

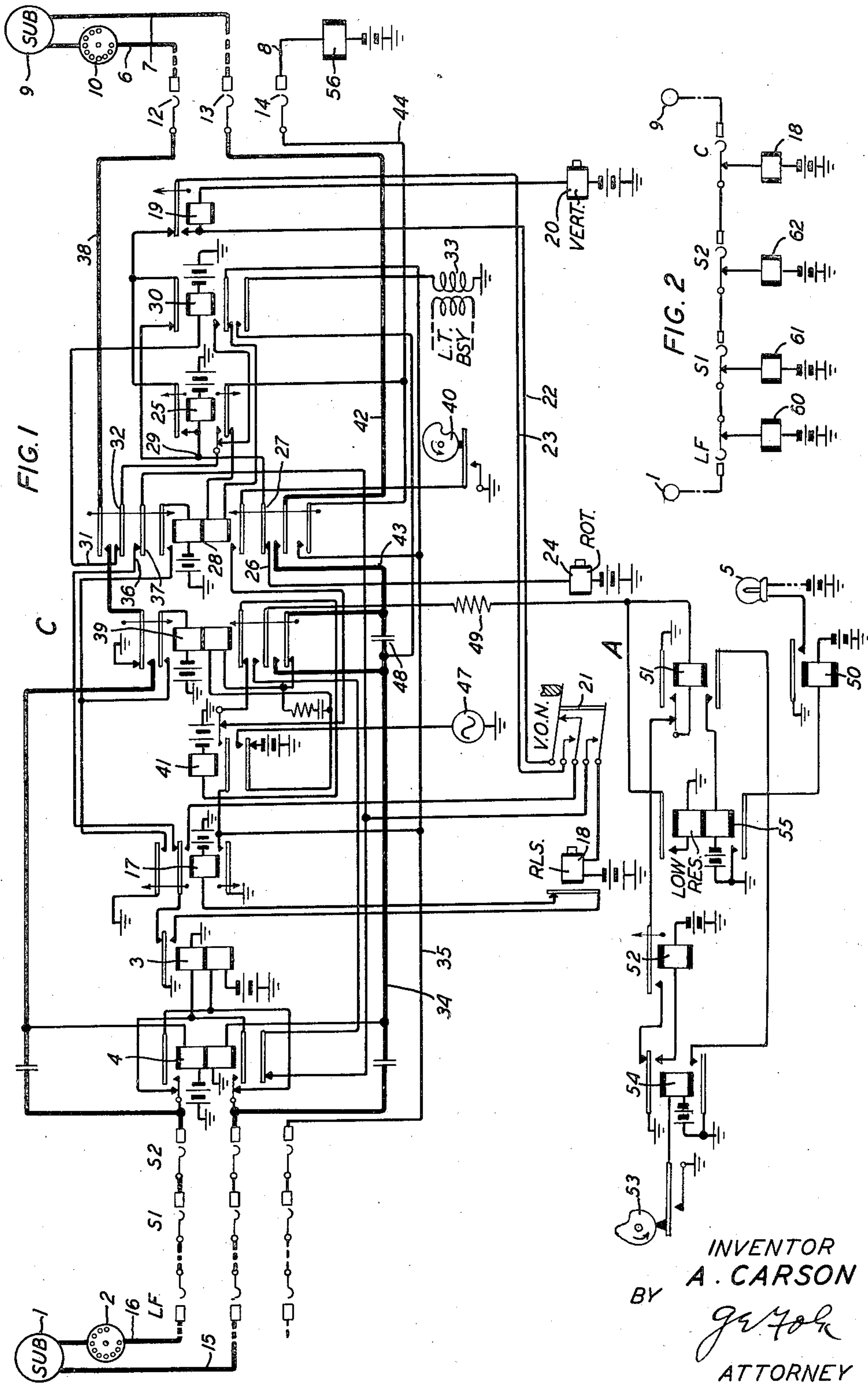
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TELEPHONE SYSTEM

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TELEPHONE SYSTEM

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This invention relates to telephone systems and particularly to those in which conversational connections are established by automatic switches.

The objects are to simplify and improve the releasing operations of established connections; to prevent the release of one connection from interfering with other established connections; and otherwise to improve such systems.

Systems have been devised heretofore in which the immediate release of all switches of the connection takes place when the calling subscriber replaces his receiver, and in which release of the final or connector switch is effected at the end of a measured interval following the replacement of the called subscriber's receiver, provided the calling party is slow in hanging up his receiver.

