No. 641,737. Patented Jan. 23, 1900.

G. K. THOMPSON.

REGISTERING APPARATUS AND CIRCUITS FOR TELEPHONIC MEASURED SERVICE.

(Application filed June 15, 1899.)

(No Model.) 2 Sheets—Sheet 1.

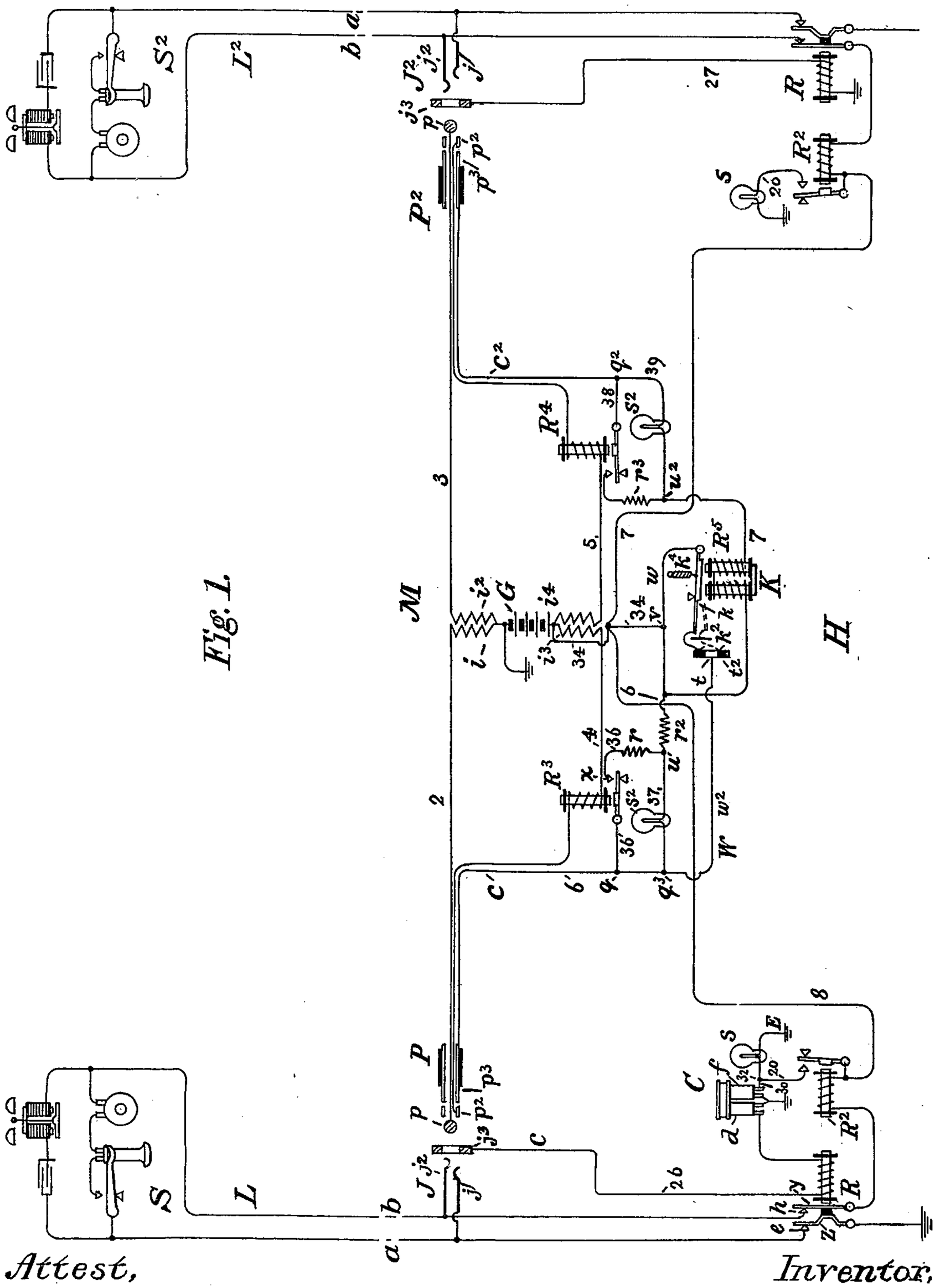

Fig. 1.

Attest,

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(No Model.) 2 Sheets—Sheet 2.

