No. 719,736. PATENTED FEB. 3, 1903.

A. M. BULLARD & L. A. FALK.

SERVICE METER SYSTEM AND APPARATUS FOR TELEPHONE EXCHANGES.

APPLICATION FILED APR. 10, 1902.

NO MODEL. 2 SHEETS—SHEET 1.

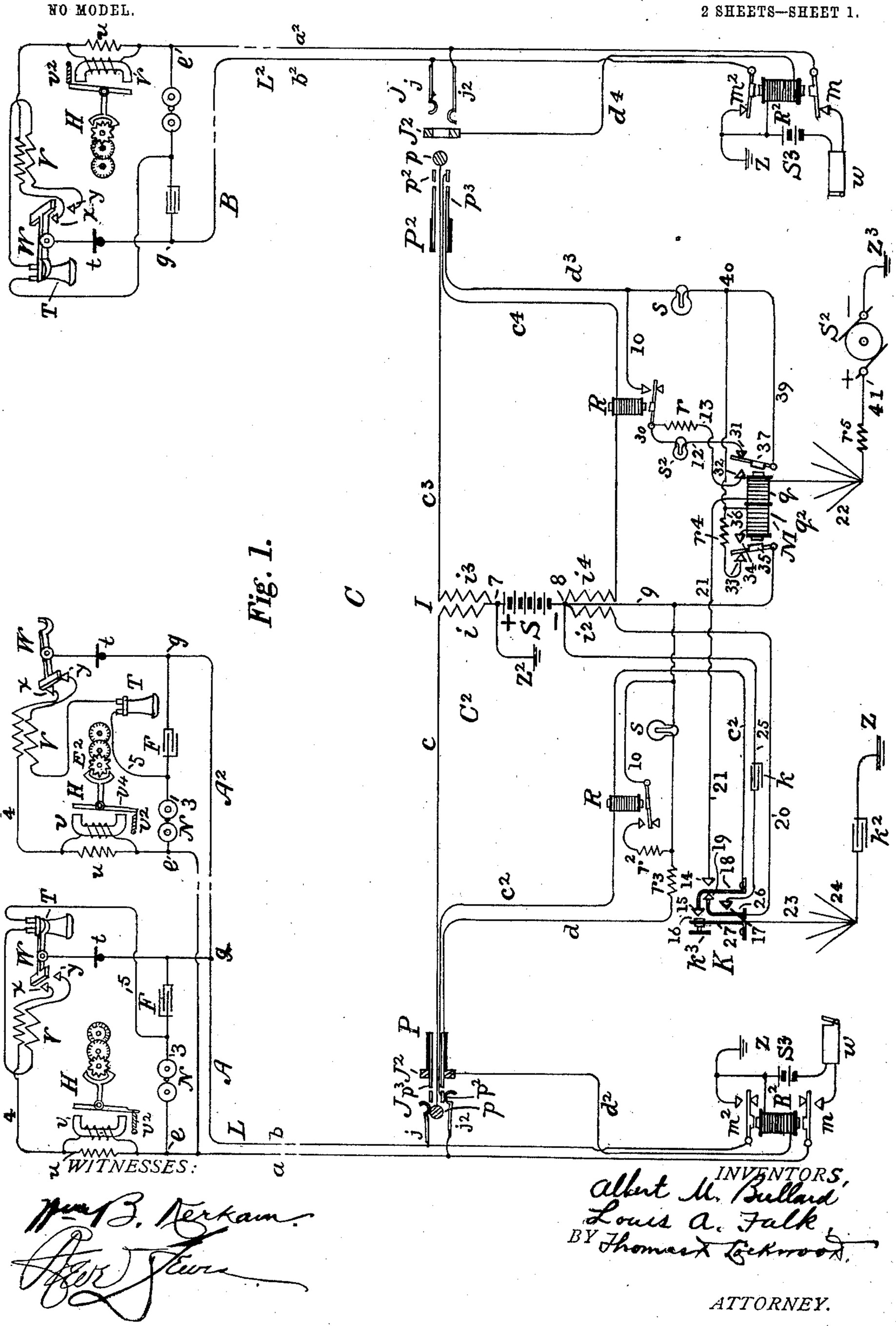

Fig. 1.

WITNESSES:

Wm. B. Merkam.

Peter J. Steers.

INVENTORS,
Albert M. Bullard
Louis A. Falk
BY Thomas & Lockwood.
ATTORNEY.

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NO MODEL. 2 SHEETS—SHEET 2.