A feature of the present invention is an improvement in these prior systems which consists in arranging a timing mechanism in common to a number of connector switches such that when the mechanism has measured a definite interval following the replacement of the called subscriber's receiver a circuit including a resistance is closed through the winding of the release magnet of the connector involved. This circuit energizes the magnet sufficiently to open the circuit of the holding relay without, however, releasing the connector switch. The holding relay removes ground from the release conductor, and all switches preceding the connector restore to normal. This releases the pulse relay of the connector, thereby closing the release circuit in which the release magnet is fully operated to restore the connector to normal. In this way it is assured that the battery connections to the brushes of the connector are opened before the connector releases, thus preventing the application of potential by these brushes to the multiple terminals of lines engaged in conversation as such brushes wipe over these terminals on their way to the normal position.

The foregoing and other features of the invention will be described more fully in the following detailed specification, which should be taken in conjunction with the accompanying drawing, and also in the appended claims.

In the accompanying drawing Figure 1 shows a connector circuit C arranged to effect the timed release of itself and all switches preceding it. At the left of the drawing are shown abbreviated diagrammatic representations of a subscriber's telephone 1 and dial 2, a line finder LF, and first and second selectors S1 and S2, all of the usual type found in step-by-step offices. There is also

shown a timing and alarm circuit A, common to a number of connectors, the function of which is to effect the release of a connector C and the preceding switches of the established connection and to cause the lighting of a signal lamp 5, when said release, by reason of some trouble condition, is delayed beyond a certain predetermined interval. At the right of the drawing are shown connector terminals associated with conductors 6, 7, and 8 of the line of substation 9 with which is also associated a dial 10.

Fig. 2 is a diagram of a train of switches showing the release magnets for restoring these switches to normal.

The finder LF and selectors S1 and S2 may be of any suitable type, such as the Strowger switch, the operation and release of which are controlled by circuits well known in the art.

A detailed description of the operation of the invention will now be given. Let it be assumed that the subscriber at substation 1 desires to establish a connection with the station 9, and that the connection has been extended in the usual manner through line finder LF and selectors S1 and S2 to the tip, ring and sleeve terminals of connector C. When the connector is seized by the selector S2, a circuit is closed through the windings of relay 3 which may be traced from battery through the lower winding of relay 3, lower inner normally closed contacts of relay 4, ring contacts of selectors S1, S2 and line finder LF, thence over line conductor 15, through subscriber's telephone 1 and dial 2, over conductor 16 and through tip conductors of line finder LF and selectors S1 and S2, upper normally closed contacts of relay 4 and upper winding of relay 3 to ground. Relay 3 operates and operates relay 17 through a circuit traceable from battery through the winding of relay 17, break contacts of release magnet 18 to ground on the operated contacts of relay 3. Relay 17 in operating connects ground on its lower contacts to the sleeve contacts of selectors S1 and S2 and line finder LF and thereby holds operated the switches of said selectors and line finder and guards connector C from seizure by other selector circuits.

On the first break of the contacts of dial 2 to dial the tens digits of the called number, relay 3 releases and closes a circuit from battery through the windings of vertical magnet 20 and relay 19, upper normally closed contacts of the vertical-off-normal contact assembly 21, upper inner operated front contacts of relay 17 to ground on the back contacts of relay 3. Relay 17 is slow to release and does not release during the mo-

mentary open periods of the front contacts of relay 3, while responding to dial 2. Relay 19 and vertical magnet 20 are operated through the circuit hereinbefore traced. As soon as the shaft of the connector switch is moved from its normal position on the first vertical step, the vertical-off-normal springs 21 operate and transfer the operating circuit for relay 19 and vertical magnet 20 from conductor 22 to conductor 23, thereby placing the windings of relay 19 and vertical magnet 20 in series with the operated make contacts of relay 19. This transfer from conductor 22 to conductor 23 is made without interrupting the circuit, since the three upper springs of combination 21 are of the make-before-break type. After the contacts of dial 2 are closed again after the first break, relay 3 reoperates and again closes the circuit through the winding of relay 17 before this relay can release, as hereinbefore explained. On the next open period of dial 2 relay 3 again releases and transmits a second ground pulse through the circuit of relay 19 and vertical magnet 20. Relay 19 is slow to release and remains locked up over the open period of the back contacts of relay 3. The second ground pulse causes the shaft of the switch to take another step upward. This action continues until all required pulses for the tens digits are transmitted by dial 2 and brushes 12, 13 and 14 have reached the level of the terminals of the line being called. After the tens impulses have been dialed, dial 2 is restored to normal, relay 3 remains operated, relay 19 releases, and the winding of vertical magnet 20 is deenergized. When relay 19 releases, a circuit is closed through rotary magnet 24 and relay 25 for rotary stepping. This circuit may be traced from battery through the winding of rotary magnet 24, normally closed springs 26 and 27 of relay 28 to junction point 29, from battery through the winding of relay 25 to said junction point 29, thence through the upper normally closed contacts of relay 30, back contacts of relay 19, over conductor 23, through upper, operated contacts of combination 21 to the upper, inner front contacts of relay 17. On the first break of dial 2 for dialing the units digit of the called number, i. e., for rotary stepping, relay 3 releases and transmits a ground pulse through the upper inner operated front contacts of relay 17 and the rotary stepping circuit just traced. Relay 17 remains operated during dial pulses as in the case of vertical stepping. In response to the first ground impulse rotary magnet 24 operates and causes the switch to rotate one step in the horizontal direction and relay 25 to operate and short-circuit the upper contacts of relay 30, which were included in the original operating circuit. Subsequent pulses cause rotary magnet 24 to move the switch around until the line of the called subscriber 9 is reached.

