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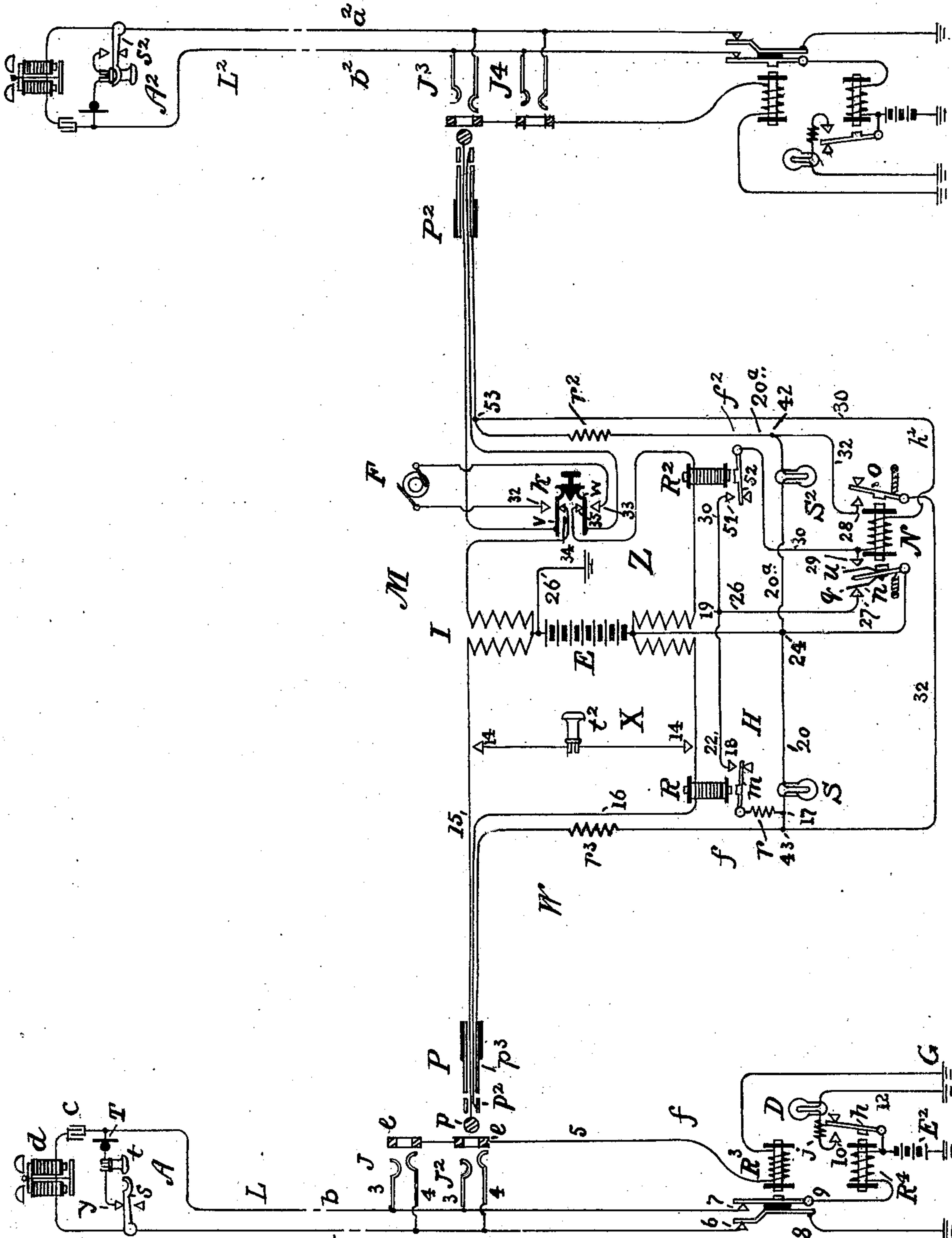
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D. S. HULFISH.

SWITCHBOARD AND SUPERVISORY SIGNAL CIRCUIT.

(Application filed July 1, 1902.)