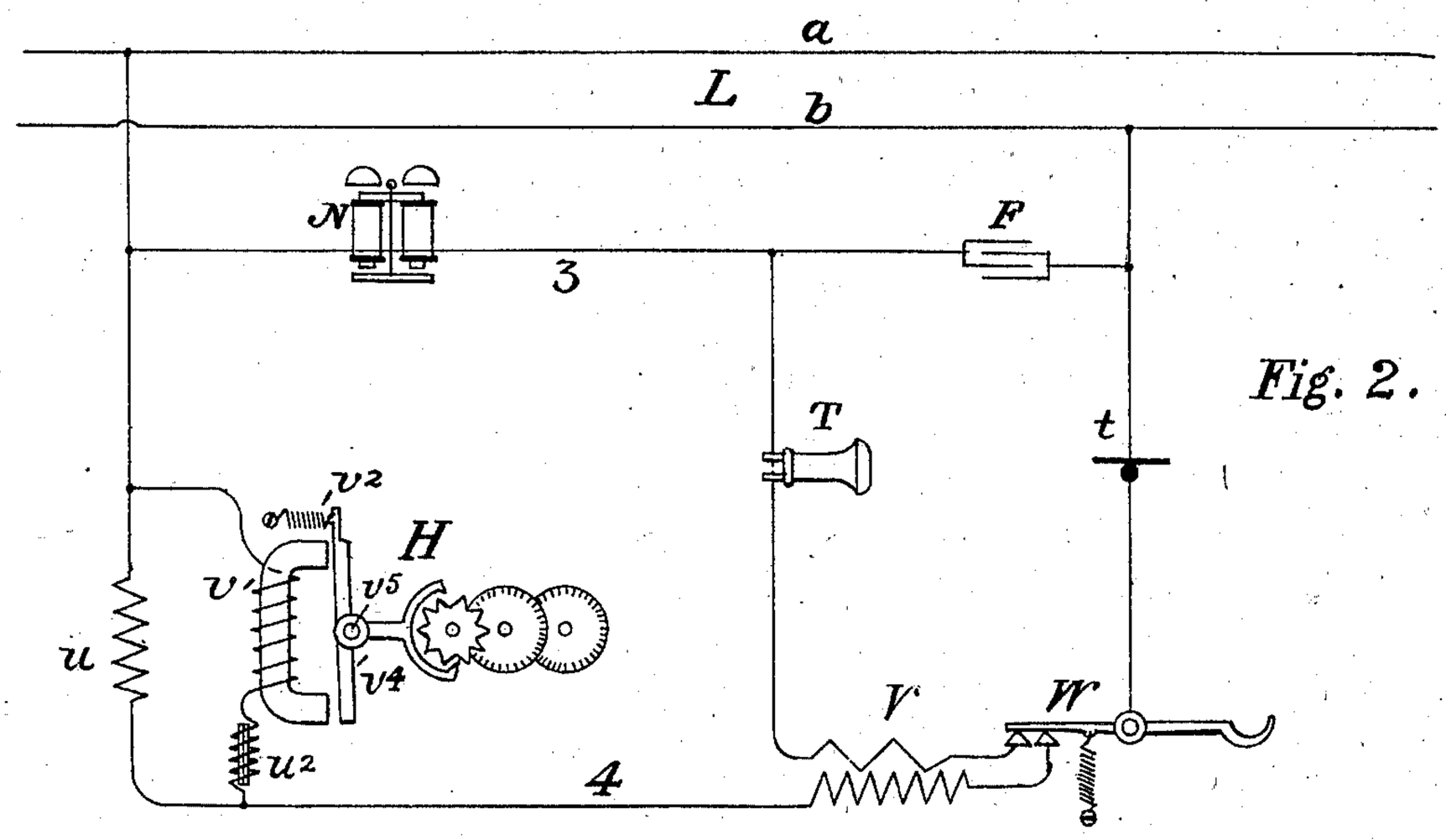

Fig. 2.

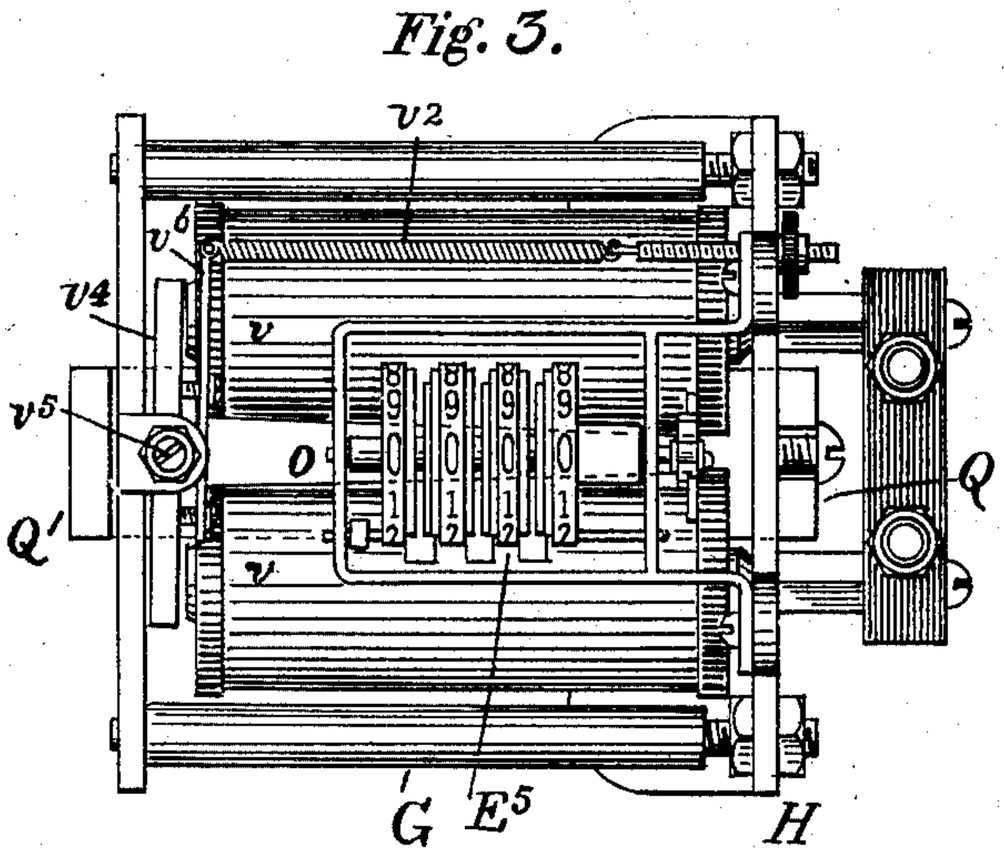

Fig. 3.