Before connecting ringing current to the called line, a test is made to determine whether the line is busy or idle. If busy, ground will be found on the sleeve terminal and will cause the operation of test relay 30 through a circuit from battery through its winding, upper normally closed contacts 31 and 32 of relay 28, lower operated make contacts of relay 25 conductor 44, to ground on conductor 8 through brush 14. Relay 30 in operating opens through its upper break contacts the pulsing circuit for rotary magnet 24, thereby stopping further rotary stepping, and connects through its lower outer make contacts the secondary winding of busy tone transformer 33 to

ring conductor 34. The source of busy tone potential connected to the primary winding of transformer 33 is interrupted by the usual busy back interrupter (not shown). The operation of relay 30 just described was through a circuit including the lower operated make contacts of relay 25, which being slow to release held up after the final digits pulse until said relay 30 operated. When relay 25 finally releases, relay 30 is locked up through a circuit, from battery through the winding of relay 30, contacts 31 and 32 of relay 28, lower inner back contacts of relay 25, lower inner operated make contacts of relay 30 to ground on sleeve conductor 35. The calling subscriber at station 1 hearing the busy tone connected as before described will disconnect, causing the release of relays 3 and 17, and thereby closing a circuit from battery through the winding of release magnet 18, lower operated contacts of VON combination 21, normally closed contacts 36 and 37 of relay 28, and back contacts of relays 17 and 3 to ground. Release magnet 18 is energized and causes the restoration of the connector switch including VON combination 21 to normal. Relay 30, which was locked to ground on sleeve conductor 35, releases since ground was removed by the opening of the lower make contacts of relay 17 when this relay released. The removal of ground from conductor 35 causes in a well known manner the operation of release magnets 60, 61 and 62 of the preceding switches and the consequent restoration of these switches.

Let it be assumed now that the line 9 of the called subscriber is found idle. Under this condition battery will be found by sleeve brush 14 on the terminal connected to sleeve conductor 8, to which battery is connected through the winding of cut-off relay 56. Therefore relay 30 will not operate as hereinbefore described when the line 9 was found busy since now a battery potential is connected to both winding terminals of relay 30. After relay 25 has released upon the completion of rotary stepping, a circuit is closed for the operation of relay 28 which may be traced from the aforesaid battery connection on brush 14, through lower outer normally closed contacts of relay 25, lower winding of relay 28, lower normally closed contacts of relay 30 to ground on sleeve conductor 35. Relay 28 in operating locks through its upper winding and upper inner make contacts to ground on the upper outer operated make contacts of relay 17. In operating relay 28 also connects tip conductor 33 through its upper outer contacts to ground on the upper back contacts of relay 39; disconnects the winding of relay 30 by opening its contacts 31 and 32; connects ground from pick-up interrupter 40 through its lower inner make contacts, inner normally closed contacts of relay 41, lower inner normally closed contacts of relay 39 to battery through the winding of relay 41. Relay 41 operates and locks through its inner make contacts to ground on the lower operated contacts of relay 17. Relay 28 in operating also disconnects the winding of rotary magnet 24 through its contacts 26 and 27; connects ring conductor 42 to conductor 43 through the contacts of springs connected thereto and joins sleeve conductor 35 to sleeve conductor 44, with its lower, outer operated contacts, thereby grounding conductor 44, operating cut-off relay 56 and guarding the terminals of the line 9 from seizure by another connector.