(No Model.)



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SWITCHBOARD AND SUPERVISORY SIGNAL CIRCUIT.

SPECIFICATION forming part of Letters Patent No. 712,801, dated November 4, 1902.

Application filed July 1, 1902. Serial No. 113,972. (No model.)

To all whom it may concern:

Be it known that I, DAVID S. HULFISH, residing at Chicago, in the county of Cook and State of Illinois, have invented certain Improvements in Switchboard and Supervisory Signal Circuits, of which the following is a specification.

This invention relates to the central-station apparatus of telephone-exchanges, and especially to the construction and arrangement of the lamp or other signals which are associated with switch-cords and which enable the operators to exercise intelligent supervision over calls and over connections between two substations at any or all stages of the operation.

In standard central-station telephone systems and apparatus as at present generally constituted and employed the main or substation circuits when inactive are conductively open or discontinuous, but when the substation-receiver is taken from the switch-hook are closed by the action of said switch, which therefore controls the continuity of the circuit.

The switch-cords whereby any two main circuits may be united at the central station are provided with terminal switch-plugs, one of which, usually termed the "answering-plug," is inserted in a switch-socket of the call-originating substation-circuit, while the other, which may be termed the "companion" plug, is similarly placed in a switch-socket of the called or wanted main circuit. Each switch-cord has two main-circuit conductors, which when the plugs are thus inserted extend respectively between the main conductors of the two substation-circuits concerned; but as the working battery or other source of current-supply is bridged between the said main-cord conductors it follows that the main-circuit conductors of the switch-cord are formed thereby into two main-circuit loops, each closed at its inner extremity through the said source and each extending to its respective plug and adapted thereby to constitute a terminal loop, through which the main circuit in whose switch-socket the plug is inserted is or may be closed. The switch-cord system also has a local-circuit conductor for each of its

plugs, and the said local circuits are completed through suitable resistance when the plugs are inserted in main-circuit switch-sockets. Signal devices—generally small glow-lamps, one associated with each switch-plug—are included in these local circuits, and the said lamps are provided with controlling-shunts extending around them and leading through the local switching or contact points of corresponding relays, also one for each plug, which relays are connected in the main-circuit switch-cord loops. The relays are thus responsive to the operation of the hook-switches pursuant to the removal and replacement of the receivers at the respective substations, and by closing and opening the shunt-circuits in response to such operation permit the display of the lamp-signal associated with any plug when the receiver is on its hook at the substation of a line in whose socket such plug is inserted, but causes the same to remain undisplayed or be withdrawn when the said receiver is removed from the hook. These lamp-signals are termed "supervisory signals" and the relays controlling them "supervisory relays." The display of the signal associated with either plug indicates, therefore, that the receiver at the substation of the line directly connected with such plug is on its hook, and the absence of such signal display indicates that the receiver has been removed from the hook. Such indication has, however, been found insufficient, since in the case of a called subscriber the signal is the same whether the said subscriber has failed to respond at all by taking up his receiver or whether he has answered by such action and has then for some reason replaced his receiver, yet in the former instance the operator is required to ring up the wanted substation again and in the latter case is not so required. To remedy this insufficiency and the confusion liable to be caused thereby and to provide fully discriminative signals are the objects of this invention.

To this end the invention consists, mainly, in providing an additional local-circuit conductor for the companion plug, in controlling this by the relay of said plug, and in an electromagnetic switch connected therein and

adapted when actuated by the operation of said relay to connect both signals in parallel branches of the local circuit of the answering-plug, to extend the controlling-shunt of the
 5 supervisory signal of the said answering-plug and establish said shunt around both signals, and to lead said shunt thus extended through the local or contact points of both supervisory
 10 relays, so that the deenergization of either relay pursuant to the replacement of the receiver on its hook at the substation of the circuit containing such relay and the consequent opening of the extended shunt-circuit will cause the simultaneous display of both
 15 supervisory signals and will thus furnish an unmistakable signal for disconnection which cannot by any possibility mean anything else.

