

No. 669,901.

Patented Mar. 12, 1901.

M. C. RORTY.

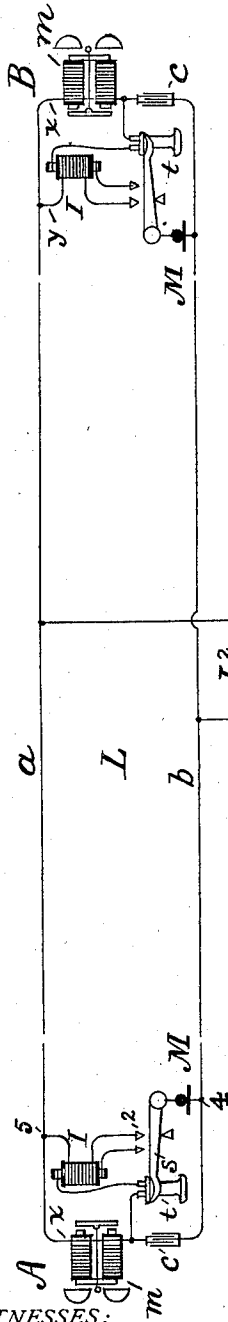
SYSTEM OF CENTRAL CURRENT SUPPLY FOR PRIVATE LINE TELEPHONE CIRCUITS.

(Application filed Oct. 4, 1900.)

(No Model.)

2 Sheets—Sheet 1.

Fig. 1.



WITNESSES:

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Fig. 3.

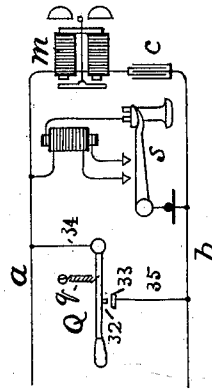
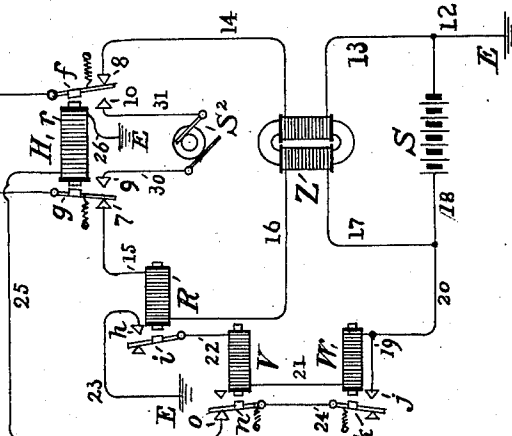
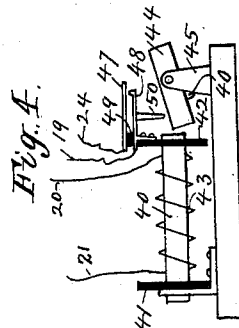


Fig. 4.



