and both kinds can enter the same section of the switch-board without causing any inconvenience, and the operation of receiving and answering calls is more rapid than with the apparatus now in use, whether the apparatus forming the subject of this invention be used with grounded circuits alone or metallic circuits alone, or with both kinds of circuits.

In the present apparatus, instead of having connecting-cords that are normally independent of the circuits and provided with two plugs, one to enter the jack of each of the two circuits to be connected, there is a connecting-cord for each circuit permanently connected with said circuit and having a single plug, which is to be inserted in the spring-jack of the circuit to be called, and thus completes the connection between the two circuits.

In the apparatus now in general use the central operator, on receiving a call, has to first insert a plug in the spring-jack of the calling-circuit and then operate a switch to place the central telephone in connection with said circuit; but in the apparatus forming the subject of this invention the act of lifting the connecting-plug from its place on the table puts the central telephone in circuit, and the said plug can be then carried at once to the spring-jack of the other circuit with which a connection is desired. The means for testing whether or not a circuit is in use are also substantially different from those now commonly employed.

Figure 1 is a diagram representing two sections of a switch-board and two subscribers' circuits, one a metallic and the other a grounded circuit, and one terminating in each section of the switch-board. The testing apparatus at one section only is shown, as it is the same at all sections. Fig. 2 is a diagram showing the circuit by which the central operator communicates with a subscriber on a metallic circuit from whom a call has been received, the signaling or calling circuit being shown in dotted lines, as is also the testing-circuit; Fig. 3, a similar diagram showing in full lines the circuit by which the central operator communicates with a subscriber on a grounded circuit, and in dotted lines the circuit by which the call-signal is received; Fig. 4, a diagram showing two metallic circuits connected for communication, and showing the test-circuits in dotted lines; Fig. 5, a diagram showing a metallic calling-circuit connected with a grounded called circuit; also showing the test-circuit in dotted lines; and Fig. 6, a sectional view of one of the connecting-plugs.

The switch-board shown in Fig. 1 is divided into a number of sections B B′, each having a number of indicating-instruments or drops D′ D^{100}, connected with a number of circuits from which calls are received by the attendant in charge of that section of the board, and also provided with a number of spring-jacks or connecting-pieces A^{100} A′ corresponding to all the circuits of the exchange, all of which instruments may be of usual construction, the said spring-jacks consisting of a metallic plug-socket or test-piece *a*, which is touched to make the test as to whether or not the line is in use, and also receives the connecting-plug by which the circuit corresponding to said spring-jack is connected with some other circuit from which a call has been received. The said spring-jacks also comprise a contact-spring a' and a co-operating contact or anvil a^2, both insulated from the frame-piece a, and both forming a part of the subscriber's circuit, which enters a given section of the switch-board at the spring a' and is normally continued from said spring a' and contact a^2 to the next section of the switch-board, and when a plug is inserted the spring a' is lifted from the contact a^2 and placed in contact with a corresponding portion of the plug, which then forms a continuation of the subscriber's circuit, the portion of which leading from the contact a^2 to the remaining sections of the switch-board is then cut off. One of the wires of a metallic circuit C', which may be called the "direct wire," corresponds in its connections to the single wire of a grounded circuit. The said direct wire 2 of a metallic circuit C' or main line 2 of a grounded circuit C^{100} (see Fig. 1,) extends from the telephone-supporting switch-hook S' or S^{100} at the subscriber's station to the spring a' of the spring-jack at the first section of the board, and from the contact a^2 of the said spring-jack, by wire 3, to the spring a' of the next section, and so on through all sections of the board, and from the contact a^2 of the last section thereof, by wire 4, to one terminal of the magnet of the drop D in the section of the board at which calls are received from the said circuit in question, the other terminal of which drop D is connected by wire 5 with a contact-spring d, forming part of the connecting apparatus at the central office, which will be hereinafter more fully described. The other wire or branch 20 of the metallic circuit, which may, for distinction, be called the "return-wire," extends from the telephone-instrument at the subscriber's station to the central office, and is connected by branches 21 with the metallic frames or test-pieces a of the spring-jacks corresponding to that circuit in all sections of the board. The wire 20 is connected with the wire 2 to make a metallic circuit. As shown in this instance, the said wire 20 terminates in an upper contact for the switch-hook S', and there is a branch wire 22 around the telephone connected with a lower contact for said switch-hook, which has another lower contact connected with a branch wire 10, including the call-bell b' and generator g' and connected with the ground. Resistance R' is included in the branch wire 22 or otherwise normally included in the return-wire circuit, the amount and purpose of which resistance will be hereinafter explained.