It consists also in certain details of construction and arrangement of the said circuit
 20 connections and apparatus, and provides also that the said electromagnetic switch shall after it has been energized be enabled to transfer its own local circuit from the contacts of the companion-plug relay to a new path
 25 through contacts controlled by its own magnet, thereby leaving said relay free to participate in the direct control of the supervisory signals.

The drawing which accompanies and illustrates this specification is a diagram representing a modern telephone-exchange system of substation-circuits converging to a central station, where by means of a suitable switching apparatus they may be united in pairs for
 35 through communication.

The several substation-circuits are exemplified by two main circuits L L^2 , and the switching apparatus is exemplified by a single switch-cord circuit or system W .

40 In the said drawing, A and A^2 represent the substations of the main circuits L and L^2 , respectively, and M is the central station. The substation apparatus is of standard type, as is also the call-receiving portion of
 45 the central-station appliances. The substation apparatus comprises, as usual, the call-bell d , the condenser c , the telephone-transmitter T and receiver t , and the suspension-switch s , having a hook termination, on which,
 50 as shown at substation A^2 , the receiver is hung when not being used. When the switch s , in virtue of the presence of the telephone on the hook, is in its lower position, the circuit is conductively open, the condenser c
 55 being interposed therein, but the bell d is of course readily operated through the condenser by the alternating call-currents of the regular generator; but when the receiver is taken from the hook and the switch s moves
 60 to its upper position the circuit is conductively closed through the switch-lever, its contact-stop y , and the station-telephones.

J J^2 are the spring-jacks or switch-sockets of main circuit L , and J^3 J^4 the sockets of
 65 main circuit L^2 , and each contains a contact connection of both main wires a b or a^2 b^2 of the circuit. In the sockets J J^2 3 3 are the

contact-springs extending from conductor b , and 4 4 those which are branched from conductor a . The socket-frames e of the said
 70 switch-sockets are grounded through conductor 5 and through an appropriate resistance, which, as shown, may take the form of a cut-off relay R^3 , operating when excited to sever the normal line-terminals 8 and 9 at the
 75 points 6 and 7 when the circuit is transferred to a switch-cord by the insertion of a plug in any one of its sockets. The said conductor 5, extending from the switch-sockets to
 80 ground G or return, forms part of local circuit f , which includes the said cut-off relay or resistance and which, as presently to be described, is associated with the answering
 85 switch-plug and the corresponding supervisory signal. The normal terminals of the substation-circuits are as usual.

The main conductor a extends through the cut-off relay-contact 6 and extension-conductor to earth, and conductor b extends
 90 through cut-off relay-contact 7, the winding of line signal-relay R^4 , and the source of current E^2 to earth. The said line-relay R^4 controls the call-signal D in a normally open local circuit 12 of the generator E^2 , which extends
 95 through the armature h of the line-relay and its front contact 10 and also may include an appropriate resistance j . The said signal is shown as being a small glow-lamp, and the said generator E^2 may be and generally is a
 100 voltaic battery and the same battery as that to which reference will presently be more particularly made as being that which supplies current for the transmitters and signals for lines which are in use or active operation.

P is the answering switch-plug, and P^2 the
 105 companion switch-plug, of the switch-cord circuit or system W ; I , the usual split winding repeating induction-coil; t^2 , a receiver symbolizing the operator's telephone apparatus; k , a ringing-key, and F a call-current
 110 generator. The tip and ring contact-surfaces p and p^2 of the two plugs, arranged when the plugs are inserted in the sockets J to register and make contact with the springs 3 and 4, respectively, of said sockets, are united by
 115 the main cord-conductors 15 and 16. The battery E , having the usual ground connection 26, is bridged between the said conductors at the middle of the two windings of the split repeating-coil I , and the main cord con-
 120 ductors are thus divided into main-circuit loops X and Z , the former associated with the answering-plug P and the latter with the companion plug P^2 and each constituting the terminal loop or section of the main or sub-
 125 station circuit with which its associated plug is or is about to be connected.

