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TELEPHONE EXCHANGE SYSTEM

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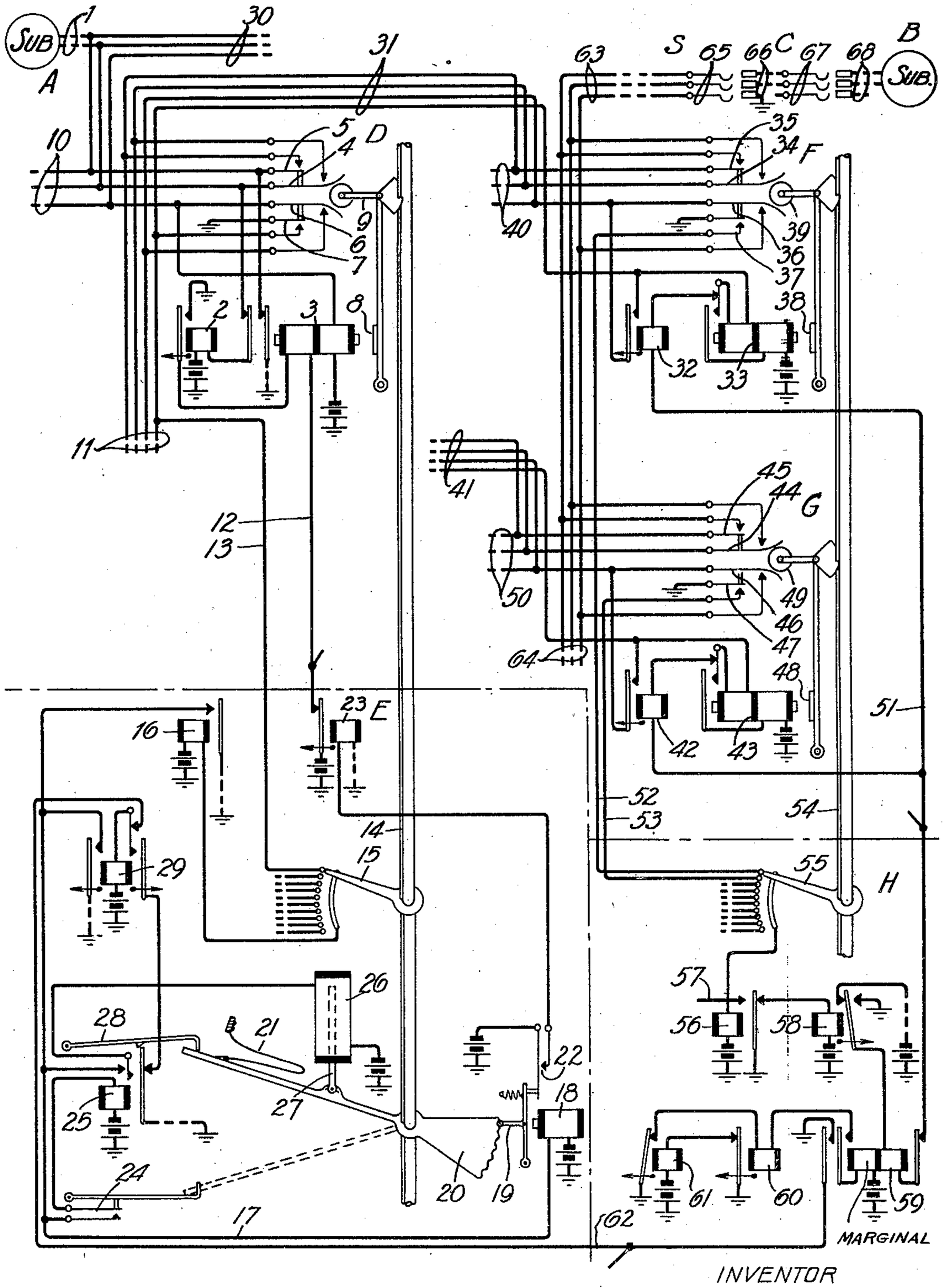

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TELEPHONE-EXCHANGE SYSTEM

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This invention relates to telephone systems, and more particularly to automatic systems in which line-switches are employed.

The object of this invention is to improve the quality of telephone service by reducing the frequency with which double connections occur in systems of the character above mentioned.

