Feb. 11, 1936. S. B. WILLIAMS 2,030,419

TELEPHONE EXCHANGE SYSTEM

Filed Oct. 24, 1934 2 Sheets-Sheet 1

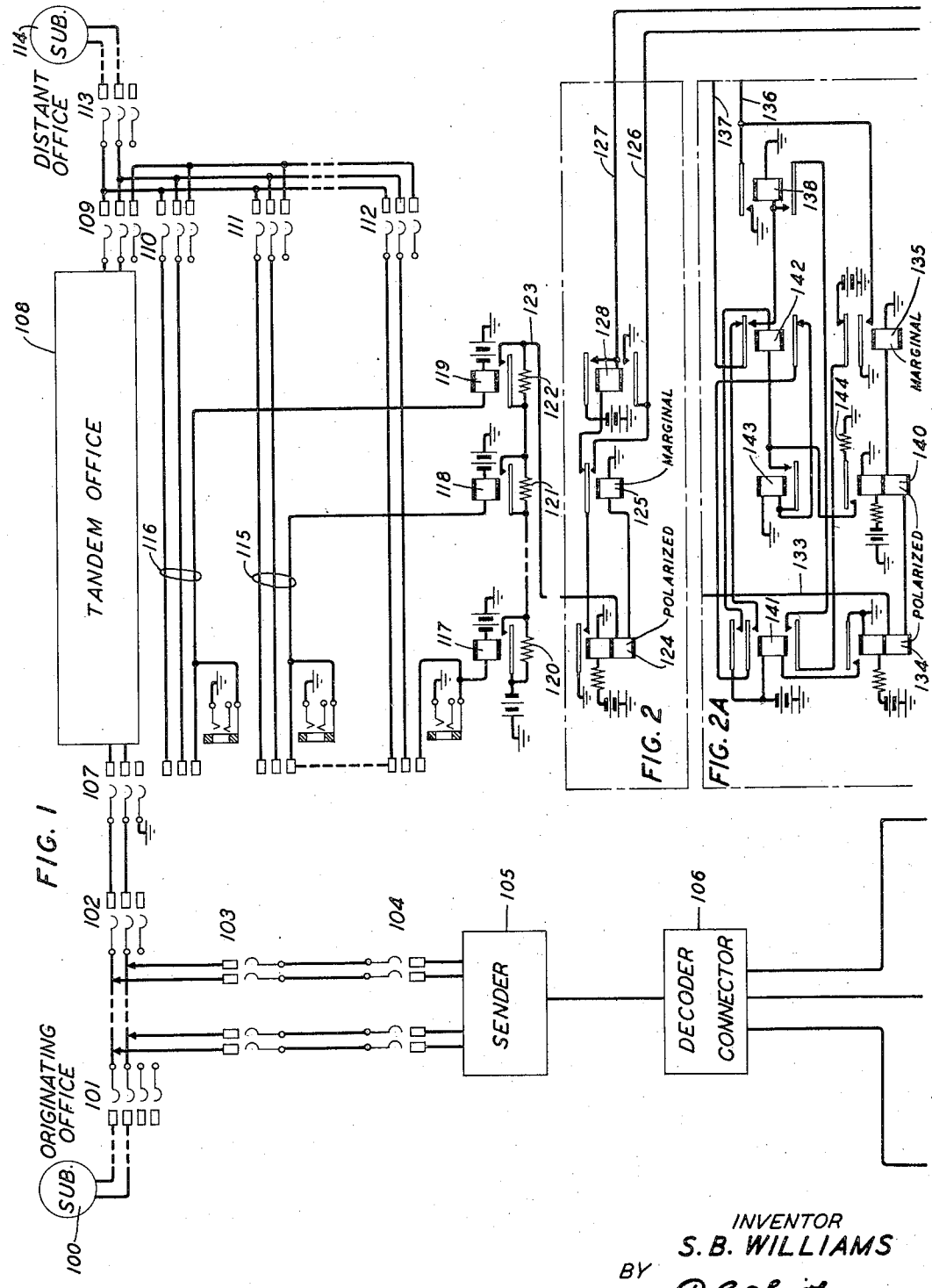

FIG. 1

FIG. 2

FIG. 2A

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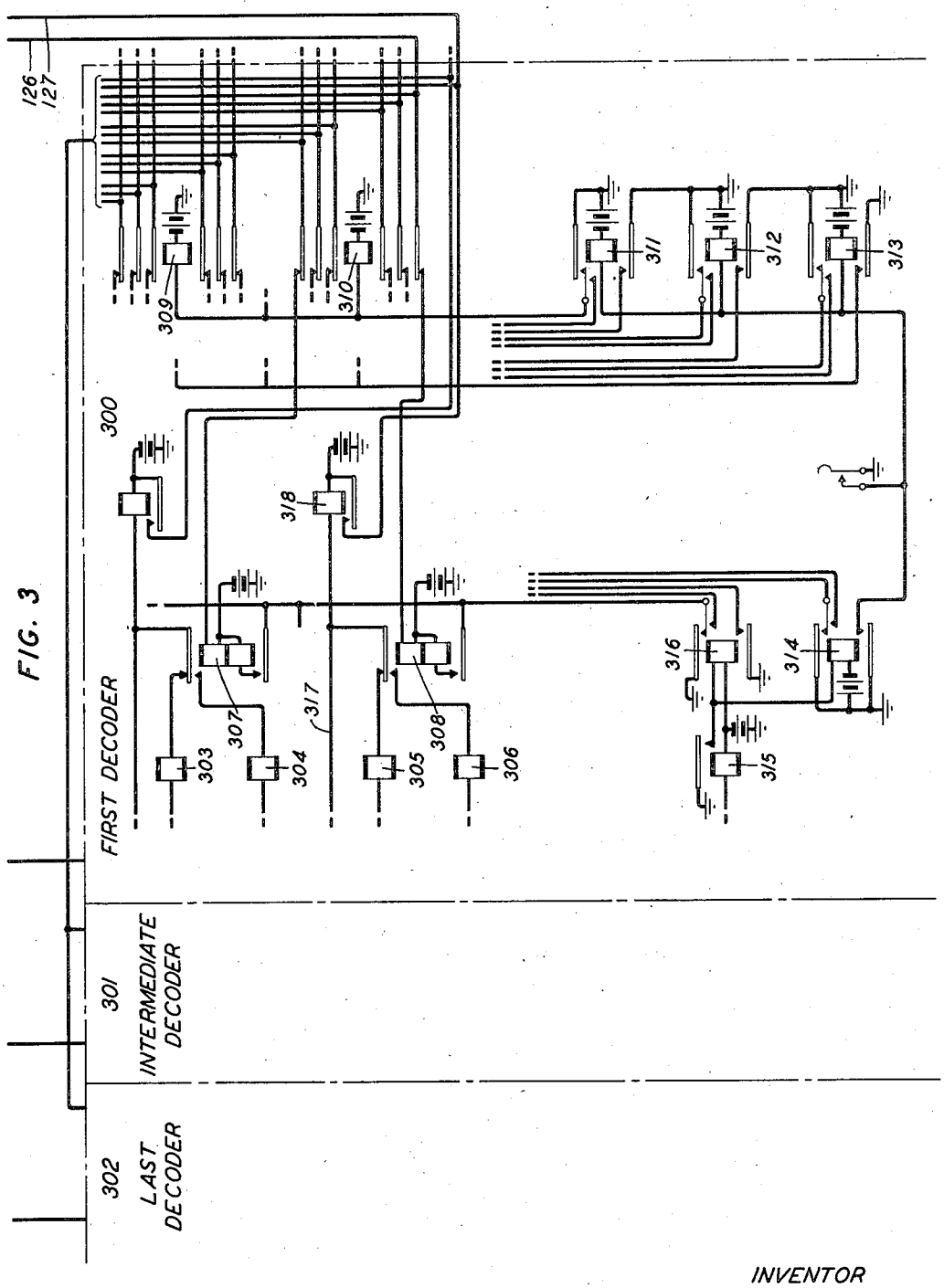

FIG. 3

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TELEPHONE EXCHANGE SYSTEM

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9 Claims. (Cl. 179—18)

This invention relates to telephone exchange systems and more particularly to systems in which connections between subscribers' lines terminating in different offices of the exchange area are established by automatic switching mechanism over groups of interoffice trunks.