When relay 41 operated it closed a circuit for ringing station 9. This circuit is traced from

the source 47, which may comprise an alternating current generator connected in series with a direct current source, through lower operated make contacts of relay 41, lower winding of relay 39, lower outer normally closed contacts of relay 39, over conductor 43, associated operated contacts of relay 28, over conductor 42, through connector brush 13 and associated contacts, over subscriber's line 9, connector brush 12 and associated contacts, conductor 38, upper outer operated contacts of relay 28 to ground on the upper outer back contacts of relay 39. The ringer (not shown) of station 9 is now actuated, but relay 39 does not operate on the ringing current through its lower winding until the called subscriber answers by removing his receiver from the switchhook, thereby connecting a low impedance bridge across the line. Ringing tone is sent back to the calling subscriber through condenser 48. Relay 39 is adjusted so that, when operating, a locking circuit is closed from battery through its upper winding and upper inner make contacts to ground on the upper outer operated contacts of relay 17, before the circuit through its lower winding is broken, at either its upper or lower outer break contacts. If the called subscriber should remove his receiver from the switchhook before relay 41 operates in response to the operation of pick-up interrupter 40, then relay 39 operates from battery on the lower back contacts of relay 41. The operation of relay 39 accordingly either disconnects ringing current or the aforesaid battery on the lower contacts of relay 41. Relay 39 in operating opens the circuit through the winding of relay 41 which releases and also completes the conversational circuit between the calling and called subscriber by closing through the tip conductors on its upper outer make contacts and the ring conductors on its lower outer make contacts. Relay 39 in operating also completes the operating circuit for relay 4 which may be traced from battery through the upper winding of relay 4, over tip conductors of connector C and the line of station 9, through station 9 including dial 10, over ring conductors of the line and of connector C to ground through the lower winding of relay 4. Relay 4 in operating reverses the direction of current over the line of calling station 1, thereby causing the operation of an associated line message register (not shown) in the well-known manner. After the aforesaid reversal, battery through the lower winding of relay 3 is connected by the upper operated make contacts of relay 4 to the tip conductor and ground through the upper winding of relay 4 by the lower make contacts of relay 4 to the ring conductor.

At the end of the conversation when the calling subscriber disconnects, relays 3 and 17 release which removes ground from the upper locking winding of relays 39 and 28 which release. The release of relay 28 closes a circuit for release magnet 18 which may be traced from battery through the winding of magnet 18, lower make contacts of VON combination 21, contacts 36 and 37 of relay 28, to ground through the upper back contacts of relays 17 and 3. The operation of release magnet 18 restores the connector switch to normal in the well-known manner. Also the removal of ground from conductor 35 causes the immediate release of the preceding switches LF, S1, and S2.

A description will now be given of the operation whereby, after the conversation is completed, the called subscriber by hanging up his receiver

effects a timed release of the connector C and all the other switches of the connection, assuming that the calling subscriber 1 fails to disconnect promptly. When called subscriber at station 9 disconnects, relay 4 releases, restoring the original direction of current flow, but relays 3 and 17 remain operated and also relays 28 and 39. A circuit is now closed from battery through the winding of release magnet 18, lower operated contacts of VON, combination 21, lower outer break contacts of relay 4, lower middle operated contacts of relay 39, resistance 49, winding and normally closed contacts of relay 51, to the armature of relay 52. An interrupter 53 is arranged to connect ground to the winding of relay 54 for two minutes and then to disconnect said ground for two minutes. Relay 54 operates through an obvious circuit in response to the closing of said interrupter contacts and operates relay 52 through an obvious circuit. On the next opening of the interrupter contacts relay 54 releases immediately, but relay 52 being slow to release holds up momentarily and a circuit is closed for operating relay 51 which is traced from ground on the back contacts of relay 54 through operated contacts of relay 52 and thence through the hereinbefore traced circuit to battery on the winding of release magnet 18. Relay 51 locks to ground on its upper make contacts but release magnet 18 does not receive sufficient current in this circuit to open its contacts. On the next closure of interrupter 53 relay 54 reoperates and closes a circuit for operating relay 55 through its lower winding, which circuit may be traced from ground on the lower contacts of relay 54 through lower operated contacts of relay 51, and lower winding of relay 55 to battery. Relay 55 now operates and locks through its low resistance upper winding to the release magnet circuit hereinbefore traced. The low resistance shunt due to the upper winding of relay 55 releases relay 51. The low resistance ground applied by the upper winding of relay 55 now causes release magnet 18 to energize sufficiently to open its contacts thereby releasing relay 17. Magnet 18, however, does not receive sufficient current in this circuit, which includes resistance 49, to cause the release of the connector C. The release of relay 17 removes ground on its lower contacts from sleeve conductor 35, which causes the release of the preceding switches and the release of relay 3. Relay 17 in releasing also causes the release of relays 39 and 28 by removing the holding ground from the upper windings of these relays. When relays 3 and 28 release, a circuit is closed for fully operating release magnet 18 which may be traced from battery through the winding of release magnet 18, lower operating contacts of VON combination 21, contacts 36 and 37 of relay 28, and upper back contacts of relays 17 and 3 to ground. The connector switch including the VON spring combination 21 and all associated apparatus are now restored to normal.