According to one feature of this invention, a marginal relay is inserted in a lead which connects battery to the plunger magnets of each switch in a group of secondary line-switches. The arrangement is such that if the circuit branch through more than one plunger magnet is established at any given instant, the common marginal relay will operate and open the lead which connects to battery. The marginal relay is quick-acting while the plunger magnets are sluggish, so that under the conditions assumed the marginal relay prevents the plunger magnets from operating.

According to another feature of the invention, the operation of a marginal relay, which is inserted in the lead which connects battery to the plunger magnets of each switch in a group of secondary switches, not only prevents the simultaneous plunging of two or more secondary line-switches, but also prevents the immediate recurrence of such a condition after the release of the primary line-switches by causing a re-distribution of all idle primary line-switches with respect to the secondary line-switches.

The drawing illustrates a portion of an automatic telephone system in which this invention has been embodied. Referring to the drawing, A represents diagrammatically a calling subscriber's station, B represents a called subscriber's station, D represents a primary line-switch, E a primary master-switch, F and G represent secondary line-switches. H represents a secondary master-switch, S represents a selector switch and C represents a connector switch.

The calling subscriber's station A is shown connected over the line 1 to the springs 4 and 5, of the primary line-switch D, through which the line may be connected to the trunk 31. The line-switch D, which is individual to the line 1, is one of a group of primary line-switches, all of which are associated with the primary master-switch E. The primary line-switch D is of the well-known Keith type and may be similar to that described on pages 47, 48 and 49 of the second edition of "Automatic Telephony" by Smith and Campbell. The master-switch E is similar to that illustrated in Figure 46 on page 48 and described on pages 49 and 50 but modified, for use when both primary and secondary line-switches are furnished, as illustrated in Figure 78 on page 85 and as described on pages 87 and 88 of the second edition of Smith and Campbell. The trunk 31, which is multipled over leads 11 to other primary line-switches in the group with switch D, is one of a group of trunks to which all of these primary line-switches have access. The line 1 is multiplied over leads 10 to other springs (similar to springs 4 and 5) through which the line 1 may be connected to the other trunks in the same group with trunk 31. The line 1 is also multipled over leads 30 to the banks of connector switches through which calls are completed when the station A is the called station.

The trunks to which the primary line-switches have access terminate at, and are each connected to, secondary line-switches such as F and G. The trunk 31 is shown connected to springs 34 and 35, of the secondary switch F, through which a connection may be extended to trunk 63. The switch F, which is individual to the trunk 31, is one of a group of secondary line-switches, all of which are associated with the secondary master-switch H. The secondary switch G is one of the switches in this group. The trunk 63, which is multipled over leads 64 to the other secondary switches in the group with switches F and G, is one of a group of trunks to which all of the secondary switches in the group associated with the master-switch H have access. The secondary line-switches F and G and the secondary master-switch H are of the type illustrated in Figure 78 on page 85 and described on pages 83 to 89, inclusive, of the second edition of "Automatic Telephony" by Smith and Campbell. The trunk 31 is multipled over leads 40 to other springs

(similar to springs 34 and 35) of the switch F, through which the trunk 31 may be connected to the other trunks in the group with trunk 63. The trunking scheme between the primary and secondary line-switches is similar to that illustrated in Figure 17 on page 17 and described on pages 16 and 18 of the second edition of "Automatic Telephony" by Smith and Campbell. Accordingly, the leads 41, which are individual to the secondary switch G, represent one of a group of trunks which are accessible to the line-switches in a primary group other than the one with which the master-switch E is associated. This trunk, which is shown connected to springs 44 and 45 of the secondary switch G, is multipled over leads 50 to other springs, of switch G, through which it may be connected to any other of the trunks in the same group with trunk 63.

The trunks, to which the secondary line-switches have access, terminate at, and are connected to, selector switches used in further extending connections from calling lines; each trunk is individual to the selector switch to which it is connected. The trunk 63 is shown connected to a selector switch S, which is diagrammatically represented by the brushes 65 and the broken lines connecting thereto. The selector S has access, under control of a calling device at the calling station, to trunks one of which is shown as terminating at the connector switch C. The connector C, which is diagrammatically represented by the brushes 67 and the broken lines connecting thereto, has access, under control of the calling device at the calling station, to subscribers' lines, one of which, line 68, is shown as terminating at the called station B. The selector switch S is of the type illustrated in Figure 62 on page 62 and Figure 63 on page 63 and described on pages 62 to 65, inclusive of the second edition of "Automatic Telephony" by Smith and Campbell. The connector switch C is of the type illustrated in Figure 60 on page 59 and described on pages 57 to 61, inclusive, of Smith and Campbell.