In exchange areas having a large number of local offices it is not economical to provide direct groups of trunks for interconnecting each office with every other office, particularly where the offices are widely separated and the traffic load is heavy. In some exchange areas therefore it is more economical to route traffic between certain offices through a tandem office which serves as a common intermediate distributing point.

It has heretofore been proposed to render more efficient the trunks in a group directly interconnecting any two offices by limiting the number of the direct trunks to the maximum required for handling normal traffic between such offices and by automatically rerouting the abnormal or overflow traffic between such offices to a tandem office where the traffic may be directly routed to the desired office. This proposal also enables existing direct trunk groups between offices to be employed without the addition of further trunks thereto when traffic loads increase beyond the capacity of such trunk groups by rerouting calls through a tandem office. To accomplish the rerouting of calls through a tandem office in systems employing central office senders which control the setting of selector switches to establish connections, the sender must receive a signal when all trunks of a direct trunk group extending to an office are busy in order that the sender may take the necessary steps to reroute the next connection for that trunk group over a different trunk group extending to the tandem office which in turn has direct trunks also extending to the desired office. This signal depends upon the closure of a chain circuit controlled by the trunks of the direct group when all trunks of the group become busy.

A sender may be given information to route a call to a trunk of a direct trunk group extending to a desired office and proceed to cause the selection of a trunk in such group when there is only one idle trunk in the group and since an interval of approximately 4.5 seconds may elapse before a selector switch controlled by the sender is actually positioned on the terminals of the idle trunk, the trunk may during this interval become seized in a previously initiated call and the later initiated call will not then be capable of completion as the selector switch would be driven to the direct trunk group overflow position. To guard against this condition, it is the object of this invention to signal the sender when there is still one available idle trunk and also when there is no idle trunk in a trunk group in order that rerouting to a tandem trunk group may be effected without the hazard of encountering a false overflow condition. It is a further object of the invention where traffic conditions are such as to warrant it to signal the sender when there are still two available idle trunks, again when there is only one available idle trunk and again when there is no idle trunk in a trunk group in order that rerouting may be made at a time when it will be most accurately effective.

In systems of the type disclosed in Patent 1,862,549 granted June 14, 1932 to R. Raymond and W. J. Scully the establishment of connections from an originating office to any other office of the exchange area is made possible by district and office selectors which are set to select an idle trunk of the group of trunks extending to the office in which a desired subscriber's line terminates by a sender common to all subscribers' lines of the originating office. A plurality of senders, any of which may be taken for use by a calling line, is provided, each sender having registers for registering both the office and numerical designations of a desired line dialed by a calling subscriber, and controlling apparatus for controlling the setting of a district and an office selector to extend a connection to the office in which the desired line terminates and for controlling other apparatus in the selected office for completing the connection. A plurality of decoders is also provided common to all of the senders, an idle one of which becomes associated with a sender taken for use by a calling subscriber. The decoder is provided with office code registers to which the office code is transferred from the registers of the associated sender and which is also provided with as many route relays as there are trunking points to which calls may be trunked from the originating office. The combined setting of the office code registers of the decoder determines which one of these route relays shall be operated for any particular call. The operated route relay is then instrumental in establishing in the associated sender a registration of the class of the call and a decoded office code registration for directing the sender to control the setting of the district and office selector switches or the setting of the district selector alone to select a group of trunks extending to the office in which the desired line terminates.

In accordance with one modification of the invention, each trunk group extending directly from one office to another office, to which it is desirable to apply alternate routing through a tandem office, is provided with a chain circuit having two relays associated therewith, one of which operates only when all but one of the trunks of the group are busy and the other of which operates when all trunks of the group are busy. Associated with each decoder are as many reroute relays individualized to each direct trunk group as there are direct trunk groups to which the rerouting feature is to be applied.