Fig. 2.

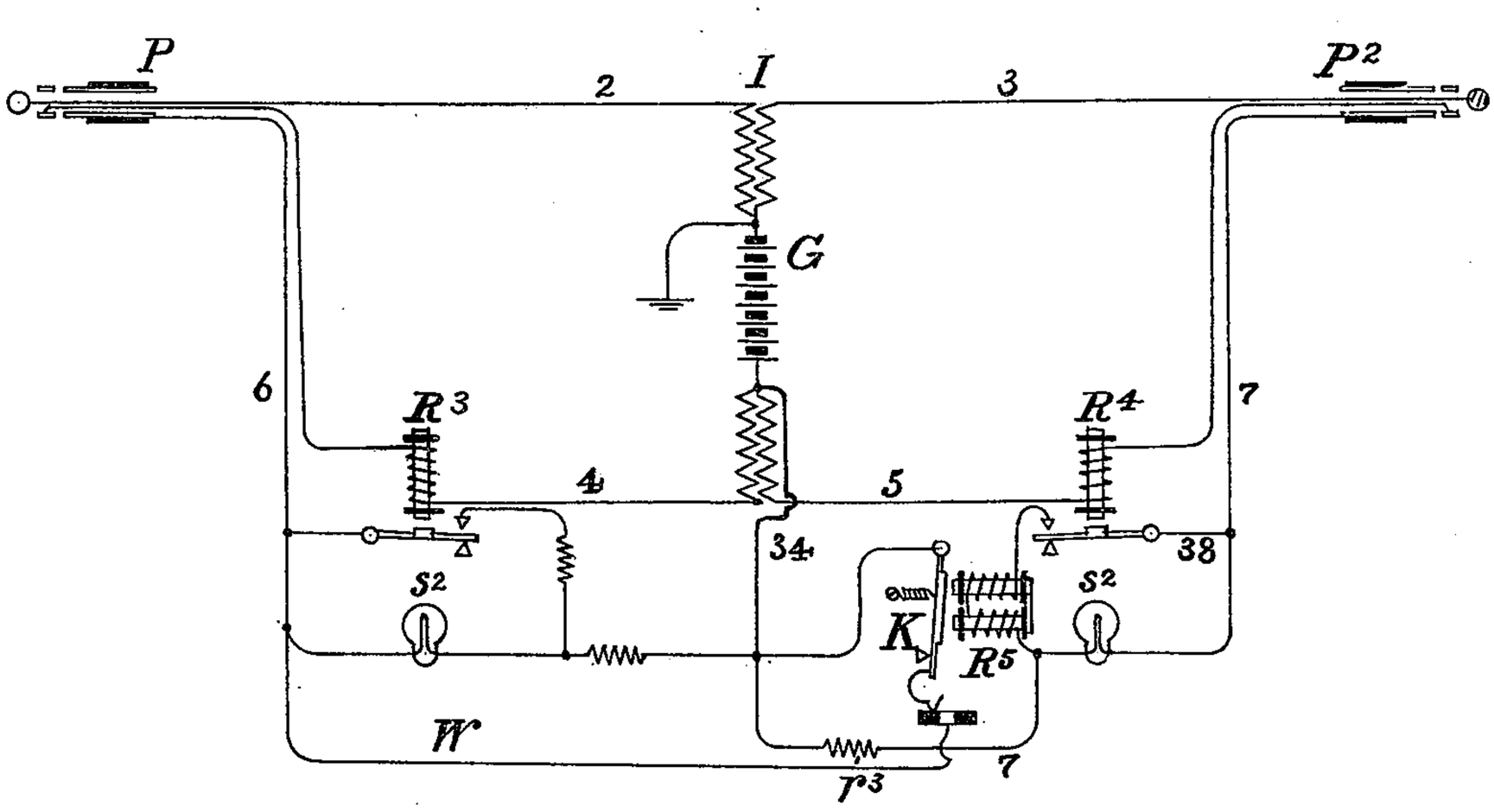
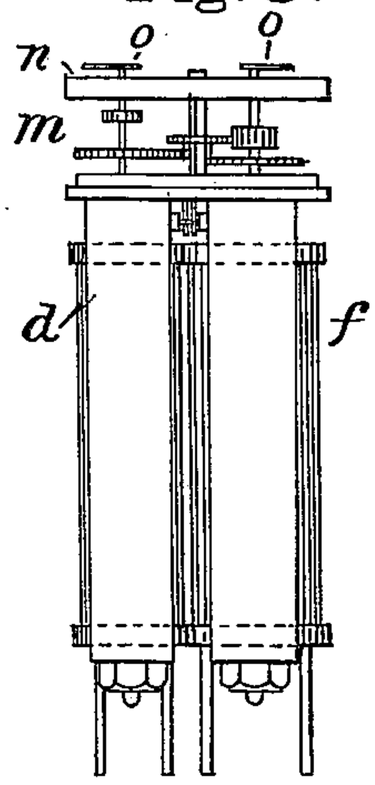