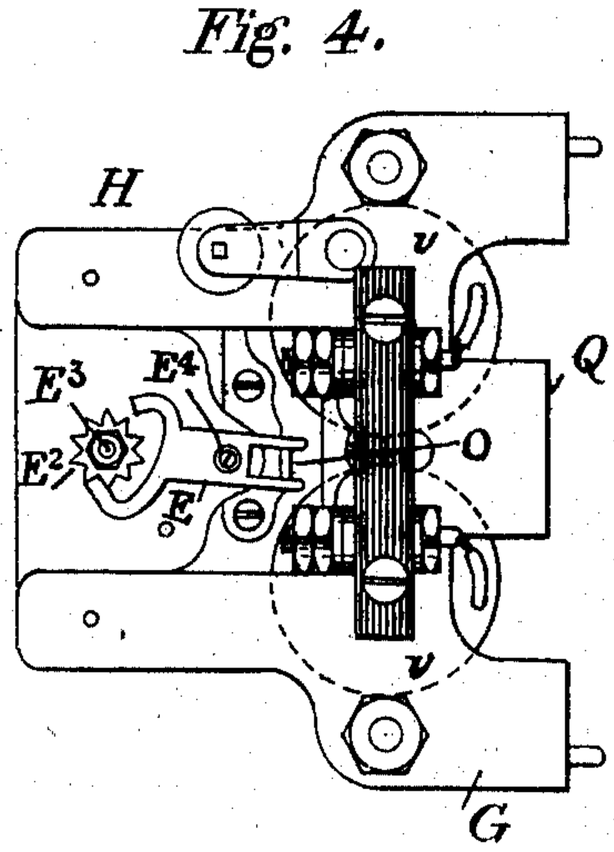

Fig. 4.

WITNESSES:

INVENTORS

Albert M. Bullard.
Louis A. Falk.
BY Thomas D. Lockwood

ATTORNEY.

UNITED STATES PATENT OFFICE.

ALBERT M. BULLARD, OF SOMERVILLE, AND LOUIS A. FALK, OF BOSTON, MASSACHUSETTS, ASSIGNORS TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK.

SERVICE-METER SYSTEM AND APPARATUS FOR TELEPHONE-EXCHANGES.

SPECIFICATION forming part of Letters Patent No. 719,736, dated February 3, 1903.

Application filed April 10, 1902. Serial No. 102,275. (No model.)

To all whom it may concern:

Be it known that we, ALBERT M. BULLARD, residing at Somerville, in the county of Middlesex, and LOUIS A. FALK, residing at Boston, in the county of Suffolk, State of Massachusetts, have invented certain Improvements in Service-Meter Systems and Apparatus for Telephone-Exchanges, of which the following is a specification.

This invention relates to service-meters or connection counting and registering appliances for the lines of telephone-exchanges and to systems or circuit arrangements for their appropriate and efficient operation.

The objects sought to be attained by it are the provision of a directly-indicating service-meter capable of operating satisfactorily at substations to count in each case the completed connections initiated by the calls of its own station and no other, and this whether the circuit to which it belongs be a single-station or a polystation circuit.

In this invention the service-meter is placed in the telephone substation-circuit (by preference at the substations, or in the case of a polystation-line at each substation) and is made irresponsive to the regular line-current of the normal source which supplies energy for the telephone-transmitters for incoming call-signals and for switchboard-signals, but responsive to a current of greater strength and opposite direction furnished by a supplementary source at the central station, which auxiliary generator may at the proper time be substituted for the said normal source in the main-circuit switch-cord conductors, and thereby in the main circuit itself. The said main telephone-circuit has at the substation the usual two terminal branches, one containing the call-bell in normal connection with the line and the other containing the telephones normally switched out of connection with said line, there being likewise a circuit-changer to transfer the line or main circuit conductors as required from each branch to the other, the same being preferably the ordinary automatic telephone-switch whose forked lever supports the receiver when not in use, which switch maintains the connection of the line and bell branch when said receiver is hung on said lever, transfers the line connection to the telephone branch when taken from said lever, and restores the normal arrangement when replaced. The service-meter is associated with the normally open telephone branch and is thus brought into circuit only when the switch is operated by the displacement of the receiver, and this arrangement is found very useful in the case of polystation-lines, it being apparent that when an operating current impulse is transmitted through the circuit no service-meter can be operated to register a completed call except at the station where the receiver has been taken up for use. When any two such substation lines are united at the central station to constitute a through circuit between their respective substations, the ordinary switch-cord, with terminal plugs and main and local circuit conductors, is utilized, and with such switch-cord, its bridged current-generator, ordinary split induction-coil, main-circuit supervisory relays, and local-circuit signals having shunts controlled by said relays we associate a supplementary source of current adapted to be substituted for said bridged generator in the call-originating circuit and to produce therein a current of reversed direction and of strength sufficient for the operation of any substation-meter brought into the circuit by the operation of the substation-switch. We also provide in connection with said switch-cord a key or switch which when operated acts to disconnect the said bridged normal source from the call-originating circuit and to substitute the supplementary generator therefor. Moreover, to prevent disturbing clicks or rasping noises, which otherwise are liable to be heard in the substation-telephones by reason of such transfer, we provide condensers which by the operation of said key are respectively branched to the main-circuit conductor and around a portion of the induction-coil winding, which is disconnected, together with the bridged source. We also provide a special or distinctive signal in the shunt of the supervisory signal associated with the switch-plug

connecting with the second or wanted line, the withdrawal of said supervisory signal and the display of said distinctive signal being practically simultaneous and both responsive to the operation of the telephone-switch or equivalent circuit-changer at the substation of said second line. Both of the said signals are preferably small glow-lamps; but the distinctive signal is adapted to be displayed with a much lower voltage than that required for the operation of the supervisory signal. An electromagnetic switch having an actuating-coil included in the circuit of the substitute source and a retaining-coil in the switch-cord companion-plug local circuit are also provided and brought into operation when the key is depressed to transmit the current of said substitute source.

