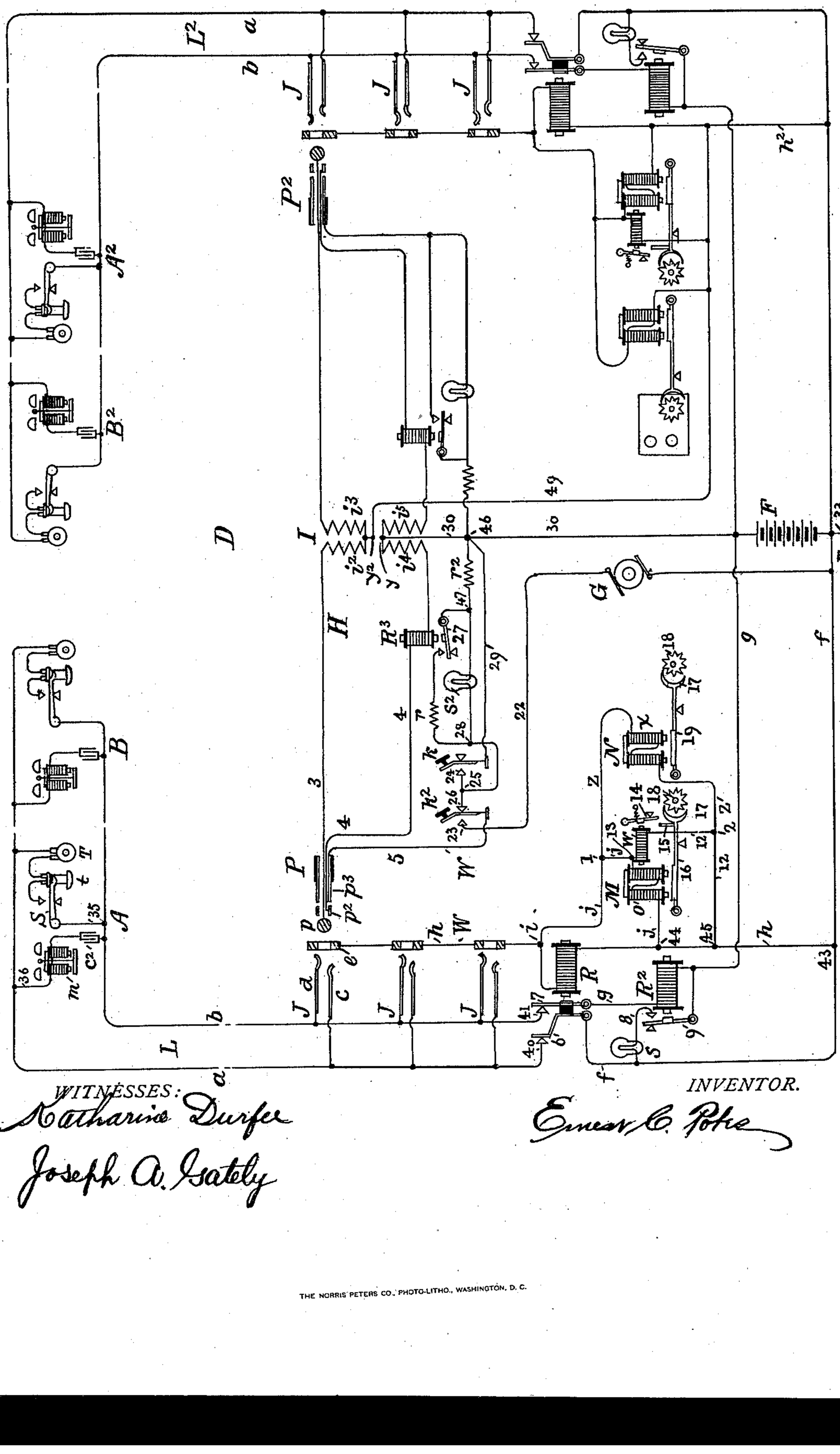
No. 686,340. Patented Nov. 12, 1901.

E. C. ROBES.

SERVICE METER APPARATUS FOR TELEPHONE CIRCUITS.