Fig. 3.



Attest,

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Geo. Willis Pierce

Inventor;

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UNITED STATES PATENT OFFICE.

GEORGE K. THOMPSON, OF MALDEN, MASSACHUSETTS, ASSIGNOR TO THE AMERICAN BELL TELEPHONE COMPANY, OF BOSTON, MASSACHUSETTS.

REGISTERING APPARATUS AND CIRCUIT FOR TELEPHONIC MEASURED SERVICE.

SPECIFICATION forming part of Letters Patent No. 641,737, dated January 23, 1900.

Application filed June 15, 1899. Serial No. 720,700. (No model.)

To all whom it may concern:

Be it known that I, GEORGE K. THOMPSON, residing at Malden, in the county of Middlesex and State of Massachusetts, have invented certain Improvements in Registering Apparatus and Circuits for Telephonic Measured Service, of which the following is a specification.

This invention concerns means for equitably charging for telephone-service, and more particularly relates to the electrical arrangement and mode of operating a call-registering or connection-counting mechanism to be associated with a substation-line at the central-station end.

In the measured-service system of charging for telephone-exchange connections it is desirable that such a connection-counting mechanism shall be placed in association with the lines whose service is to be charged for and that such mechanism shall register a charge against its line only when a call is completed or attains fruition in a conversation between the calling and desired substations, it being furthermore requisite that no charge shall be made against a line except for connections initiated by such line.

In Letters Patent granted to me February 7, 1899, No. 619,240, I have described and claimed a registering mechanism or connection-counter which has been put into use and has in its operation been found efficient and satisfactory. The said apparatus is actuated by the orderly successive and consecutive operation of two independent electromagnets, one of which is responsive to the act of a call-initiating subscriber in sending the call-signal, while the other prior to my present invention has been arranged to become excited when the switch-plug is in inserted in the switch-socket of the calling-line to answer the said call. Thus in order that the device shall register one call or make one charge against the substation of the associated line it is necessary that two distinct steps shall be taken, one dependent upon action at the substation in sending a call and the other dependent upon action at the central station in answering the said call; but although the counting mechanism is itself satisfactory its electrical arrangement and operation are not wholly so, since from what has been stated it is clear that the said mechanism so connected and operated counts the call and makes it the basis of a charge, whether it matures and eventuates in a completed connection with the line wanted and a conversation with the desired substation or not, and when a line wanted is busy or when for some reason communication therewith cannot be had the calling substation is either charged with service which it has not received or else the operator is required to keep a record of the unfruitful calls to the end that they may be deducted from the score. One of these alternatives is apparently inequitable and the other involves unnecessary work for the operator and consequent slowness of operation. My present invention, while retaining and preferring a call-counting mechanism of the same character and structural principles, involves a new arrangement of the same in relation to the substation-lines concerned, by means of which the said counting mechanism is withheld from registering a charge against the calling-line until it shall have become certain that a connection with the line wanted can be attained.

The said invention involves a substation-line or subscriber's circuit provided with a call-register or connection-counter preferably embodying the principles underlying the counting mechanism of my former patent, to which I have referred, other substation lines or circuits to which the same may be connected for through conversation, means, such as a switch-cord, having an answering switch-plug at one end, and a companion switch-plug at the other for uniting the said first-mentioned substation with a desired one of the others, and an associated switchboard local circuit for the several lines. One of the coöperative electromagnets of the connection-counter is associated with the call-signal device of the call-initiating line, as by connecting it in derivation or in parallel therewith, and the first of the two steps required for the registration of a toll-charge is thus made dependent upon action occurring at a call-initiating substation. The other actuating-magnet, that which when operated effectuates the second necessary step looking to such registration, is connected in the associated local circuit, which likewise

