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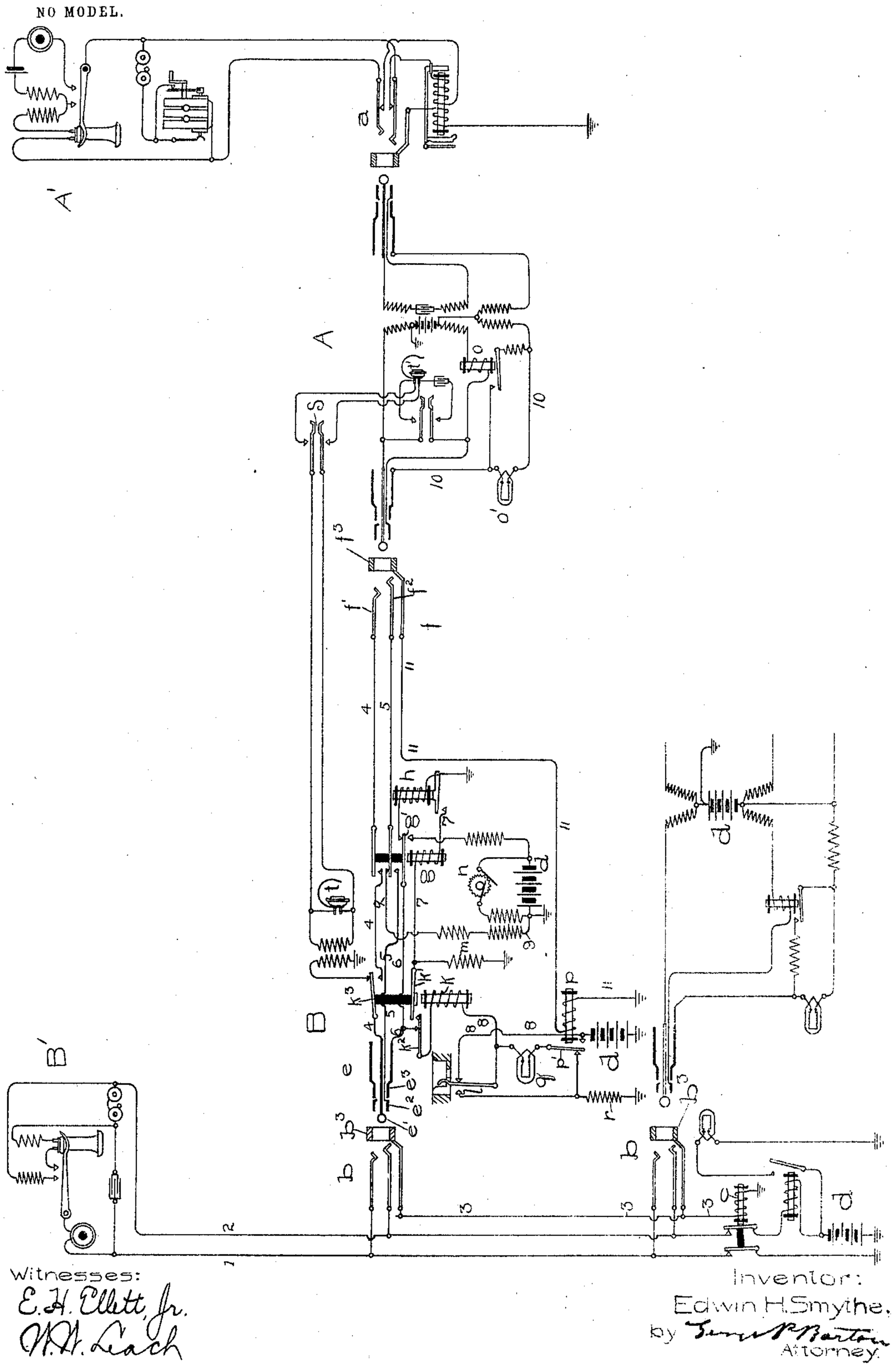
E. H. SMYTHE.

TELEPHONE EXCHANGE SYSTEM.

APPLICATION FILED MAY 24, 1902.

NO MODEL.



Witnesses:
E. H. Elliott, Jr.
W. A. Leach

Inventor:
Edwin H. Smythe.
by Turner P. Barton
Attorney.

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UNITED STATES PATENT OFFICE.

