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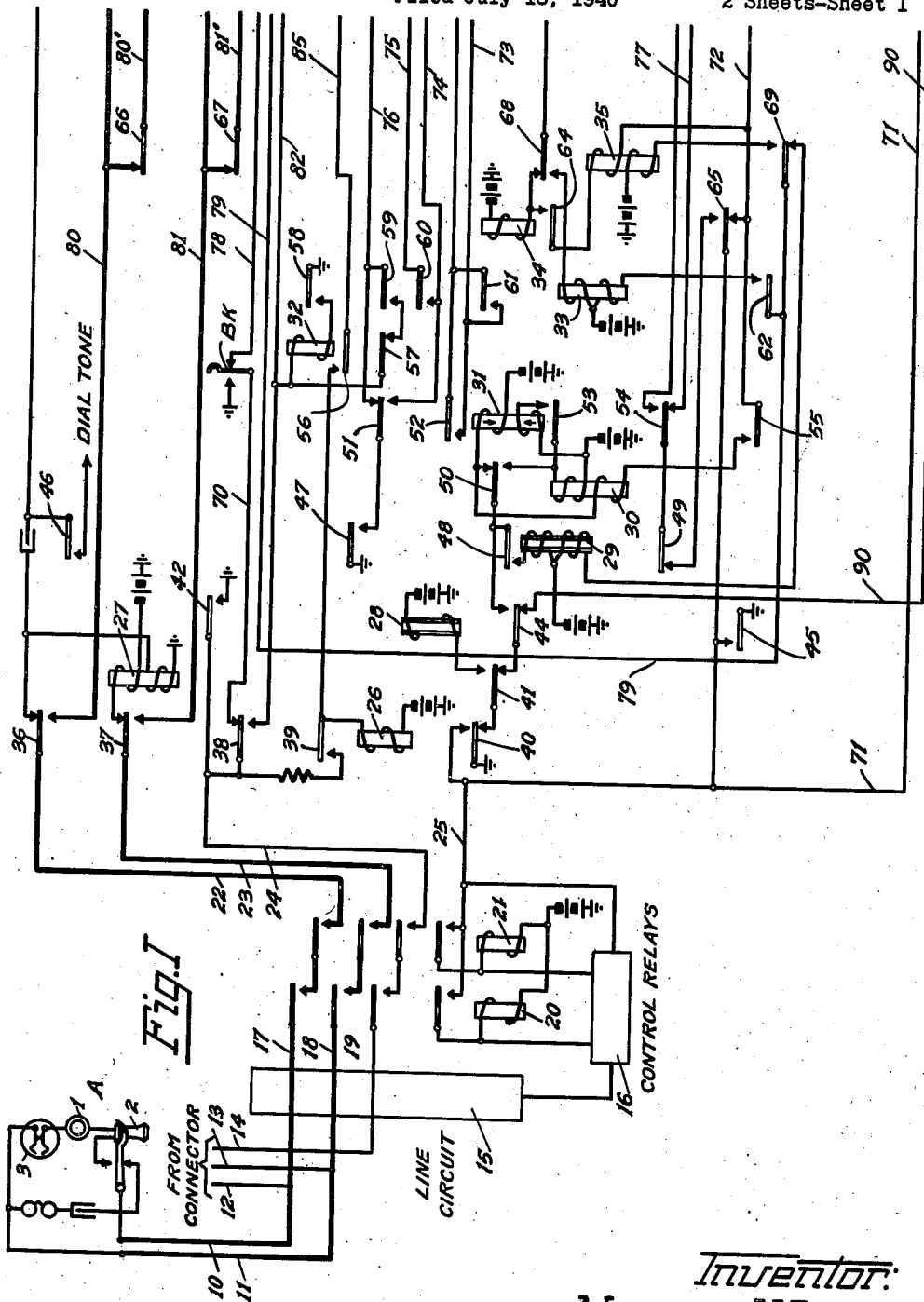
N. H. SAUNDERS