may contain the cut-off relay, and the supervisory signal and its usual resistance-shunt in series, and in the case of a multiple switchboard may serve also as as the test-circuit in a manner well understood. This associated local circuit leads through the line-switch socket, so that when the switch-plug is inserted in such socket to answer a call the said local circuit is completed through separable contacts therein and connects by a cord-conductor with a suitable source of current, and a current from said source flows therein. This normal current, though of sufficient strength to operate the cut-off relay or switchboard signals, does not excite the counter-magnet, which is constructed or adjusted to be irresponsive to the normal strength thereof, and the said magnet accordingly does not operate, and no registration is at this stage of the operation made. There is, however, an electromagnet controlling a circuit-changing switch connected in the local associate circuit of the companion plug, and when this circuit is closed through it the circuit-changer is operated and acts to so strengthen the current in the associate circuit of the calling-line that it becomes sufficient to excite the counter-magnet, which operating effectuates the final step required for registration. This step and the registration of the connection therefore are dependent upon the completion of the said connection between the two lines.

By a slight change of the position in the companion-plug associate circuit of the circuit-changer magnet the operation of the second counter-magnet, and consequently the operation of the counter mechanism, may be made to depend either on the simple insertion of the companion plug in the switch-socket of the line wanted or on the removal by the so-called subscriber of his receiving-telephone at will. Experience, however, has demonstrated that, as a rule, if a line is found at liberty and a switch connection be made with it communication can be had, and it rarely happens after the line called for is ascertained to be free and is switched to the line of the substation giving the call that an answer cannot be obtained therefrom or that anything occurs to prevent the satisfactory exchange of conversation. The operating value of the two alternative modes mentioned by me of connecting the circuit-changer magnet is therefore in substance the same.

In the drawings which accompany this specification, Figure 1 is a diagram illustrating the application of the invention to one of two substation-lines adapted for interconnection. Fig. 2 is a diagram of a form of switch-cord connection, showing the alternative position of the circuit-charger magnet; and Fig. 3 shows in elevation a view of the connection-counter I preferably employ, reference being made to my Patent No. 619,240 for other views thereof.

Referring to the said drawings, L and L^2 are main telephone-circuits extending from substations S and S^2, respectively. They are hereinafter referred to as "substation circuits." Each is shown as being equipped at the substation with the usual station apparatus arranged in the usual way for sending and receiving calls and for transmitting and receiving telephonic conversation. The circuits L L^2 have at the central station switchboard-sockets J J^2, respectively, these containing main-line contact-pieces $j j^2$, representing and constituting terminals of the main-line conductors a b, and each also is at the central station provided with a cut-off relay R, a signal-relay R^2, and a signal-lamp or equivalent device s.

A call-register or connection-counting mechanism C is shown as being provided for the substation-circuit L, and is one of that class requiring for the registration of a connection two successive steps or suboperations depending for their occurrence upon two successive acts to be performed at different stages in the work of bringing two subscribers into communication. In the present instance the counting mechanism is organized to have the said two distinct suboperations performed by two distinct electromagnets which are excited successively, one of them in consequence of the act of the subscriber with whose line the instrument is primarily associated in sending the call or otherwise initiating the communication and the other at a later period, when the line wanted has been ascertained to be at liberty and when the connection between the two lines has been effectuated, either directly upon the establishment of such connection or subsequently thereto, when after the desired substation has been called the subscriber removes his telephone from the hook to respond.

The form of connection-counting mechanism patented to me, as hereinbefore stated, February 7, 1899, has proved efficient and satisfactory in practice and is that which I prefer to employ as a factor in my present invention. It does not appear necessary that I shall here redescribe the same in detail, and it need merely be stated that it has an actuating movement m, a series of dials n, representing units, tens, hundreds, &c., a pointer o for each dial, appropriately impelled by the said movement, and two polarized electromagnets d f, one of which is to be in some way associated with the main circuit, to which the connection-counter belongs, while the other is similarly associated with the switchboard apparatus concerned in connecting the calling and called lines together, and that the action of the first magnet, broadly stated, is to move its armature out of a position where it locks the armature of the second magnet into one permitting the free motion thereof, while the action of the armature of the second magnet when thus freed is to directly actuate the counting mechanism. One conductor a of the substation-circuit L continues to earth after passing through a separable contact e, controlled by armature z of the cut-off