When there is only one idle trunk in the direct trunk group extending to a desired office, the chain circuit associated with such trunk group is so established through contacts of operated relays of the trunks of that trunk group as to cause the operation of the first of the relays associated with the chain circuit to signal all decoders that there is but one idle trunk. When thereafter a decoder is taken for use by a sender and the registration transferred thereto from the associated sender indicates that a call is to be routed to this trunk group, the route relay of the decoder which is instrumental in causing the routing of the calls to this trunk group will be operated and the sender will be caused to set selector switches to seize the remaining idle trunk of the trunk group. As soon as the sender has received the translated code from the route relay of the decoder, the decoder is dismissed and then the reroute relay in each decoder allotted to the particular trunk group is operated preparatory to rerouting the next call incoming to any decoder for that particular trunk group to a tandem trunk group extending to a tandem office through which calls may be extended to the office in which the desired line terminates. As soon as the last idle trunk of the direct trunk group has been seized by a selector switch, the chain circuit is altered in such a manner that the second relay associated therewith signals all decoders that there are no more idle trunks in the direct trunk group and maintains the reroute relays of all decoders appertaining to such trunk group operated. When thereafter any decoder is seized by a sender, with the reroute relay operated, the office code registers of the decoder cause the operation of a tandem route relay for routing the calls through a tandem office to the office indicated by the office code rather than the operation of the direct route relay. Should one or more trunks of the direct trunk group thereafter become idle the reroute relay appertaining to that trunk group in each decoder is released and the next subsequent call for that group of trunks will again be routed thereto. Thus the relays associated with the chain circuit of a trunk group are instrumental in counting one idle trunk and informing all decoders when such condition exists. This insures satisfactory operation of the rerouting feature of decoders when direct trunk groups do not have more than ten trunks and the proportion of the traffic to be rerouted through a tandem office will not exceed 20 per cent.

Where direct trunk groups have more than ten trunks and the proportion of the traffic to be rerouted through a tandem office exceeds 20 per cent, a more satisfactory operation of the rerouting feature of decoders may be made by employing a circuit such as disclosed in the second modification of the invention. In accordance with this modification, each direct trunk group to which it is desirable to apply alternate routing is provided with a chain circuit having three relays associated therewith, one of which operates only when all but two of the trunks of the group are busy, a second of which operates only when all but one of the trunks are busy, and a third of which operates when all trunks are busy. This circuit is therefore enabled to count two idle trunks and to prepare all decoders sufficiently in advance of the actual seizure of the last two idle trunks of the group for rerouting calls through a tandem office when there are no available idle trunks in the direct trunk group to a desired office.

For a clearer understanding of the invention reference may be had to the following detailed description taken in connection with the accompanying drawings of which:

Fig. 1 shows schematically a calling subscriber's line, a line finder, district selector, office selector, link circuit, sender and decoder-connector of an originating office; a subscriber's line, incoming selectors and a final selector of a distant office; a group of direct trunks extending between the offices; and a tandem office indicated by a rectangle through which connections may also be established between the originating and distant offices;

Fig. 2 shows a circuit for counting when all but one of the trunks of the direct group of Fig. 1 are busy and for counting when all trunks of the group are busy;

Fig. 2A shows a modification of the circuit of Fig. 2 for counting when all but two, all but one and all trunks of a direct group are busy; and

Fig. 3 shows such portions of one decoder accessible from the decoder-connector of Fig. 1 as are necessary to an understanding of the invention and other decoders schematically illustrated by the dot-dash rectangles also accessible from the decoder-connector.