Normally, when the telephone T' of a metallic circuit C' is on its switch-hook the latter connects both the direct wire 2 and the return-wire 20 22 with the branch 10 through the usual call-bell b' and the generator g' to the ground.

When the telephone T' is removed from its hook, the corresponding direct wire 2 is disconnected from the ground-branch 10, containing the signaling-instruments, and is connected through the telephonic instruments with the return-wire 20, these making a wholly metallic circuit from the telephone at the subscriber's station to the central office, which circuit has one side connected with the test-pieces a of all the jacks A' of that circuit, and its other side connected through the contacts a' a^2 of said spring-jacks, *seriatim*, to the drop D' and other connections beyond said drop, which will be referred to later on.

The connections of a grounded subscriber's circuit are the same as those of the direct wire just indicated, as before stated; but instead of a return-wire from the telephone T^{100} at the subscriber's station to the central office the said telephone is connected in a branch wire 23 to the ground. The signaling-branch 10 on a grounded circuit is the same as on a metallic circuit.

The test-pieces a of the spring-jacks A^{100} of the grounded circuits are all connected together by wires 25, and are connected, preferably, at the first section of the switch-board by wire 26, through resistance R^{10}, with the ground at the central office. The resistance R^{10} is equal to the resistance of the return-wire 20 of a metallic circuit, including the resistance R' between it and the ground-connection through branch 10, or by direct wire to ground at central office, the said latter resistance R' being adjusted according to the resistance of the line-wire 20, with which it is used, so as to make the total resistance between the test-pieces a of the spring-jacks A' of metallic circuits and the ground equal to the resistance between the test-piece of the spring-jacks A^{100} of grounded circuits and the ground at the central office, so that normally when lines of either kind are not in use the test-pieces are connected to ground through a resistance considerably larger than the normal resistance of the line and instruments therein.

The means for making the connections between different circuits at the central office and for placing the central operator in communication with the subscribers comprise a connecting-plug P' P^{100}, corresponding to each circuit, the construction of which plug is best shown in Fig. 6, the same consisting of a central metallic portion p, which, when the plug is inserted, makes contact with the spring a' of the jack and an outer metallic portion or sleeve p', insulated from the plug p and adapted to make contact with the test-piece a of the spring-jack in which the plug is inserted. The said parts p p' are provided with contacts p^0 p^{10}, that project from the insulating-handle portion of the plug, and the inner part p is also connected with a contact portion

p^2 at the lower end of the handle of the plug, which normally rests on a contact-piece c, connected by wire 30 with the ground. For convenience the parts p and p' will be called the "inner" and "outer" parts, respectively, and the said parts are connected with two wires 31 32, insulated from one another and constituting a flexible cord, and which will, for convenience, be called the "inner" and "outer" wires. The said inner wire 31 is connected, as shown, with the spring d', adjacent to the socket in which the plug normally rests, and the outer wire 32 is connected with the test-piece a of the corresponding line. The handle portion of the plug normally rests in a metallic sleeve or thimble e, as shown at the section B, Fig. 1, which, when pressed down into its socket in the table, makes contact with the springs $d\ d'$, connecting the same directly together, the said thimble e then being out of contact with the projections $p^0\ p^{10}$ of the inner and outer connecting members of the plug. When, however, a call is received, the central operator lifts the plug from its socket by taking hold of the sleeve e, which is thus removed from between the springs $d\ d'$, as shown at section B' of the board, Fig. 1, and comes into contact with the projections $p^0\ p^{10}$ of the inner and outer members of the plug connecting the same and the wires 31 32 thereof directly together. The springs d and d' then come into contact with corresponding contact-pieces $d^2\ d^3$, connected, respectively, by wires 33 34 with the signal-keys $k\ k'$, the upper contacts of which are connected by wire 35 36 with the central operator's telephone T, which is thus brought into circuit between the wire 5 and the inner wire 31 of the connecting-cord.