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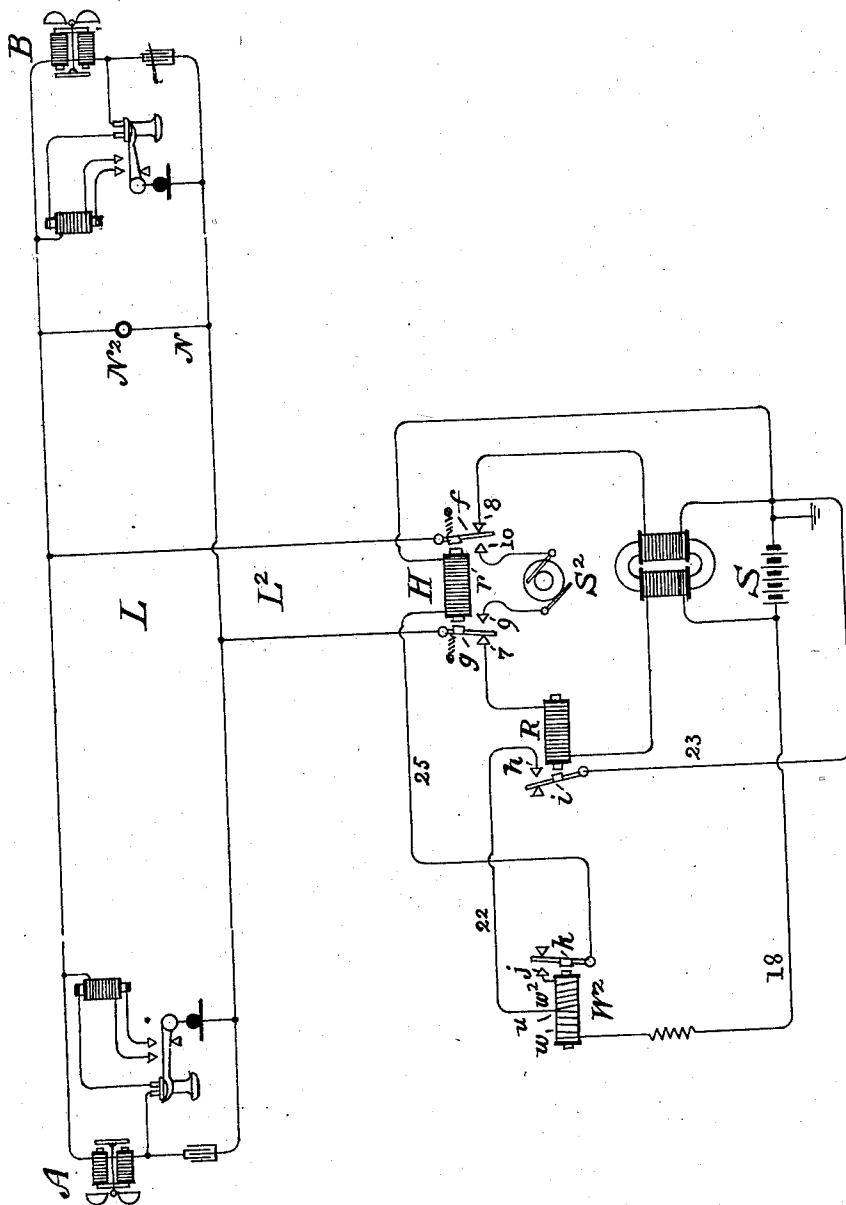
SYSTEM OF CENTRAL CURRENT SUPPLY FOR PRIVATE LINE TELEPHONE CIRCUITS.

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2 Sheets—Sheet 2.

(No Model.)

Fig. 2.



WITNESSES:

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UNITED STATES PATENT OFFICE.

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SYSTEM OF CENTRAL CURRENT-SUPPLY FOR PRIVATE-LINE TELEPHONE-CIRCUITS.

SPECIFICATION forming part of Letters Patent No. 669,901, dated March 12, 1901.

Application filed October 4, 1900. Serial No. 32,028. (No model.)

To all whom it may concern:

Be it known that I, MALCOLM C. RORTY, residing at Dedham, in the county of Norfolk and State of Massachusetts, have invented certain Improvements in Systems of Central Current-Supply for Private-Line Telephone-Circuits, of which the following is a specification.

This invention concerns telephone-circuits and their operation, and more particularly relates to private telephone-circuits and to a system for enabling such private lines to participate in the advantages of the central-battery system.

A private telephone line or circuit is one with which two or more particular telephone-stations are permanently associated, each such station being restricted to communication with the other stations of the same circuit and which does not constitute a member of a telephone-exchange to be interconnected with other lines by means of a switchboard for the establishment of through communication with the telephones of such other lines. Prior to this invention the supply of signaling and transmitter currents to such private lines from centrally-placed sources has, so far as I am aware, not been attempted, and it has therefore uniformly been necessary to place at each station of such lines a local magneto-electric call-generator for the development of the currents required in the operation of call devices or signals and a local transmitter-battery for the production of the requisite telephone-transmitter current.