The object of the distinctive signal is to indicate that the called subscriber has answered and that it is now in order to depress the said key. The electromagnetic switch accordingly acts to open the shunt-circuit through the distinctive signal which is no longer wanted and to close it through a new branch and an inert resistance corresponding to the resistance of said signal and acts also to change the route of the local circuit in such manner as to include its own retaining-coil therein. By this device the distinctive signal is withdrawn and prevented from further operation, and the supervisory signal, though also withdrawn, is held in readiness to be again displayed when the telephone-switch at the substation of the called line is returned to its normal position by the replacement of the receiver.

In the drawings which accompany this specification, Figure 1 is a conventional diagram illustrating the application of my invention to two substation-circuits—to wit, a call-originating circuit and a second or called circuit—and to the central station switchboard devices whereby the said circuits are or are about to be united. Fig. 2 is a diagram, on an enlarged scale, showing one way of connecting the service-meter in the substation telephone branch. Figs. 3 and 4 are respectively a front and end elevation of a form of meter adapted for use in connection with the system and appliances constituting the invention.

Referring to the said drawings, L and L^2 are substation-circuits having main conductors a b and a^2 b^2, respectively, extending between their substations and the central station C.

L is a polystation-circuit and is shown as having two substations A A^2, and L^2 is represented as having a single substation B. In the usual manner each main circuit has at its sub station or stations a call-bell branch 3, a telephone branch 4, and a circuit-changing switch W. The said call-bell branch is normally (or, if desired, permanently) connected with the main circuit and includes the call-bell N and condenser F, the said condenser maintaining the continuity of the circuit for the alternating ringing current while making it discontinuous in respect to steady currents. The telephone branch 4, as shown at stations A and B, is normally open or disconnected at the point x of the switch and includes the secondary winding of the induction-coil V, and it may include the receiver T also; but for purposes apart from this invention the receiver, in common battery systems, is generally placed in a local circuit 5, set off from the other branches including, as shown, said receiver, the primary winding of the induction-coil V, the condenser F, and the transmitter t, and normally open at contact-point y. The telephone branch 4 of the main circuit may be regarded as extending from the point e on main conductor a through the secondary winding of the induction-coil to switch-contact x, thence through the switch W by way of the transmitter t to the point g, where it joins the other main conductor b, the section of conductor which includes the transmitter being, as shown, common to the said branch and local circuit.

H is the service-meter, having its magnet v connected in the normally open telephone branch 4. It is polarized in such manner as to be irresponsive to the regular current of the circuit which is supplied for the operation of the telephone-transmitters and central-station call-signals, and its armature, moreover, is provided with a biasing and retracting spring v^2, which acts to promptly return said armature to its normal position, when, after the same has been oscillated by a current impulse of appropriate direction, such current ceases, or when the normal working current is again caused to flow in the circuit. The adjustment of the meter magnet and armature is, moreover, so high that for its operation there is required a current not only opposed in direction to the normal current, but also much stronger when flowing in the same circuit; and, finally, such stronger and reversed current can operate the meter only at a station where the telephone branch 4 has been closed by the action of switch or circuit-changer W, as shown at station A^2, where the receiver T is represented as having been removed from its support and the switch-lever into position to close said branch in connection with the main circuit. By this arrangement the operation of the several substation-meters of a polystation-line are made to a very large extent selective.

Any preferred form of polarized service-meter may be employed, provided it is arranged and adjusted to respond in the first half of its oscillation to the passage of a reversed current impulse strong enough to overcome the tension of the spring v^2 and in the second half-oscillation restoring the armature to its resting position, to the cessation of such reversed current for the resumption of the flow of the normal current, and provided that one call or completed connection is meted or

counted and recorded by each complete oscillation of the armature, or, in other words, for each change to a current of reversed direction and back.

At the central station each substation may have the usual outfit of a central-battery installation, J representing the switch-sockets, with frame-piece or test-rings J^2, R^2 the cut-off relay, *w* the line-signal or signal-relay, S^3 the line-battery, Z a general ground, and Z^2 and Z^3 ground connections for the alternative sources S and S^2. The line-wire *a* makes normal connection through the cut-off relay contacts *m* with the earth Z through the signal *w* and battery S^3, and line-wire *b* through contacts m^2 with the earth direct. The cut-off relay is connected in the ordinary way in the incomplete local circuit d^2, extending from the socket-frame J^2 to said ground connection. On the insertion in the socket of the switch-plug this local circuit is completed by means of a local-circuit conductor of said plug and receives current which excites the cut-off relay, enabling it to disconnect the normal terminals of the main circuit and thereby leave the switch-socket springs $j\ j^2$ as the only terminals thereof, and as the said springs have (also by the insertion of said plug) been brought into contact with the plug tip and ring contact, surfaces the main-circuit conductors are continued by way of the switch-cord to any second line to which the companion plug may be switched.

C^2 is the switch-cord apparatus as a whole and may of course be taken to represent any necessary number of such cords.

P P^2 are the answering and companion plugs, each having tip and ring contacts $p\ p^2$, arranged on the insertion of the plug to register with the socket-springs $j\ j^2$, respectively, and a rear or sleeve contact p^3 to engage with the socket-ring J^2.

The main-circuit conductors $c\ c^2$ of the answering-plug P are looped through one winding, and the similar conductors $c^3\ c^4$ of the companion plug P^2 through the other winding, of a repeating induction-coil I, and the normal battery or equivalent generator S of the regular working current is bridged between the said main conductors at points 7 8 at the middle of both of the said windings, the said windings for the purpose being divided into two half-windings $i\ i^2$ and $i^3\ i^4$. By this means the said source is enabled to develop an independent normal current in the two plug-circuit loops, and obviously in the two main circuits with which the said two plugs may be respectively connected.