R is the supervisory relay associated with the answering-plug end of the cord-circuit, and R^2 the supervisory relay of the com-
 130 panion plug. These relays are in the main-circuit loops X and Z , respectively, and of course when the plugs are inserted in the sockets of substation-circuits L and L^2 are brought di-

rectly into the said circuits and are thereby made subject or responsive to the operation of the substation-switches s and s^2 .

The signal S , preferably also a small glow-lamp, is connected in the local-circuit conductor 20, which forms part of the local circuit f , the said circuit being completed when the plug P is inserted in a socket J^2 of the calling-line by way of the frame-piece e of said socket and cut-off relay R^3 . The said local-circuit conductor extends from the ungrounded pole of battery E through said lamp-signal S and a reducing-resistance r^3 to the sleeve-contact piece p^3 of the plug P . The signal S^2 , associated with the companion plug P^2 in like manner, is in a similar local circuit f^2 , the cord conductor 20^a whereof branches from conductor 20 at any convenient point 24. This circuit may also have a steadying or reducing resistance r^2 .

H is a normally open shunt around the signal S , beginning at point 24 of conductor 20, ending at point 17 of the same conductor, and leading by conductor 26 through the resting-contacts n and 27 of a device hereinafter to be described and by conductor 22 through the contact-points 18 and m of the supervisory relay R and through resistance r . This shunt is therefore controlled by the said relay, being closed when the relay is excited and attracts its armature and opened when the said relay is not excited, and is thus enabled to control the display of the signal S .

With the companion plug is associated a second or auxiliary local circuit h^2 , the cord portion of which circuit normally extends from any convenient point 19 on conductor 22 of the controlling-shunt H by conductor 30 through the contacts of supervisory relay R^2 to any point 53 on the ordinary local-circuit conductor 20^a on the plug side of the resistance r^2 .

N is a switching-relay or electromagnetic switch, whose magnet-coil is connected in the said auxiliary local circuit. The said electromagnetic switch is shown as having two armatures n and o , controlling different sets of switching-points. Obviously, however, if desired, one armature carrying two switching-levers or one armature-lever carrying both sets of contacts could readily be arranged. The armature o makes no electrical contact in its quiescent position, but when attracted forward establishes contact with its front stop 28. The armature n is adapted to make electrical contacts in both quiescent or back and active or forward positions and is provided with continuity-preserving springs q and u , whereby it is enabled to maintain its contact on either side closed until that on the other side is established. Its back contact between armature n and point 27 is in the circuit of the controlling-shunt H , and the normal circuit of said shunt, as hereinbefore stated, leads therethrough, so that as long as the electromagnetic switch remains unactuated the said normal circuit of the shunt H

is maintained thereby. The front contact-stop 29 of armature n is branched from conductor 30 of the auxiliary local circuit within which the magnet of the electromagnetic switch is connected. When, therefore, the said switch is operated and the said armature is attracted forward, contact is established between the contact-spring u of said armature and stop 29.

From a point 42 on the conductor 20^a of the regular local circuit f^2 of plug P^2 a branch connection 32, passing through the contacts 28 and o of the electromagnetic switch N , extends to a point 43 on the cord conductor 20 of local circuit f , associated with plug P . Since the said points 28 and o are normally out of contact with one another, this branch connection is normally open. When closed at the said contacts, however, by the operation of the switch N , it forms the principal portion of a parallel branch of the said local circuit f of plug P and includes the supervisory signal S^2 , which is thus connected in parallel with signal S , the said parallel branch now extending from point 24 by conductor 20^a to the said signal S^2 , thence to point 42, contacts 28 and o , and conductor 32 to point 43 on conductor 20 of local circuit f . The portion 30 of the auxiliary local circuit extending between point 19 and the forward contact-point 29 of armature n of the switch N and passing through the contacts 51 52 of the supervisory relay R^2 becomes when said electromagnetic switch is operated a continuation of the shunt H , which is thus extended around both of the two signals S S^2 , connected in parallel, and exercises control over both, and since the said shunt now includes the contacts of both relays, so that it is controlled by both relays, it follows that the deenergization of either relay pursuant to the replacement of the receiver at the substation of either line will operate both of the said signals. Thus the display of both signals together can only occur when after both receivers have been removed from their respective switch-hooks one or both are replaced.