relay, and the other main conductor *b* of the said circuit, after passing the separable contact *h* of armature *y* of the cut-off relay, continues through the exciting-coil of the signal-relay R^2 and by conductor 8 to any suitable source of current—for example, the common battery G, whose other pole is grounded. The call-signal lamp *s* of each substation-circuit is in a normally-discontinuous branch 20 of the said supply-wire 8, controlled by the said signal-relay and closed and connected with the said battery, when the armature of the said relay, which is conductively united to said supply-wire, is attracted by the magnet thereof, in which case a portion of the battery-current is diverted through the lamp to illuminate the same. The connections so far described are similar for both substation-circuits.

One of the electromagnets of the connection-counter C requires to be in operative relation with the line to which the said counter belongs, to the end that the preliminary suboperation thereof shall be dependent on the act of sending a call from the substation S to the central station H. Accordingly the magnet *f* is placed in a parallel branch or derivation conductor 30 of the call-signal-lamp circuit 20, extending from the point 32 to earth. Thus when the armature of relay R^2 is attracted forward to operate the call-signal current likewise passes through the coils of the counter-magnet *f*, and the said magnet becoming excited moves its armature and accomplishes the first step toward the registration of the call.

The switch-sockets J J^2 have also insulated frame-pieces, which (when the switchboard is multiplied) are termed the "test-rings," and each of these serves as a third contact-piece j^3, forming the terminal of the fixed portion of a local circuit associated within the central station with each substation-circuit.

c is the associate circuit of the substation-circuit L, and it has a fixed or permanently-mounted portion 26, and, as will be hereinafter more fully described, a movable or interchangeable portion comprised in the switch-cord connection. The said conductor 26 extends from the contact-piece j^3 of the switch-socket to earth or return through the winding of the cut-off relay R and through the coil of magnet *d* of the connection-counter. Should the switchboard be of the multiple type, the said conductor 26 would of course extend to the contact or test pieces j^3 of all of the switch-sockets of the substation-circuit and would under such conditions constitute the switchboard portion of the busy test-circuit.

M is a switch-cord connection with terminal plugs P P^2, adapted to be inserted in the switch-sockets J J^2.

P is the answering-plug, and P^2 may be termed the "companion plug." Both have three contact-pieces, a tip-conductor *p*, a front sleeve-conductor p^2, and a rear sleeve-conductor p^3, and when the plug is thrust into a switch-socket they register or engage with the socket contact-pieces and springs *j*, j^2, and j^3, respectively. The main-line connections of the two plugs and their cord-conductors are as usual.

2 is the answering-plug section and 3 the companion-plug section of the main-line cord-conductor uniting the tip-conductors *p* of the two plugs, the two windings *i* i^2 of the split repeating-coil I being serially included in the circuit of the said conductor. In the same manner 4 is the answering-plug section and 5 the companion-plug section of the main-line conductor uniting the forward sleeve contact-pieces p^2 of the two plugs, and the repeating-coil windings i^3 i^4 are serially connected between the said sections. The section 4 of this conductor contains the supervisory-signal relay R^3 and the section 5 contains the supervisory-signal relay R^4, and in a bridge between the said tip and sleeve conductors, extending from a point on the former between the repeating-coil windings *i* and i^2 to a point on the latter between the windings i^3 i^4, is the common source of current G, shown as a battery, the same being grounded at its tip-conductor pole.

A leading conductor 34, extending from the ungrounded pole of the generator G, has branches 6 and 7 continuing to the rearward sleeve conducting-surfaces of the plugs P and P^2, respectively, and these each constitute the switch-cord or movable portions of the local associate circuits *c* c^2 of the substation main circuits L L^2. At any suitable point *u* the conductor 6, after passing through the artificial resistance r^2, bifurcates, one branch, 37, leading through the supervisory-signal lamp s^2 and the other, 36, leading through the resistance *r* and the separable contact-points of the supervisory relay R^3 to a junction-point *q*, where they again coalesce into the single conductor 6. When the relay-armature is in its retracted position, all of the current in the associate circuit passes through the lamp in branch 37; but when the relay R^3 attracts its armature the branch 36 is closed at *x* and forms a resistance-shunt around the lamp. The current then divides and the portion passing through the lamp is not strong enough to light it.