2,279,531

AUTOMATIC TELEPHONE SYSTEM

Filed July 18, 1940

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

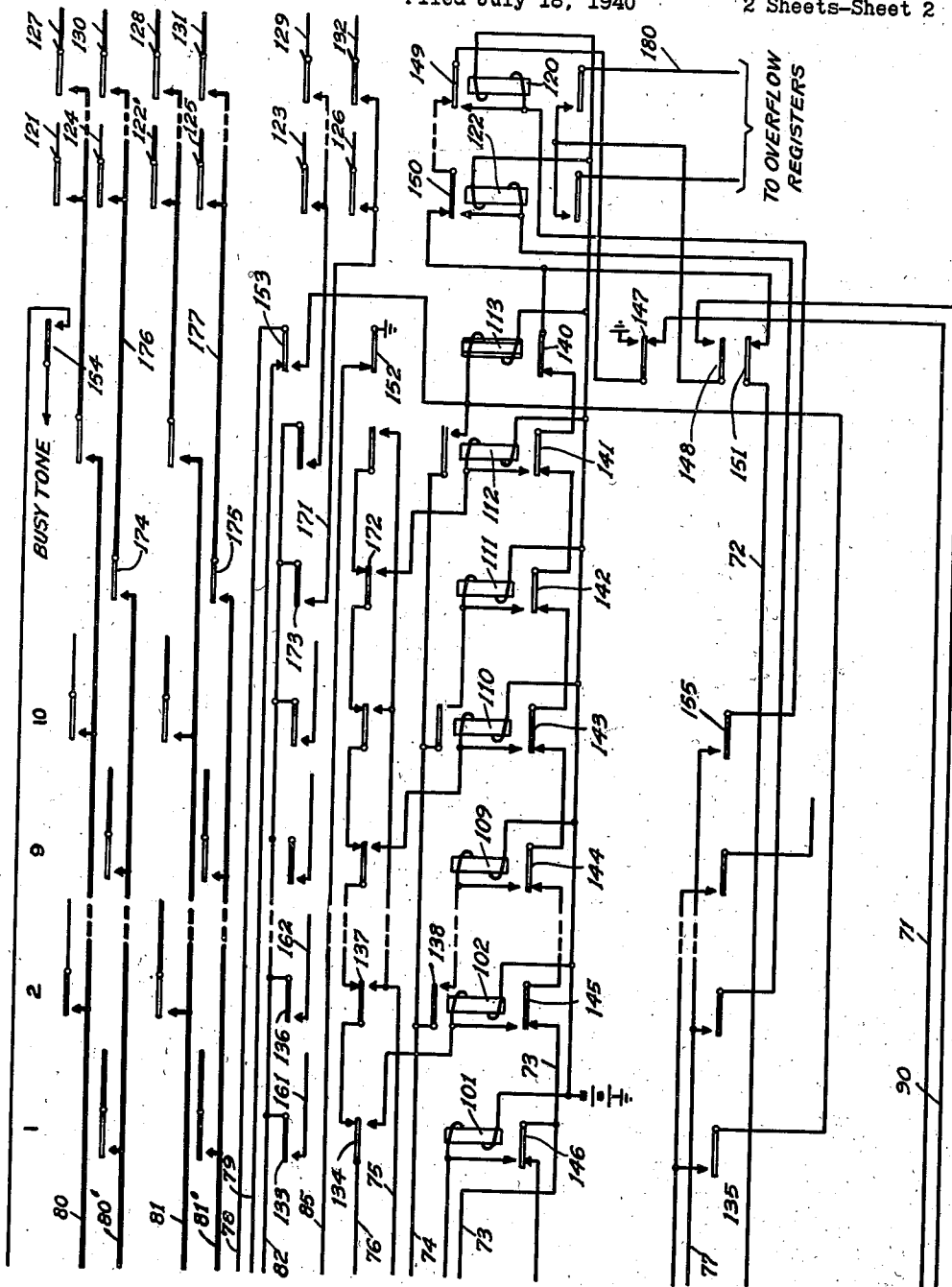


Fig. 2

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UNITED STATES PATENT OFFICE

2,279,531

AUTOMATIC TELEPHONE SYSTEM

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24 Claims. (Cl. 179—18)

The present invention relates in general to automatic telephone systems, in which connections are established by automatic switches under control of a dial or calling device at the calling subscriber's station. The switches employed in such systems are of several types, depending on the functions they are intended to perform. Thus systems in common use may include finder switches, selector switches, and connector switches.

The invention relates more in particular to selector switches. These switches are provided on a percentage basis. When a subscriber makes a call his line is extended to an idle selector switch by a preliminary trunking operation, performed by a finder switch, for example, after which the selector switch is directly controlled by the dial to select a main group of trunk lines leading to connector switches or to a second order of selector switches, depending on the size of the system. Upon the completion of the directive control, the selector switch operates automatically to select an idle trunk line in the selected group and to extend the calling subscriber's line to such trunk line.

The object of the invention is to produce a new and improved selector switch of the foregoing character, adapted for use either as a first selector or a second selector, or in any position in an automatic switch train where selectors are customarily used.

A special object of the invention is to provide a new and improved selector switch of the relay type, that is, a selector switch in which all the various functions of the switch are performed by relays.

The invention and the features of improvement included therein will be described fully hereinafter with reference to the accompanying drawings, Figs. 1 and 2, which show diagrammatically the relays and circuit connections of a complete selector switch, together with the circuit connections whereby the selector is made available to a calling line to perform the functions of a first selector.

Referring to the drawings, the reference character A indicates a subscriber's station of known type, including a transmitter 1, receiver 2, and the usual dial or calling device 3. The station A is connected with the exchange over a pair of line conductors 10 and 11, which terminate in the usual line circuit, represented by the rectangle 15. Conductors 11, 12, and 13 are the so-called normal conductors, which extend to the

connectors which have access to the line of station A.

It may be assumed that finder switches of the relay type are used for connecting with calling lines and extending them to first selector switches. The relays 20 and 21 are tens and units relays of such a finder switch. Each relay has a plurality of sets of contacts, although the drawing shows only the single contact set on each relay which is involved in extending the line of station A. The rectangle 16 represents a group of control relays for the finder switch, including a relay allotter which assigns idle selectors for use by calling lines.

The conductors 22—25 are the conductors of a trunk line extending to a first selector switch. Conductors 22 and 23 are the line conductors, conductor 24 is the test conductor, while conductor 25 is the holding conductor.

The selector switch is shown in the remainder of Fig. 1 and in Fig. 2. Relays 26 to 35, inclusive, Fig. 1, are the selector control relays. Relays 101 to 110, inclusive, of which only the first two and last two are shown, are so-called counting relays, which perform a numerical group selection in response to the dialling of a digit at the calling station, and which also function as searching relays to select an idle trunk. Relays 111 and 112 are additional searching relays, which provide for twelve trunks in each group instead of ten. Relay 113 is an overflow relay, which is energized in case all the trunks in a selected group are found busy.

The selector switch may have access to ten groups of trunk lines, and for that purpose may be provided with ten group relays each having sufficient sets of contacts for connecting up all the trunks of a group. However, at the first selectors it is the usual practice to omit the first group of trunk lines, as there is danger of false selection of the first group by an accidental preliminary impulse; and accordingly it will be assumed that the selector shown has access to only nine groups of trunk lines and is provided with nine group relays. Of these nine group relays the second and tenth group relays are shown in the drawing, being indicated by reference numerals 122 and 120, respectively.

The drawings show the last two trunk lines in the second group and the corresponding trunks in the tenth group. More specifically, conductors 121, 122, and 123 are the conductors of the twelfth trunk line in the second group, while conductors 124, 125, and 126 are the conductors of the eleventh trunk line of the second group.