The signal-keys $k\ k'$ have lower contacts connected by wire 40 through a generator g with the ground, so that depressing either of the said keys opens the telephone-circuit 35 36 and connects either the wires 33 and 5 through the generator with the ground or the wires 34 and 31 through the generator with the ground for the purpose of signaling either the calling or the called station in the usual manner, as will be hereinafter more fully explained.

If the sleeve is dropped back to its socket while the plug is still retained in the operator's hand or is inserted in a spring-jack, as shown in dotted lines at the section B', Fig. 1, the inner and outer members of the plug will be no longer connected from p^0 to p^{10}; but the springs d and d' will be connected directly together, making a direct connection from wire 5 to 31, and the central telephone and signaling-branch 33, 34, 35, 36, and 40 will be out of circuit, so that the central telephone and the signal-keys can be used with any other circuit, it being understood that the wires 33 and 34 connect with the contacts $d^2\ d^3$ corresponding to all the connecting devices in that section of the board, but will be in circuit with only that one in which the sleeve e is out of contact with the springs $d\ d'$. One of the said springs is made higher than the other, so that the thimble e, if merely dropped by the operator, will not connect said springs together nor disconnect either of them from the contacts $d^2\ d^3$, so that the central telephone T will remain in circuit after the plug has been inserted in the spring-jack of the called circuit, and will not be removed from the said connected circuits until the sleeve e is positively pressed down into its socket, which is usually done after the answer to the call is received.

The various connections may be briefly stated again, as follows: The direct wire 2 of a metallic circuit or the main line 2 of a ground-circuit normally affords a circuit for signaling from ground at the subscriber's station through signaling-instruments to the central office, and through the contacts $a'\ a^2$ of the different spring-jacks in the different sections of the switch-board to the drop-instrument, and by wire 5, conductors $d\ e\ d'$ to the inner wire 31 and inner member p of the connecting-plug, which is normally grounded through plate c and wire 30, and in this circuit the central telephone T and calling-keys $k\ k'$ may be included by raising the sleeve e and permitting the springs $d\ d'$ to touch the contacts $d^2\ d^3$. In other words, the main line of a subscriber's circuit is permanently connected directly or through the central telephone with one end of a flexible cord, the other end of which terminates in a plug which when inserted in a spring-jack continues the circuit to another main line. Second. The test-pieces of the spring-jacks are connected either with ground at the central office for a grounded circuit or with the return-wire of a metallic circuit, which is either grounded at the subscriber's station or connected with what is commonly the ground side of the telephone-instrument, so as to complete the telephone-circuit, and the said test-pieces are also connected with the other wire 32 of a flexible cord and the other member p' of the connecting-plug, which is insulated from the member p and makes contact with the test-piece or plug-socket of the spring-jack in which it is inserted. The sleeve e, when raised into contact with $p^0\ p^{10}$, thus places the central telephone in circuit with the subscriber's telephone—that is, between the wires 2 and 20 of a metallic circuit or between the main line and the wire 26 and the ground at the central office for a grounded circuit—and when a plug is inserted in the jack it connects the main line, of which the inner member p forms the terminal, with the main line terminating in the contact a' of the jack in which it is inserted, and at the same time connects together the test-pieces of the two lines by the outer member 32 of the connecting-cord. This connecting together of the test-pieces either completes the return when two metallic circuits are connected or affords a ground for the return-line of a metallic circuit when connected with a grounded circuit, or in case two grounded circuits are connected it merely affords two paths from the test-pieces of either of said circuits through the two wires 26, one connected with each set of test-pieces and resistance R^{10} in each to the ground, so that in accordance with well-known laws the actual resistance between any test-piece of either of the said circuits and the ground is one-half what it was before they were connected.