The object of this invention is to provide for private line-circuits the advantages of having their sources of current necessary for all purposes centralized without introducing the intermediation of a central-station switchboard and the intermediary switching and signaling operations of a central-station operator.

To this end the invention provides that the private line-circuit shall enter a central station and shall there normally and also while telephonic communication is going on be connected with a source of steady current, such as a battery, while a source of alternating current, such as is required for the operation

of standard polarized bells, shall also be placed at the said central point and shall be associated with special apparatus responsive to the consecutive closing and opening of the main circuit at either operative station and thereupon acting to disconnect the main circuit temporarily from the source of steady current and to connect it with the source of alternating current for a brief but definite period of time, during which the call-bell at the station desired, and incidentally the bell at the calling-station also, may be operated and rung to give the call-signal. The circuit at the operative stations is arranged in the well-known plan generally adopted for central-battery exchange-circuits. The electromagnetic call-bell is placed in one continuation branch of the circuit, which also contains a condenser, and the circuit is normally in connection with this branch. The condenser does not oppose the passage of the alternating ringing-currents, but maintains the circuit in a conductively incomplete condition, so that though the central source of steady current is normally connected no current can flow therefrom through said circuit. The station-telephones are in a separate continuation branch of the circuit which is conductively continuous, so that when this branch is substituted for the former a shunt is established around the condenser, the main circuit is conductively closed, and steady current from the normally-connected source may flow therein. At each operative station there is means for producing such a closure of the main circuit. This may be a special circuit-closing switch; but I prefer to employ the usual hook-lever switch, serving when the line is unemploye as a telephone-support and moving in a direction to close the circuit when the telephone is removed and to reopen the circuit when the same is replaced. The special appliances at the central station comprise a circuit-changer comprehending movable terminals of the main circuit transferable between fixed terminals of the steady and alternating sources of current respectively, so that when connection is established with the terminals of the steady-current source or battery, the main circuit being conductively closed by the

action of the operative-station switch pursuant to the removal of the telephone, a steady current from said battery flows over the circuit to supply the telephone-transmitters thereof and also to furnish power for the source-transferring mechanism, while when this original connection is disestablished and the line terminals are united to the terminals of the alternative source alternating call-currents traverse the main circuit and, acting through the condensers, operate the station-bells. The said circuit-changer is actuated by an electromagnet in a local circuit, this being controlled by a slow-acting relay also in a local circuit, and this in turn by a main-line relay associated with the normal battery connection in such manner as to be responsive to the movements of the operative-station switch. The operation of closing the circuit by one movement of said switch brings the said relays into position for action, and the reverse motion of said switch produces such action and closes the circuit of the circuit-changer, which thereupon transfers the line from the source of steady current to the source of alternating current. After the lapse of sufficient time to transmit an effective ringingsignal the slow-acting relay breaks the circuit of the actuating-magnet and the circuit-changer reestablishes the normal condition of the circuits.

In the drawings which accompany this specification, Figure 1 is a conventional diagram of a telephone-circuit containing the invention. Fig. 2 is a similar diagram of a similar circuit, illustrating a modified arrangement which in some respects is an improvement. Fig. 3 illustrates the employment at the telephone-stations of a special switch having no other function than that of opening and closing the circuit, and Fig. 4 illustrates a sluggish or slow-acting relaysuitable for use in a circuit embodying the invention.

Similar parts have similar letters and numerals of reference in all of the figures.