EDWIN H. SMYTHE, OF FREEPORT, ILLINOIS, ASSIGNOR TO WESTERN ELECTRIC COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF ILLINOIS.

TELEPHONE-EXCHANGE SYSTEM.

SPECIFICATION forming part of Letters Patent No. 776,435, dated November 29, 1904.

Application filed May 24, 1902. Serial No. 108,778. (No model.)

To all whom it may concern:

Be it known that I, EDWIN H. SMYTHE, a citizen of the United States, residing at Freeport, in the county of Stephenson and State of Illinois, have invented a certain new and useful Improvement in Telephone-Exchange Systems, of which the following is a full, clear, concise, and exact description.

My invention relates to telephone-exchange systems, and more particularly to apparatus for use at multiple switchboards, its object being to permit an operator who has a call for a line which is already busy at some other section of the board to take the necessary steps preliminary to completing connection, such as the insertion of the plug in a spring-jack of the line, after which a complete operative connection with the line will be automatically made as soon as the connection at the other section has been removed and the line is again free—that is to say, the operator by inserting the plug in the spring-jack of a busy line brings the calling-line into such relation to the called line that a complete operative connection will be automatically established at the instant the called line ceases to be busy. Heretofore it has been usual for the operator before making connection with a line called for to test the line and if it is found free to complete the connection; but if the line wanted is found to be already connected at some other section the calling party is simply notified that the line is busy and that he must make a second call. When the calling party makes his second call, it may be that the line wanted has been free and again connected to some other line, so that further delay and annoyance results. In accordance with my invention the calling party is brought instantly and automatically into operative connection with the line wanted as soon as the connection which may already exist at some other section has been removed. My invention further contemplates signals for the calling-line to indicate automatically the busy condition of the called line and also to indicate the instant it is free.

My invention will be especially valuable where the calling-line is a trunk-line to permit the incoming-trunk operator who has a call coming in over one of the trunk-lines to give that call precedence over ordinary calls from local lines and to take all the preliminary steps for the establishment of the trunk connection, so that the connection with the calling-line may be operatively completed the instant the called line becomes free.

In the accompanying drawing, which illustrates the preferred embodiment of my invention, I have shown a trunk-line extending from an answering-switchboard A to a trunk-board B. A telephone-line is shown extending from a toll-station A′ to a spring-jack *a* at the board A, and another telephone-line is shown extending from a substation B′ to multiple spring-jacks at the board B. The line to station A′ is of a type in which a local battery is employed at the substation for exciting the subscriber's transmitter, and a hand-generator is employed for operating the call-annunciator at the answering-switchboard. The apparatus of the line to station B′ is of another well-known type, in which automatic signals are employed and the substation-transmitter is excited by current from a central battery brought into circuit therewith by way of the plug with which connection is made with the line at the exchange-switchboard. Multiple spring-jacks or connection-terminals *b b* are provided for the line to station B′ at the switchboard B, each of said spring-jacks having the usual short and long line springs, which are connected, respectively, with the conductors 1 2 of the line, and each spring-jack having also the usual thimble or test-ring b^3. The thimbles of all the jacks of the line are connected together by a conductor 3, which extends to earth through the winding of the usual cut-off relay *c* of the line. I have shown only two of these multiple spring-jacks, of which there may actually be a large number, one at each section of the multiple switchboard, so that connection may be made with the line at any section by inserting a plug in the spring-jack at that section. In association with the lower one of the two spring-jacks shown in the drawing I have illustrated a portion of an

operator's plug-circuit of a well-known and standard type. The plug has the usual tip, ring, and sleeve contacts, adapted to engage, respectively, with the short and long line springs and the test-ring b^3 of the jack into which such plug is inserted, and the third contact of the plug is connected, as usual, through a supervisory signal with the free pole of a grounded battery d, which is bridged between the two main conductors, leading to the tip and sleeve of the plug. The operator at each section of the multiple switchboard (except where the incoming trunks are located) is provided with a number of plug-circuits for uniting lines. Whenever a connection is made at any one of the multiple spring-jacks of a line, the electrical condition of all the multiple spring-jacks is changed by the connection of the grounded battery d by way of the third contact of the plug and the test-ring of the jack into which it may be inserted to the test-conductor 3, and so to the test-rings of all the jacks—that is to say, the insertion of a plug into any one of the multiple jacks establishes a "test-potential" at the test-rings of all the other multiple jacks. The existence of this potential may be detected at any section of the board by touching a grounded conductor containing a testing instrument to the thimble of the jack at that board. This busy-test system is well known in the art, it being the usual practice for the operator before inserting a plug into the spring-jack of a line called for to touch the tip of her plug, which is connected to earth through a winding of her telephone induction-coil, to the thimble of the jack. If a potential exists at the test-ring of the jack as a result of connection with the line at some other section of the board, a click will be produced in the operator's telephone, which notifies her that the line is busy.

