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TELEPHONE SYSTEM

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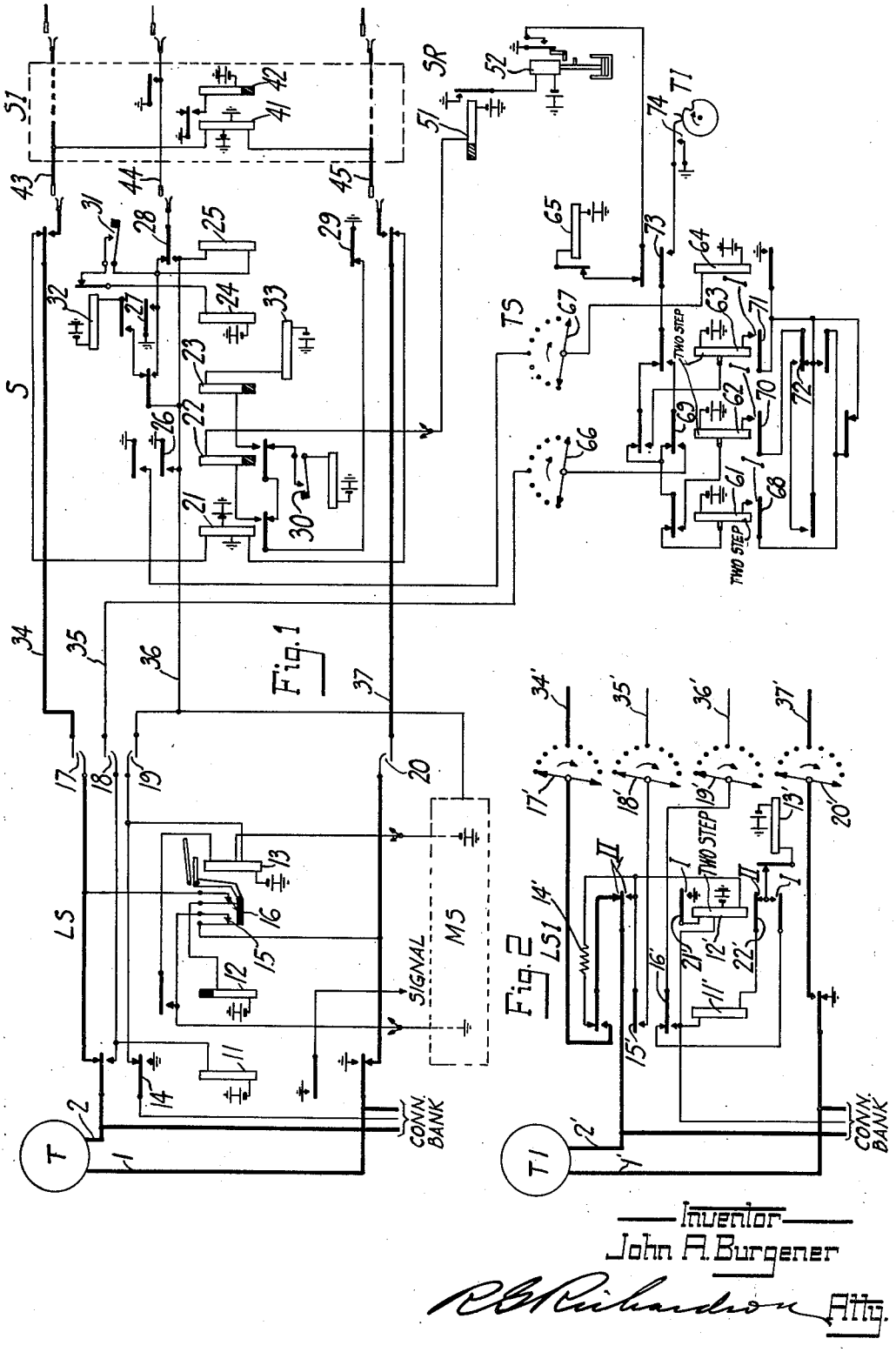


Fig. 1

Fig. 2

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TELEPHONE SYSTEM

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This invention relates to telephone systems in general, particularly to telephone systems employing common switching apparatus and is concerned primarily with arrangements for dealing with defective lines in such systems.