The operation of a system in which this invention is embodied, as shown in the drawing, will now be described in detail. The primary and secondary master switches E and H are not shown in their entirety, the parts shown being limited to those which are involved in the disclosure of the invention. Assume that the shaft 14 of the master-switch E is in such a position that the line-switch plungers, such as 9, which are engaged by said shaft are opposite the springs of trunk 31. When the receiver is removed from the receiver hook at station A to originate a call, an obvious circuit is closed over line 1 to operate the line relay 2. In operating, relay 2 closes a circuit from battery through the back contact of relay 23, over the "open-main" battery lead 12, and through the left-hand (pull-down) winding of line-switch magnet 3, to ground at the front contact of relay 2. The energization of the left-hand winding of magnet 3 attracts both armatures of the line-switch, thereby disconnecting the winding of the line relay 2 from the line and forcing the plunger 9 out of engagement with the shaft 14 into the bank between springs 4 and 6, so as to connect the line 1 to the tip and ring leads of the trunk 31. The movement of the plunger 9 connects ground through spring 7 to the holding lead 13 of the trunk 31 and connects the right-hand (bridge cut-off) winding of the line-switch magnet 3 through spring 6 to the sleeve (release) lead of the trunk 31.

As soon as ground is connected to the holding lead 13 the starting relay 16 is energized in a circuit which includes the brush 15 and the terminal to which the holding lead 13 is connected. Starting relay 16 closes an obvious circuit in which the winding of lock-magnet 18 is energized. The lock-magnet 18 pulls the locking lever 19 out of engagement with the notched sector of the arm 20, and closes a circuit through spring 22 and its associated front contact to operate open-main relay 23. Relay 23 disconnects battery from the open-main battery lead 12 so that none of the primary switches, in the group with which master-switch E is associated, can be operated during the time that the master-switch shaft is being moved. The lock-magnet having operated, spring 21 is effective to rotate the shaft 14, the brush 15 and all line-switch plungers which are engaged by the shaft 14 into a position opposite the next trunk in the group. If this trunk is idle there is no ground on the corresponding terminal, with which brush 15 is now in contact, and relay 16 releases. The release of relay 16 causes the release of lock-magnet 18 so that the lock-lever 19 engages a notch in the sector of the arm 20 to hold the line-switch plungers, which are engaged by the shaft 14, opposite the springs of this idle trunk. If this trunk were busy, the starting relay 16 and lock-magnet 18 would be held operated and the shaft would continue to rotate until the brush 15 made contact with the terminal of an idle trunk. When the shaft 14 reaches the position corresponding to the last trunk, the arm 20 closes the contacts 24. If this last trunk is busy, relay 16 and magnet 18 do not release and trip relay 25 is operated. Relay 25, which is locked in its operated position by the latch 28, connects ground to lead 17 to hold the lock-magnet 18 operated and closes an obvious circuit for energizing the solenoid 26. The solenoid draws in its plunger 27 thereby forcing the arm 20 and shaft 14 back to the position in which the engaged line-switch plungers are opposite the first trunk, trunk 31. While moving back

to this position the shaft 14 picks up (re-engages) all disengaged plungers which have been released by the restoration of the receiver to the receiver hook at the associated calling station. When the arm 20 reaches the position corresponding to trunk 31, the latch 28 is moved to release the armature of trip relay 25. The release of the armature of trip relay 25 releases lock-magnet 18 unless starting relay 16 is held operated by a ground on the holding lead 13 of trunk 31.