(Application filed Apr. 17, 1901.)

(No Model.)



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SERVICE-METER APPARATUS FOR TELEPHONE-CIRCUITS.

SPECIFICATION forming part of Letters Patent No. 686,340, dated November 12, 1901.

Application filed April 17, 1901. Serial No. 56,297. (No model.)

To all whom it may concern:

Be it known that I, ERNEST C. ROBES, residing at Medford, in the county of Middlesex and State of Massachusetts, have invented certain Improvements in Service-Meter Apparatus for Telephone-Circuits, of which the following is a specification.

This invention relates to service-meters or call-registers for the substation-circuits of a telephone-exchange, and concerns more particularly that class of such appliances as have their actuating-magnets in series or in parallel with the cut-out-relay local circuit completed through the switch plug and cord, the said meter-magnets being irresponsive to the normal current of the said relay-circuit, but responsive to the flow of a stronger current therein, whether such increase in strength be brought about by withdrawing resistance from or adding electromotive force to the said circuit.

The invention contemplates the application of direct-reading service-meters to telephone-circuits extending between two substations and a central station, there being one meter for each substation arranged to register and indicate the calls or connections originating at its own station only and to altogether disregard the business of the other station, both meters being, however, placed at the central station. Each meter has an actuating-electromagnet, and one of them has also an auxiliary locking-magnet responsive to the current which excites the actuating-magnet of the other, the exciting-coils of the said electromagnets being preferably in parallel with each other and with the magnet-coils of the cut-off relay. The actuating-magnet of that meter which is provided with the auxiliary magnet is constructed and arranged to be slow-acting or to operate sluggishly, but responds to a current which, while stronger than the normal cut-off-relay current, is still too weak to operate its associated auxiliary magnet or the actuating-magnet of the other meter. This moderately-increased current I term a current of "medium" strength; but the said auxiliary or locking magnet and the actuating-magnet of the said other meter thus requiring for their operation a still stronger current, which I term a current of "maximum" strength, are designed to respond promptly and quickly to a sufficiently strong current, and when such a current strong enough for their operation is caused to flow in the circuit they respond thereto by the action of their armatures before any such response from the slow-working meter-actuating magnet is possible. The auxiliary magnet associated with the said sluggish actuating-magnet controls a detent or locking device which acts to prevent the operative movement of the armature of the latter, or, in other words, the quick-acting magnet working with the strongest or maximum current acts to interpose a block or obstacle in the path of the armature of the sluggish actuating-magnet, which is thus prevented from yielding to the attractive influence of said magnet. By such means it is arranged that a moderate increase of current—that is to say, the medium current—in the cut-off-relay circuit shall operate one meter, and that a greater increase, constituting the maximum current, shall operate the other, and that the two meters may be operated selectively, each to indicate directly the calls or connections of its own substation.

Associated with the switch-cord devices, whereby a calling-circuit is united to the line of the wanted station and in particular with the local circuit or third conductor thereof, are two keys, one adapted to modify the original current of the cut-off-relay circuit and the other to connect a substitute and more powerful source of current therewith. One of these keys is so connected with the circuit that its operation establishes a shunt or short circuit around the supervisory signal and its accompanying resistance which are in the cord-connection section of the cut-out-relay circuit, and thereby reduces the resistance of such circuit moderately, increasing the current to the medium strength required for the operation of the slow-working actuating-magnet of one of the meters, and thus registering the service rendered on call of the corresponding substation. The connection

of the other key with the local circuit is such that its operation disconnects the normal source of current altogether, substituting the more powerful one. By manipulating this key, therefore, the maximum current is caused to flow in the cut-off-relay circuit. The actuating-magnet of the second meter and the locking-magnet of the first are thereby excited, and a call or connection is registered by the second meter against the substation it represents, the other or first-named meter being prevented from operating in this instance by the action of the locking or detent magnet, which, working quicker than its associated actuating-magnet, engages the armature thereof, preventing the same from completing its stroke and from effecting any registration.