Common switching apparatus is employed in the majority of modern telephone systems. In automatic and semi-automatic systems this apparatus comprises directively operable switches and in manual systems, particularly those arranged for automatic traffic distribution, the apparatus will include various answering and completing circuits. The common apparatus is ordinarily made accessible to the subscribers' lines and trunk lines by means of non-numerical switching devices which serve to automatically connect a calling line with an available unit of the apparatus. Switching devices of two general types are in common use for this purpose; namely, lineswitches which are associated individually with lines and connect with idle switching apparatus, and finder switches which are associated with switching units and connect with calling lines.

Telephone lines such as those above-referred to are subject to certain unstandard conditions which effect the exchange switching apparatus. These conditions may result from faults occurring on the lines themselves or from the accidental removal of a substation receiver from the switchhook. When such a condition exists on a line, the associated non-numerical switch will operate to connect the line with a common apparatus unit. The particular apparatus unit involved will, of course, be withheld from regular use until the defective line is disconnected therefrom. Holding the apparatus in this manner decreases the efficiency of the exchange and, unless corrected promptly, may seriously interfere with the exchange service.

The common method of dealing with this condition is to provide alarm signals for the various apparatus units subject to being held out of service by defective lines. The signals enable the exchange attendant to readily locate apparatus being held in this manner so that steps can be taken to disconnect the defective lines. In order that this procedure may be effective it is necessary that the attendant inspect the signals frequently which is usually impractical for economic reasons. Furthermore, lines that have been disconnected will remain out of service, even though the defective condition is removed, until such time as the attendant can make the necessary tests and reconnect the line. This method is even more unsatisfactory in unattended exchanges for obvious reasons and since such exchanges are usually relatively small, the possibility of service interference from defective line is disproportionally large.

The present invention is designed to deal with the above discussed conditions in a reliable and efficient manner. One of the features of the invention is the arrangement whereby defective lines are automatically disconnected from the exchange apparatus after a predetermined time. Another feature is the arrangement for maintaining such lines disconnected until the defective condition is removed whereupon the cleared lines are immediately restored to service. Both of these functions are performed quickly and surely without the intervention of an attendant. A further feature is the provision of a simple and relatively inexpensive common timing device for controlling the disconnecting apparatus. An incidental feature is the arrangement whereby the line relay of a well known type of lineswitch is adapted to perform additional duties.

The foregoing paragraphs indicate the scope of the invention which is disclosed in one of its narrower phases in the accompanying drawing. This drawing comprises Figs. 1 and 2, shows by means of the usual conventional circuit diagrams the manner of employing the invention in connection with subscribers' lines in an automatic telephone system equipped with non-numerical switches of the lineswitch type. The application of the invention to other types of telephone systems and in connection with trunk lines will be readily apparent.

Referring now to Fig. 1, T represents an ordinary automatic substation associated with a subscriber's line terminating in line-

switch LS. Lineswitch LS is of the well known plunger type having access to various trunks extending to first selectors under control of a master switch MS which is shown in skeleton form. Selector S is one of a group of selectors accessible to lineswitch LS and in turn has access to second selectors of which only the switch S1 is shown. Both selectors S and S1 are of the ordinary two-motion type having a directive vertical movement and automatic rotary movement. Common supervisory relay equipment SR is associated with a group of first selectors. This relay equipment comprises the low-resistance supervisory relay 51 through which battery is fed to the release relays of the various selectors, and a slow relay for operating the alarm circuit. The slow relay shown is of the so-called "dash-pot" type, which is characterized by extremely slow operation and quick release. Timing switch TS consists of an ordinary rotary switch of any convenient size having movement only in a forward direction, and a group of counting relays operated under control of a timing interrupter TI. A set of contacts in the banks of the timing switch TS is allotted to each of the first selectors of a group. The timing interrupter shown is of the cam type although any source of timed interruptions will be satisfactory. The impulsing rate may be adjusted to any desirable figure, for example at half-minute intervals, which in the instant case will allow a period of three minutes before a connection is released.

Referring now to Fig. 2 there is shown a rotary lineswitch adapted to operate with the first selector and timing switch shown in Fig. 1. This switch is of the usual non-homing type and is provided with a two-step line relay which functions under certain conditions as a disconnecting relay, as will be explained in later paragraphs.