A ground connection Z^2 is supplied for the battery S at the point 7, between the said battery and the coil half-windings $i\ i^3$, and with the ungrounded pole of said battery the local-circuit cord conductors *d* and d^3 are united by a common conductor 9, the said conductors being enabled to complete their circuits when the plugs are placed in their sockets through the fixed local-circuit conductors d^2 d^4, associated with main circuits L L^2, respectively.

The signal-controlling relays R are connected in the plug-circuit main conductors, and the supervisory signals *s*, preferably small glow-lamps, in the local-circuit conductors *d* d^3. The relay and signal associated with the answering-plug P are, however, not concerned with the present invention, which makes use of these devices associated with the companion plug only.

The main-line relays R are controlled by the substation-circuit changers W, being quiescent when these are in their resting positions and when consequently no current flows in the circuit, but becoming excited when the said circuit-changers are moved to their working positions, as by the displacement of the receiver, and when as a consequence the circuit is closed and current permitted to flow therein.

The supervisory signals *s* in turn are controlled by the said relays through the intermediation of shunts 10 of suitable resistance, these being open when the relays are quiescent and closed when said relays are excited. When closed, they divert so much of the current from the signal that the said signal is withdrawn—that is, it is no longer displayed.

S^2 is an auxiliary or supplemental generator having one pole grounded at Z^3; K, a key or switch controlling the connection of the switch-cord main conductor c^2, and thereby the entire main circuit L, with the two sources of current S and S^2; M, an electromagnetic switch; *k* and k^2, condensers; s^2, a special or distinctive signal connected in a detachable portion 12 of the shunt 10, controlled by relay R; and *r* is an inert resistance in an alternative shunt or branch conductor 13 of said shunt 10, parallel to said distinctive signal and adapted under certain conditions to be substituted therefor. The said supplemental generator is shown as being a straight-current dynamo, although, except for the inconvenience of employing so many cells, a voltaic battery may be employed and would answer as well. It must, however, be adapted to develop in the call-originating circuit L a current much stronger than that of the normal source S—that is, a current which shall be strong enough to operate the service-meter through any ordinary substation-circuit. It must also be so arranged in respect to polarity that when connected with the main circuit L^2 the current it produces in said circuit shall be of direction opposite to that of the normal current generated therein by the normal source S. To present a concrete case, if the electromotive force of the normal source be, as is frequently the case, twenty-four volts that of the supplementary generator may be one hundred and ten volts, and if the said normal source, as shown, has its minus pole directed to the main cord conductor C^2 the auxiliary generator should have its plus pole

similarly directed toward the said conductor and its minus pole grounded.

The key or switch K is primarily a device for disconnecting the normal source of current S from the call-originating circuit L and for connecting the supplementary generator S^2 in place thereof, although it has other functions, presently to be described. To this end the cord conductor c^2 is led through contact-spring 18 and point 19, normally united, and from the latter by conductor 20 to the induction-coil half-winding i^2 and battery S, and the lineward pole of the supplemental generator S^2 is extended by conductor 21 to the normally unconnected contact-point 14 in said key. When the key K is operated by pressing the button k^3, the contact-spring 18 is forced away from the point 19, thus disconnecting conductor c^2 and the main circuit from the source S, and the said spring-tongue is forced into contact with point 14, thereby uniting the main-circuit conductor a through cord conductor c^2 with the alternative source S^2.

The condenser k is in a normally discontinuous branch 25, extending from a point 8 at the minus pole of battery S to the normally unconnected contact-point 17 within key K. When said key is depressed, the contact-spring by its own resiliency makes contact with the said point 17, and an electrostatic shunt, formed of said conductor 25, the condenser k, and conductor 20, is thus established around the induction-coil half-winding i^2 to receive and absorb the discharge from the said half-winding. The condenser k^2 in like manner is in a normally detached branch 23 of the main circuit, extending from the contact-spring 27 of said key through said condenser to ground at Z. When the key is operated, the contact-point 16 of said spring is brought into contact with its mate point 15, which connects directly through cord conductor c^2 with the line-wire, and the said line with any magnet-coil which may be therein discharges into condenser k^2. By these arrangements disturbing clicks or rasping sounds which otherwise would be heard in the substation-telephones are to a large extent prevented.

A consideration of the key and its several contacts will show that it comprises terminals of the line conductor c^2, the two sources, and the two condenser branches. Also that when the key is pressed to send the strengthened and reversed current to line its action is to first unite points 15 and 16, closing the branch 23 and condenser k^2 to line; second, permit spring 26 to make contact with point 17, bridging the condenser k around the half-winding i^2; third, break the normal contact between spring 18 and point 19, thus opening the normal line-circuit, disconnecting the battery S and half-winding i^2, and permitting the said half-winding and line to discharge into said condensers, respectively, and, fourth, bring spring 18 into contact with point 14, thus connecting generator S^2 in place of S. When the key is released, the reverse operations are performed and in reverse order.

The distinctive signal s^2 is also preferably a lamp; but it is adapted to glow and display itself as a signal with a much lower electromotive force than is required for the operation of the supervisory signal s. In general practice the said supervisory signal works under a pressure of twelve volts; but the distinctive signal may be arranged to work with as low a pressure as four volts. Generally it may be stated the resistance and required voltages of the said two signals are to be so proportioned that the lamp s will be extinguished by the closure of the shunt, while the lamp s^2 is by the amount of current diverted brought to its proper brilliancy of incandescence.