The drawing which accompanies and illustrates this specification is a diagrammatic representation of the invention as arranged in association with two substation-circuits, each having two stations and appropriate central-station switching and signaling apparatus.

L and L^2 are telephone-circuits extending, respectively, between substations A B and A^2 B^2 to a central station D, where by appropriate switch mechanism they may be united to each other, as indicated, or each with any other substation-circuit entering the central station. Each circuit consists of two main conductors *a b*, the substations being each provided with the usual appliances, shown herein as a call-bell *m* and condenser c^2 in a bridge 36, and the transmitting and receiving telephones T and *t* in a bridge 35, held normally open by the telephone-switch S. The conductors *a* and *b* extend at the central station D to the contact-stops 40 41 of the springs or contact-levers 6 and 7, respectively, which are attached to the armature of the cut-off relay R, the contact-lever 6 being united by conductor *f* with one pole of the battery F or ground, while the other lever 7 connects with the other pole of said battery by conductor *g*, which includes in its circuit the line-signal relay R^2. Switch-sockets J J J contain switch-springs *c* and *d*, constituting branch terminals of the main conductors *a* and *b*, respectively, and have each a conducting-plug-receiving ring *e*, (ordinarily serving as a contact-ring in some one of the well-known busy-test systems.) The rings of the several switch-sockets of each substation-line are united by conductor *h*, which leads through the winding of the cut-out relay R to earth, being shown as forming a junction at 43 with conductor *f* for this purpose. The relay R^2, by its armature 9, controls the branch circuit 8, and thereby the lamp-signal *s*, contained therein, in a manner well understood.

M and N are the service-meters for the substations A and B, respectively, of circuit L, the substations A^2 and B^2 of circuit L^2 having, as shown, similar corresponding meters. The meter M comprises an actuating-electromagnet *o*, an armature 16 therefor, carrying an escapement 17, and a star or ratchet wheel 18, engaged by the said escapement for the progressive operation or control of the usual registering mechanism. The actuating-magnet *o* is in a branch *j* of the local circuit W parallel to the magnet of the cut-out relay R, the said branch extending between points *i* and 44 on conductor *h*, and the locking or controlling magnet *w*, associated with meter M, is in a third parallel branch 12, uniting point 13 on branch *j* to point 45 on conductor *h*. The said auxiliary magnet has an armature 14, which when attracted is brought in front of a detent or stop-pin 15, carried by the armature-lever 16 of the actuating-magnet *o*. Obviously if the armature 14 of the auxiliary magnet *w* be attracted into its forward position and the actuating-magnet *o* subsequently energized the armature of the latter will be locked and rendered unable to move forward, because its path is blocked by the said armature 14.

The actuating-magnet *x* of the service-meter N is connected in a fourth parallel branch *z* of the local relay-circuit W, the same being shown as extending from the point 1 on branch *j* to the point 2 on conductor 12. This meter N comprises the said actuating-magnet *x*, its armature 19, the pallets 17, carried thereby, and the ratchet or star wheel 18, whereby the requisite motion is imparted to the meter mechanism proper, these mechanical features being in every substantial respect similar to those of meter M.

The actuating-magnet *o* and locking or detent magnet *w* of the service-meter M and the actuating-magnet *x* of meter N being in parallel branches of the cut-out-relay circuit, all receive a portion of the normal current of that circuit—that is to say, of the current which flows therein for the operation of the relay R—as soon as a call is answered by the insertion of a switch-plug. This current, however, or such portion thereof as passes through each of the several branches, is not strong enough to excite the said electromagnets, and none of these magnets attracts its armature.

The actuating-electromagnet *o* of meter M and its armature are sluggish, or, in other words, are constructed electrically and mechanically in a well-known way to be slow in responding to a sufficient operative current; but are also designed to become operative and respond when the normal current of the cut-off-relay circuit is increased to medium strength, as by short-circuiting such resistances as may be included in the main portion thereof external to that portion which splits into several parallel branches. The auxiliary electromagnet *w* of meter M and the actuating-magnet *x* of meter N are irresponsive not only to the normal circuit-current, but also to the said current when increased to the medium extent required for the operation of the actuating-magnet *o*.