A better understanding of the features of the invention will be had from a detailed description of the various operations involved in establishing a connection and in disconnecting a faulty line. Assuming first that the subscriber at substation T initiates a call, relay 12 of the lineswitch will operate over a circuit including contacts 15 and 16, the outer armatures of relay 11, the two line conductors 1 and 2, and the subscriber's loop. Relay 12 on operating closes a circuit from supervisory ground, through the upper winding of pull-down magnet 13, to main battery at the master switch. The magnet operates and pushes the plunger into the bank, thereby closing contacts 17—20 which extends the calling line over the trunk comprising conductors 34—37 to selector S. Contacts 15 and 16 open when magnet 13 operates and relay 12, although disconnected from the calling loop will remain operated for a short time due to its slow release characteristic and maintain magnet 13 operated until a ground is returned by the selector. Immediately after the call is extended to the selector, relay 21 operates over the calling loop and completes a circuit for relay 22 which also operates. Relay 22 prepares the impulsing circuit and opens the circuit of the release magnet at its lower armature, marks the selector in the banks of the timing switch at its upper armature, and at armature 26 connects a holding ground to release trunk conductor 36 to energize the lower winding of magnet 13 and maintain the lineswitch in operated position. Supervisory relay 51 operates in series with relay 22 and closes a circuit for the dash-pot relay 52 which will start its operation. The calling subscriber will then dial the first digit of a telephone number and relay 21 will respond and transmit a corresponding series of impulses to relay 23 and vertical magnet 33 in series. The magnet operates in the usual way to step the wipers to the called level. Relay 23 operates in response to the first impulse of the series and, being slow-to-release, maintains its armatures actuated during the series of impulses. Off-normal springs 30 and 31 close upon the first vertical step of the wipers and a circuit is completed for relay 24 including the interrupter contacts of rotary magnet 32, off-normal contacts 31, and the upper armature of relay 23, to ground at armature 26. Relay 24, operates, completes a locking circuit for itself independent of relay 23 at armature 27, and at its upper armature prepares a circuit for the rotary magnet. Shortly after the last impulse of the series relay 23 restores and completes a circuit for the rotary magnet which operates and steps the wipers in on the first set of bank contacts of the called level. The opening of the interrupter contacts allows relay 24 to release, which in turn opens the circuit of the rotary magnet. The interrupter contacts re-establish the circuit for relay 24, this time in series with relay 25. In case the trunk now engaged by the wipers is busy, the test wiper will encounter ground on the test contact which shunts relay 25 and permits relay 24 to operate. The stepping circuit is again completed and the wipers are advanced to the next set of contacts as before. This cycle of operation is repeated until the test wiper encounters an ungrounded contact marking an idle trunk, at which time switching relay 25 operates in series with relay 24. Relay 24, however, does not operate due to the high resistance of relay 25. Relay 25 disconnects the incoming talking conductors from line relay 21 and extends them by way of its outer armatures to the talking wipers which are engaging the contacts associated with the talking conductors of the idle trunk. It may be assumed, for example, that the trunk selected is the one comprising conductors 43—45 terminating in second selector

S1. Relay 25 also disconnects the test wiper from its lower terminal and instead connects it to its upper terminal to prepare a holding circuit for itself, and at armature 29 disconnects ground from the lower armature of relay 21 to prevent the release of the switch at this time. Relays 21 and 22 restore, relay 22 remaining operated a short time after its circuit is opened due to its slow release characteristic and maintaining the ground connection to the release trunk. Line relay 41 of selector S1 operates over the calling loop and completes a circuit for relay 42. Relay 42 operates and connects ground to release trunk conductor 44 which extends back to relay 25 and magnet 13 to maintain them in operated position. Supervisory relay 51 restores as soon as the selector switches through and opens the circuit of dash-pot relay 52. The dash-pot relay is adjusted to operate very slowly, for example, requiring twelve seconds to close its contacts after its circuit is completed. In case the subscriber dials within a reasonable time after seizing the selector, the supervisory relay will thus be released before the dash-pot relay completes its operation and the timing switch will not be actuated. The subscriber continues to dial and complete the connection in the usual way which is of no particular interest as far as the invention is concerned.