The electromagnetic switch M has an actuating-coil q in the circuit of the conductor 21 of the auxiliary source S^2, and therefore adapted to be excited when said circuit is closed by the key K, and a retaining-coil q^2 in a normally open branch 36 of the local circuit d^3. It has movable contact-pieces 35 and 37, shown as being operated by two armatures. The contact-piece 37 normally rests in contact with the fixed point 31, which forms the terminal of the detachable portion 12 of the shunt-circuit 10, which includes the special signal s^2, but moves when the switch operates into contact with a second point 32. This point 32 is the terminal of the alternative shunt or branch conductor 13, extending from point 30 on conductor 12 parallel with the signal s^2 and including the inert resistance r, which may be substantially equivalent to that of said signal. The said contact-piece 37 is itself united to the conductor 39, forming the unchanging portion of the shunt-circuit 10 and extending from the point 40 on the local-circuit conductor d^3. The other movable conductor 35 connects directly with the principal conductor 9 of the local circuit d^3, and when the electromagnetic switch is unexcited it rests on point 33, which is the terminal of said local circuit; but on the operation of said switch M the movable conductor is separated from point 33 and brought into contact with point 34, which is an alternative terminal of said local circuit d^3, including the retaining-coil q^2 and leading through branch 36. When, therefore, the switch M is operated, it acts to open the shunt 10 through the distinctive signal s^2, to close the same through the inert resistance r, thus maintaining the withdrawal of the supervisory signal s, and to change the path of the local circuit d^3 in such manner as to include the retaining-coil q^2 therein, and thereby maintain the operative position of the switch M after the key K has been released and the withdrawal of the distinctive signal.

As already mentioned, r is the inert resistance of the shunt-section 13, associated with the companion plug, r^2 being a corresponding

resistance in the controlling-shunt 10 of plug P. So, also, the resistances r^3 of local circuit d and r^4 of local circuit d^3 correspond, and the resistance of the latter and that of the retaining-coil q^2 should be about the same. In the main-circuit conductor 41 of the auxiliary source S^2 there may also be introduced a resistance r^5 of any suitable magnitude, which, if desired, may be made adjustable. The relations of these resistance-coils with the several local shunt and supply circuits are well understood by those skilled in the art and need not be further elaborated.

The several conductors 22 and 24, shown as diverging from the stem-conductors 41 and 23 of the auxiliary source S^2 and of the branch including condenser k^2, indicate that the said source and said condenser may be common to a number of switch-cords.

In Figs. 3 and 4, which show a suitable form of meter mechanism H, v v are the magnet-coils; v^4, the oscillating armature, centrally pivoted at v^5; v^2, the adjustable biasing or retracting spring of said armature, attached to a plate v^6, screwed to the under side thereof, and Q the polarizing-magnet, the several essential parts being mounted in a framework G, such as that employed with like parts in the ringer apparatus of the well-known standard magneto bell-boxes. O is a lever-arm attached at one end to the armature and at the other ending in the fork of the pallet-lever E, which is swung thereby on the pivot or arbor E^4 in conformity with the oscillations of the armature. The said pallet-lever engages and revolves the star-wheel E^2 on the axis E^3, and thereby operates the direct-reading counter or registration-disks E^5, mounted on said axis, which work in harmony with one another to produce a direct-reading record with a range of from "0" to "9999."

The polarity of the meter-magnet is so arranged that the normal line-current will tend to retain the armature toward the same magnet-pole as that to which it is drawn by the spring v^2. When the magnet is excited by a current of opposite direction and increased strength, the armature is caused to swing against the force of the spring toward the other pole of said magnet, oscillating the lever O and moving the star-wheel for half a step. When the said stronger reversed current ceases the spring v^2 assisted by the normal current draws the armature back to its original position, moving the star-wheel, now by the other pallet of the pallet-lever for the remaining half-step. The counter will thus be moved forward one whole space and will register one connection.

It frequently happens that through misunderstanding or inadvertence ringing-currents intended to operate the call-bell N are transmitted over the line from the central station, when the receiver having already been taken from its support the switch W has been operated to bring the actuating-magnet of the meter into the line of conduction. Under these circumstances the meter is of course liable to be adversely affected and its record falsified.

To protect the meter from the operation of the ringing-current, which, as is well known, is composed of rapidly-alternating impulses, the meter-magnet is shunted by a non-inductive resistance u. This, by the application of ordinary and accepted engineering principles, may readily be so porportioned to the meter-magnet that while the alternating ringing-current is mainly diverted from said magnet by reason of the high impedance offered to such current the steady current of the source S^2, designed to actuate the meter, finds no such impedance and divides between said magnet and its shunt in such manner that sufficient current for the operation of said magnet will surely pass through its exciting-coil. An incidental advantage of this arrangement is that it facilitates the transmission of voice-currents, avoiding the obstruction thereto which otherwise would accrue from the presence in the telephone branch of the meter-magnet. A modified arrangement for the same purpose of protecting the meter from undesired operation by ringing and like stray currents is shown in Fig. 2. The circuit connections and instrumentalities are substantially the same as in Fig. 1; but in addition to the shunt around the meter-magnet, including the non-inductive resistance u, there is placed an electromagnetic or choking resistance u^2 in series with the actuating-magnet v of the meter, and the shunt is made to include the said choking resistance as well as the magnet. This will materially increase the apparent resistance of the path through the meter-magnet for the ringing-current in comparison with the path through the non-inductive resistance of the shunt, while it will not greatly increase the real resistance of the said magnet branch to the steadily-applied actuating-current.