They require for their operation a considerably-stronger current, stronger, in fact, than can be developed in the circuit by the normal source, and to supply the said maximum current I provide a special source. It is, however, to be stated that they are quick-acting in their response to a current sufficiently strong for their operation.

The features of the system thus far described are in permanent association with the two station-lines fitted with the direct-reading meters. The arrangement of the service-meters for the substation-circuit L^2 is in all respects similar and does not require further description, since the said meters are operated only when the said other substation-circuit in turn becomes a call-originating line. The remaining features of the system are associated with the movable parts of the switching apparatus and with that portion of each switch-cord connection which belongs to the call-answering plug. The companion plug-section of the switch-cord need not be provided with the coöperative features of the meter system, as in each complete connection it is invariably switched to that one of the two substation-circuits concerned which has been called for and which therefore is not subject to a charge.

H is a connecting switch-cord whereby a line L originating a call may at the central station be united to the wanted line L^2 responding to such call. There is of course such a number of switch-cords as are necessary to properly handle the business. Much of the switch-cord apparatus and the major part of its circuits are of the well-known standard type.

P P^2 are respectively the answering and companion switch-plugs, each having a main-circuit tip-contact surface p and a ring-contact surface p^2, these being adapted when the plug is thrust into the socket to register and make contact with the jack-springs c and d, respectively, and having also a local or rear sleeve contact-piece p^3, adapted to register and form contact with the frame-piece or ring e of the switchboard-socket J. When the plug is placed in the socket, the switch-cord and fixed portions of the cut-off-relay local circuit are united through the local contact thus established, and the said circuit W is constituted for the line over which the call has been received. The tip-contacts of the two plugs are united by strand conductor 3 through the two windings i^2 i^3 of the induction-coil I, and the ring-contacts are similarly united by conductor 4 through the remaining windings i^4 i^5 thereof and the supervisory relay R^3, the battery F or similar source of current being bridged between the said conductors 3 and 4 at points y and y^2 and through conductors 30 and 49. The source F supplies a normal current for the substation-transmitters for call and supervisory signals and also for the local circuit W between its poles when a plug P is in a switch-socket. The said local circuit may thus be traced: from one pole of source F to point 46, then through the lamp-signal s^2 and its accompanying resistance r^2 to point 28, thence to point 25, contact 26 of key k^2, and conductor 5 to the plug-contact p^3. From this point the circuit continues by socket-ring e and conductor h to point i, where it divides between the four parallel branches, reuniting at point 45 and passing by conductor h, point 43, and conductor f to the other pole of the battery F. The usual lamp-controlling shunt extends between points 28 and 47 of the local-circuit conductor through a suitable resistance r and is itself controlled by the forward contact of the armature 27 of the supervisory relay R^3 in the main-circuit conductor.

G is a separate and substitute source of current constructed and arranged to establish in the local circuit W a current considerably stronger than can be developed by the source F in the same circuit, even when the lamp s^2 and resistance r^2 are withdrawn therefrom. It is shown as a straight-current magneto or dynamo machine; but obviously a voltaic battery may, if desired, be employed, or, again, the source F itself may be utilized for this purpose, a sufficient number of cells being added thereto, but brought into circuit only when the operation of the strongest current is desired. One pole of the substitute source G is grounded or connected with the return-conductor f and the other extends by a conductor 22 to the front contact 23 of the key k^2. This key, together with another key or like circuit-changer k, is associated with the switch-cord section of the local circuit W, which in its ordinary arrangement supplying current of normal value leads through the key k^2 and its back or resting contact 26. The other key k when at rest is dissociated from the local circuit, but is united by conductor 29 from the point 46 on the battery-conductor 30. The front contact-stop 24 of key k is, however, branched from the same point 25 of the local circuit as is the resting-contact 26 of key k^2. If the key k be operated, it acts to short-circuit the lamp-signal s^2 and its resistance r^2, together with its shunt and resistance r. If the key k^2 be operated, it acts to disconnect the source F, the signal s^2, and the resistances r and r^2 and to connect the fixed or board portion of the local circuit W through the plug P to the more powerful source G.