In association with the upper one of the spring-jacks b I have shown an incoming-trunk plug e, which forms the terminal of a trunk-line extending in two limbs 4 5 from the tip and ring contacts e' e^2, respectively, of the trunk-plug to the line-springs f' f^2 of a spring-jack f at the distant answering-board A. The plug e has a third contact or sleeve e^3, which registers with the test-ring b^3 of any jack into which the plug may be inserted, and this sleeve-contact forms one terminal of a conductor 6, the other end of which is connected to the armature switch-lever g' of an electromagnetic switch g. The switch-lever g' is normally maintained closed against a back contact which is connected to earth through the high-resistance test-magnet h. When the electromagnetic switch g is excited, it draws the armature g' away from its back contact, thus cutting off the test-magnet h, and connects said lever instead to a front contact, which is connected through a resistance with the free pole of the grounded battery d. While four batteries (marked d) are shown at the switchboard B, it is understood that in accordance with the usual practice a single central battery may be employed, which may be connected as indicated. When the lever g' is in its normal position, the test-magnet h is thus connected in a grounded branch from the sleeve e^3 of the trunk-plug, and when the plug is inserted in a spring-jack this magnet is sensitive to the electrical condition of the test-ring of such jack. If a connection already exists at some other jack of the line, so that there is a potential at the test-ring, the magnet h will be excited; but if no connection exists there will be no potential on the test-ring and the magnet h will be inert.

The magnet h has an armature which is connected to earth, and the back contact, against which said armature normally rests, forms the terminal of a conductor 7, leading through the winding of magnet g to the armature k' of a magnet k. A conductor 8 extends from the free pole of battery d, through the contacts of a plug-seat switch l, to one terminal of the winding of magnet k and from the other terminal thereof, through a switch-spring k^2 and its resting contact-anvil, to a connection with the conductor 6 between the sleeve of the plug and the switch-lever g'. When the magnet k is excited, it draws its armature k' against the contact-spring k^2, and after this contact is made spring k^2 is separated from its resting contact-anvil, thus cutting off the connection of conductor 8 with conductor 6. The magnet k has another armature, k^3, which controls the tip-strand 4 of the trunk-line. The armature k^3 is connected to the tip of the plug and normally breaks the conductor 4 at its front contact, making an alternative circuit to earth through a winding of the trunk-operator's-telephone induction-coil. The tip of the trunk-plug is thus normally disconnected from the conductor 4 and connected to earth through the induction-coil winding, so that the operator may make the usual test by touching the tip of the plug to the thimble of the jack into which the plug is to be inserted. If there is a potential on the jack, a click will be produced in the operator's telephone in the usual manner. When the magnet k is excited, however, the armatures k' and k^3 are drawn down, the armature k^3 cuts off the ground connection from the tip of the plug and closes the break in the tip-strand 4 at its front contact, and the armature k' establishes first the circuit 8 7 and then cuts off at spring k^2 the connection of conductor 8 with the strand 6. The conductor 7 between the magnet g and the armature k' has a ground connection through a resistance m. The plug-seat switch l maintains the connection of the conductor 8 to the battery normally open; but as soon as the plug is lifted from its socket the battery is applied through the winding of magnet k to the conductor 6, from which it finds circuit to earth through the armature g'