The operation of the electromagnetic switch has still another result. It transfers its own auxiliary local circuit from its original path through the contacts 51 and 52 of supervisory relay R^2 to the forward contacts u and 29 of its own armature n , and thus becomes independent of said relay-contacts.

The operator's telephone t^2 is adapted to be bridged in a well-known manner between the main conductors 15 16 of the cord-circuit by means of the usual listening-key, which is conventionally indicated by the contacts 14.

The ringing-key k is adapted when pressed to sever the main conductors of the main loop Z by separating the springs v w from the contact-points 34 and 35 and to connect the former to the terminal contacts 32 and 33 of the call-generator F for the purpose of sending a ring or call-signal over circuit l^2 to the substation A^2 . In these devices the several re-

sistance should, of course, be proportioned
 on proper engineering principles. Good re-
 sults will be attained by giving to the cut-off
 relays a resistance of about thirty ohms, the
 5 resistance-coils r^2 and r^3 eighty ohms, and the
 shunt resistance r twenty ohms. In the op-
 eration of these devices a call coming in over
 substation-circuit L will be responded to by
 inserting the answering-plug P into socket J².
 10 Since the receiver at the calling-substation
 has already been taken from the hook to give
 the call and order, the circuit of battery E is
 closed through the relay R, which therefore
 is excited. At the same time the local circuit
 15 f is closed from the battery E to ground by
 way of the signal-lamp S, the socket-ring e ,
 and the cut-off relay R³; but the said signal S
 is not displayed, because the controlling-shunt
 H thereof is closed around it by the relay R,
 20 which being excited has attracted its arma-
 ture and brought its contacts m and 18 to-
 gether, the shunt for the present being main-
 tained through the armature and back con-
 tact n and 27 of the switching-relay N. The
 25 signal S though not displayed remains under
 the control of the switch s at substation A in
 the usual way, so that if the subscriber at
 any time prior to the culmination of the call
 wishes to attract the attention of the central
 30 operator he may do so by oscillating his switch-
 lever, which will cause the signal to operate
 the signal intermittently. The calling sub-
 scriber having stated his order plug P² is
 placed in a switch-socket of the circuit of the
 35 wanted substation, and the local circuit f^2
 of said plug being thereby closed current
 flows through signal S² and causes the same
 to be displayed. The call is now sent over
 line L² by operating the ringing-key k . At
 40 this juncture signal S remains undisplayed,
 because the receiver t at substation A has
 been taken from the hook to send the call
 and give the order and has not been replaced,
 and signal S² is displayed because its circuit
 45 f^2 is closed through the local contacts of the
 plug P² and socket J³, and its display con-
 tinues until the subscriber at A² responds to
 the call by removing his receiver from the
 hook s^2 ; but when the receiver is lifted from
 50 the switch-hook the main circuit is conduct-
 ively closed through the telephones, and the
 current from the source E circulates therein
 and energizes the supervisory relay R², which
 bringing its contacts 51 and 52 together closes
 55 the auxiliary local circuit h^2 and causes the
 operation of the electromagnetic switch N in-
 cluded therein. The said electromagnetic
 switch then attracts both armatures by ar-
 mature o closing the branch 32 of the local
 60 circuit f of plug P through signal S², and
 thus placing the two signals S and S² in
 parallel with one another between the points
 24 and 43 and by armature n uniting the
 spring and fixed contacts u and 29 and im-
 65 mediately thereafter separating the spring
 contact q from the back-stop 27, thereby clos-
 ing the extended shunt-circuit around both