The operation of the invention requires no extended mention. When in response to a call of either substation of line L—let us say A^2—the two circuits L and L^2 are united at the central station by switch-cord C^2, the supervisory signal is manifested until the substation B responds by operating switch W. When the said switch or circuit-changer is operated and closes the circuit, current from the source S flows and the relay R is excited, closing the shunt-circuit around signal s and through signal s^2. Signal s is withdrawn and signal s^2 is displayed. This indicates that substation B has answered and that the call may be registered against substation A^2 of circuit L. Accordingly the operator presses key K, which disconnects the battery S through the induction-coil half-winding i^2 and connects the more powerful source S^2, the stronger and reversed current of which flows over circuit L between the ground connections Z^3 and Z^2. The meter H at station

A^2 responds to such current and registers the call, and at the same time the electromagnetic switch M switches the distinctive signal s^2 out of circuit, substituting for it the inert resistance r, and also changes the path of the local circuit d^3 to include its own retaining-coil. The pressure of the key K also establishes a condenser branch to the line and around the induction-coil winding i^2. When the substations replace their receivers, the supervisory relays R break the shunt-circuits around the signals s, which accordingly are redisplayed. The plugs are then withdrawn from the sockets and the local circuits d d^3 thereby broken. The retaining-coil of the electromagnetic switch M is thus deënergized, and the said switch resumes its normal condition, as does also the entire apparatus.

We claim—

1. In a telephone system, the combination with a call-originating substation-circuit, and a second or called substation-circuit extending from substations to a central station and switched together thereat; a source of current-supply adapted to establish normal working current independently in both circuits, an alternative source adapted to be substituted for said first-named source in the call-originating circuit and to develop therein a stronger current of reversed direction, and means for changing such circuit from each source to the other, all at the central station; of a service meter or register in said call-originating circuit irresponsive to said working current but responsive to said stronger and reversely-directed current; a circuit-changer at a substation of the second substation-circuit controlling the conductive continuity thereof and thereby the flow of current therein; and two signal devices associated with said second circuit at the central station both responsive to the operation of said circuit-changer and adapted to be displayed, one, when the said circuit-changer is in or restored to its normal position, and the other when the same is moved to its second or operative position; subtantially as set forth.

2. In a telephone system, the combination of a call-originating substation-circuit, and a second or called substation-circuit extending each from one or more substations to a central station and connected thereat by switch devices; an electrical generator such as a battery bridged across said circuits and adapted thereby to establish an independent normal or working current in each, a substitute generator adapted to take the place of said first-named generator in the call-originating circuit and to develop therein a current stronger than said normal current and of opposite direction, and a key or like device controlling the relations of said call-originating circuit and the said alternative generators and adapted to transfer said circuit from each to the other, all at the central station; a service-meter in said call-originating circuit at a substation thereof, irresponsive to said normal current, but responsive to said stronger and reversed current; a telephone-switch at a substation of second substation-circuit actuated by the displacement of the receiver from its support to establish and by its replacement to disestablish the conductive continuity of the said circuit and thereby the flow of working current therein; a supervisory signal in a local circuit associated at the central station with said second circuit; a similarly-associated auxiliary or distinctive signal in a branch of said local circuit; and a relay in said second substation-circuit controlled by the operation of said telephone-switch and controlling the said local circuit, its branch, and the signals contained therein respectively, in such manner as to close said local circuit and operate the supervisory signal when unexcited, and to open the same, withdraw said signal, close the branch and operate said distinctive signal when excited; substantially as described.

3. The combination in a telephone system, with a telephone main circuit extending between a substation and a central station, and provided at said substation with a normally connected call-bell branch, a normally disconnected telephone branch, a service-meter with a polarized actuating-magnet connected in said telephone branch, and a telephone-switch to connect said telephone branch with said main circuit when required; of a switch-plug and switch-cord circuit at said central station adapted to complete said main circuit through a battery supplying normal current thereto; a supplementary generator adapted to be substituted for said battery in said circuit and to supply a stronger current of reversed direction thereto; and a key or switch associated with said switch-cord and adapted when operated to disconnect said battery and connect said supplementary generator in place thereof; substantially as described.

4. The combination in a telephone system, of a telephone main circuit extending between a plurality of substations and a central station provided at each substation with a normally connected call-signal branch, a normally disconnected telephone branch, and a telephone-supporting switch operated by the removal of the receiver to connect said main circuit with said telephone branch; and a switch-plug and cord-circuit at said central station completing or adapted to complete said main circuit through a normal current-generator supplying working current thereto; of a polarized service-meter in said telephone branch at each substation irresponsive to said working current but responsive to a stronger current of opposite direction or sign; a supplementary generator at said central station adapted to be substituted in the main circuit for said normal generator and to develop therein the required stronger reversed current; and a key or switch associated with said switch-cord and controlling the connection of the main circuit therethrough with the

said normal and supplementary generators respectively; whereby the operation of said key is enabled to actuate the service-meter at any station where the receiver has been removed from its support, but at no other, substantially as described.

5. In a telephone-exchange central-station apparatus, the combination of two substation-circuits (viz: a call-originating and a second or called circuit) switched together to constitute a through circuit between their respective substations; a current-generator such as a battery bridged between the conductors of said through circuit and adapted to maintain an independent working current in each constituent circuit; an alternative or substitute current-generator of superior power for the call-originating constituent circuit, normally disconnected therefrom; a key or equivalent device containing terminals of the said two generators and the said call-originating circuit, and adapted to connect at will either generator in said circuit; a service-meter irresponsive to normal working current, but responsive to the current of the said alternative or substitute generator to register calls of the call-originating circuit; a supervisory signal in a local circuit associated with said second constituent substation-circuit; a normally open primary shunt controlling said signal, and a special or distinctive signal included therein and adapted when said shunt is closed to be operated by the current diverted therethrough; an alternative or secondary normally open branch of said shunt parallel to the said special signal, including an inert resistance corresponding to that of said distinctive signal; a relay in said second constituent circuit adapted when excited to close said first-named shunt and thereby control said supervisory signal; and an electromagnetic switch in the circuit of said substitute generator controlling said shunt and adapted when excited to open said first-named shunt and close the said secondary shunt, thereby withdrawing the said distinctive signal, and maintaining the withdrawal of said supervisory signal; substantially as and for the purposes specified.