and the sensitive magnet *h*. The magnet *h*, as previously stated, may be of high resistance—say one thousand ohms—and the magnet *k* of low resistance—say thirty ohms—so that when these two magnets are thus connected in series in the circuit 8 6 the magnet *h* will respond and draw up its armature; but the magnet *k* will allow its armatures to remain in their retracted positions. As soon as the trunk-plug *e* is inserted in the spring-jack of a line, however, the conductor 6 will be connected by way of the registering contacts e^3 b^3 of the plug and jack to the test-conductor 3 of the line and thence to earth through the cut-off relay *c*, which may have a resistance of, say, thirty ohms, so that the magnet *k* will receive increased current and draw down its armatures *k'* k^3. The circuit 8 7 will thus be established through the winding of magnet *k* and the armature *k'* thereof to earth through the resistance *m*, so that the magnet *k* will remain excited until the circuit is broken by the replacement of the trunk-plug in its socket. The flow of current in the conductor 7, which includes the winding of magnet *g*, is now dependent upon the condition of the test-magnet *h*. If the line with which connection has been made is already engaged, there will be a potential on the test-ring b^3 of the jack and the magnet *h* will receive current, holding its armature up. If, however, the line to which the plug *e* has been connected is free, there will be no potential on the test-ring of the jack and the magnet *h* will allow its armature to fall back, thus closing the circuit 7 to earth in shunt of the resistance *m*. The flow of current through this shunt-path will excite the magnet *g*, which will attract its armature *g'*, cutting off the test-magnet *h* from connection with the sleeve of the plug and connecting the sleeve instead to the free pole of the battery *d* through a suitable resistance. Current will thus flow from the battery to conductor 6 by way of the armature *g'* and its front contact, thence to the sleeve of the plug and to earth through the conductor 3, containing the cut-off relay, establishing the busy-test potential at the other multiple jacks of the line. The electromagnetic switch *g*, whose operation is thus dependent upon the free condition of the line to which the trunk-plug may be connected, controls the electrical condition of the trunk-line. I have shown two additional armatures for the magnet *g*, connected, respectively, with the conductors 4 5, leading to the line-springs *f'* f^2 of the trunk-line jack at the answering-board. These armatures control the continuity of the conductors 4 5 at their front contacts, so that in the normal condition of the switch the circuit of the trunk-line is broken. The armature of magnet *g*, which is connected to the strand 5 of the trunk-circuit, normally rests against a back contact-anvil, which is connected to earth by a conductor 9. Said conductor 9 includes the secondary winding of an induction-coil whose primary winding is included in a local circuit with a constantly-running interrupter *n* to produce a characteristic "tone-test" on the trunk-line. When the magnet *g* is excited, the circuit of the trunk-line is completed and the ground-conductor 9 is disconnected, while at the same time, as before explained, the test-magnet *h* is disconnected from the sleeve of the plug and a battery connection substituted therefor.

At the answering-switchboard I have shown a pair of plugs and a plug-circuit of a well-known type for uniting lines. The plugs of this pair each have the usual three contacts, the tip and ring contacts of each plug being inductively connected with the corresponding contacts of its mate through the windings of a repeating-coil and the sleeve of each plug being connected to the free pole of a grounded battery. This battery is connected in a bridge of the plug-circuit conductors, which lead to the tip and ring contacts of the left-hand plug, which is designed for insertion in the jack *f* of the trunk-line, and the usual supervisory relay *o* is included in the circuit between the free pole of the battery and the ring-contact of the plug. This supervisory relay *o* controls a normally open shunt about the supervisory signal-lamp *o'*, which is included in the conductor 10, leading from the free pole of the plug-circuit battery to the left-hand plug. The third contact or thimble f^3 of the spring-jack *f* of the trunk-line forms the terminal of a conductor 11, which leads with the other trunk-line conductors to the B switchboard, being led to earth at the last-mentioned board through the windings of a relay-magnet *p*. When the plug is inserted in the spring-jack *f* at the answering-switchboard A, therefore, the circuit 10 11, including the supervisory lamp *o'* at the answering-board and the magnet *p* at the trunking-board, is completed. The magnet *p* is excited by current flowing in this circuit and the supervisory lamp *o'* is brought under the control of the supervisory relay *o*. The magnet *p* has an armature *p'*, which is connected, through a signal-lamp *q*, with the lever or moving part of the plug-seat switch. The normal resting contact of the armature-lever *p'* is connected to earth through a resistance, and the front contact of said armature-lever is connected to the battery *d*. The plug-seat switch has alternative contacts, the switch-lever thereof being connected to the winding of magnet *k* and normally resting against a contact which is connected to the free pole of the battery *d*, while the alternate contact of said switch *l*, closed while the plug is in the seat, is connected to earth through the resistance *r*.