When the plug P is inserted in the socket J, the main conductors *a* and *b* are united by the springs *j* j^2, which press upon the plug contact-surfaces *p* p^2, to the main cord-conductors 2 and 4, and thereby on the insertion of the companion plug with the main conductors of the wanted substation-circuit L^2. Moreover, the movable and fixed portions 6 and 26 of associate circuit *c* are also united by the contact of plug-conductor p^3 and socket-ring j^3, and the associate circuit *c* is then closed and permits the circulation of the current from the source G, which flows through lead 34, conductor 6, resistance r^2, branch 37, lamp s^2, (or, when the relay-armature is at-

tracted, lamp-conductor 37 and resistance shunt-conductor 36 in parallel,) conductor 6, plug contact-surface p^3, switch socket-ring j^3, conductor 26, winding of cut-off relay R, and magnet d of the connection-counting instrument to ground. The cut-off relay is operated by this current and separates the contact-points e and h, and the supervisory signal (unless its shunt is closed) is also operated thereby, and a potential test is at the same time established on the rings j^3, if the switchboard be of the multiple type; but the magnet d of the counting instrument is not operated, it being so constructed or adjusted as to be irresponsive to the normal current thus caused to flow in the associate circuit. The current is maintained at such a normal strength by the presence in the circuit of the lamp s^2 and its resistance r^2, or alternatively (the shunt being closed) by the said resistance and the joint resistance of the lamp branch 37 and the shunt branch 36. The associate circuit c^2 of substation-circuit L^2 is arranged generally in a similar way, but does not include a duplicate of the artificial resistance r^2. As with circuit c, it divides at point w^2 into two branches, one, 39, permanently closed, which includes the supervisory lamp-signal, and the other, 38, containing resistance r^3 and passing through the contact-points of relay R^4 to the reunion-point q^2. The branch 38 is thus a shunt for the lamp, having its continuity controlled by relay R^4. The associate circuit c^2 is, however, so arranged that at the proper time on or after the insertion of the companion plug P^2 in the socket of the substation-circuit called for certain appliances may be brought into operation, which act to materially increase the strength of the current in the associate circuit c, bringing it, in fact, to a strength fully sufficient for the operation of the second magnet d of the counting instrument. To this end I provide a normally-open shunt W, one of the normally-severed portions thereof, w, being connected at v with the lead 34 of the associate circuit c of substation-circuit L^2, and the other, w^2, being united to conductor 6 thereof at point q^3. The said shunt therefore forms when closed a short circuit around the lamp s^2 and its resistance-shunt, having its continuity controlled by an electromagnetic switch or circuit-changer K, whose actuating-magnet is connected in conductor 7, so that when the said conductor by the insertion of plug P^2 in a switch-socket is made part of an associate circuit c^2 the said electromagnet R^5 is brought into the circuit so formed and is excited by the current thereof. I do not restrict myself to any particular form of circuit-changer, but consider the form indicated to be generally suitable. The armature-lever k of the electromagnet R^5 is attached to and forms the terminal of conductor w and has a retracting-spring k^4. It carries a light metallic brush or contact-spring k^2, adapted to sweep over a switch-surface k^3, comprising a conducting-plate t, secured between two marginal plates of non-conducting material t^2 and conductively attached to and forming the terminal of conductor w^2. The non-conducting and conducting surfaces are flush with each other, and this plane surface may, if desired, be made in disk form and may consist of a circular contact-plate inclosed in the center of a non-conducting annulus.