When the circuit through release magnet 18 is opened relay 55 is unlocked and releases. If, however, due to some trouble condition the connector fails to release as herein described, provision is made for indicating the presence of this condition. When relay 55 operated, it also operated relay 50 through an obvious circuit. Relay 50 in operating closes a circuit to battery through lamp 5 and a pick-up circuit indicated by dotted lines but not shown, which is arranged so that if relay 50 remains operated for a certain pre-

determined interval, lamp 5 is lighted and remains lighted until the trouble condition is removed, when relays 55 and 50 release.

What is claimed is:

5 1. In a telephone system, automatic switches, means for setting up a connection involving a plurality of said switches in series, timing mechanism, release means for a particular one of said switches, means controlled by the called
10 party for rendering said mechanism effective to prepare a circuit for the partial operation of said release means, means responsive to such partial operation for releasing certain of said switches, and means for fully operating said re-
15 lease means to cause the release of said particular switch.

2. In a telephone system, automatic switches, means for establishing a connection over a plurality of said switches in series, mechanism for
20 measuring a predetermined interval of time, release means for a particular one of said switches, means responsive to the disconnection of the called party for connecting said timing mechanism with said particular switch, means controlled by the timing mechanism at the end of
25 the predetermined interval for causing the partial operation of said release means, means responsive to such partial operation for releasing certain of said switches, and means for fully
30 operating said release means to effect the release of said particular switch.

3. In a telephone system, automatic switches, means for establishing a connection involving a plurality of said switches in series, timing mechanism, release means for a particular one of said
35 switches, means controlled by the calling subscriber for effecting the immediate release of all of said switches, means controlled by the called party for rendering said timing mechanism effective to prepare a circuit for the partial
40 operation of said release means, means controlled by said release means for causing the release of all switches in the series except said particular switch, and means for fully operating said re-
45 lease means to cause the release of said particular switch.

4. In a telephone system, a calling line and a called line, automatic switches, means for setting
50 up a connection involving a plurality of said switches in series, release means for each of said switches in the series, means effective when the calling subscriber is the first to disconnect for immediately operating all of said release means to restore all switches in the series to normal,
55 timing mechanism rendered effective if the called subscriber is the first to disconnect for partially

operating the release means of a particular one of said switches after a predetermined interval has expired following the act of disconnection by the called subscriber, means responsive to the partial operation of said release means for causing
5 the restoration of all switches in the series except said particular switch, and means for causing the restoration of said particular switch.

5. In a telephone system, automatic switches including selectors and connectors, timing mechanism common to said connectors, means for establishing a connection involving a plurality of
10 selectors and any particular one of said connectors in series, said connector having a release magnet and a holding relay, means controlled by
15 the called party for rendering said timing mechanism effective to close a high-resistance circuit for said release magnet at the end of a predetermined interval of time, said release magnet partially operating in said circuit to cause the re-
20 lease of said holding relay, means responsive to the release of said holding relay for causing the restoration of the operated selector switches in said series, and means for closing a low resistance circuit for said release magnet to cause the res-
25 toration of said connector switch.

6. In a telephone system, an established connection including a series of automatic switches, release means for each of said switches, means controlled by the calling party for causing the
30 operation of said release means to effect the immediate restoration of all of the switches in said series, means controlled by the called party for causing the partial operation of the release means of a particular one of said switches, means re-
35 sponsive to such partial operation for causing the release of all switches in the series except said particular switch, and means for fully operating the release means of said particular switch to cause the restoration of such switch.
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7. In a telephone system, a first switch and a second switch, a pulse relay, a hold relay, and a release magnet for said second switch, means for operating said switches in series to establish a
45 connection, means for energizing said release magnet partially to cause the release of said hold relay without releasing said second switch, circuit means controlled by said hold relay for causing the release of said first switch, circuit means controlled by the release of said first switch for
50 releasing said pulse relay, and circuit means controlled by said pulse relay for fully energizing said release magnet to cause the release of said second switch.

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