The line finder **101**, district selector **102**, office selector **107**, district finder **103** and sender selector **104** of the link circuit, sender **105** and decoder-connector **106** being of the well-known type and functioning in the usual manner have, for the purpose of simplifying the drawings, been disclosed only schematically herein. For a complete disclosure and description thereof, reference may be had to Patent No. 1,862,549, granted to R. Raymond and W. J. Scully, hereinbefore referred to. The decoder **300**, only such portions of which as are deemed necessary to an understanding of the present invention have been disclosed, is of the type disclosed in the aforementioned patent. The tandem office equipment indicated by the rectangle **108** of Fig. 1 is of the type disclosed in detail in Patent No. 1,840,132, granted January 5, 1932 to T. H. Roberts. The incoming selectors **109** to **112**, inclusive and the final selector **113** are also of the well-known type and therefore have been only schematically disclosed.

In order that the invention may be more clearly understood, it will be assumed that the subscriber at substation **100** of an originating office of an exchange area desires to establish a connection with a subscriber's line **114** which terminates at a distant office of the same exchange area and, upon removing his receiver from the switchhook, obtains a connection with an idle sender **105** in the originating office through the operation of the line finder **101**, district finder **103** and sender selector **104** in the well-known manner and then dials the office code letters and numerical digits of the directory number of the wanted line **114**.

In response to dialing, the office code and numerical designations are registered in the sender in the well-known manner and following the registration of the letters of the office code designation the decoder-connector **106** is operated to associate an idle one of a plurality of decoders with the sender. Three of the plurality of decoders are indicated by the rectangles **300**, **301** and **302** of Fig. 3. Assuming that the first decoder **300** is at the time free, the decoder-connector **106** causes the association thereof with the sender **105** and operates the decoder start relay **315**.

Each decoder is provided with the usual receiving registers to which an associated sender transfers the registered office code designations, a route relay corresponding to each route over which connections may be extended from the originating office and transmitting registers which are selectively set by any operated route relay. The transmitting registers are employed to transfer routing information to registers of the associated sender which in turn control the functioning of the sender to establish the desired connection over district and office selectors, or over a district selector only, by the route indicated by the operated route relay of the decoder. Four of the route relays of decoder **300** are disclosed, of which relays **303** and **305** designate direct routes over which connections may be established from the originating office directly to different distant or terminating offices and relays **304** and **306** designate tandem routes extending from the originating office to different tandem offices. If it be assumed that there are two hundred local terminating offices in the exchange area, there would be two-hundred direct route relays such as **303** and **305** and as many tandem route relays such as **304** and **306** as there are tandem offices in the area to which the originating office has access.

In addition to the usual equipment the decoder is also provided with a reroute relay corresponding to each direct route to which it is desirable to apply alternative routing. Two of these reroute relays **307** and **308** have been disclosed. With the recoder idle, the operating winding of each reroute relay is normally connected to the trunk group busy conductor of the group of direct interoffice trunks forming a part of the corresponding direct route, over the back contact of a cut-off relay. Nine groups of such cut-off relays of four relays each may be provided, or thirty-six relays, over the back contacts of which the trunk group busy conductors of as many as two hundred direct groups of trunks may normally extend to the two hundred reroute relays, if it should be required that alternative routing be applied to all direct routes. Two of these cut-off relays **309** and **310** have been disclosed. The nine groups of cut-off relays are in turn controlled by a smaller group of three relays **311**, **312** and **313** which are in turn controlled by relay **314** and the decoder start relay **315**. Thus, when the decoder is seized and the start relay **315** operates, relays **314**, **311**, **312** and **313** and all cut-off relays, such as **309** and **310**, operate in cascade to disconnect the operating windings of all reroute relays of the decoder from the corresponding trunk group busy conductors. An additional relay **316** is also provided which operates in parallel with relay **314** for providing locking grounds to the locking windings of all reroute relays. The start relay **315** also functions in the usual manner to initiate the registration and translation functions of the decoder.