The testing apparatus preferably employed in connection with the appliances thus far described comprises a relay *r*, which is differentially wound, having the coils 50 51 both connected by wire 52 with the battery 53, the said coil 50 being connected by return-wire 54 with the ground or other pole of the battery 53, the said return-wire containing resistance R, which should be considerably above that of one of the subscribers' circuits and the instruments normally contained therein, say five hundred ohms. The other wire 51 is connected with a test-cord 55 terminating in a contact-piece, which may be a thimble worn on the finger of the central operator, so that it can be readily touched upon the test-piece *a* of any of the spring-jacks. The coil 51 is thus normally in open circuit, and the current of the coil 50 is unbalanced and retains the armature of the relay *r* attracted, and will retain it attracted unless a current of about equal strength is caused to pass through the coil 51, in which case the magnetism would be neutralized and the armature fall back. If, however, the current in the coil 51 is considerably weaker or stronger than that in the coil 50, it will not balance the effect of the coil 50, and the armature of the relay will still remain attracted, so that it is only when the coil 51 is closed through a resistance about equal to the resistance R that the armature will be retracted. The said armature when thus retracted closes a branch circuit 60 from the wire 36 at either side of the central receiving-telephone, said branch including a vibrator or buzzer 61 and battery 62, so that if the said branch circuit is closed by the armature of the relay the buzzing sound will be heard in the central telephone.

The resistance R^{10} in the ground-branch 26 from the test-pieces *a* of the grounded subscribers' circuits and the resistance of line 20, including signaling-instruments and resistance R′ between the test-pieces of metallic circuits and the ground when such lines are not in use, is equal to the resistance R in the coil 50 of the relay *r*, so that if there is no other connection with said test-pieces *a* when the test-wire 55 is touched thereto the current in coil 51 will just equal that in coil 50, and the buzzing sound will be heard in central telephone T, which will show that the said line is not in use.

Whenever a connecting-plug is inserted in one of the plug-sockets, it varies the resistance between the test-pieces of both connected circuits and the ground, as will be hereinafter described, so that when the test-wire 55 is touched to any of said test-pieces the relay *r* is not demagnetized and no sound is heard in the central telephone T, which absence of sound is understood as the indication that the line is in use.

The various operations of calling the central office, answering the call, connecting with the called line, and signaling the called station will be best understood in connection with the diagrams Figs. 2 to 5 inclusive, with an occasional reference to Fig. 1, in which the apparatus is shown more fully.

When a subscriber on a metallic circuit C′ wishes to call the central office, the drop D′ is operated by the generator *g*′ in the usual manner over the circuit indicated, part in full and part in dotted lines—namely, from the ground at the subscriber's station by branch 10, direct wire 2, through the various spring-jacks, as before stated, to the contact a^2 of the last spring-jack, and by wires 4 and 5 to the spring *d*, which is then connected by the thimble *e*, as indicated by dotted lines *e*′, from which the circuit is continued by wire 31 to the inner part *p* of the plug, which then rests on the ground-plate *c*, so as to complete the signaling-circuit through wire 30 to the ground, this latter part of the circuit being best understood from Fig. 1, section B, in which the plug rests on the ground-plate *c*, and the sleeve *e* connects springs *d d*′, keeping the central telephone T out of circuit. The central operator on receiving such call by the drop D′ lifts the corresponding sleeve *e* from its socket, and as the subscriber has at the same time taken the telephone T′ off the hook the central and subscribers' telephones are connected through the circuit shown in full lines only, Fig. 2—namely, from the subscriber's telephone T′ by return-wire 20 to the test-piece *a* of the corresponding spring-jack, thence by wire 32 of the connecting-cord to the outer part *p*′ of the plug and the contact p^{10} thereof, which is then connected by sleeve *e* with contact p^0 of the inner part of the plug, from which the circuit is continued by wire 31 to the spring *d*′, thence to the contact d^3 and by wires 34 36 through the central telephone T, thence by wire 35 33 to contact d^2 *d*, and by wires 5 4, contact a^2 *a*′, and direct wire 2 back to the subscriber's station and other terminal of the telephone-instrument. Then the test may be made by touching the test-cord 55 to test-piece of the spring-jack (A^{100}, for example, Fig. 3) of the line to be called, and if said line is not in use the connecting-cord 32 from said test-piece will terminate in the outer part *p*′ of the plug, which will be in open circuit, and the test-cord will make a circuit for the coil 51 of the relay *r*, through wire 26, and resistance R^{10}, if the tested line be a ground-line, as in Fig. 3, or the return-wire 20, branch 22, and resistance R′, if the tested line be a metallic circuit, the said resistance in either case being equal to that in the other coil 50 of said relay, which will thus be neutralized and close the branch circuit 60 through the buzzer 61 and central telephone T, which will indicate that the said line is not in use. If, however, the said line is in use—as, for example, if a call is just being answered on a ground-line, as shown in Fig. 3—the outer wire 32 of the connecting-cord would be connected by the sleeve *e* with the inner wire 31, thence through the central telephone T, wires 5 4, to the subscriber's line 2 and ground at the subscriber's station, thus forming another circuit from the test-piece, so that the total resistance in circuit with the coil 51 is much less than the resistance R in the other coil of the relay, which consequently would not be demagnetized, so that no sound would be heard in the central telephone.