signals and through the contacts of both re-
 lays R and R² in series and transferring the
 control of the switch N from the contacts 70
 of relay R² to its own contacts u and 29.
 As has been indicated, the signals S S²
 though now undisplayed remain during the
 pendency of the communication under the
 control of the substation-switches $s s^2$ in such 75
 manner that the restoration of the receiver to
 the hook at either substation will cause the
 display of both signals S S² at the same time,
 for when either subscriber hangs up his tel-
 ephone his main circuit is opened at the 80
 switch, and the corresponding relay R or R²
 becomes deenergized, and as the shunt around
 both lamps leads through the contacts of both
 relays it will evidently be broken by the re-
 traction of the armature of either relay. Re- 85
 ceiving the disconnection-signal the operator
 pulls the switch-plugs from their sockets.
 The circuit maintaining the magnetization of
 the switching-relay N, which upon the ini-
 tial operation of the same was formed through 90
 the forward contacts u and 29, through the
 winding of said relay, and by conductor 30 to
 the sleeve contact of plug P², returning
 thence by way of the switch-socket earth
 branch, which contains the cut-out relay of 95
 main circuit L², is broken by the withdrawal
 of the said plug P², and the excitement of the
 magnet of the switch-relay N ceases, permit-
 ting its armatures to move to their original
 positions, and thus restoring all portions of 100
 the switch-cord apparatus to their normal or
 resting state.

Thus by means of my improved supervi-
 sory switch-cord circuit a new and distinctive
 signal is obtained from the same two lamps— 105
 viz., the display of both at the same time—to
 indicate the requirement of disconnection,
 even though at the close of the communica-
 tion but one of the substation-receivers be re-
 placed upon its hook. 110

Having now fully specified my invention
 and its mode of operation, I claim—

1. In a telephone-system switchboard ap-
 paratus, the combination of answering and
 companion switch-plugs, united by a switch- 115
 cord comprising a main-circuit loop and a
 local signal-circuit conductor for each plug;
 a supervisory relay included in the main-cir-
 cuit loop of each plug; a supervisory signal
 for each plug in the local circuit thereof; a 120
 shunt-circuit around the answering-plug sig-
 nal and including the switch-points of the
 answering-plug relay; and means controlled
 by the companion-plug relay and operating
 pursuant to the excitement thereof to con- 125
 nect both of the said supervisory signals in
 parallel branches of the answering-plug local
 circuit, and to connect the switch-points of
 both supervisory relays in series in said
 shunt-circuit, whereby both signals are ren- 130
 dered responsive to the deenergization of
 either relay; substantially as described.

2. In a telephone-system central-station ap-
 paratus, the combination with answering and

companion switch-plugs, and a switch-cord uniting them and containing a main-circuit loop and a local signal-circuit conductor for each plug; a supervisory relay associated with each plug in the main-circuit loop thereof; a supervisory signal associated with each plug in the local circuit thereof; and a shunt-circuit around said signal normally controlled by the relay of the answering-plug only; of a normally open branch circuit parallel to the local-circuit conductor containing said answering-plug signal, adapted when closed to include the supervisory signal of said companion plug; a normally disconnected continuation of said shunt-circuit adapted to extend the same through the contacts of the companion-plug relay and to shunt the companion-plug signal also when thus included in said parallel branch; and an electromagnetic or relay switch controlled by the said supervisory relay of the companion plug, and adapted when actuated to close said parallel branch through said companion-plug signal, and to extend said shunt through said continuation; whereby both supervisory signals may be made responsive to either supervisory relay, substantially as described.

3. In a telephone-system switchboard apparatus, the combination of answering and companion switch-plugs united by a switch-cord comprising a main-circuit loop for each plug, a local signal-circuit conductor for each plug, and an auxiliary local-circuit conductor for said companion plug; a supervisory signal associated with the answering-plug and connected in the local circuit thereof; a normally incomplete branch of the said answering-plug local circuit arranged in parallel with the signal thereof; a second supervisory signal connected in the local signaling-circuit of the companion plug and also in the said normally incomplete branch of the answering-plug local circuit; a shunt-circuit normally around the said first-named signal but adapted when the said branch is completed to be extended also around the said second signal included therein; a supervisory relay in the main-circuit loop of the answering-plug and adapted to alone control said shunt as normally constituted; a second supervisory relay in the main-circuit loop of the companion plug normally controlling the said auxiliary local circuit but adapted when the said shunt is extended around both signals to control the same jointly with said first-named relay; and an electromagnetic switch in said auxiliary local circuit maintaining when quiescent the normal circuit of said shunt, but adapted when excited to close said normally incomplete branch through said second signal, and to extend the said shunt-circuit around both signals and through the contacts of both relays; whereby both signals originally responsive each to its own relay alone, are made responsive to the deenergization of either relay; substantially as described.