The foregoing paragraphs describe the operations in the case of a normal call. Assume now that the subscriber at substation T accidently knocks the receiver from the switchhook or removes it to make a call and then for some reason or other neglects to operate the calling device. The lineswitch will operate exactly the same as in the previous connection and extend the calling line to an idle first selector, for example, the selector S as before. Relays 21 and 22 will operate as in the previous case as will supervisory relay 51. In case the subscriber does not operate the calling device the switch will remain in normal position and consequently the relays will remain operated. After a predetermined time dash-pot relay 52 will close its contacts thereby completing a circuit for stepping magnet 65 of timing switch TS. This magnet operates and interrupts its own circuit advancing wipers 66 and 67 one step at a time. The wipers will be stepped ahead until wiper 67 encounters the contact associated with selector S to which ground is connected by way of the upper armature of relay 22. This ground will cause the operation of relay 64 which opens the circuit of the stepping magnet at its upper armature, prepares a holding circuit for the counting relays 61—63 at its lower armature, and connects up interrupter contacts 74 at armature 73. It is assumed for convenience that the timing interrupter TI is arranged to operate in a complete cycle every half-minute and consequently contacts 74 close at half minute intervals. When these contacts are closed for the first time following the operation of relay 64 a circuit is closed for the upper winding of relay 61 including the upper armatures of relays 61, 62, and 63 and armature 73 of relay 64. Relays 61—63 are two-step relays and operate only their contacts designated by the Roman numeral I when energized over the upper winding. Relay 61 on operating, as just described, prepares a circuit for its two windings in series by operating armature 68. As the interrupter continues to operate contacts 74 will be opened, thereby removing the shunt from the lower winding of relay 61 which will now operate fully and actuate the remainder of its armatures. This relay on operating in its second step switches its initial operating circuit over to relay 62 at its upper armature, and at its lower armature, prepares a holding circuit for relay 62. The next closure of the impulsing contacts will operate relay 62 in its first step and on the opening of the interrupter contacts relay 62 will operate fully and transfer the operating circuit to relay 63. Relay 62 at its lower armature opens the holding circuit of relay 61 which now restores. The third closure of the interrupter contacts will operate relay 63 in its first step and, when the interrupter contacts open, this relay will operate fully and lock to ground at the lower armature of relay 64, prepare a new operating circuit for relay 61 and open the holding circuit of relay 62. On the forth closure of the interrupter contacts, relay 61 will operate as before and complete a locking circuit, this time through the lower armature of relay 63. The fifth closure of the interrupter contacts will operate relay 62 which locks through armature 72 and the lower armature of relay 61 and connects wiper 66 to the impulse contacts by way of the upper armature of relay 63 and armature 73. It will thus be seen that five impulses are required to operate the three counting relays to their present positions, and assuming that these impulses are at one-half minute intervals, a period of two and one-half minutes has elapsed since the timing switch was associated with the selector. After the lapse of another half minute, interrupter contacts 74 will again close and ground will be extended by way of these contacts, armature 73, upper armature of relay 63 and armature 69, wiper 66, and conductor 35 to relay 11 of the lineswitch LS. Relay 11, operates, disconnects the talking conductors of the line from the trunk leading to the selector and bridges itself across these conductors and closes a circuit for operating a line identifying signal. Relay 11 also connects ground potential to the test conductor by operating armature 14, thereby marking the line busy in the banks of the connectors. Relay 21 of the selector will restore immediately upon the opening of the loop and relay 22 will restore

very shortly thereafter. The removal of ground from release trunk conductor 36 will release pull-down magnet 13 of the lineswitch and thus free the trunk for use by other lines. Referring back to the lineswitch, relay 11 will remain locked up over the loop of the subscriber's line and, of course, will maintain the line disconnected from the lineswitch.

Assume now that the subscriber at substation T notices the receiver off the hook and restores it thereby removing the unstandard condition from the line. The loop at the substation will be opened in the usual way and relay 11 will restore and reconnect the line to the lineswitch so that an originating call will now operate the switch exactly as in the previously described connection.

While the foregoing description deals with conditions arising from a receiver left off the switchhook, the operation will be substantially the same for faults occurring on the lines, such as conductors 1 and 2 becoming crossed or conductor 2 becoming grounded. In any event the line will be disconnected from the exchange switching apparatus and will be locked in this condition until such time as the unstandard condition is removed or disappears.

Lineswitch LS1 of Fig. 2 is arranged to operate in connection with the selector and timing switch shown in Fig. 1. The operation on the initiation of a call is as follows: When the subscriber at substation T1 initiates a call a loop circuit is closed over conductors 1′ and 2′, from ground at the lower armature of relay 11′, and through the upper armatures of relays 12′ and 11′, lower winding of relay 12′ in series with resistance 14′, to battery. Relay 12′ is a two-step relay and operates only its armatures designated by the Roman numeral I when its lower winding is energized in series with resistance 14′. The operation of armature 21′ completes a circuit for the upper winding of relay 12′, relay 11′, and magnet 13′ in series. The actuation of the lower armature of relay 12′ connects test wiper 19′ to the junction of relay 11′ and magnet 13′. If the trunk on which the wipers are standing is busy, wiper 19′ will encounter a ground and this ground will shunt relay 11′ and cause magnet 13′ to advance the wipers one step to the next set of contacts. This operation will be repeated until such time as an idle trunk is encountered. Relay 11′ will then energize in series with the upper winding of relay 12′ and magnet 13′. The magnet, however, will not operate due to the relatively high resistance of relay 11′. Relay 11′ will switch the test wiper over from its previous connection to upper terminal of the relay thus preparing a holding circuit for itself, and will connect the talking conductors through to the wipers at its upper and lower armatures. The calling loop will thus be extended to the first selector in the usual way which will return a ground on release trunk conductor 36′ to maintain relay 11′ in operated condition. This ground returned from the selector will also shunt the upper winding of the relay 12′ over which the relay was being held operated, and will permit the relay to restore.