L is a telephone-circuit, which may be a private-line circuit having main conductors *a* and *b*, extending between operative telephone-stations A and B and connecting with a central or intermediate station C by a loop *L*², having conductors *d* and *e*, leading from the main conductors *a* and *b*, respectively. At each operative station is the usual polarized electromagnetic call-bell *m*, condenser *c*, telephone-transmitter M, receiver *t*, induction-coil I, and telephone-supporting switch *s*. The bell and condenser are in series in a continuation branch *x* of the main circuit, which normally constitutes the only electrical connection at the station between the conductors of said circuit—that is, when the switch is in the position shown, with the telephone in place thereon. Under these conditions the circuit is conductively open or discontinuous in virtue of the presence of the condenser, which, however, forms practically no bar to the op-

eration of the bell by the alternating call-currents when transmitted over the line. Another continuation branch *y*, which I term the "telephone" branch, is also provided, and when the telephone *t* is removed from the switch the point 4 on conductor *b* is united to point 5 on conductor *a* through the transmitter M and the secondary winding of the induction-coil I, and the condenser being thus shunted the main circuit is conductively closed.

At the central station C, S is the source of steady current. S² is the source of alternating or call current; Z, an impedance-coil or electromagnetic resistance; H, the electromagnetic switch or circuit changer, and V and W are ordinary and slow-acting relays, respectively.

R is a main-line relay, and E is the earth connection, which, though shown in several places, may conveniently be one and the same.

The source S may conveniently be a primary or secondary battery, and the source S² is by preference a magneto-electric generator of alternating or call current.

The electromagnetic circuit-changer H has an actuating-electromagnet *r* in a local circuit of the battery leading from one pole of said battery by conductors 18, 20, and 19, the front stop *j* and armature *k* of the slow-acting relay W, conductor 24, armature *n* and back stop *o* of relay V, conductor 25, coil of magnet *r*, and conductor 26 to earth E or the other battery-pole. This local circuit is normally open between the armature and front-stop contacts *k* and *j* of the relay W, and the actuating-magnet *r* of the circuit-changer H thus is unexcited. Consequently the armature-lever contacts *f* and *g*, forming the movable terminals of the conductors *d* and *e* of the main-circuit loop *L*², remain in their normal retracted position and in contact, respectively, with the back contact-stops 5 and 7, which form the fixed terminals of the battery S. The said battery is thus in normal connection with the main circuit, conductor *b* of said circuit being united to the plus-pole thereof, by way of conductor *e*, armature and back contacts *g* and 7 of the circuit-changer H, conductor 15, magnet-coils of relay R, conductor 16, one winding of the inductive resistance Z and conductors 17 and 18, and main conductor *a*, similarly united to the minus-pole of the battery by loop-conductor *d*, armature and back-stop contacts *f* 8 of the circuit-changer H, conductor 14, the second winding of the coil Z, and conductor 13. No current flows over the main circuit as long as the telephones *t* at the stations A and B remain on their respective switch-hooks, notwithstanding the normal connection of the battery, as described above; but the said battery establishes a definite potential on the circuit, whereby a current is developed in one-half of the circuit when the telephone is removed from its switch at one station and throughout the circuit when the switches at both stations, relieved from the

weight of the telephones, move into position to close the circuit by bringing the switch-levers *s* into contact with the points 2 and 3.

The electromagnetic resistance *Z* offers an opposition due to its resistance only to the passage of the battery-current; but when the station transmitters are in operation the said coil opposes impedance to the voice-currents which traverse the main line, and a loss of such currents through the loop L^2 is thus avoided. The main-line relay *R* is connected in the circuit of the conductors 18, 17, 16, and 15, leading from one pole of the battery *S* to the fixed terminal 7 of the circuit-changer *H* and is therefore in permanent association with the said battery, so that it is connected with the main circuit *L* when the said circuit-changer is in its normal position, with its members *g* and *f* in contact with the points 7 and 8, and severed, with the battery, therefrom when the said movable members separate from the points 7 and 8 and are transferred to the front contact stops or terminals 9 and 10 of the generator S^2 , and being, as stated, normally in the main-line and battery circuit the said relay *R* obviously is under the control of the telephone-switches *s*, remaining unexcited when such switches are in their normal position, because the condensers *c* are then maintained in circuit, and becoming excited when the said switches are brought into position to close the circuit through the transmitter and induction-coil by making contact with the point 2. It is by means of the action of the said line-relay *R* that the actuating-magnet *r* of the circuit-changer *H* is in due season excited, and such action is exerted through the relays *V* and *W*, as will be presently described; but as the operation of the said line-relay *R* is dependent upon the current of the battery *S* the steady current of that battery, as may now be seen, is utilized not only as a transmitter-supply, but also as furnishing the agency whereby either operative station may cause a ringing-current to traverse the line for the purpose of operating the bell at the other operative station.