4. In a switch-cord-circuit system, the com-

bination with the answering and companion switch-plugs of said cord; the standard main and local circuits of the said plugs respectively; the supervisory relays and lamp-signals connected in said main and local circuits respectively; and the standard controlling-shunt of the signal-lamp of the answering-plug local circuit; of an auxiliary local circuit associated with said companion plug; and an electromagnetic switch included therein, responsive to the supervisory relay of said companion plug; the said switch being organized when operated, to connect said signals in parallel branches of the answering-plug local circuit, to establish said controlling-shunt around both signals, and to connect the contacts of both supervisory relays in series in said shunt-circuit; whereby the signal-lamps normally responsive each to its associated relay are brought into such relation that both are responsive to either relay; substantially as described.

5. In a telephone-exchange system, the combination of two main or substation circuits, viz: a calling and a called circuit, both adapted to be closed and opened by the substation hook-switch as the receiver is taken therefrom or replaced, and both having switch-sockets comprising main and local circuit switch contacts at the central stations; a switch-cord with answering and companion switch-plugs, and containing main conductors with a source of current bridged between them and dividing the same into loops, one for each plug, and a local signal-circuit conductor for each plug; a supervisory relay in each main-circuit loop responsive to the operation of the respective substation switch-hooks; a supervisory signal for each plug in the local circuit thereof; a shunt normally arranged around the answering-plug supervisory signal and controlled by the relay of said answering-plug main loop, but having an alternative circuit around both supervisory signals, and through the switch contacts of both supervisory relays; a normally open branch circuit in parallel circuit with the supervisory signal of the answering-plug and adapted when closed to include the other signal; and an electromagnetic switch or switching-relay controlled by the supervisory relay of the companion plug, the said switching-relay having two positions, and being adapted in its quiescent position to maintain the normal circuit of said shunt, but in its active position to close the said parallel branch circuit through said companion-plug signal, and to establish the alternative circuit of said shunt; substantially as and for the purposes specified.

6. In a telephone-exchange, a compound circuit extending between two substations and comprised of two substation-circuits switched together at a central-station switchboard on the call of one of them, and having a battery bridged between its main conductors at said central station; a switch at each station each

controlling the conductive continuity of its own component circuit; a relay at the central station in each of the said component circuits responsive to the switch at the substation of
5 its own circuit only; a local circuit associated with each component main circuit; a supervisory signal included in each local circuit; an auxiliary local circuit associated with, and leading through the contacts of the relay of
10 the called component main circuit; a shunt-circuit for the signal of the calling component circuit leading through the contacts of the corresponding relay; a continuation thereof normally disconnected but adapted to extend
15 the same around both signals and through the contacts of both relays; a normally incomplete branch for the local circuit associated with the calling component main circuit in parallel with the signal included in said local
20 circuit, and adapted when completed to in-

clude the signal of the other local circuit; and an electromagnetic switch connected in the said auxiliary local circuit, and adapted in its quiescent position to maintain the normal circuit of said shunt, but when operated
25 to establish parallel connection of the said two signals, to transfer its own local circuit from the contacts of the called-circuit relay to contacts controlled by its own magnet, and to extend the shunt-circuit through the said
30 continuation thereof; substantially as described.

In testimony whereof I have signed my name to this specification, in the presence of two subscribing witnesses, this 20th day of
June, 1902.

DAVID S. HULFISH.

Witnesses:

L. G. RICHARDSON,
A. B. RAYMOND.