Conductors 127, 128, and 129 are the conductors of the twelfth trunk line of the tenth group, while conductors 130, 131, and 132 are the conductors of the eleventh trunk line of the tenth group. Each group relay, of course, has ten contact sets in addition to the two sets shown, to take care of trunks one to ten, but these additional contact sets have been omitted for lack of space. The trunk lines are multiplied to other selectors, as indicated in the drawings.

The selector switch is not limited to use as a first selector, as shown herein, but may also be used as a second or third selector without change, except that the holding conductor 25 is omitted. The holding conductors are used only on first selectors and not only serve to maintain the finder connecting relays in operated position, but also function as auxiliary test conductors over which the idle or busy condition of the selectors is manifested to the allotter heretofore mentioned. When used as a second selector, the selector disclosed herein is tested over the usual test conductor corresponding to conductor 24, and a busy key BK is provided for making the selector artificially busy to incoming calls. This key is not required on first selectors and may be omitted if desired. The first selectors are artificially busied at the allotter.

The operation of the selector switch will now be described. When the subscriber at station A removes the receiver from the hook, a bridge is closed across the line conductors 10 and 11 and the subscriber's line relay (part of the line circuit) is operated in the usual manner. On energizing, the line relay causes the operation of a finder switch associated with an idle selector switch to extend the subscriber's line to such selector switch. Assuming that the selector switch shown is idle at the time, and has been allotted for use on the next call, the tens and units relays 20 and 21 of the associated finder are energized, and the line conductors 10 and 11 are extended by way of conductors 17 and 18 and contacts of relays 20 and 21, to the trunk conductors 22 and 23.

The line relay 27 of the selector is now energized over the calling line in the usual manner, and at contact 41 closes a circuit for the slow acting release relay 28. On energizing, the latter relay prepares an impulsing circuit at contact 44, grounds the test conductor 24 at contact 42, and grounds the holding conductor 25 at contact 45.

The grounding of holding conductor 25 establishes holding circuits for the tens and units relays 20 and 21 in the finder switch, which maintain these relays energized after the control apparatus has restored. The grounding of the test conductor 24 energizes the cut-off relay in the line circuit, which disconnects the line relay from the subscriber's line and allows it to restore. Ground potential is also placed on conductor 14, whereby the subscriber's line is made busy to the connector switches which have access to it. These operations are all well known and require no detailed explanation.

Returning to the selector switch, energization of the release relay 28 closes a circuit for relay 34, extending from ground by way of contact 45, conductor 71, contact 147, chain contact 149 on group relay 120, and similar contacts including contact 150 on other group relays, chain contacts 140 to 146, inclusive, contact 68, and winding of relay 34 to battery. On energizing, relay 34 prepares the group relay marking circuit at contact

65 and prepares a locking circuit for itself at contact 64.

The energization of release relay 28 also brings about the energization of the slow acting change-over relay 29, over a circuit extending from ground by way of contact 42, contact 38, conductor 70, busy key BK, conductor 78, contact 153, conductor 79, contact 69, and lower winding of relay 29 to battery. On energizing, relay 29 opens a point in the group relay marking circuit at contact 49, prepares a holding circuit for itself at contact 43, prepares the counting relay control circuits at contact 47, and at contact 46 connects dial tone to one side of the calling line. The signal thus transmitted over the line informs the calling subscriber that the dialling of the number of the called line may proceed.

It will be assumed that the first digit of the number is the digit 0. When the calling device is operated in accordance with this digit, ten momentary interruptions are produced in the sub-station bridge across the calling line and the line relay is caused to deenergize ten times in rapid succession. These operations of the line relay control the counting relays 101 to 110, inclusive, as will be described. It may be mentioned first, however, that the release relay 28, being slow to deenergize, does not fall back in response to the momentary interruptions of its circuit during the deenergizations of the line relay.

When the line relay 27 falls back in response to the first interruption of the line circuit, it transmits an impulse to relay 31 over a circuit extending from ground by way of contact 40, contact 41, contact 44, contact 50, and upper winding of relay 31 to battery. A branch of the foregoing circuit extends by way of contact 48 and the upper winding of the change-over relay 29 to battery. This branch circuit serves to maintain relay 29 in operated position during the operation of the line relay, said relay 29 being slow to deenergize. Thus relay 29 as well as relay 28 is maintained in operated position while the line relay is responding to the dial, the former receiving impulses on deenergizations of the line relay and the latter on the energizations of the line relay. When the circuit of relay 31 is closed as described, the relay energizes and prepares a locking circuit for itself at contact 55. Other results of the operation of this relay will be considered presently.

At the end of the first interruption of the line circuit, the line relay 27 energizes and opens the energizing circuit of relay 31. The relay is held energized, however, over a circuit extending from the grounded conductor 71 by way of contact 147, chain contacts including contacts 149 and 150, contact 151, conductor 72, contact 55, lower winding of relay 30, and upper winding of relay 31 to battery. Relay 30 energizes over the above circuit in series with relay 31 and at contact 50 breaks the former energizing circuit of relay 31, also preparing a circuit for deenergizing said relay on the next deenergization of the line relay. The line relay has now gone through the first cycle of deenergization and energization, and relays 31 and 30 have been energized.

Other operations have taken place, due to the energization of relay 31. When this relay operates, it closes a circuit for the first counting relay 101, the circuit extending from ground as previously traced through the chain contacts 140—145, and thence by way of conductor 73, contact 52 of relay 31, and winding of relay 101 to bat-

tery. On energizing, relay 101 locks itself at contact 146, and at contact 134 prepares a circuit for the second counting relay 102. It will be noted also that at contact 146 relay 101 breaks the initial energizing circuit of relay 34, which now locks up, however, over a circuit extending from the grounded conductor 72, by way of the upper winding of relay 35, contact 64, and winding of relay 34 to battery. Relay 35 energizes over the above circuit, locks itself at contact 69, and at contact 68 prepares a circuit for relay 33. Also at contact 69 relay 35 breaks the initial energizing circuit of the change-over relay 29, but this relay is maintained in operated position by deenergizations of the line relay, as previously described.