In case the subscriber fails to dial within a reasonable period, the timing switch associated with the selector will operate as has been previously described and, at the expiration of the predetermined time, will connect ground to conductor 35′ which by way of wiper 18′ and armature 15′ will operate relay 12′. It will be noted that resistance 14′ is not in the circuit at this time and relay 12′ will operate fully, that is in its second step. The operation of armature 22′ will open the circuit of relay 11′ which will restore and relay 12′ will bridge itself across the line. Relay 12′ will thus remain locked up over the line loop to ground at the lower armature of relay 11 until such time as the defective condition is removed from the line, at which time the relay will restore and reconnect the line in its normal condition. In the case of a ground on the negative side of the line, that is on conductor 2′, relay 12′ will lock to this ground instead of to the ground at the lineswitch.

What is claimed is:

1. In a telephone system, a line comprising two talking conductors, switching apparatus terminating said line, and means for automatically disconnecting the talking conductors of the line from said apparatus when an unstandard condition exists on the line and for re-connecting said talking conductors to said apparatus when the unstandard condition is removed from the line.

2. In a telephone system, a plurality of lines, a trunk selecting switch individual to each line and normally connected thereto, means individual to each line for disconnecting the line from the associated switch when an unstandard condition exists on the line and for reconnecting the line to the switch when the unstandard condition is removed, and means common to all of said lines for controlling the initial operation of said first means.

3. In a telephone system, a line, a trunk selecting switch individual to said line and normally connected thereto, a relay for disconnecting the line from said switch, a control device for operating said relay responsive to an unstandard condition on the line, and means for maintaining said relay operated independent of said device as long as the unstandard condition exists on the line.

4. In a telephone system, a line terminating in an individual trunk selecting switch, a branch of said line accessible to other

switches, a relay for disconnecting the line from said switch and for marking the branch busy to said other switches, a control device for operating said relay responsive to an unstandard condition on the line, and means for maintaining said relay operated independent of said device as long as the unstandard condition exists on the line.

5. In a telephone system, a line, switching apparatus, a relay, means for connecting the line to said apparatus responsive to an unstandard condition on the line, means for operating said relay, and contacts on said relay for disconnecting the line from said apparatus and for bridging itself across the conductors of the line.

6. In a telephone system, a plurality of lines, switching apparatus adapted to be seized by any line on which a call is initiated or on which an unstandard condition exists, a relay associated with each line, contacts on said relays for disconnecting the associated line from the seized apparatus and for bridging the relay across the line, and a common timing device for operating the relay associated with the particular line on which an unstandard condition exists.

7. In a telephone system, a switching device equipped with wipers, a line comprising two conductors normally connected to said wipers, a relay, and contacts operated by said relay to disconnect said conductors from said wipers and to bridge the relay across said conductors.

8. In a telephone system, a line, a non-numerical trunk selecting switch individual to said line, a numerical switch accessible to said first switch, means for operating said first switch to seize said second switch responsive to an unstandard condition on the line, means for freeing both of said switches while the unstandard condition remains on the line, and means controlled by said second switch for operating said last means.

9. In a telephone system, a line terminating in an individual lineswitch, other switches accessible to said lineswitch, means for operating said lineswitch to seize one of said other switches responsive to an unstandard condition on the line, means for freeing both of said switches, and a timing device controlled by said one switch for rendering said last means effective a predetermined time after the seizure of said one switch.

10. In a telephone system, lines terminating in individual non-numerical switches, numerical switches accessible to said non-numerical switches, a timing device common to said numerical switches, means for operating a non-numerical switch to seize an idle one of said numerical switches responsive to an unstandard condition on the associated line, and means controlled by said device for freeing both of said switches after a predetermined time.