The alternating-current or call generator S^2 has its poles extended by conductors 30 31 to the forward contact-stops 9 10 of the circuit-changer *H*, so that the said stops are fixed terminals of the said generator. Obviously when the said circuit-changer is actuated for the motion of its armatures by the excitation of its actuating-magnet its movable members will be separated from the normal contact with the fixed terminals of the battery and transferred to a new contact with the fixed terminals of the generator S^2 . Obviously also this new contact will continue as long as the excitation of the actuating-magnet continues and will be discontinued when such excitation ceases, and it follows that during the pendency of such connection the call-generator is contained in the circuit of the loop L^2 of the main circuit *L*, and the

call-currents developed thereby will pass over the main-circuit conductors in both directions and will operate the telephone-station bells. 70

The ordinary relay *V* and the slow-acting relay *W* are serially connected in a local circuit of the source *S*, which may be traced by way of conductors 18 and 20, magnet-coil of relay *W*, conductor 21, exciting-coil of relay *V*, conductor 22, to the armature *i* of relay *R*, and when said armature is excited to the front stop *h* and conductor 23 and thence to earth at *E*, and thereby to the other battery-pole by conductors 12 and 13. This local circuit is therefore controlled by the line-relay *R*. The relay *V* is of the ordinary type, acting promptly in the release of its armature when its magnet having been excited is demagnetized. The relay *W*, however, is a slow-acting relay and acts with considerable sluggishness in allowing its armature to fall away after its magnet-coil circuit is opened. Relays adapted for such sluggish action are now well known and may be arranged in several ways, all of which, however, depend upon increasing either their magnetic or mechanical inertia, or both. For example, the time required for discharge may be made longer by using a long thin core, by using differential helices, or by shunting the exciting-coils, while sluggishness in the retractive movement of the armature pursuant to discharge may be imparted by providing heavy and nearly-balanced moving parts or by providing the armature with a dash-pot attachment, and the contact between the local points may further be protracted by mounting one or both of them on a spring.

A sluggish or slow-acting relay, such as mentioned in the preceding paragraph, is illustrated in Fig. 4. It has a long thin magnetic core 40, supported at opposite ends by plates 41 and 42 of insulating material. A helix or coil 43, wound on core 40, connects at one end to conductor 21 and at its other end to conductor 20. A heavy nearly-balanced armature 44, mounted to move slowly in response to the excitation of the core and also in its reverse motion when such excitation ceases, is pivoted to a bracket 45, the downward movement of the heavier end of the armature nearest the end of core 40 being limited by a stop 46.

47 and 48 are two spring-contacts separated by insulation 49 and mounted on plate 42. Lower spring-contact 48 has an arm 50, which depends into the path of upward movement of the armature 44 when said armature is attracted by the excitation of core 40. The armature pressing upwardly against arm 50 presses spring-contact 48 upwardly against spring-contact 47, thereby closing the local circuit from conductor 19, which connects with contact 47 to conductor 24, which connects with contact 48. The armature 44 being attracted by the core 40, the contact between the local spring-contacts 47 and 48 is prolonged for an instant after the circuit, in-

cluding the exciting-coil 43, is opened, and this prolongation comes about by the combined action of the long core, which is slow in parting with its magnetism, the weight and inertia of the armature, which is slow in yielding to the retractive forces on the disappearance of the attracted force, and the resiliency of the spring-contacts, which makes them slow in separating when the pressure existing on them by the armature when attracted is released.