Upon the second interruption in the line circuit, the line relay 27 again deenergizes momentarily and transmits an impulse to relay 29 over the path previously traced. The circuit also continues by way of contact 50 of relay 30, which is now energized, and by way of contact 53 and the lower winding of relay 31 to battery, also from contact 50 through the upper winding of relay 30 to battery. Relay 31 is differentially wound and now deenergizes, breaking its locking circuit at contact 55 and its deenergizing circuit at contact 53. The circuit through the upper winding of relay 30 maintains this relay energized momentarily until the line relay energizes, whereupon relay 30 deenergizes. At the end of the second cycle of operation of the line relay, therefore, relays 31 and 30 are both in deenergized position.

When relay 31 deenergizes, it closes a circuit for the second counting relay 102 over a circuit extending from ground by way of contact 47 of relay 29, contact 51, conductor 76, contact 134, and winding of relay 102 to battery. On energizing, relay 102 locks itself at contact 145, and prepares a circuit for counting relay 103 (not shown) at contact 138. Relay 102 also breaks the locking circuit of relay 101 at contact 145, and relay 101 accordingly deenergizes.

In the foregoing the first two interruptions of the line circuit and the first two deenergizations of the line relay 27 have been accounted for. The second counting relay 102 has been energized. The ensuing deenergizations of the line relay which effect the energization of the other counting relays may be described more briefly.

It will have been observed that relays 31 and 30 are energized in response to the first cycle of operation of the line relay and are deenergized in response to the second cycle of operation of the line relay. These relays continue to operate in the same manner, energizing on every odd operative cycle of the line relay and falling back on every even operative cycle of the line relay. Relay 31 accordingly connects ground alternately to conductors 74 and 76 at contact 51. The first counting relay 101 energizes over a special circuit including contact 52, as described, but the remaining counting relays are energized over conductors 74 and 76. The second counting relay 102 energizes over conductor 76, as described. The third counting relay 103 (not shown but arranged the same as relay 109) energizes over conductor 74. The fourth counting relay 104 (not shown but arranged the same as relay 102 or 110) energizes over conductor 76. Thus the counting relays are successively energized in response to successive operations of the line relay 27, each counting relay locking itself, breaking

the circuit of the preceding relay, and preparing the circuit of the succeeding relay.

On the tenth deenergization of the line relay 27, being an even numbered deenergization, relay 31 is deenergized, conductor 76 is grounded, and the tenth counting relay 110 is energized. Relay 110 locks itself at contact 143 and at the same contact breaks the locking circuit of relay 109, which deenergizes. At contact 155 relay 110 prepares a marking circuit for energizing the tenth group relay 120.

The interruptions of the line circuit now cease, the tenth interruption being the last, and the line relay 27 comes to rest in energized position, maintaining the circuit of the release relay 28 closed at contact 41. As no more impulses are transmitted to the change-over relay 29, this relay falls back after a brief interval and closes the marking circuit, which extends from ground by way of contact 45, contact 65, contact 49, contact 54, conductor 77, contact 155 on the tenth counting relay 110, and winding of the tenth group relay 120 to battery. Relay 120 energizes over the above circuit, locks itself at contact 149, and connects up the twelve trunks of the tenth group, including the two trunks of this group which are shown in the drawing.

When the group relay 120 energizes it also disconnects ground from the counting relay chain circuit at contact 149, which breaks the locking circuit of counting relay 110 and permits this relay to deenergize. Ground is also disconnected from conductor 72, which breaks the locking circuit of relay 34. Relay 34 accordingly deenergizes, but relay 35 remains energized over its lower winding. When relay 34 falls back, it replaces ground on conductor 72 at contact 65, thus again connecting ground to the counting relay chain circuit including contacts 140, 141, etc. Since the counting relay 110 has been deenergized, this chain circuit is now closed, and since relay 35 is in energized position, a circuit is completed for relay 33. The complete circuit may be traced from ground by way of contact 45, contact 65, conductor 72, contact 151, chain contacts 140—146, contact 68, and upper winding of relay 33 to battery. On energizing, relay 33 locks itself at contact 62.

The function of relay 33 is to start the automatic searching operation, in which an idle one of the twelve trunks connected up by the group relay is selected. In energized position, relay 33 connects ground to the test relay 32 at contact 58, prepares circuits for the counting relays at contacts 59 and 60, and at contact 61 closes a circuit for the first counting relay 101. This circuit includes the grounded chain contacts 140—145, conductor 73, contact 61, and the winding of relay 101. On energizing, relay 101 locks itself at contact 146 and at the same contact breaks the initial energizing circuit of relay 33. This relay remains locked up through its contact 62.

Another result of the energization of relay 101 is the completion of a test circuit extending from ground by way of contact 58, winding of test relay 32, conductor 82, contact 133 of relay 101, conductor 161, contact of energized group relay 120, and the test conductor of the first trunk line of the tenth group. This trunk line and the contacts on relay 120 for connecting it are not shown, but are similar to the two trunk lines and associated contacts that are shown. Relay 101 also connects the second counting relay to the above traced test circuit over a path extend-

ing from conductor 82 by way of contact 57 of test relay 32, contact 59, conductor 76, and contact 134. Further operations now depend on whether the first trunk of the selected group is idle or busy.

It may be assumed that the trunk lines lead to second selectors. These second selectors may be similar to the selector shown herein, which as previously explained is adapted for use either as a first or second selector. The circuit conditions at the second selectors which render the associated incoming trunk lines busy or idle may therefore be readily understood by reference to the drawings.

In case the first trunk line of the selected group is busy, the test conductor 161, which corresponds to test conductor 24, will be grounded due to the energization of the release relay in the second selector, or due to the busy key corresponding to key BK being in operated position. If the first trunk line is idle, the test conductor 161 will have a battery potential on it. The circuit over which the battery potential is derived may be traced in the selector shown from the test conductor 24 by way of contact 38, busy key BK, conductor 78, contact 153, conductor 79, contact 69, and lower winding of relay 29 to battery. From this it will be understood that the first selector whose operation is being described is searching for a trunk line the test conductor of which has a battery potential on it, this battery potential denoting an idle trunk line.