The usual order-wire is shown extending from the operator's telephone *t* at the trunking-switchboard B to a special order-wire listening-key *s* at the answering-switchboard A,

said listening-key *s* being adapted when depressed to connect the A operator's telephone *t'* with the order-wire. The A operator also has the usual listening-key for connecting her telephone set in a bridge of that side of her plug-circuit which is intended for connection with the trunk-line.

It will be understood, of course, that the A operator would be provided with the ordinary ringing-keys and sources of current controlled thereby for operating the bells at stations A' B'.

The operation of the system may be traced as follows: Assuming that the A operator has a call—say from the subscriber at station A'—for a subscriber whose line terminates at switchboard B—say subscriber at station B'—she makes connection with the calling-line by means of her answering-plug, inquires the number of the called subscriber, and finding it to be a call which will necessitate the use of a trunk-line to the board B she depresses her order-wire key *s*, gives the number of the subscriber wanted, and receives in return information as to which trunk-line to use. The A operator then inserts her connecting-plug (the one on the left hand) into the spring-jack *f* of the trunk-line which the B operator has designated. The line conductors of the calling-line are thus extended to the conductors 4 5 of the trunk-line, and so to the B switchboard, and the signaling-circuit 10 11 is also completed, whereby the magnet *p* at the board B is excited. If the B operator has not yet picked up the terminal plug *e* of the trunk which she has designated, the lever of the plug-seat switch *l* will be forced over against its ground-contact, and the armature *p'* being drawn up by the magnet *p* a circuit will be completed from the battery *d* through the resistance *r* to earth, thus lighting the signal-lamp *q* and indicating that the trunk-line has been plugged into at the A board. The operator B thereupon picks up the trunk-plug *e* and inserts it in the jack of the called subscriber. The lamp *q* is then short-circuited by the plug-seat switch and extinguished.

I prefer to leave the B operator the usual apparatus for making a preliminary busy-test. This will be desirable where the called party has a number of lines running into the switchboard B, as is frequently the case where a subscriber has much telephone business. The B operator may thus test the several lines of the called party until she finds one that is not busy and inserts the plug into the jack of that line; but if on testing she finds that all the lines of the called party are busy she inserts the plug *e* into the spring-jack of any one of said lines regardless of its busy condition. As soon as the plug *e* is lifted from its seat the circuit 8 6 is established, as previously explained, exciting the test-magnet *h*, so that the latter draws up its armature and breaks the normal ground connection through the magnet *g*. Then when the plug is inserted in the spring-jack the magnet *k* responds, as previously explained, and draws up its armatures, cutting off the ground connection through the operator's induction-coil from the tip of the plug and also cutting off the battery connection 8 from the conductor 6, thus leaving the test-magnet *h* in said conductor connected only with the sleeve of the plug, so that the excitement of said magnet will depend upon the existence of a test-potential at the thimble of the jack into which the plug has been inserted. At the same time the local circuit 8 7 containing the winding of magnet *g* is established, said circuit being controlled at the armature and back contact of the test-magnet *h*. In other words, by the insertion of the plug *e* into the spring-jack of the called line the electromagnetic switch *g* is brought under the control of the test-magnet *h*. Now if the line called for is free there will be no potential on the test-ring of the jack, and the magnet *h* which was heretofore excited by current in the circuit 8 6 will be deprived of current and allow its armature to fall back, closing the local circuit, including the electromagnetic switch *g*, whereupon said switch will be actuated, completing the circuit of conductors 4 and 5 of the trunk-line, disconnecting the test-magnet *h* from the sleeve of the trunk-plug, and substituting a battery connection therefor; but if a connection already exists with the called line at some other multiple spring-jack thereof the magnet *h*, which is sensitive to the test-potential at the spring-jack, will keep its armature drawn up and the local circuit containing the switch *g* consequently open. The switch *g* will therefore remain inert, leaving the circuit of the trunk-line broken and the ground conductor 9 containing the secondary winding of the signaling induction-coil connected to the trunk-conductor 5. The operator at board A will therefore hear in her telephone a characteristic hum or tone, which will inform her that the desired connection has been made, but that the line called for is for the time being busy. Circuit will also be completed from the A operator's plug-circuit battery through the supervisory relay *o* to the conductor 5 of the trunk-line and thence through conductor 9 to earth, so that as long as the called party's line is busy the supervisory lamp *o'* will be shunted out. As soon, however, as the called line has been freed from its previous connection at some other spring-jack the magnet *h* will be deprived of current and will allow its armature to fall back, closing the local circuit of the electromagnetic switch *g* and bringing about the establishment of a complete operative connection between the trunk-line and the line in whose spring-jack the trunk-plug has been inserted. The conductor 9 is also disconnected from the trunk-line, so that the battery-circuit from conductor 5 to