The armatures n and k of the relays V and W, with the back contact-stop o of the former and the front contact-stop j of the latter, are in the local circuit of the circuit-changer-actuating magnet r , which circuit therefore can be closed for the excitation of said magnet and the consequent operation of the said circuit-changer to transfer the main circuit from the battery to the magneto generator only when the armature n and the armature k simultaneously rest on their respective back and front contacts o and j . This occurs when of both relays, having been closed by the operation of the line-relay R, is opened by the falling back of armature i of the said line-relay R, for when the said circuit of the relays V and W is thus broken the armature n of relay V falls promptly to its back stop o , while the armature k of the sluggish relay W delays its retraction and maintains its contact with the front stop j for a brief period of time, presently, however, falling away in turn to its back stop; but while the contact between armature k and joint j persists, the armature n resting on its back stop o , the local circuit of the circuit-changer-actuating magnet is closed and may be thus traced: from the battery S by conductors 18 and 20, branch conductor 19, point j , armature k , conductor 24, armature n , point o , and conductor 25, to said actuating-magnet and thence to the opposite pole of the battery by conductor 26, earth connection E, and conductors 12 and 13. The actuating-magnet r is in this manner transiently excited and transfers the loop L^2 and main circuit L to the call-generator for the brief interval of time during which such excitation continues.

When the armature k falls away from its magnet-pole and parts from front stop j , the circuit of the actuating-magnet r is broken and the circuit-changer H resumes its normal position, transferring the main circuit back from its transient or temporary connection with the alternating-current generator S^2 to its normal and more permanent one with the battery S.

In Fig. 2 is illustrated a modified arrangement of the local circuit of the circuit-changer-actuating magnet r and the slow-acting relay controlling the same, which in some respects is regarded as being preferable. The relay V may by such modification be dispensed with, together with one pair of separable contacts, a single relay W^2 taking the

place of the two relays V and W of Fig. 1. This is the only change of importance. The relay W^2 has two exciting-coils, differentially wound and connected, as shown, and has considerable magnetic inertia, while its mechanical and contact inertia is provided by employing one or more of the expedients hereinbefore enumerated. It is thus enabled to perform satisfactorily the functions of a slow-acting relay. The conductor 18 connects the battery S with one end of the rear coil w of the relay W^2 , and the front coil w^2 connects at one end with the remaining end of coil w and at its other end with the front stop j of the armature k , which itself is electrically united with conductor 25 of the local circuit of the actuating-magnet r . A conductor 22 unites the point u between the coil-windings $w w^2$ of relay W^2 with the front stop h of relay R, and the armature of said relay connects by conductor 23 with the other pole of the battery.

In Fig. 2 a third operating-station N^2 in a bridge N is conventionally indicated, and it is to be understood that a number of stations may be so connected with the same private line.

Although ordinarily it will be more convenient in practice to employ the telephone-support switch in the operation of ringing the bell of any station of the main circuit from another, a special switch having no other function may be added when desired. Such an appliance is indicated in Fig. 3, where, in addition to the telephone-switch s , a switch or circuit-closing lever Q is shown, normally retracted by a spring q , but adapted when pressure is exerted on its handle to bring a point 32, carried by it, into contact with a fixed point 33. The switch-bar is electrically united by conductor 34 with one main conductor a , and the fixed point by conductor 35 with the other main conductor b of the main circuit. Hence when the switch Q makes contact between the points 32 and 33 the main circuit will be closed.