The contact brush or spring is normally at rest on the non-conducting surface, but on the excitation of the magnet R^5 the armature being attracted causes the said contact-spring to sweep over the face of the plate K^3, closing the shunt W transiently as it makes contact with the metal plate t and opening the same as at the end of its traverse it again reaches the marginal non-conducting surface, Obviously at the moment when the brush or spring k^2 is in contact with the plate t and the shunt W thereby closed the resistance composed of the lamp s^2, its shunt-resistance r, and its serially-connected resistance r^2 is short-circuited, the total resistance of associate circuit c is materially lessened, and the current in such circuit is correspondingly strengthened and becomes strong enough to excite the actuating-magnet d of the counting mechanism C, which thereupon counts and registers the connection, which has been so far attained that the substation-circuit L^2, having been ascertained to be at liberty, has been connected with the calling-circuit L by the insertion of the companion plug P^2. The circuit-changer magnet R^5 has been enabled to operate for the closure of the shunt W and the consequent operations in pursuance (in the arrangement of Fig. 1) of its inclusion in associate circuit c^2, which extends from the ground attached to one pole of the generator G to the complementary ground of the cut-off relay R of substation-circuit L^2 by way of the said generator, lead 34, conductor 7, including circuit-changer magnet R^5, point u^2, lamp-signal s^2, conductor 39, and point q^2, contact-surface p^3, socket-ring j^3 of socket J^2, conductor 27, and cut-off relay R. When the supervisory relay R^4 becomes vitalized, the lamp-shunt 38 is of course closed through resistance r^3 in parallel with the said lamp, and this occurs when by reason of the called subscriber having removed his receiver from his hook-switch the main circuit has been conductively closed and a current from the battery G has been enabled to flow therein through the magnet of the said relay R^4.

It is manifest that a common return-conductor could readily be substituted for the several earth connections shown.

The operation of the system in regard especially to the counting mechanism is apparent. When the call is sent from substation S of circuit L, the signal s is exhibited. The magnet f of the register C, being in a parallel branch of the same circuit and in like manner controlled by relay R^2, is at the same time

excited and operates to release the armature of the other magnet *d* of said counting mechanism. The plug P, being inserted in socket J to answer the call, operates to close the associate circuit *c*, which brings about the operation of the cut-off relay and establishes a current through magnet *d;* but since the resistance of the lamp s^2 and coil r^2 is in the circuit, the former under certain conditions being shunted, the current is too weak to excite magnet *d*. The operator after examining the line wanted and finding it to be free makes connection therewith by inserting plug P^2 in the switch-socket thereof. This closes the circuit of the generator G through the magnet of the electromagnetic switch W, which reduces the resistance of associate circuit *c*, increasing the current thereof to a strength adapted for the operation of counter-magnet *d*. This is excited, and, actuating the counting mechanism, registers the connection.

If instead of registering or counting when the plug P^2 is inserted—that is, when the substation-circuit L^2 is found to be free and that a connection therewith can be had—it is desired that no registration shall be made until the subscriber wanted shall have actually responded, thus making it certain that a conversation will ensue, the only change necessary from the arrangements so far described is that indicated by Fig. 2, where it appears that the electromagnet R^5 of the circuit-changer K and the resistance-coil r^3 have exchanged positions, the latter being placed in the main portion of the associate-circuit conductor 7 and the former in the lamp-shunt 38. This modification makes the operation of the resistance-reducing circuit-changer K, and consequently that of the counter-magnet *d*, dependent on the operation of the supervisory signal-relay R^4, which does not become excited until current from the battery G is determined in the main substation-circuit after the insertion of the switch-plug P^2 by the action of the subscriber in taking up his telephone for use, which permits the hook-switch to close the circuit.

Referring briefly to the counting mechanism itself, it may be stated that the pole-piece of the magnet *d* is (as disclosed by my former patent) provided with a soft-iron auxiliary pole-piece which retains the armature of magnet *f* after the cut-off relay has operated and when current therefore ceases to flow in the coils of the said magnet *f*. Moreover, the normal current flowing in the winding of magnet *d* though insufficient to draw up the armature is strong enough to hold it in place after it has once been attracted by the increased current due to the transitory short-circuiting by the circuit-changer K of the lamp and shunt-resistance. It may also be remarked that when the magnet R^5 of the circuit-changer K is placed as in Fig. 1 its resistance should preferably equal that of r^2 and that when placed as in Fig. 2 its resistance should be substantially identical with that of r^3.

Having thus described the nature, arrangement, and operation of my invention, what I desire to claim is—

1. The combination in a telephone central-station switchboard apparatus, of two substation-circuits equipped with the usual switch-socket and call-signal devices; a switch-cord connection with terminal plugs fitting the said switch-sockets respectively, and uniting or adapted to unite the said substation-circuits; and a local associate circuit for each line, passing through switch-contacts in the switch-socket thereof, and composed of fixed and cord conductors; with a call or connection counting mechanism for one of the said substation-circuits actuated by two coöperating electromagnets, one connected in parallel with the call-signal device of said substation-circuit and the other in the local associate circuit of said substation-circuit but adjusted to be irresponsive to the normal current thereof; a circuit-changer organized to reduce the resistance or increase the current of said associate circuit for the operation of said second magnet, and an actuating-magnet for said circuit-changer connected in the associate circuit of the other substation-circuit; substantially as and for the purposes set forth.