earth will be broken and the supervisory relay *o* will allow its armature to fall back, breaking the shunt about the lamp *o'* and causing said lamp to light. Upon seeing this signal the A operator knows that a complete operative connection with the called line has been established. The called subscriber may now be signaled in the usual way, which need not here be described, and the connection may be "supervised" from the A board in accordance with the well-known practice. When the subscribers have finished conversation and the A operator, who has supervised the connection, pulls out the plugs, the circuit 10 11 is broken and magnet *p* at the board B allows its armature to be retracted. A circuit from battery *d* through the lamp *q* is thus completed by way of the plug-seat switch, the armature *p'* and its back contact, and the resistance *r*, and the lighting of this lamp may be taken as a signal to the B operator to take down the connection. When the plug is replaced in its socket, the plug-seat switch *l* is operated, breaking the circuits through the lamp *q* and the magnets *k* and *g*, so that the apparatus is restored to its original condition in readiness for another connection.

It will be observed that the connection of the trunk-plug with a busy line does not in any way interfere with the signaling on such line, nor does it impair the transmission, since the connection of the high-resistance magnet *h* to the test-conductor 3 of the line is not sufficient to change materially the flow of current through the conductor which includes the cut-off relay.

Having thus described my invention, I claim as new, and desire to secure by Letters Patent, the following:

1. The combination with a telephone-line having multiple spring-jacks, of a circuit terminating in a switch-plug adapted for insertion in a spring-jack to make connection with the line, a test-conductor extending to all the multiple spring-jacks, means for making connection with the line at any of the multiple spring-jacks thereof, and means for changing the electrical condition of the test-conductor in making connection at any spring-jack, an electromagnet included in a conductor which terminates in a contact-piece of the aforesaid plug and brought thereby into circuit with the test-conductor of the line when the plug is inserted in a spring-jack thereof, a switch adapted when actuated to disconnect the magnet from the test-conductor and to operate other mechanism, and means controlled by the cooperation of the plug and the spring-jack into which it may be inserted, for bringing the switch under the control of said magnet, whereby when the plug is inserted in the spring-jack, the condition of the switch and its controlled mechanism is dependent upon the busy or free condition of the line.

2. The combination with a telephone-line having multiple spring-jacks, of means for making connection with the line at any of the spring-jacks, means controlled by connection at one of the spring-jacks for establishing a peculiar electrical condition at the other spring-jacks, a circuit terminating in a switch-plug adapted for insertion in a spring-jack of the line to make connection therewith, a test-magnet and switching mechanism adapted to be controlled thereby, for changing the electrical condition of the circuit having the plug-terminal, said magnet being associated with the plug and sensitive to the electrical condition of the spring-jack into which the plug may be inserted, and means actuated by the insertion of the plug into a spring-jack for bringing said switching mechanism under the exclusive control of the test-magnet, whereby the electrical condition of the circuit having the plug-terminal is dependent upon the busy or free condition of the line with which the plug may be connected.

3. The combination with a circuit terminating in a switch-plug at a switchboard having spring-jacks into which the plug is adapted to be inserted, of a conductor terminating in a contact-piece of the plug, two branches from said conductor, one containing an electrical responsive device sensitive to an electrical potential which may be applied to the spring-jack in which the plug is inserted, the other branch being connected to a source of current, a switch normally closing the first-mentioned branch and adapted alternatively to open the first branch and close the second, mechanism actuated in the operation of said switch for changing the electrical condition of the circuit having the plug-terminal, means for operating said switch, adapted to be controlled by the magnet, and means actuated in the insertion of the plug, for bringing the switch under the control of the magnet, whereby upon the insertion of the plug in a spring-jack, the electrical condition of the plug-circuit will be made dependent upon the potential at the jack with which connection is made, as set forth.