In the operation of this system let it be supposed that station A of the circuit L wishes to communicate with station B. The initial operation is to remove the telephone from the hook-switch, as usual. When this is done, current flows from the source S through conductor 18 and 17, a winding of the impedance-coil Z, conductor 16, relay R, conductor 15, contacts 7 and g of circuit-changer H, loop-conductor e , main conductor b , the switch and telephone branch at station A, main conductor a , loop conductor d , circuit-changer contacts f and 8, conductor 14, the other winding of the coil Z, and to the opposite battery-pole by conductor 13. The impedance-coil is of low resistance, and the current flowing is therefore of sufficient strength to excite the line-relay R. Referring to Fig. 1 as being a more obvious exemplification of the principles involved, the operation of relay R closes the circuit of the two relays V and W, which are both excited and operate

by attracting their armatures; but the armature n of relay V separates from its back stop before the armature k of relay W can reach its front stop, the latter relay being sluggish in coming into action as well as in going out. Hence the circuit of the actuating-magnet r of the changing device H is not closed. The person sending the call at A must now pull down his telephone-hook for a moment to open the main circuit, and current thereupon ceases to flow, the excitement of relay R is discontinued, and the armature of said relay falls back, once more opening the local circuit which contains the exciting-coils of relays V and W. The armature of relay V falls back instantly; but the armature of the slow-acting relay W is retained in its forward position for a short time during which the circuit of the circuit-changer-actuating magnet is closed. The said magnet thus becomes transiently excited and operates, transferring the main circuit from its normal connection with the battery S to one with the call-generator S², and thus sending a ringing-current from the said generator over the line. The bells at both of the stations consequently ringing, the call-signal is given at station B, while the person giving the call at A hearing his own bell may infer that the operation is proceeding properly. Of course the period of ringing is short; but it has been found sufficiently long to satisfactorily ring the bells. The attendant at the calling-station A having heard his own bell ring may now permit his switch to again close the circuit through the telephone apparatus, and conversation may be exchanged. In the modified arrangement of Fig. 2 the operation is precisely the same up to the excitation of the line-relay R. When this relay attracts its armature, a circuit of the battery is closed through the rear coil w of the slow-acting differential relay W², and the armature k thereof is attracted, closing a branch of the circuit through the front coil w^2 , the stop j and armature k , and the circuit-changer-actuating magnet r . No appreciable current, however, flows through this branch, because it is shunted by the direct return connection established by the contacts of relay R between the middle point u of the differential relay and the ground or the other battery-pole. When, however, the relay R responds to the circuit-opening operation of the switch at station A and allows its armature to be retracted, the shunt is removed and current now flows through both coils w and w^2 of the differential relay and through the actuating-magnet r , which at once transmits the call-current to line; but the action of the said two coils of the sluggish relay on the core thereof is neutralizing, and after the brief season required by the relay to overcome its own general inertia the armature k also falls back and the actuating-magnet circuit opens, the generator S², as in the former case, being thereby disconnected and the battery S re-

stored. It is evident that when the excitement of the actuating-magnet r has ceased and the movable members f and g of the circuit-changer have consequently restored connection between the line and battery S the line-relay R, and therefore the relays V and W, are again operated. Thus when the stations have finished the conversation and have replaced their telephones on their hooks the bells will again be rung. If there are several stations connected with the main circuit, any or all of the may be called in the same manner, it being manifest that to call any particular one it is only necessary to operate the switch at the calling-station a number of times corresponding to the signal of the station desired.

Having now fully described the invention and its mode of operation, I claim—

1. In a telephone system, the combination of a main circuit; an electric bell at a station thereof; a switch at a second station thereof capable of being placed in either of two positions and adapted to conductively close the said circuit at its own station in one, and to open the same in the other of said positions; an electromagnetic circuit-changer having its actuating-magnet in a local circuit open normally and while the switch at the second station is in position to close the said main circuit, a source of steady current, and a source of alternating or ringing current adapted for alternative connection with said main circuit by means of said circuit-changer, the former when the local circuit of said actuating-magnet is open and the latter when the same is closed, and means responsive to the circuit-opening operation of the switch at said second station for transiently closing the local circuit of said actuating-magnet and for then reopening the same the said sources of current circuit-changer and means for operating the same, being all located at a third station; whereby the main circuit connection may be transferred from the said source of steady current to the source of ringing-current for a brief period of time to operate the bell at the first station whenever the switch at the second station after having been in its circuit-closing position is moved to its circuit-opening position; substantially as set forth.