It may be assumed that the first trunk line of the selected group is busy, in which case there will be a ground potential on test conductor 161, as previously explained. The test conductor being grounded, the test relay 32 will be prevented from energizing, and the second counting relay 102 will be energized over the circuit previously traced, extending from ground on the test conductor 161, and by way of conductors 82 and 76 to relay 102. When counting relay 102 energizes, it locks itself at contact 145 and at the same contact opens the locking circuit of counting relay 101, which deenergizes. Relay 102 also connects up the test conductor 162 of the second trunk line at contact 136 and at contacts 137 and 138 closes a circuit for energizing the third counting relay 103 in case the second trunk line is busy. The third counting relay is not shown but is arranged the same as relay 109.

Assuming that the second trunk line is busy and that the test conductor 162 is grounded, the third counting relay will be energized over a circuit which extends from the grounded test conductor 162 by way of contact 136, conductor 82, contacts 57 and 59, conductor 76, contact 134, contact 137, conductor 75, contact 60, conductor 74, contact 138, and winding of the third counting relay to battery. On energizing, the third counting relay locks itself, breaks the locking circuit of the second counting relay, and prepares a circuit for the fourth counting relay. The circuit arrangements at the third counting relay are the same as those at first and ninth counting relays, while the fourth counting relay is arranged the same as the second and tenth counting relays.

It will be clear from the foregoing that the test relay 32 cannot energize so long as the counting relays connect up test conductors of busy trunk lines. The counting relays, on the other hand, energize in succession in the manner described until the test conductor of an idle trunk line is connected up. It will be assumed

that the eleventh trunk line is the first idle trunk line, and accordingly relay 111 will be energized in due course, following the energization of the preceding relays in the manner explained.

On energizing, relay 111 locks itself at contact 142, at the same time breaking the locking circuit of counting relay 110. The latter relay therefore deenergizes. Relay 111 also connects up the test conductor 171 of the eleventh trunk line at contact 173, and at contact 172 extends the test conductor through to relay 112. Relay 112, however, is not energized, due to the absence of ground potential on test conductor 171, and to the operation of the test relay 32.

When relay 111 energizes, two parallel circuits are established for the test relay. One of these circuits extends from ground by way of contact 58, winding of test relay 32, contacts 57 and 59, conductor 76, contacts 134, 137, etc., including contact 172, and winding of relay 112 to battery. The other circuit extends from ground by way of contact 58, winding of test relay 32, conductor 82, contact 173, test conductor 171, and contact of group relay 120 to test conductor 132, and thence to battery through the lower winding of the change-over relay in the second selector. As previously explained, the battery potential indicative of the idle condition of the trunk line is placed on the test conductor through the winding of the change-over relay. The current flow through the test relay and over the last described circuit is sufficient to operate the test relay, the energization of the relay being expedited somewhat at the start by the current flow over the first described circuit extending back over conductor 76 to relay 112. The circuit through relay 112 is broken at contact 57 as soon as relay 32 has partially operated and consequently relay 112 cannot energize.

The test relay 32 also closes a circuit for the switching relay 26, extending from ground by way of contact 152, conductor 85, contact 56, and winding of relay 26 to battery. On energizing, relay 26 locks itself at contact 39 to the grounded test conductor 24. Other results of the energization of relay 26 will be described.

At contact 38, relay 26 disconnects conductor 70 from the test conductor 24 and thus removes ground from conductor 70, which breaks the locking circuits of relays 33 and 35. These two relays accordingly deenergize. Also at contact 38 relay 26 extends the incoming test conductor 24 to conductor 82 and thence over conductor 171 to test conductor 132 of the selected idle trunk. At contact 40 relay 26 places ground on the holding conductor 25 and disconnects ground from contact 41 of the line relay, which latter operation prevents the line relay from sending another impulse to relay 31 when the line relay falls back an instant later. Finally, at contacts 36 and 37, relay 26 disconnects the incoming trunk conductors 22 and 23 from the windings of the line relay 27 and extends them by way of conductors 80 and 81, contacts 66 and 67, conductors 89' and 81', contacts 174 and 175, conductors 176 and 177, contacts of group relay 120, and line conductors 130 and 131 of the selected idle trunk to the line relay of the second selector in which such trunk terminates.

The line and release relays in the second selector are accordingly energized and the latter relay places ground on the test conductor 132. Thus ground potential is extended back over conductors 132, 171, and 82 to the test conductor 24

to maintain this conductor grounded and to hold the switching relay 26 energized. The line relay 27 deenergizes when it is disconnected and the release relay deenergizes an instant later. The falling back of the latter relay is without effect at this time, for the test conductor 24 has been grounded at the second selector and the holding conductor 25 has been directly grounded at relay 26, all as previously described.

The operation of the selector has now been completed. The tenth group of trunks has been selected by the operation of the counting relays in response to the dialling of the digit 0 and the eleventh trunk in such group has been selected and connected with automatically. The connection is maintained by relays 26, 111, and 120. When the subscriber dials the remaining digits of the called number, the connection is further extended to the called subscriber's line in known manner, through the operation of the second selector which has been connected with one or more additional selectors if the size of the system is such as to require their use, and a connector.

When the calling subscriber hangs up his receiver, the connection is released. The replacement of the receiver opens the bridge across the line, which brings about the deenergization of the line and release relays, usually located at the connector, which control the maintenance of the connection. The deenergization of the release relay removes ground from the test circuit, extending back through the selector or selectors and permits them to restore to normal. At the selector shown herein, the removal of ground from test conductor 132 breaks the circuit of the switching relay 26, which deenergizes and removes ground from conductors 71 and 72, permitting relays 120 and 111 to deenergize. The selector is thus restored to normal. Relay 26 also removes ground from the holding conductor 25, which permits relays 20 and 21 to restore. The removal of ground from test conductor 24 deenergizes the subscriber's cut-off relay and removes the busy potential from the test conductor 14, which makes the line of station A accessible to incoming calls. Thus all the equipment, the operation of which has been described, is restored to normal condition and is ready for use in establishing other connections.