11. In a telephone system, a subscriber's line equipped with a calling device, a switch individual to said line, other switches accessible to said first switch and adapted to be directively operated under control of said calling device, means for operating said first switch to connect with an idle one of said second switches responsive to the initiation of a call on said line, and means for disconnecting said line from said first switch in case the calling subscriber fails to operate the calling device within a predetermined time after initiating the call.

12. In a telephone system, a line terminating in a trunk selecting switch, a two-step line relay for the switch, means for operating said relay in its first step responsive to the initiation of a call or to an unstandard condition on the line whereby said switch is caused to hunt for and connect with an idle trunk, and means for operating said relay in its second step to free said trunk when an unstandard condition exists on the line.

13. In a telephone system, a non-numerical switch terminating a line, a two-step line relay for the switch adapted to initiate the operation of the switch when operated in its first step and to disable the switch when operated in its second step, means for operating the relay in its first step responsive to the initation of a call on the line, and means for operating the relay in its second step responsive to an unstandard condition on the line.

14. In a telephone system, a line, a non-numerical switch terminating said line, trunks accessible to said switch, and a combination line and disconnect relay in said switch for initiating the operation of said switch to extend a calling line to an idle one of said trunks and for disconnecting the line from said one trunk in case an unstandard condition exists on the line.

15. In a rotary lineswitch, a line relay for initiating the operation of the switch, a switching relay for extending the talking conductors of the switch through to the wipers, a resistance, an operating circuit for the line relay including normally closed contacts of the switching relay and said resistance, and a second operating circuit for the line relay including normally open contacts of the switching relay and excluding said resistance.

16. In a rotary lineswitch, a two-step line relay adapted to initiate the operation of the switch when operated in its first step and to disable the switch when operated in its second step, a switching relay for extending the talking conductors of the switch through to the wipers, a circuit for operating the line relay in its first step including normally closed contacts of the switching relay, and a circuit for operating the line relay in its second step including normally open contacts of the switching relay.

17. In a telephone system, a plurality of automatic switches, means for extending connections to said switches, a delay device common to said switches, a timing switch, a hunting switch associated with said timing switch, means responsive to the extension of a connection to one of said automatic switches for operating said delay device, means controlled by said device for operating said hunting switch to connect with said one automatic switch, and means responsive to said hunting switch effecting said connection for initiating the operation of said timing switch.

18. In a telephone system, a plurality of automatic switches, means for extending connections to said switches, a delay device common to said switches, a timing switch comprising a group of counting relays common to said switches, means responsive to the extension of a connection to one of said automatic switches for operating said delay device, means controlled by said device for associating said timing switch with said one switch individually, and means for initiating the operation of said timing switch responsive to its association with the automatic switch.

19. In a telephone system, a plurality of automatic switches, means for extending connections to said switches and for directively operating the same to further extend the connections, a timing device, means for connecting said device with a switch to which a connection has been extended in case the directive operation of the switch is delayed for a predetermined interval, and means for disconnecting said device from the switch in case the switch is directively operated within a predetermined interval after said device is connected thereto.

20. In a telephone system, a plurality of automatic switches, means for extending a connection to one of said switches, means controlled over the connection for operating the switch to further extend the connection, a timing device common to said switches, means effective in case the operation of the switch is delayed for a predetermined interval after the connection has been extended thereto for associating the timing device with the switch individually, and means controlled by the timing device for releasing the switch from the connection in case the operation thereof is delayed for a predetermined interval after the association of the timing device therewith.

21. The combination with a line comprising two conductors, of a switching device connected to said line, a timing device associated with said switching device, a second timing device, means in the switching device for operating said first timing device, means controlled by said first timing device for connecting said second timing device to said switching device, and means controlled by said second timing device for disconnecting said line from the swithing device.

22. The combination with a line comprising two normally unconnected conductors, of a switching device terminating said line, and means responsive to the short circuiting of said conductors for disconnecting the line from said switching device and for maintaining the line disconnected only so long as said conductors are short circuited.

23. The combination with a line comprising two normally unconnected conductors, of a switching device terminating said line, a relay, means responsive to the short circuiting of said conductors for completing an operating circuit for said relay, and means controlled by said relay for disconnecting the line from said switching device and for completing a holding circuit for itself over the short-circuited conductors.

24. In a telephone system, lines terminating in trunk selecting switches, a plurality of trunk lines accessible to said switches, a timing device common to said trunk lines for releasing the trunk lines after a predetermined interval, and means for rendering said device individual to a trunk line while said predetermined interval is being measured.

In witness whereof, I hereunto subscribe my name this 23d day of May, A. D. 1930.

JOHN A. BURGENER.