6. In a telephone system and central-station switch apparatus, the combination with a call-originating main substation-circuit and a second or called main circuit both extending from a substation to a central station and switched together at said central station to constitute a through circuit; a battery bridged between the conductors of said through circuit; a normally disconnected alternative or substitute source of current; a service-meter irresponsive to normal working current of said battery, but responsive to the current of said alternative or substitute source, associated with said call-originating circuit; a local circuit associated with said second main circuit and a supervisory signal connected therein; a normally open shunt or branch of said local circuit around said signal; and a relay in said second main circuit adapted to close and open said shunt and thereby control said signal; of a second or distinctive signal connected in said shunt; a secondary normally open branch of said shunt parallel with the said distinctive signal and including an inert resistance corresponding to that of said distinctive signal; a key associated with the call-originating main circuit adapted to disconnect the said bridged battery from said circuit, and to connect the said substitute source in place thereof; and an electromagnetic switch having an actuating-coil in the circuit of said substitute source and a retaining-coil in a normally open branch of said local circuit, said switch being energized on the operation of said key and adapted thereupon to substitute the said secondary shunt for the first, and to close the local circuit through its own retaining-coil and thereby maintain such substitution; substantially as described.

7. The combination in a telephone system, of a call-originating substation-circuit, a second or called substation-circuit, a service meter or register irresponsive to normal working current but responsive to the current of an auxiliary or substitute current generator to register calls of the call-originating substation-circuit; a switch-cord-circuit system comprising answering and companion terminal plugs, main conductors joining the tip-contacts and ring-contacts of said cord respectively, and local-circuit conductors one for each plug; an induction-coil having its windings connected between the main conductors of each plug respectively, so as to form a loop for each plug; a battery bridged at the middle of said windings; a supervisory signal in the local circuit of said companion plug; a controlling-shunt therefor; and a relay in the main circuit of said companion plug controlling the continuity of said shunt and thereby the display of said signal; with an auxiliary or substitute current-generator; a distinctive signal included in said shunt-circuit; a normally open branch of said shunt-circuit parallel to said distinctive signal and containing an inert resistance corresponding thereto; a key adapted to disconnect said battery from the answering-plug section of said switch-cord, and to connect the said substitute generator in place thereof; and an electromagnetic switch with an actuating-coil in the circuit of said substitute generator, and a retaining-coil in a normally open branch of said local circuit, the said switch being adapted to transfer the said shunt-circuit from its signal branch to its inert resistance branch, and to switch its own retaining-coil into said local circuit, whereby such transfer may be maintained; substantially as described.

8. In a telephone-exchange system, the combination with a main telephone-circuit closed at a central station through a switch-cord or continuation-loop; and a regular source of current; of an alternative and nor-

mally disconnected source of current; a condenser in a normally detached branch of said main circuit or its continuation; and a key or switch interposed in a conductor of said main circuit, and comprising terminals of said conductor, the said regular and alternative sources, and said condenser branch, said key normally maintaining contact between the main circuit and regular-source terminals, and adapted when operated to disestablish the same, and to establish contact between the main circuit, alternative source, and condenser-branch terminals, substantially as described.

9. The combination in a telephone system, with a main telephone-circuit closed at a central station through a switch-cord or continuation-loop; and a regular source of current, and a winding i^2 of an induction-coil included in said loop; with an alternative and normally disconnected source of current; a normally discontinuous branch around the said induction-coil winding; a condenser contained therein; and a key or switch having normally united contacts maintaining the connection of said main circuit and its regular source of current, and normally detached contact-terminals of said alternative source and condenser branch, the said key being adapted when operated to disconnect the said regular source of current and said induction-coil winding from the main circuit, to substitute the alternative source therefor, and to establish the said condenser branch; substantially as described.

10. The combination in a telephone system, with a main telephone-circuit; a switch-cord or continuation-loop connected or adapted to be connected thereto; and a generator supplying the regular working current for said circuit, normally included together with an induction-coil winding i^2 in said loop; an alternative and normally disconnected generator adapted to supply a stronger current to said circuit; two condensers, one in a normally detached earth branch from a conductor of said main circuit, and the other in a normally incomplete electrostatic shunt or branch around said induction-coil winding; and a key or switch interposed between terminal contacts of a conductor of said main circuit, the said two generators, and the said condenser branches, and adapted when at rest to maintain the connection in said main circuit of said regular current-generator, and when operated to successively complete the circuits of the said condensers respectively, disconnect the said first-named generator and coil-winding, and connect the said alternative generator in place thereof; and when released or returned to its normal condition to reverse said operations in reverse order; substantially as hereinbefore described.

11. The combination in a telephone central-station apparatus, of a switch-cord-circuit system comprising answering and companion plugs, a main conductor-loop between the tip and ring contacts of each plug, and a local-circuit conductor for each plug; a battery in a bridge common to both loops; an induction-coil having its windings in the said loops respectively, one-half of each winding being on each side of said battery; and a ground connection between said half-windings and said battery, at one side thereof; a grounded auxiliary or substitute current-generator associated with said answering-plug loop but normally disconnected therefrom; a normally incomplete earth branch from the ungrounded side of the said answering-plug loop, and a normally incomplete shunt around the ungrounded induction-coil half-winding of said loop; two condensers connected respectively in the said earth branch and shunt; and a key or switch associated with the ungrounded conductor of said loop, and adapted when operated to successively complete the said condenser earth branch, and the said condenser-shunt, disconnect the said battery and ungrounded half-winding from said loop-conductor, and transfer said loop-conductor to the said grounded auxiliary generator, substantially as described.

In testimony whereof we have signed our names to this specification, in the presence of two subscribing witnesses, this 4th day of April, 1902.

ALBERT M. BULLARD.
LOUIS A. FALK.

Witnesses:
THOMAS D. LOCKWOOD,
M. E. LEDDY.