Lead 62, which connects the winding of relay 29 in the primary master-switch E to the secondary master-switch H is multipled to all other primary master-switches which are associated with primary line-switches having access to trunks terminating at secondary line-switches in the group with which the master-switch H is associated. Whenever all of the trunks to which a secondary line-switch has access are busy (for instance, whenever all of the trunks to which the switches F and G have access), the associated master-switch is effective to connect ground to lead 62, and thereby operate relay 29 of master-switch E and the corresponding relay in all of the master-switches to which lead 62 is multipled. Each of these master-switches then functions to pick up all disengaged line-switch plungers and to set them opposite the first idle trunk in each of the groups to which the groups of line-switches have access. The trunking scheme being as hereinbefore described, this pick-up action of the primary master-switches results, as far as possible, in the preselection of trunks to different secondary groups in which one or more of the trunks to which the secondary line-switches have access are idle. In master-switch E, the grounding of lead 62 operates relay 29. Relay 29 connects ground to lead 17 to operate trip magnet 18, and closes a locking circuit to ground through the back contact of relay 25. The operation of trip magnet 18 releases the arm 20 which swings to its end position in which spring 24 is actuated to operate relay 25. Relay 25 locks and the operation of solenoid 26 swings the shaft 14 back to the position opposite the first trunk. Relay 29 releases when relay 25 operates. Further operation of the master-switch E is similar to that described in the preceding paragraph.

When the plunger 9 moved into the bank between the springs 4 and 6, as hereinbefore described, a circuit was closed from battery through the front contact of relay 58 in the secondary master-switch H, through the right-hand winding of relay 59, armature and back contact of relay 59, open-main battery lead 51, winding of line relay 32 of the secondary line-switch F, normally closed contacts and left-hand (pull-down) winding of the line-switch magnet 33, over the holding lead 13 of trunk 31, to the ground on spring 7 of the line-switch D. Lead 51 is multipled, as shown, to the winding of relay 42 of secondary line-switch G and to the windings of similar relays in each of the other switches in the group with switches F and G. Relay 32 and line-switch magnet 33 operate, in the circuit to ground over the holding lead of trunk 31, but relay 59 is marginal and does not operate unless ground is simultaneously connected by the operation of primary line-switches to the holding leads of two or more trunks which terminate at secondary line switches in the group with which the open-main battery lead 51 is associated. Such a condition will be considered later in this description.

When relay 32 of secondary switch F operates, a circuit is closed from battery through the right-hand winding of the magnet 3 of line-switch D, spring 6 and associated front contact, over the release (sleeve) lead of trunk 31, front contact of relay 32, and over the holding lead of trunk 31, to ground on spring 7 of line-switch D. The energization of the right-hand (bridge cut-off) winding of magnet 3 in this circuit is sufficient to hold the armature 8 in its operated position although not sufficient to attract this armature from its normal position; the left-hand (bridge cut-off) armatures of magnet 3 are also held in their operated position. Line relay 2 of switch D is slow to release so that the line-switch magnet 3 is held energized by relay 2, after relay 2 is disconnected from the line 1 as hereinbefore described, long enough for the circuit through the right-hand winding of magnet 3 to have been established by the operation of relay 32. The ground which was connected to the release lead of trunk 31, as hereinbefore described, to energize the right-hand winding of the magnet 3, is also effective as a busy potential to prevent seizure of the line 1 by any of the connectors to whose banks the line is multipled.

Assume that the shaft 54 of the secondary master-switch H is in the position in which the engaged secondary switch plungers, including the plunger of switch F, are opposite the springs of trunk 63. The energization of the left-hand winding of magnet 33, as hereinbefore described, is effective to attract the right-hand (pull-down) armature 38 and thus thrust the plunger 39 into the bank between springs 34 and 36; the tip, ring and release leads of trunk 31 are thereby extended through springs 34, 35 and 36 of secondary switch F to the tip, ring and release leads of trunk 63. The energization of magnet 33 is also effective to attract its left-hand armature, thereby disconnecting the branch from the open-main battery lead 51 through the winding of relay 32 from the holding lead of trunk 31, and closing a locking circuit from battery through the right-hand winding of magnet 33, armature and front

contact of magnet 33, left-hand winding of magnet 33, over the holding lead of trunk 31, to ground at spring 7 of primary switch D.