In the operation of the invention it may be assumed that one of the substations of line L has sent in a call by taking his receiver from the hook and by thus closing the circuit of the battery F through the station-telephones. The line-relay R^2 responds and causes the display of the lamp-signal s, to which the operator responds by inserting the answering-plug P in the appropriate switch-socket J, receiving the order for a station of line L^2, and then proceeding to make the required connection. As soon as the said plug

is inserted the local circuit W is closed and the normal current thereof excites and operates the cut-off relay R. The said current is competent to work the supervisory signal-lamp s^2, but does not, because the main-line current exciting the relay R^3 establishes the shunt around said signal. The said normal current is not strong enough to work either of the meters M and N. When, however, the connection called for is established, it becomes necessary to make a charge against the substation originating the call, and should the said call have been sent in by substation A it is to be registered by the service-meter M. To effectuate such registration, the operator presses the key k, and this, making contact with point 24, closes the short circuit from point 46 through conductor 29, and around the lamp s^2, its controlling-shunt, and resistance r^2. The resistance of the local circuit being thereby reduced, the current of battery F is correspondingly strengthened and is now strong enough to fully excite the actuating-magnet o of the service-meter M, which accordingly registers the call against substation A; but the said current thus strengthened to a medium degree is still too weak to affect the actuating-magnet x of meter N or the detent-magnet w of meter M and no registration is made except by meter M. In case, however, the call shall have proceeded from substation B the operator presses the key k^2 to make the required registration or count. In this case all of that portion of the normal local circuit W that lies between said key and point 33, including the battery F, is dissevered from the portion of the circuit which includes the meters and a new connection between the latter and the more powerful generator source G is established, the old circuit being opened at the back contact 26 and the new one closed through the front contact 23. The current from source G thus thrown on the line is strong enough to excite the actuating-magnet x of meter N and the said meter is operated, registering the call against substation B; but the current of maximum strength sufficient for the operation of magnet x is clearly strong enough to operate magnet o also, and it is therefore necessary to provide means for preventing the operation of meter M when the key k^2 is manipulated to operate meter N. This is done by the detent or locking-magnet w, which responds to the current of source G and which is operated simultaneously with magnet x of meter N. The locking-magnet w operates much quicker than magnet o, which, as has been stated, is sluggish or slow-operating, and registration by the meter M is thus prevented by the prompt movement of the armature of magnet w, which is attracted into line with the stop-pin 15 of armature 16 and the consequent blocking of the latter armature. The meter M, representing substation A, is thus exclusively responsive to the manipulation of the key k, and the meter N in like manner is exclusively responsive to key k^2.

I claim—

1. In a telephone-exchange system, the combination of two substations; a main circuit connecting both with a central station; switching devices at the central station for uniting the said main circuit to any other substation-circuit; a local circuit associated with said switching devices; and a source of current for the local circuit; with two service-meters representing the said substations respectively, and having actuating-electromagnets connected in the local circuit; and means associated with said switching devices for the selective operation of either service-meter, to count or register the calls of the corresponding substation.

2. In a telephone-exchange system, the combination of two substations; a main circuit connecting both with a central station; a normally incomplete associated local circuit containing a relay; switching devices at the central station for uniting the said main circuit to any other substation-circuit and for completing the said local circuit; and a source of current at said central station connected with the said local circuit when closed by the operation of said switching devices and adapted thereupon to supply current for the operation of said relay; with two service-meters representing the said substations respectively, and having actuating-electromagnets connected in separate branches of the local circuit parallel to the relay thereof; and means associated with said switching devices for the selective operation of either service-meter, to count or register the calls of the corresponding substation; substantially as set forth.

3. In combination with a telephone-exchange main circuit having two substations and extending therefrom to a central-station switchboard; and the cut-off-relay circuit therefor associated with said switchboard; of two keys controlling the current in said local circuit and adapted to increase the same to medium and maximum strength respectively; and two electromagnetic service-meters connected with said local circuit representing the two substations of said main circuit, and corresponding to the said two keys, one of the said service-meters being responsive to the maximum strength and the other being held quiescent thereby, but being adapted to respond to the medium strength of current in said local circuit, and each being consequently responsive exclusively to the operation of its corresponding key; whereby the calls of the said substations may be directly registered by the said service-meters respectively; substantially as set forth.