4. The combination with a telephone-line having multiple spring-jacks, of a circuit terminating in a switch-plug adapted for insertion in a spring-jack of said line to make connection therewith, means for making connection with the line at the other spring-jacks, means for establishing a test-potential at all the spring-jacks of the line during the existence of a connection at one of such other spring-jacks, a testing device associated with the aforesaid plug sensitive to the test-potential of the jack into which said plug may be inserted, switching mechanism brought into action upon the response of said testing device to the failure of the test-potential at the jack in which the plug is inserted, controlling the circuit which has the plug-terminal, and adapted further to render said testing device independent of the electrical condition of the jack,

as by disconnecting the said device therefrom, and means actuated upon the operation of the last-mentioned switching mechanism, for re-establishing the test-potential at the spring-jacks of the line.

5. The combination with a telephone-circuit, of a magnet *h* and switching mechanism controlled thereby for changing the electrical condition of said telephone-circuit, a local circuit containing said magnet in a branch thereof, means for producing a flow of current in said local circuit, and switching mechanism brought into action through the agency of said magnet when the same becomes inert, for rendering the magnet irresponsive to the flow of current in said local circuit, as by disconnecting the branch containing the magnet, substantially as set forth.

6. The combination with a telephone-circuit, of a plug and spring-jack switch therefor, a local test-circuit established in contacts of said switch, means for changing the electrical condition of said test-circuit, a relay-magnet *h* in a normally closed branch of the test-circuit, an electromagnetic switch adapted when excited to close the telephone-circuit and simultaneously to render the relay-magnet *h* independent of said test-circuit, as by disconnecting the same therefrom, and means controlled by the insertion of the plug in the spring-jack, for establishing a local circuit for said electromagnetic switch, controlled at resting-contacts of said relay, whereby the condition of the telephone-circuit is made dependent upon the condition of the test-circuit when the plug is inserted in the spring-jack.

7. The combination with a telephone-line having multiple spring-jacks, of a telephone-circuit terminating in a switch-plug adapted to be inserted in a spring-jack of the telephone-line to make connection therewith, means for making connection at the other spring-jacks, and means actuated in making connection with the line for changing the electrical condition of the spring-jacks thereof, a testing device associated with the plug and sensitive to the electrical condition of the spring-jack into which said plug may be inserted, switching mechanism actuated in the response of said testing device, for rendering said device independent of the electrical condition of the spring-jack into which the plug is inserted, and a signal-circuit also controlled through the agency of said testing device.

8. The combination with a telephone-line having multiple spring-jacks, of a circuit terminating in a switch-plug adapted for insertion in a spring-jack to make connection with said line, a test-conductor extending to all the multiple spring-jacks, means for making connection with the line at any of the multiple spring-jacks thereof, and means for changing the electrical condition of the test-conductor in making connection at any spring-jack, a conductor terminating in a contact-piece of the plug and adapted to form a local circuit with said test-conductor when the plug is inserted in a spring-jack, an electromagnet included in a normally closed branch of said local circuit and sensitive to the electrical condition of the test-conductor, and switching mechanism controlled by said magnet adapted when actuated to change the electrical condition of the telephone-circuit and simultaneously to render said magnet independent of the local circuit, as by disconnecting the same therefrom, substantially as set forth.

9. The combination with a telephone-circuit, of a local circuit and means for producing a current therein, a relay in a branch of said local circuit, and switching mechanism actuated through the agency of said relay when the same becomes inert, adapted to change the electrical condition of the telephone-circuit and also to render said relay thereafter independent of the flow of current in said local circuit, as by disconnecting the said branch containing the relay.

10. The combination with a telephone-circuit and a plug and spring-jack switch controlling the same, of a local circuit established in contacts of said switch, and means for producing a flow of current therein, a relay-magnet *h* in a branch of said local circuit, a switch-contact actuated through the agency of said relay-magnet when the same becomes inert, adapted to change the electrical condition of said telephone-circuit, and another switch-contact simultaneously actuated, for disconnecting the branch containing the relay-magnet.