Certain features of the operation of the selector which it was not convenient to describe before may now be discussed briefly. One of these features has to do with the operation of testing for idle trunks. It has been explained that busy trunks are characterized by having a ground potential on their test conductors, whereas the test conductors of idle trunks have battery potentials on them, and it has been further explained that the ground potentials on the test conductors of busy trunk lines operate the counting relays while the battery potential on the first idle trunk operates the test relay. It may now be pointed out that the presence of a ground potential on the test conductor of a trunk line is not necessary in order to effect the continuance of the hunting operation, which will continue until a trunk line having battery potential on its test conductor is found, trunk lines the test conductors of which have no potential on them at all being passed by as well as those having grounded test conductors.

In order to explain the foregoing, it may be assumed that the operation of testing for an idle trunk line has been started and that relay 101

has energized, connecting up the test conductor 161 of the first trunk line. It may be further assumed that conductor 161 has neither a ground potential nor a battery potential on it. This condition may be due to trouble of some kind, such as a dirty contact or a broken connection. Under these circumstances the test relay 32 cannot energize over test conductor 161, due to the absence of battery potential thereon, nor can the relay 102 energize over said test conductor, due to the absence of ground potential. Relay 102, however, energizes over another circuit extending from ground by way of contact 58, winding of test relay 32, contacts 57 and 59, conductor 76, contact 134, and winding of relay 102 to battery. Relay 102 is of relatively high resistance, and relay 32 cannot energize in series with relay 102, or any of the other counting relays. Accordingly, the hunting operation proceeds, the counting relays being energized normally by ground potential on the test conductors of busy trunk lines, but energizing in series with the test relay in case trunk lines are tested which have no potential on their test conductors.

In view of the foregoing, it will be understood that the test relay 32 is a so-called marginal relay, of relatively low resistance, which is incapable of energizing in series with a high resistance counting relay, but is adapted to energize in series with the lower winding of a change-over relay, through which battery potential is placed on the test conductor of a trunk line to indicate the idle condition thereof. The lower windings of the change-over relays are of lower resistance than the windings of the counting relays. The resistance of the change-over relays is, however, so proportioned to the operating characteristics of the test relays that two test relays in parallel cannot energize in series with a change-over relay, which prevents two selectors which may happen to be searching at the same time from selecting the same idle trunk.

It will have been noted that the conductors 80 and 81 extend direct to contacts of the even numbered counting relays, whereas the odd numbered counting relays are reached by way of the branch conductors 80' and 81'. The latter conductors are normally connected to conductors 80 and 81, respectively, but are disconnected therefrom by relay 35, which is energized when dialling begins and remains energized until the automatic trunk hunting operation is completed. The purpose of this arrangement is to prevent the momentary connecting together of adjacent trunk lines during the hunting operation of the selector. Relay 102 is energized, for example, before relay 101 is deenergized, and if conductors 80 and 81 were connected to contacts of both relays 101 and 102, the first and second trunk lines of the group selected by the energized group relay would be momentarily connected together. The use of separate pairs of conductors extending to the connecting contacts of the odd and even counting relays, which are not connected together until relay 35 deenergizes after the trunk hunting operation is completed, avoids the disturbance which would otherwise take place on adjacent busy trunk lines when tested by a selector in search of an idle trunk line.

For a similar reason two separate marking conductors such as 77 are provided, and are connected up alternately by relay 31. The marking contacts of adjacent counting relays therefore do not have a common multiple, and the danger of operating additional group relays during the

hunting operation of the selector is avoided. For example, in the described connection the tenth group relay 120 was energized. This relay being locked up, ground is extended back to contact 155. Now when relay 110 is energized during the searching operation, ground is extended to conductor 77 by way of contact 155, and if conductor 77 was multipled to the marking contacts of relay 109 a circuit would be closed for the ninth group relay, since relay 110 energizes before relay 109 deenergizes. The provision of separate conductors leading from relay 31 to the marking contacts of the odd and even counting relays prevents such false operation of the group relays.

The operation and function of the overflow relay 113 may now be explained. In case all the trunk lines of a selected group are found to be busy, all of the relays 101 to 112, inclusive, will be energized in succession during the hunting operation and following the energization of the last relay 112 the overflow relay 113 will be energized in an obvious manner, the circuit being similar to the circuits over which relays 109 and 111 are energized. On energizing, relay 113 locks itself at contact 153, and at the same point breaks the locking circuits of relays 33 and 35, which accordingly deenergize. At contact 149, relay 113 breaks the locking circuit of relay 112, and this relay deenergizes. At contact 147 relay 113 places direct ground on the locking circuit of the energized group relay, which may be assumed to be relay 120. Finally, at contact 154, relay 113 connects a source of busy signalling current to the calling line and the calling subscriber is given the busy signal.

On hearing the busy tone, the calling subscriber will hang up his receiver, whereupon the line relay 27 is deenergized, followed an instant later by the deenergization of the release relay 28. A circuit for operating the overflow register for the tenth group of trunk lines is thereupon established, said circuit extending from ground by way of contacts 40, 41, and 44, conductor 99, contact 148, lower contact of group relay 120 and conductor 180 to the overflow register (not shown), and thence to battery. At the same time that the above circuit is completed, relay 28 removes ground from the test conductor 24, also from conductor 10, and breaks the locking circuit of relay 113. This relay is slow to deenergize, however, and remains in operated position long enough for the overflow register to be actuated. When relay 113 finally restores, the locking circuit of the group relay 120 is broken at contact 147 and the group relay restores also.