2. The combination with two telephone-lines; and means for uniting them; of a connection-counter for one of the said lines actuated for the registration of a completed call by the successive action of two electromagnets, one responsive to the action of sending in a call over the line associated with said counter, and the other in the cut-off-relay circuit of said line; a source of current connected with the said cut-off-relay circuit by the initial step of switching the two telephone-lines together, and adapted to establish a current therein sufficient for the operation of said relay, but insufficient for the operation of the said counter-magnet; and means responsive to the establishment of connection between the two lines concerned, for increasing the said current to the strength required for the operation of the said counter-magnet; substantially as set forth.

3. The combination with two main telephone-circuits; and switch-plug and cord connections for uniting them at a central station; a call or connection counter associated with one or both of the said main circuits, having two actuating-electromagnets and adapted to become operative for the registration of a call, only on the successive action of both magnets, one of the said magnets being in a derived circuit of the line-signal and adapted to respond to the act of sending such line-signal, and the other placed in the cut-off-relay circuit of the associated line; and a source of current-supply; of means controlled by the connection of the answering switch-plug

with a switch-socket of the calling-line for establishing through the said cut-off relay and counter-magnet a current from the said source sufficient in strength for the operation of the former, but too weak for the operation of the latter; and other means controlled wholly or in part by the connection of the companion plug of a pair in a switch-socket of the desired line, for strengthening the said current to a degree sufficient to fully energize the said counter-magnet; substantially as and for the purposes set forth.

4. In a telephone system, the combination of a substation-line entering a central station, and having a call-relay controlling the circuit of a signal, and a cut-off relay in a local circuit; a call or connection counter associated therewith having two actuating-electromagnets connected respectively in a branch of the said signal-circuit, and in the circuit of the said cut-off relay, the said counter being adapted to register a call only after the successive orderly operation of both magnets; switch devices comprising first, main conductors for answering calls, second, main conductors for uniting a calling-line with a desired line, and third, local conductors for closing the cut-off-relay circuits of both of the said lines; a source of current included in the latter, and adapted when a call is answered to establish a current through the cut-off relay of the calling-line; a regulating-resistance in the said cut-off-relay circuit maintaining the strength of said current at a value insufficient for the operation of the counter-magnet; a normally-open shunt around the said resistance; and an electromagnetic switch associated with the said switch-device conductors of the line wanted controlling the said shunt, and adapted on, or subsequent to, the establishment of connection between the said calling and called lines to close the said shunt, and thereby to increase the strength of the current through the counter-magnet to a value sufficient for the operation of the said magnet.

5. In a telephone-switchboard apparatus, the combination of a substation-line having a call-signal device in a branch circuit, a jack or switch socket, and a cut-off relay in an incomplete local circuit normally terminating in the said socket; an associated connection-counting mechanism with two coöperating actuating-magnets, one in a derivation of the signal-device branch circuit, and the other in the said cut-off-relay local circuit; a second substation-line also provided with a switch-socket; a switch-cord connection for uniting the said substation-lines, provided with the usual terminal switch-plugs, and comprising main-line conductors extending between the plugs, and a local-circuit conductor extending from a source of current to each plug, and adapted on the insertion of the plug to complete the cut-off-relay circuit; a lamp-signal provided with a resistance-shunt in the said local-circuit conductor of the answering-plug, serving to maintain the current flowing in the said cut-off-relay circuit at a strength insufficient for the operation of the counter-magnet contained therein; a normally-open short-circuiting shunt around the said lamp and resistance-shunt; an electromagnet in the local circuit of the companion switch-plug; and a switch operated thereby, controlling the said short-circuiting shunt, and adapted when the said magnet is excited to transiently close the same, and thereby to increase the current through the counter-magnet to a strength sufficient for the operation of said magnet, and the consequently complete operation of the call-counting mechanism.

In testimony whereof I have signed my name to this specification, in the presence of two subscribing witnesses, this 13th day of June, 1899.

GEORGE K. THOMPSON.

Witnesses:
GEO. WILLIS PIERCE,
JOSEPH A. GATELY.