11. The combination with a plug and spring-jack switch and a telephone-circuit controlled thereby, of a local circuit established in contacts of said switch, means for producing a flow of current in said circuit, a conductor terminating in a contact-piece of the plug and forming a part of said local circuit, a relay-magnet responsive to the flow of current in said conductor, switching mechanism adapted to close a normally open break in the telephone-circuit and to cut off the relay-magnet from the path of current in said local circuit, and means actuated in the insertion of the plug for bringing said switching mechanism under the control of the said relay-magnet, said mechanism being actuated by the relay when inert, whereby the condition of the telephone-circuit is made dependent upon the condition of the local circuit.

12. The combination with a plug and spring-jack switch and a telephone-circuit controlled thereby, of a local circuit established in contacts of said switch, means for producing a flow of current in said local circuit, a magnet in a conductor terminating in the plug and forming a part of said local circuit, switching mechanism controlling the telephone-circuit, and means actuated in the insertion of the plug in the spring-jack for bringing said switching mechanism under the control of said magnet,

whereby the condition of the telephone-circuit is made dependent upon the condition of the local circuit.

13. The combination with a telephone-line and multiple spring-jacks thereof having test contact-pieces, of a telephone-circuit terminating in a switch-plug adapted to be inserted in a spring-jack of the telephone-line to make connection therewith, means for making connection at the other spring-jacks, and means actuated in making connection with the line for establishing a test-potential at the test contact-pieces of the several multiple spring-jacks thereof, a relay *h* in a conductor terminating in a contact-piece of the plug which is adapted to engage the test-contact of the spring-jack into which said plug may be inserted, said conductor forming a branch of a local circuit for the relay, said relay being thus responsive to the test-potential at the jack, an electromagnetic switch in a local circuit closed by said relay *h* when the same is inert, said electromagnetic switch controlling the circuit which has the plug-terminal, a source of current connected with said relay *h* to maintain the same excited independent of the circuit thereof closed at the test-contact of the jack, and means actuated in the insertion of the plug in the spring-jack, for disconnecting said source of current from the relay, whereby the condition of the circuit having the plug-terminal is made dependent upon the busy or idle condition of the line into whose spring-jack the plug is inserted.

14. The combination with a trunk-line extending between two switchboards, of a signal *o'* and a testing appliance *t'* associated with the trunk-line at one of the switchboards, a telephone-line, and a connection-switch for establishing connection between the trunk-line and the telephone-line at the other switchboard, a source of busy-test potential, and a switch for applying said potential to the telephone-line, and an electromagnetic switch *h* controlling the circuit of the trunk-line, said electromagnetic switch being sensitive to the presence of busy-test potential on the said telephone-line, whereby the busy or free condition of the line is automatically indicated.

15. The combination with a telephone-line having a busy-test conductor 3, a source of test-potential and a switch for applying the same to said test-conductor, a second telephone-circuit 4 5, and a connection-switch *e* for uniting the two telephone-circuits, a test-magnet *h* and a switch *g* having normally closed contacts connecting said test-magnet to the test-conductor, a signal *o'* associated with the second telephone-circuit, controlled through the agency of said switch *g*, and means made operative by the test-magnet when it becomes inert, for actuating said switch *g*, whereby the circuit of the test-magnet is broken and the signal *o'* actuated upon a failure of the test-potential applied to said test-conductor.

16. The combination with a telephone-line having multiple terminals, of a connection-switch adapted to be applied to one of said terminals, a source of test-potential applied by said switch to all the said multiple terminals, a second connection-switch adapted to engage another of said multiple terminals, a magnet associated with said second connection-switch responsive to the failure of the test-potential at the multiple terminal with which said last-mentioned connection-switch is engaged, and a switch *g* controlled by said magnet adapted to disconnect the magnet and reëstablish a test-potential at the several multiple terminals.

17. The combination with a telephone-line and multiple spring-jacks therefor, of a plug and plug-circuit, a trunk-circuit also having a plug-terminal, a local busy-test circuit composed of three conductors, one extending to a contact-piece on each of the multiple spring-jacks, another associated with the trunk-plug and including a test-magnet, and the third associated with the other plug, a battery included in said test-circuit to actuate the test-magnet when the test-circuit is completed by the insertion of the trunk-plug and the other plug into multiple spring-jacks respectively of the same line, a signal device at the distant end of the trunk-line, and means for actuating said signal device controlled by said test-magnet.

In witness whereof I hereunto subscribe my name this 18th day of April, A. D. 1902.

EDWIN H. SMYTHE.

Witnesses:
JOHN G. ROBERTS,
FREDERICK A. WATKINS.