The movement of plunger 39 of secondary line-switch F, as hereinbefore described, also closes a circuit from ground through spring 37 and the associated front contact of switch F, through lead 52 and the terminal to which it connects, brush 55 of the master-switch H, and through the winding of starting relay 56 to battery. Relay 56 operates in this circuit connecting ground over lead 57 to the lock magnet (not shown) of master-switch H. The shaft of master-switch H is thus released and moves to a position opposite the next trunk, in a similar manner to that in which the shaft of master-switch E was moved when trunk 31 was seized by the primary line-switch D, as hereinbefore described. The operation of starting relay 56 also opens the circuit for the normally operated open-main relay 58. Relay 58 releases, thereby disconnecting battery from the open-main battery lead 51 so that none of the secondary switches, in the group with which master-switch H is associated, can be operated during the time that the shaft 54 is being moved.

When the connection from line 1, through switch D, and over trunk 31 was extended by the movement of the plunger 39, through the switch F, over trunk 63 to the selector S, the operation of the line and release relays (not shown) of selector S are effective to connect ground to the release lead of trunk 63 so as to hold the right-hand winding of magnet 3 of primary line-switch D energized and thus prevent release of the connection. Relay 32 is slow to release so that this winding of magnet 3 is held energized in the circuit over the holding lead of trunk 31 to ground on spring 7 of switch D until after the ground in selector S has been connected to the release lead of trunk 63.

The selector S is then controlled by the actuation of the calling device at the station A to select a group of trunks which terminate at connector switches which have access to the line 68 of the called station B. The selector S automatically selects an idle trunk, in the selected group, which is represented by the trunk 66 which terminates at the connector C. The release lead of trunk 63 is extended through the sleeve brush of selector S to the release lead of trunk 66. Ground is connected in the usual manner at the connector C to the release lead of trunk 66 to hold the magnet 3 of primary line-switch D energized, until the connection is released by replacing the receiver on the receiver hook at the calling station A. The ground at selector S is removed from the release lead as soon as sufficient time has elapsed for ground to have been connected to the release lead of trunk 66 by the connector C. The connector C is controlled by the actuation of the calling device at the station A to select the line 68 of the called station B. A busy potential is connected to the test terminal of line 68 to prevent the seizure of this line by other connectors. This line is tested and if found idle, a source of signalling current is connected to said line; and, when the called subscriber answers, the talking connection is established between stations A and B.

When the connection is released by replacing the receiver on the hook at the calling station A, the ground at connector C is disconnected from the release lead of trunk 66 thereby releasing magnet 3 of primary line-switch D. The consequent release of armature 8 withdraws the plunger 9, disconnecting the line 1 from the trunk 31; and the release of the left-hand armatures of magnet 3 connects the winding of line relay 2 to the line 1 in readiness for the origination of another call.

Now assume that the trunk 41 is seized by a primary line-switch having access thereto at the same time that trunk 31 is seized by the primary line-switch D. In this case the branch from open-main battery lead 51 through the winding of relay 32, left-hand winding of magnet 33, over the holding lead of trunk 31 to ground at spring 7 of switch D, is paralleled by the branch from lead 51 through the winding of relay 42, left-hand winding of magnet 43, over the holding lead of trunk 41 to ground at the corresponding spring of the primary line switch which has seized trunk 41. The closing of these two branches is effective to operate marginal relay 59 before the slower acting line-switch magnets 33 and 43 are operated. Relay 59 locks through its left-hand winding and front contact in series with the winding of relay 60 to ground at the front contact of relay 61. Relay 59 also opens the open-main battery lead 51 to prevent the operation of the magnets 33 and 43, and to release relays 32 and 42 if already operated; it also connects ground to "pick-up" lead 62 to cause a redistribution (as hereinbefore described) of the primary line-switches having access to trunks terminating at secondary line-switches in the group with switches F and G. With relays 32 and 42 in their normal position there is no circuit for energizing the right-hand winding magnet 3 of primary line-switch D, nor for energizing the corresponding winding of the magnet of the primary line-switch which seized trunk 41. As a result these primary switches are released and their disengaged plungers are re-engaged by the shafts of the associated master-switches and are positioned opposite trunks to different secondary groups. Relay 60, when energized in the circuit described for holding relay 59, releases the normally operated relay 61. The release of relay 61 releases relays 59 and 60. Relays 60 and 61 are slow to release to insure the re-

lease of the two or more primary line-switches which are involved in a double-connection before the release of relay 59 closes the open-main battery lead.