4. In a telephone-exchange, the combination of a two-station subscriber's main circuit; a local circuit therefor at the central station consisting in part of a fixed switchboard-conductor and in part of a switch-cord

conductor, and including a supervisory signal and its associated resistance; means for producing in the said local circuit currents of three different strengths, said means comprising the normal source of current, a more powerful substitute source, and two keys or circuit-changers associated with the said cord conductor, one adapted to short-circuit the said signal and resistance and thereby increase the current from the normal or lowest strength to medium strength, and the other acting to transfer the circuit from the normal to the substitute source and thereby further increase the local-circuit current to its greatest strength; the cut-off relay of said main circuit in a branch of the local circuit, reponsive to the normal or weakest current thereof; and two electromagnetic service-meters representing the substations respectively, one having a slow-acting actuating-magnet and a quick-acting detent or locking-magnet in two other branches of said circuit parallel to each other and to the relay branch, and the other having a quick-acting actuating-magnet in a fourth parallel branch; the actuating-magnet of the first-named meter being exclusively responsive to the medium current of the first-named key for the registration of the calls of the corresponding substation, and the locking-magnet thereof together with the quick-acting actuating-magnet of the second meter being simultaneously responsive to the stronger current controlled by the second key, to prevent the registration by the said first meter of the calls of the other substation, and to effect their registration by the second; substantially as, and for the purpose set forth.

5. In a telephone-exchange system, the combination of a subscriber's main circuit extending from two substations to a central station; a "relay-switchboard" therefor at said central station comprising switch-sockets of the said main circuit and switch-cord devices having "answering" and "companion" switch-plugs for insertion respectively in said sockets and the switch-sockets of other main circuits; a normally incomplete local circuit in said switchboard associated with and containing the cut-off relay of said main circuit, and adapted to be completed (when a plug is inserted in a switch-socket of the corresponding main circuit) through a local conductor of the switch-cord of said plug; a signal device and associated resistance in the switch-cord portion of said local circuit; and a source of current in the said local circuit supplying a normal current for the operation of said cut-off relay; with a separate and more powerful source of current; two keys or circuit-changers associated with the switch-cord portion of said local circuit, one adapted when operated to withdraw resistance from the local circuit without changing the source, and thus establishing a current of medium strength, and the other to transfer the circuit to the more powerful source and thus establish a current of maximum strength; and two electromagnetic service-meters associated at the central station with said main circuit to represent respectively the two substations thereof, and having their actuating-magnets connected with the said local circuit, one of the said service-meters being exclusively responsive to the medium current established by the operation of one of the said keys, and the other meter being exclusively responsive to the maximum current established by the operation of the other key.

6. The combination in a telephone-exchange system, of a subscriber's main circuit extending between two substations and a "relay-switchboard" at a central station; the local "cut-off-relay" controlling circuit of said main circuit including said relay, and supervisory-signal devices; a normal source of current for the said local circuit furnishing current for said relay and signal devices; a circuit-changing key adapted to cut out resistance from the circuit; a substitute source of higher electromotive force; a second circuit-changing key adapted to transfer the said local circuit from the normal to the substitute source; an electromagnetic service-meter for each substation having their actuating-magnets in branches of said local circuit parallel to said relay, the said actuating-magnets being respectively responsive to the operation of said keys; and an electromagnetic detent or locking device for the actuating-magnet and its armature corresponding to the first-named key, the said locking device being responsive to prevent the operation of the service-meter with which it is associated, by the stronger current of the substitute source, when the said current is transmitted by the second-named key for the operation of the other service-meter; substantially as described.

In testimony whereof I have signed my name to this specification, in the presence of two subscribing witnesses, this 4th day of April, A. D. 1901.

ERNEST C. ROBES.

Witnesses:
GEO. WILLIS PIERCE,
FRANK C. LOCKWOOD.