The circuits are so arranged that the overflow relay 113 is also operated in case the digit 1 is dialled, accidentally or otherwise. Since the first trunk group is not assigned at the first selectors, no telephone numbers start with the digit 1, and hence the receipt of a single isolated impulse or line circuit interruption at a first selector must be due to the calling subscriber dialling a wrong number, or to an accidental opening of the line circuit such as may be produced by careless removal of the receiver. Such accidental interruptions of the line circuit are known as preliminary impulses.

Assuming that the selector shown herein has been taken for use as previously described, if a single interruption is produced in the line circuit, the line relay 27 is momentarily deenergized once and relays 31 and 30 are energized. Relay 31

closes a circuit for the first counting relay 101, which energizes and locks itself, at the same time opening the initial energizing circuit of relay 34. Relay 35 now energizes in series with relay 34, locks itself to conductor 79, and breaks the initial energizing circuit of the change-over relay 29. The change-over relay is energized over its upper winding during the time that the line relay 27 is deenergized, but falls back shortly after the line relay resumes its energized position. On restoring, relay 29 closes a marking circuit extending from ground by way of contact 45, contact 65, contact 49, contact 54, contact 135, and winding of the overflow relay 113 to battery.

When the overflow relay 113 energizes over the foregoing circuit it locks itself at contact 153. At contact 151, relay 113 removes ground from conductor 72, which causes relay 34 to deenergize, as well as relays 30 and 31. Relay 35 also deenergizes, due to the breaking of its locking circuit at contact 153 of relay 113. At contact 140, relay 113 breaks the locking circuit of relay 101, which deenergizes. Thus only the line and release relays and the overflow relay remain in energized position. At contact 154 the overflow relay connects the busy tone circuit to the calling line, and the calling subscriber is given the busy signal. When the calling subscriber replaces his receiver, the line and release relays are restored, and the connection to the selector is released as previously described. The removal of ground from the conductor 70 breaks the locking circuit of the overflow relay, which accordingly deenergizes.

The invention having been described, that which is believed to be new and for which the protection of Letters Patent is desired will be pointed out in the appended claims.

What is claimed is:

1. In an automatic selector switch, means including a series of counting relays directly controlled in accordance with a digit of a called number for selecting any one of a plurality of groups of trunk lines, and means effective automatically responsive to the completion of the group selection for reoperating said counting relays to search for an idle trunk line in the selected group.

2. In an automatic switch of the relay type, a plurality of group relays each adapted to establish connections simultaneously with a group of trunk lines, means including a chain of counting relays directly controlled in accordance with a digit in a called number for selecting and energizing one of said group relays, thereby selecting the associated group of trunk lines, and means for operating said counting relays automatically to search for and connect with an idle trunk line.

3. In an automatic switch of the relay type, a plurality of group relays each adapted to establish connections with a plurality of trunk lines, a chain of counting relays directly controlled in accordance with a variable series of digit impulses for selecting one of said group relays, means for automatically energizing the selected group relay at the end of said series of impulses, and means for reoperating said counting relays automatically to select an idle trunk in the group connected with by the energized group relay.

4. In an automatic switch of the relay type, a plurality of group relays each adapted to establish connections with a plurality of trunk lines, a chain of counting relays directly controlled in accordance with a variable series of digit impulses for selecting one of said group relays,

means responsive to the termination of said series of impulses for energizing the selected group relay, means responsive to the energization of the selected group relay for starting the automatic operation of said counting relays to search for an idle trunk line in the group connected with by the energized group relay, and circuits including the test conductors of busy trunk lines for continuing the automatic operation of said counting relays until an idle trunk line is found.

5. In an automatic switch adapted to perform directive and automatic selective operations, a line relay, a test relay, a series of counting relays, means for operating said counting relays under the control of said line relay during the directive operation of said switch, and means for operating said counting relays under the control of said test relay during the automatic operation of said switch.

6. In a relay type selector switch, trunk group connecting relays, counting relays individual to said connecting relays, respectively, a circuit for each connecting relay including contacts on its associated counting relay, sets of trunk connecting contacts on each of said connecting relays, a trunk incoming to said selector switch, and contacts on said counting relays for extending said incoming trunk to any contact set on any connecting relay.

7. In an automatic selector switch, means including a series of counting relays directly controlled in accordance with a digit of a called number to select any one of a plurality of groups of trunk lines, one or more of said trunk groups comprising a number of trunk lines which is greater than the number of counting relays, additional relays equal in number to the difference between the number of counting relays and the number of trunk lines in the largest group, and means responsive to the completion of a group selecting operation for automatically operating said counting relays and said additional relays to select an idle trunk line in the selected group.

8. In a relay type selector switch, an incoming trunk, a plurality of groups of outgoing trunks, a series of counting relays controlled over said incoming trunk to select a group of outgoing trunks, a larger series of relays including the relays of said first series, means for automatically and successively operating the relays of said last mentioned series to test the trunk lines of the selected group in rotation until an idle trunk is found, and means including contacts on the last operated relay for connecting said incoming trunk to the selected idle outgoing trunk.

9. In a selector switch, a group relay having contacts for simultaneously connecting up a group of trunk lines, a series of counting relays greater in number by one than the number of trunk lines in said group, means controlled over a calling line for operating a predetermined number of said counting relays to energize said group relay, means for automatically operating a variable number of said counting relays to search for an idle trunk line in said group, said last means being effective to operate all of said counting relays in case all of said trunk lines are busy, and means including the last counting relay for transmitting a busy signal over the calling line.

10. In a relay type selector switch, a plurality of group relays, each adapted to close connections to a group of trunk lines, a plurality of counting relays operable to select a desired group

of trunks by energizing one of said group relays and also operable to select an idle trunk in the selected group, an overflow relay and means for energizing it in case all the trunk lines in the selected group are busy, and a register circuit controlled jointly by said overflow relay and the energized group relay.