If a connection were actually made on the grounded line that was tested with a metallic line, as shown in Fig. 5, the current from the test-cord and test-piece touched by it would have, in addition to the path through the resistance R^{10}, another circuit by connecting cord 32 to the test-piece *a* of the connected line, thence by the entire metallic circuit 20 2 and wires 4 5 and connecting-cord 31, and entire ground-circuit 2 to the ground at the subscriber's station, thus again dividing the resistance in circuit with coil 51 and preventing the relay *r* from being demagnetized, and the same would be true if the test had been made on a spring-jack of the metallic circuit connected with the grounded circuit.

If two ground-circuits had happened to be connected together, the connecting-cord 32 would connect the test-pieces of the spring-jacks of the other line and their grounded wire 26, also in circuit with the coil 51, which would thus have two paths, each through resistance R^{10}, making the circuit one-half the resistance R^{10}, so that the currents in coil 51 would not neutralize that in coil 50, and the relay *r* would not be demagnetized.

If the test were made on the spring-jack of a metallic circuit connected with another metallic circuit, as shown in Fig. 4, the test-cord 55 would still be in open circuit, as there is no ground connected with said metallic circuits when in use, and consequently the relay *r* would not be demagnetized and no sound would be heard in the central telephone, and the same would be true if the test were made on a metallic circuit in which a call was just being answered, as in Fig. 2. If the line tested is found to be not in use, the connection is made in the usual manner by inserting the connecting-plug in the test-piece, and a signal is transmitted over the line thus connected by the key *k'* in the usual manner. If the calling metallic circuit is connected with another metallic circuit, the connections will be as shown in Fig. 4, and the subscriber's bell b^{210} (shown in dotted lines) will be rung by depressing the key *k'*, which will make a circuit through the central-office generator *g* by wire 40 (see Fig. 1) to key *k'* and wire 34 and spring *d'*, which would then be in contact with d^3, and by wire 31 to contact *p a'* and direct wire 2 of the called line C^{210} and branch wire 10 through the bell b^{210} to the ground. If the calling subscriber should in the meantime have placed the telephone on the hook, he can again be called by depressing the key *k*, which will connect the generator *g* at the central office with wire 33, and by contact d^2 *d* with wires 5 4 and line 2 and branch 10 to the ground through the said subscribers'-signaling-instruments. When both subscribers have answered, the sleeve *e* may be pressed down between the springs *d d'*, as shown in Fig. 4, and the circuit will then be as follows: From one terminal of the telephone on the calling-circuit C' by wire 20 to the test-piece of the spring-jack, thence by outer member of the connecting-cord 32 to the test-piece of the called circuit C^{210}, and by wire 20 of said circuit through the telephone-instruments, and thence by wire 2 to the central office, and by contact *a' p* to the inner connecting-cord 31, spring *d'*, sleeve *e*, spring *d*, wires 5 and 4, contacts a^2 *a'* of the calling spring-jack and wire 2 to the other terminal of the instruments at the calling subscriber's station. The drop D' remains in the circuit in all cases, and thus answers the purpose of a clearing-out drop.

