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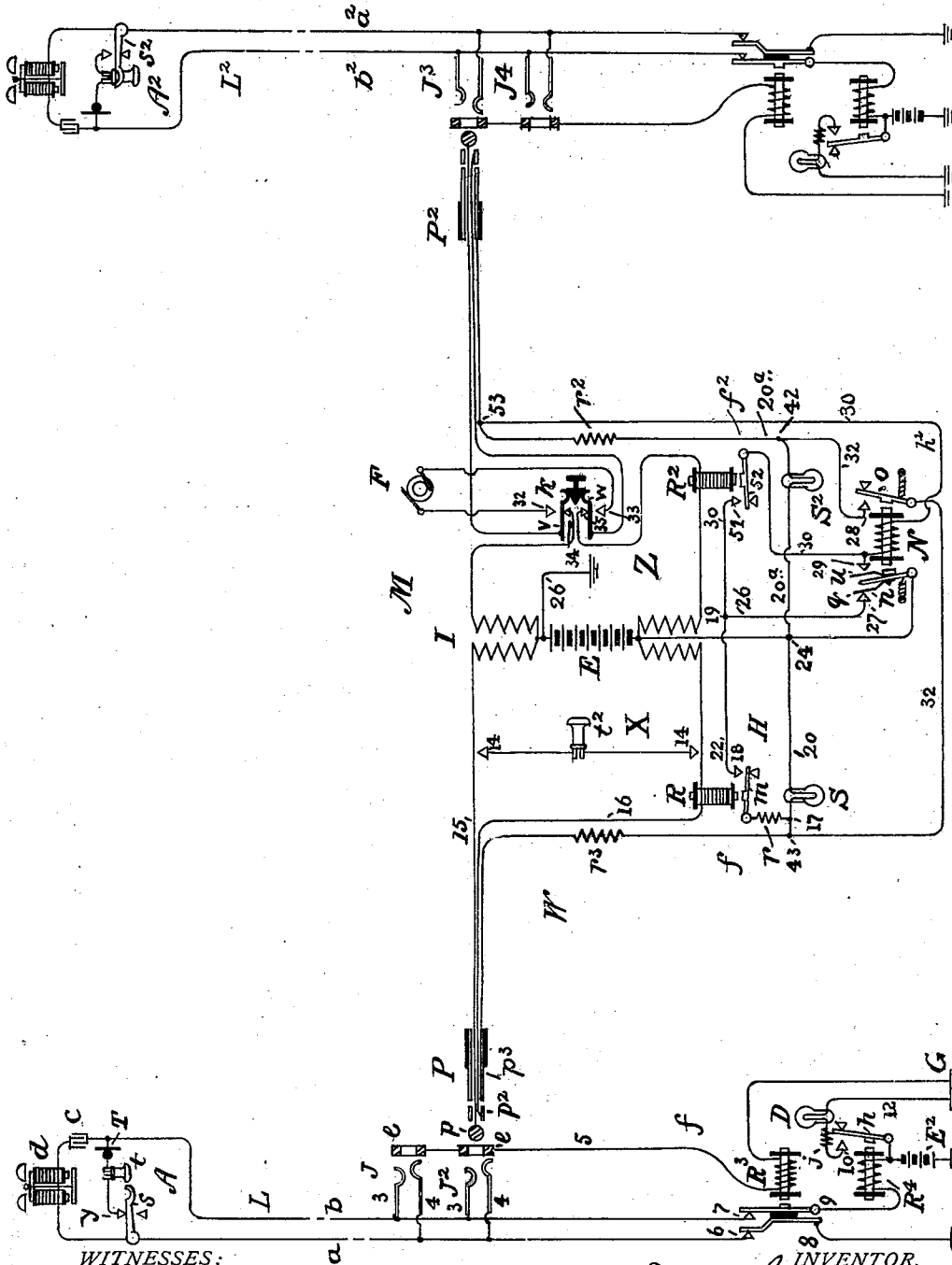
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D. S. HULFISH.

SWITCHBOARD AND SUPERVISORY SIGNAL CIRCUIT.

(Application filed July 1, 1902.)

(No Model.)



WITNESSES:

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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 relays, so that the deenergization of either relay
 10 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 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,
 45 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 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
 50 to its upper position the circuit is conductively closed through the switch-lever, its contact-stop y , and the station-telephones.

60 J J^2 are the spring-jacks or switch-sockets of main circuit L , and J^3 J^4 the sockets of 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 ground G or return, forms part of local circuit
 80 f , which includes the said cut-off relay or resistance and which, as presently to be described, is associated with the answering switch-plug and the corresponding supervisory signal. The normal terminals of the
 85 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 through cut-off relay-contact 7, the winding
 90 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 through the armature h of the line-relay and its front contact 10 and also may include an
 95 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 voltaic battery and the same battery as that
 100 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.

105 P is the answering switch-plug, and P^2 the companion switch-plug, of the switch-cord circuit or system W ; I , the usual split winding repeating induction-coil; l^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.

130 R is the supervisory relay associated with the answering-plug end of the cord-circuit, and R^2 the supervisory relay of the companion 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 β 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-

distances should, of course, be proportioned on proper engineering principles. Good results will be attained by giving to the cut-off relays a resistance of about thirty ohms, the resistance-coils r^2 and r^3 eighty ohms, and the shunt resistance r twenty ohms. In the operation of these devices a call coming in over substation-circuit L will be responded to by inserting the answering-plug P into socket J². 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 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, which being excited has attracted its armature and brought its contacts m and 18 together, the shunt for the present being maintained through the armature and back contact n and 27 of the switching-relay N. The 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 operator he may do so by oscillating his switch-lever, which will cause the signal to operate the signal intermittently. The calling subscriber having stated his order plug P² is placed in a switch-socket of the circuit of the 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 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 f^2 is closed through the local contacts of the plug P² and socket J³, and its display continues 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 the switch-hook the main circuit is conductively 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 the auxiliary local circuit h^2 and causes the operation of the electromagnetic switch N included therein. The said electromagnetic switch then attracts both armatures by armature o closing the branch 32 of the local 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 immediately thereafter separating the spring contact q from the back-stop 27, thereby closing the extended shunt-circuit around both

signals and through the contacts of both relays R and R² in series and transferring the control of the switch N from the contacts 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 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 telephone his main circuit is opened at the 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 retraction of the armature of either relay. Receiving 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 initial operation of the same was formed through 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 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, permitting its armatures to move to their original positions, and thus restoring all portions of the switch-cord apparatus to their normal or resting state.

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

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

1. In a telephone-system switchboard apparatus, the combination of answering and companion switch-plugs, united by a switch-cord comprising a main-circuit loop and a local signal-circuit conductor for each plug; a supervisory relay included in the main-circuit loop of each plug; a supervisory signal for each plug in the local circuit thereof; a shunt-circuit around the answering-plug signal 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 connect 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 rendered responsive to the deenergization of either relay; substantially as described.

2. In a telephone-system central-station apparatus, 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
 10 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 electromag-
 20 netic 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
 30 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 con-
 40 nected 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 consti-
 50 tuted; 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 electro-
 55 magnetic 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
 65 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
 80 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
 90 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
 95 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
 100 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-
 105 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
 110 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
 115 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
 120 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;
 125 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
 130 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 super-
visory 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 incom-
plete 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 nor-
mal 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 de-
scribed.

In testimony whereof I have signed my
name to this specification, in the presence of
two subscribing witnesses, this 20th day of 35
June, 1902.

DAVID S. HULFISH.

Witnesses:

L. G. RICHARDSON,
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