11. In a relay type selector switch having access to groups of trunk lines, counting relays controllable over a calling line for performing a directive operation to select one of said groups of trunk lines, means for operating said counting relays to perform an automatic searching operation for an idle trunk in the selected group, means including an overflow relay for connecting a busy signalling device to the calling line, and means for operating said overflow relay in response to a particular directive operation and also in response to an unsuccessful searching operation.

12. In a relay type selector switch, a series of counting relays, means for utilizing said series of relays for performing directive and automatic selective operations, two separate control conductors over which the odd and even numbered counting relays are operated, respectively, during the directive operation of the switch, a common operating conductor and means for connecting it to one of said control conductors during the automatic operation of the switch, and contacts on the relays operated over such control conductor which are rendered effective during the automatic operation of the switch for connecting the said control conductors together.

13. In a relay type selector having access to a group of trunk lines, a series of relays adapted to hunt for an idle trunk in said group, a test circuit for successively energizing said relays and comprising two sections, contacts on each of said relays for extending one section of said test circuit to the next adjacent relay, other contacts on said relays for extending the other section of said test circuit to the test conductors of said trunk lines one after the other, and a test relay connected to the junction of said sections.

14. In a relay type selector switch having access to a group of trunk lines, a trunk testing arrangement comprising a test relay, a series of connecting relays for closing connections to the test conductors of said trunk lines in succession, and circuit arrangements such that said test relay is energized by potential of one polarity on any one of said test conductors, whereas said connecting relays are energized by potential of the opposite polarity on said test conductors, respectively, or by current flow through said test relay in the event that a connection is closed to a test conductor on which no potential is present.

15. In a relay type selector, a plurality of group relays, a series of counting relays, means controlled over a calling line for directing operation of said counting relays to select one of said group relays, means including a chain circuit extending through contacts of said counting relays whereby each relay on energizing locks itself and unlocks the preceding relay, means for energizing the selected group relay, means including a chain circuit extending through contacts of all said group relays for locking any group relay when energized, and connections for supplying current to the counting relay chain circuit through the group relay chain circuit, whereby the energization of any group relay will deenergize the last operated counting relay.

16. In a relay type selector switch, a plurality

of group relays each adapted to select a group of trunks, a series of counting relays, means for directly controlling said counting relays to select one of said group relays, a locking chain circuit extending through contacts of said counting relays, a locking chain circuit extending through contacts of said group relays, connections for supplying current to the counting relay chain circuit through the group relay chain circuit during the directive operation of the switch, means for energizing the selected group relay, whereby the group relay chain circuit is broken, means for automatically operating said counting relays to select an idle trunk in the group associated with the selected group relay, and means responsive to the breaking of the group relay chain circuit for supplying current to the said counting relay chain circuit during the automatic operation of the switch over a path independent of said group relay chain circuit.

17. In a relay type selector switch, group relays each having a plurality of sets of trunk connecting contacts, a series of counting relays, an incoming trunk having two branches, one branch extending to the odd numbered counting relays and the other extending to the even numbered counting relays, contacts on the counting relays for extending said branches to contact sets on said group relays, means for successively operating said counting relays, and a relay for maintaining said branches disconnected from each other while said counting relays are being operated.

18. In a relay type selector switch, group relays, a series of counting relays, a control relay energized after each odd selector controlling impulse and deenergized after each even selector controlling impulse, circuits over which said control relay successively operates said counting relays, a marking conductor having two branches, contacts on said control relay for alternately connecting said branches to said marking conductor, contacts on the odd numbered counting relays for extending one branch to the odd numbered group relays, and contacts on the even numbered counting relays for extending the other branch to the even numbered group relays.

19. In a relay type selector switch, a series of counting relays, means for utilizing said relays to perform a directive selecting operation and subsequently an automatic searching operation, a chain circuit extending through serially related contacts on said relays which is maintained open at successive relays while said relays are performing said directive selecting operation, means for deenergizing any relay remaining operated at the end of said directive selecting operation, thereby closing said chain circuit, and a relay energized over said chain circuit responsive to such closure for starting said automatic searching operation.

20. In a relay type selector switch, a series of counting relays, a chain circuit extending through serially related contacts on said relays, means

for successively operating said relays in accordance with a digit in a called number, said chain circuit being broken by the first operated relay, and an off normal relay energized responsive to the breaking of said chain circuit.

21. In a switching system, an automatic switch of the relay type, groups of lines accessible to said switch, group relays assigned respectively to said groups of lines, local line conductors in said switch, a chain of counting relays directly controlled in accordance with a variable series of digit impulses for selecting and operating any one of said group relays, each group relay adapted when operated to connect said local line conductors respectively with the lines of the group to which such group relay is assigned, said counting relays being adapted to select and connect with any one of said local conductors, and means effective after group connection has been made for variably repositioning said counting relays to effect connection by way of any one of said local conductors with the corresponding line in the connected group.

22. In a switching system, an automatic switch of the relay type, groups of lines accessible thereto, a separate group relay in said switch for each of said groups of lines, a series of counting relays and means for directly operating them to effect the operation of any one of said group relays, said group relays being adapted when operated to make connections to the respective lines in the associated group, and means controlled through said connections for variably repositioning said counting relays in accordance with the respective conditions of the selected lines.

23. In a switching system, an automatic switch of the relay type, groups of lines accessible thereto, a separate group relay in said switch for each of said groups of lines, a series of counting relays and means for directly operating them to effect the operation of any one of said group relays, said group relays being adapted when operated to make connections to the respective lines in the associated group, means controlled through said connections for variably repositioning said counting relays in accordance with the respective conditions of the selected lines, said counting relays being adapted when repositioned to extend the one of said connections corresponding to the repositioning effected.

24. In a switching system, an automatic switch of the relay type, groups of lines accessible to said switch, group relays in said switch corresponding respectively to said groups of lines, individual relays in said switch corresponding respectively to the individual lines in a group, means for directly operating the individual relays successively to select and operate any one of said group relays to select a group of lines, and means for subsequently operating any one of said individual relays to effect connection with the corresponding line in the selected group.

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