The arrangement shown in the drawing is therefore effective to prevent the simultaneous actuation of two or more secondary line-switches. It is also effective to prevent an immediate recurrence of the condition by redistributing the groups of antecedent switches with respect to the groups of trunks to which these antecedent groups have access.

What is claimed is:

1. In a telephone system, calling lines terminating in primary line-switches, secondary line-switches accessible to said primary line-switches, and means operative in the event a plurality of said secondary line-switches are simultaneously seized to prevent the operation of said plurality of secondary line-switches and to cause the release of those of said primary line-switches by which said plurality of secondary line-switches were seized.

2. In a telephone system, subscribers' lines, a group of automatic switches, means for seizing an idle one of said automatic switches in extending a connection from a calling to a called line, selector switches, each of said selector switches being accessible to a plurality of said automatic switches, and means effective upon the simultaneous seizure of plurality of said automatic switches for preventing the seizure of a selector switch by any of said plurality of automatic switches.

3. In a telephone system, a group of automatic switches, trunks accessible to the switches in said group, antecedent switches, other trunks accessible to said antecedent switches, each of said other trunks being permanently connected to a switch in said group, and means effective in the event that two or more of said other trunks are simultaneously seized for preventing the actuation of any of the automatic switches in said group to which said two or more other trunks are connected.

4. In a telephone system, groups of automatic switches, groups of trunks each trunk leading to an automatic switch in a different one of said groups of automatic switches, groups of antecedent switches each antecedent switch having access to one of said groups of trunks, other trunks accessible to said automatic switches, and means individual to each of said groups of automatic switches and effective upon the simultaneous seizure of a plurality of said automatic switches for preventing the seizure of a said other trunk by any of said plurality of automatic switches.

5. In a telephone system, groups of trunking switches, groups of trunk lines each trunk line leading to one of said trunking switches, selective switches each having access over the trunk lines in one of said groups of trunk lines to a plurality of said groups of trunking switches, calling lines each leading to one of said selective switches, and means effective in the event that a plurality of trunk lines leading to switches in one of said groups of trunking switches are simultaneously seized by selective switches to prevent the operation of the switches to which the said plurality of trunk lines lead and to cause the release of the selective switches by which said plurality of trunk lines were seized.

6. In a telephone system, calling lines terminating in automatic switches, secondary switches accessible to said automatic switches, means effective to prevent the simultaneous operation of a plurality of said secondary switches and to cause the release of those of said automatic switches by which said plurality of secondary switches were seized, and means effective to prevent the immediate recurrence of the seizure of said plurality of secondary switches by said automatic switches.

7. In a telephone system, calling lines terminating in primary line-switches, secondary line-switches accessible to said primary line-switches, plunger magnets one for each of said secondary line-switches, a marginal relay, a source of current, means for connecting said source through a winding of said marginal relay to said plunger magnets of a group of said secondary line-switches, and means including said marginal relay effective in the event a plurality of said secondary line-switches are simultaneously seized to prevent the operation of said plurality of secondary line-switches and to cause the release of those of said primary line-switches by which the said plurality of secondary line-switches were seized.

8. In a telephone system, groups of subscribers' lines each line terminating in an automatic switch, groups of trunks, groups of trunking switches, each of said automatic switches having access to the trunks in one of said groups of trunks, each of said trunks terminating in one of said trunking switches so as to give each of said groups of subscribers' lines access to a plurality of groups of said trunking switches, means individual to each of said groups of trunking switches for preventing the simultaneous operation of a plurality of switches in the associated group and for causing the release of those of said automatic switches by which said plurality of trunking switches were seized, and means effective to prevent the immediate recurrence of the simultaneous seizure of a plurality of secondary switches in any of said groups of secondary switches.

9. In a telephone system, subscribers' lines, a group of switches, trunks accessible to each of said switches, means for extending the lines of calling subscribers to idle switches in said group, a relay and a mag-

net for each of said switches for operating the same to further extend a calling line to an idle one of said trunks, a battery, a conductor for connecting said battery to the windings of said relays, and a control relay having a winding in series with said conductor for preventing the operation of any of said magnets in the event that a plurality of said switches are simultaneously seized.

In testimony whereof, I have signed my name to this specification this 31st day of May, 1929.

GEORGE H. MORENCY.