2. In a telephone system the combination with a main circuit extending between two telephone-stations, and provided at each with two branches containing respectively an electromagnetic bell in series with a condenser, and telephone apparatus, and with a telephone-supporting switch adapted when the telephone is hung thereon to connect the said main circuit with its bell branch, and when the telephone is removed to transfer the main circuit to its telephone branch; of apparatus and circuits at a third station consisting of a source of steady current for transmitter supply; a source of alternating or ringing current; an electromagnetic circuit-changer controlling terminals of the said main circuit

and the said sources of current, and adapted to connect the said sources alternatively with said main circuit; and means controlled by the said switches at the telephone-stations 5 for controlling the said electromagnetic circuit-changer, and for causing the same to establish a transient connection between the main circuit and ringing-current-source terminals whenever the said telephone-switches 10 or either of them after having united the main circuit and telephone branch shall be moved to transfer said main circuit to its bell and condenser branch; and to maintain connection between the said loop and steady-current-source terminals, at all other times; substantially as and for the purposes set forth. 15

3. In combination with a private telephone-line circuit extending between two operative stations; a central or third station connected 20 also therewith; a battery furnishing steady current normally connected with said circuit, and a generator furnishing an alternating signaling-current normally disconnected from said circuit at said central station; a call-bell responsive to said signaling-current in a 25 conductively open continuation branch, and a telephone in a conductively complete continuation branch of said main circuit, at each operative station; and means for enabling 30 either operative station to transfer the main circuit transiently from the battery to the call-current generator at the central station and to thereby ring the bell at the other operative station, said means consisting of a 35 switch at each operative station adapted to determine the flow of current in the said main circuit by transferring the same from either to the other of the said continuation branches thereof, and at the central station a circuit-changer actuated by an electromagnet in a 40 local circuit and comprising movable terminals of said main circuit and fixed terminals of the battery and call-current generator respectively, a relay in circuit with the normal 45 battery connection responsive to the movements of the switches at either of the said operative stations, and circuit-controlling

devices actuated by said relay, and controlling the local circuit of the said circuit-changer-actuating magnet to excite the said 50 magnet for a brief period of time; substantially as described.

4. A central-battery private telephone-line system comprising the following circuits and instrumentalities in combination; a main 55 private-line circuit extending between a plurality of operative telephone-stations, and entering a central station; a battery at said central station normally connected with said main circuit; a bell and condenser branch in 60 normal connection with said main circuit, a normally open telephone branch shunting the said condenser, and a switch actuated by the removal and replacement of the station-telephone to transfer the main circuit from the 65 condenser branch to the telephone branch and vice versa, and thereby close and open said circuit as respects the current of said battery, said parts located at each operative station; an alternating-current generator organized to develop ringing-current adapted 70 to operate the telephone-station bells through their respective condensers, an electromagnetic circuit-changer adapted to transfer the said circuit from the battery to the call-generator and vice versa, and an actuating-magnet in a local circuit therefor, a slow-acting 75 differentially-wound relay controlling the circuit of said actuating-magnet, and a main-circuit relay responsive to the telephone-station switches associated with the normal battery connection, and controlling the circuits 80 of said slow-acting relay, all at the central station; substantially as and for the purposes specified. 85

In testimony whereof I have signed my name to this specification, in the presence of two subscribing witnesses, this 2d day of October, 1900.

MALCOLM C. RORTY.

Witnesses:

GEO. WILLIS PIERCE,
JOSEPH A. GATELY.