If a metallic circuit were connected with a grounded circuit, as shown in Fig. 5, the operation of calling would be the same as before described, and when the connection was made the circuit would be, as shown in Fig. 5, from ground at the central office by wire 26 to test-piece of the grounded circuit; thence by connecting-wire 32 to the test-piece of the metallic circuit, and thence through the said metallic circuit 20 and 2 and all of the contacts *a'* a^2 of the spring-jacks of the metallic circuit and by inner member of the connecting-cord, including wires 4 5, spring *d*, sleeve *e*, spring *d'*, and wire 31 to the main line of the grounded circuit, and ground at the subscriber's station. If the call were received on the ground-circuit, it would be answered in the manner before described, the circuit then being, as shown in Fig. 3, from the ground at the subscriber's station and subscriber's line 2 through switch-board, and by wires 4 and 5 to and through the central telephone T; and thence by wire 31 to the inner member of the plug, which would then be connected by sleeve *e* with the outer member; and thence by wires 32 and 26 to the ground at the central office. If a ground-circuit were to be connected with another grounded circuit, the connection would be substantially the same as in switch-boards now in use, except that the entire calling-circuit at the central-office switch-board, including the drop, would remain in circuit, while all of the called line beyond the section of the switch-board where the connection was made would be cut off at *a'* a^2 in the usual manner.

In the connection of two grounded circuits the outer member of the connecting-cord serves merely to connect the two sets of test-pieces with their ground-branches 26 together, thus dividing the resistance between any of said test-pieces and the ground for the purpose of showing that both said lines are in use, as before described.

If a grounded circuit were to be connected with a metallic circuit, the connection would be substantially the same as in Fig. 5 except that the terminal portion 4 5, containing the drop-instrument, would be in the grounded instead of in the metallic circuit.

When a metallic and ground circuit are connected together, the inner part of the cord connects the two circuits in the usual manner, and the function of the outer part of the connecting-cord is to afford a ground for the return-wire of the metallic circuit—namely, from the test-piece of the grounded circuit through the ground-branch 26, and at the same time to divide the resistance between both sets of test-pieces and the ground by affording a second ground-connection through both the circuits to the ground at the subscriber's station on the grounded circuits.

The mechanical construction of the various devices, especially that of the connecting-plug, its co-operating sleeve *e*, and the springs *d d'*, that control the introduction of the central telephone and signaling-instruments into the connected circuits, is shown as of the most convenient form now known to me; but it is obvious that such construction may be widely varied without departing from the invention, as equivalent devices will be readily suggested to those familiar with apparatus of this kind. It is also true that many of the circuit-connections can be varied without departing from the main features of construction and operation herein shown and described.

The resistance R in circuit with the coil 50 of relay *r* has been described as equal to the resistance R^{10}, or aggregate resistance of return-wire 20 and resistance R'; but this description was merely for simplicity, the essential feature being that the current that is continuous in the coil 50 of relay *r* should produce the same effect on the core as the current in the line 51 when connected with a test-piece of a line not in use. This equality in current may of course be effected by having the resistance R smaller and having a smaller number of turns in the coil 50 than in the coil 51, or the coil 50 may be in a different circuit, having an independent battery, or its circuit may be arranged to include only a portion of the battery 53 with the resistance properly adjusted, it being in every case equality or inequality in the effect on the core of the relay produced by the current in the two coils thereof that is depended upon to give the test.

A modification of the means for producing the test-signal is illustrated in connection with Figs. 4 and 5 at the left hand of the sheet, which will probably be adopted in practice, although its operation is not so apparent from the diagram as that illustrated in Fig. 1.

The test-relay *r* is the same; but instead of having its armature control a local circuit for the central telephone, including a vibrator, the armatures of the different test-pieces are all connected through circuit 63 with a vibrator 64, from which the circuit is continued through a battery 65 to the ground. The wires 70 from the back-stops of the armatures of the relays *r* merely tap into the central telephone-circuit 36, and thus when the branch circuit 70 is connected with the armature of the relay, when the latter is released by the operation of making the test, as before described, a circuit will be formed from the ground through the battery 65 and vibrator 66 by wires 63 and 70 to the central telephone, through which a part of the current will pass and will find a ground if the telephone is connected with a ground circuit, or if the telephone is connected with a metallic circuit there will be sufficient condenser action in the connecting cables of the switch-board to make the sound in the vibrator, which is preferably a musical note, clearly heard in the central telephone. The springs *d d'* and their contacts d^2 d^3 and the sleeve *e* that operates them perform the function of the usual cam-lever employed to throw the central telephone into circuit, so that the operator upon lifting a plug to answer a call may at the same time and by the one single operation also place the central telephone in circuit instead of doing so by a separate independent operation, as heretofore practiced. Besides a saving in time there is also a saving in space occupied at the switch-board by making the switch that controls the introduction of the central telephone a part of the socket in which the connecting-plug normally rests.

I claim—

1. A telephone-exchange comprising a number of subscribers' circuits having line-wires extending from the subscribers' stations to the central office, combined with a sectional switch-board at the central office, each section of which contains spring-jacks or connecting-pieces corresponding to each of said subscribers' lines, said spring-jacks being each composed of a test-piece and a contact-spring and contact therefor, both insulated from said test-piece, the said line-wire passing through the said contacts on all the sections of the board, and through an indicating-instrument and terminating in one strand of a flexible connector or cord, and a second strand of said connecting-cord having one end connected with the test-piece of the spring-jacks of the line of which the other strand forms the terminal, and a plug having inner and outer members connected with said strands, respectively, the outer member surrounding and being always insulated from the inner member, as described, and constituting the plug that enters the spring-jack,

whereby the said outer member of a plug makes contact with the test-piece of the spring-jack in which it is inserted, and the inner member makes contact with the spring of said spring-jack, but is insulated from the test-piece thereof, and a test-relay having a coil that is placed in connection with the test-piece of the circuit to be tested, and an armature which is moved when the normal resistance in circuit with the test-pieces is changed, substantially as described.

2. A telephone-exchange comprising a number of subscribers' circuits having line-wires extending from the subscribers' station to the central office, combined with a sectional switch-board at the central office containing spring-jacks or connecting-pieces having test-pieces, and contact-springs and contacts insulated therefrom, said line-wire passing through the said contacts and terminating in one member of a flexible connecting-cord, and including contact-pieces co-operating with other contact-pieces between which are telephonic and signaling instruments at the central office, and a second member of said flexible connecting-cord connected with the test-pieces of said spring-jacks, and a conducting-connector *e*, by which the two members of the said flexible cord may be connected together when said contacts are operated to place the telephone and signaling instruments at the central office in circuit, substantially as described.

3. In a telephone-exchange, the combination of a connecting-cord and plug and a movable sleeve surrounding said plug, with a central-office telephone and contact-points in circuit with said telephone and connecting-cord controlled by said sleeve on the plug, whereby the central telephone is included in or removed from circuit with said connecting-cord by the said sleeve, substantially as described.

4. The combination, in a switch-board, of a double connecting-cord and two-part plug having lateral projections connected with the said parts, with a movable sleeve surrounding a portion of said plug and contact-pieces operated by said sleeve controlling the introduction of the central telephone into circuit with one portion of said connecting-cord, the said sleeve also co-operating with the lateral projections of the plug to connect the two members of the plug together, substantially as described.

5. In a telephone-exchange, the combination of spring-jacks having test-pieces and a connecting-cord and plug and movable sleeve surrounding said plug, with a central-office telephone and contact-points in circuit with said telephone and connecting-cord and test-pieces of the spring-jacks and the ground, all controlled by said sleeve, substantially as and for the purpose described.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

JOHN A. McCOY.

Witnesses:
JOS. P. LIVERMORE,
M. E. HILL.