It will first be assumed that at the time decoder **300** is seized by the decoder-connector **106**, the direct route extending to the office in which the wanted line **114** terminates is available and that all but the last two trunks **115** and **116** of the group of trunks included in this route are busy, as indicated by the operated condition of their sleeve relays such as relay **117**. Associated with each sleeve relay is a resistance, the resistances associated with relays **117**, **118** and **119** being disclosed at **120**, **121** and **122**, respectively. Each resistance has a normally open shunt extending over contacts of the sleeve relay with which it is associated, and all of the resistances, when all of the trunks of the group are idle, are normally connected in a chain circuit extending from grounded battery therethrough in series to conductor **123** and thence in series through the lower operating winding of relay **124** and the winding of relay **125** to ground. Relay **124** is a polarized relay, electrically biased by the circuit through its upper winding, and so adjusted that it will operate in series with one of the resistances, but will not operate or will release in series with two or more of the resistances. Relay **125** is margined to operate only when all resistances have been removed from the chain circuit. It will thus be apparent that as each trunk of the group is taken for use, one of the serially connected resistances will become shunted by the operation of the trunk sleeve relay and that when all but one of the trunks of the group have been seized, all but one of the resistances will become shunted and relay **124** will therefore operate and, that when all trunks become busy and all of the resistances become shunted, marginal relay **125** will operate. The operation of relay **124**, therefore, is indicative that there is but one available or free trunk in the group and the operation of relay **125** is indicative that all of the trunks of the group are busy. It will, of course, be obvious that it is not necessary that the trunks be taken for use in any definite order.

Under the assumption that when decoder **300** is seized both trunks **115** and **116** are idle and that consequently neither relay **124** nor relay **125** is operated, there will be no ground potential on the trunk group busy conductor **126** individual to the group of trunks. The reroute relay **308** of the decoder allocated to the route of which this direct trunk group is a part will therefore be unoperated. Upon the seizure of the decoder and the operation of start relay **315**, the decoder then proceeds to register the office code designations of the wanted line transferred thereto from the office code registers of the sender and to translate such office code by marking the code point **317**. This causes the operation of relay **318** individual to the direct route of which the direct trunks of Fig. 1 are a part and the operation of the proper direct route relay **305** in a circuit extending over the upper back contact of reroute relay **308**. With route relay **305** operated the transmitting registers of the decoder are selectively set and the proper routing information is transmitted to the sender in the usual manner. Relay **315** also causes the operation of all cut-off relays such as **309** and **310** thereby opening the operating circuits of all route relays so that no reroute relay may be operated during the time that the decoder is making a routing thereby preventing the mutilation of the routing that is at the time in progress.

The sender after receiving the required rout-

ing information, dismisses the decoder by releasing the start relay 315 thereby in turn releasing all of the cut-off relays such as 309 and 310. Any reroute relay such as 307 or 308 may now be operated to change the routing on subsequent calls. The decoder may now be employed in connection with another call. The sender also proceeds to set the district selector 102 and the office selector 107 to extend the connection from the calling line to the proper trunk group extending to the office of the wanted subscriber, and the office selector proceeds to hunt for an idle trunk in the trunk group. It having been assumed that all but the last two trunks of the group are busy, the office selector will hunt over the terminals of busy trunks and will seize the first idle trunk or trunk 115. The sender will thereupon proceed to control the setting of the incoming selector 111 in which the trunk 115 terminates and the final selector 113 to complete the connection to the wanted line 114. Following the completion of its controlling functions the sender is dismissed in the usual manner.

Upon the seizure of trunk 115 its sleeve relay 118 is operated to shunt the resistance 121. Since now all but one of the trunks of the group are busy and therefore only one resistance 122 associated with the sleeve relay 119 of the only remaining free trunk 116, remains connected in the previously traced circuit through the operating windings of relays 124 and 125, relay 124 operates, but relay 125 does not. It will now be assumed that the decoder 309 is again seized due to the initiation of another call to the same distant office and that since the reroute relay 308 is still unoperated, there being no operating circuit therefor over trunk group conductor 126, the decoder in again marking the same code point 317 reoperates the relay 318 and the direct route relay 305. As before, the operation of route relay 305 causes the transmission of translated routing information to the sender whereupon the sender proceeds to extend a connection from the calling line to the desired office over the one remaining idle trunk 116 of the trunk group.

Relay 318 upon operating establishes a circuit from battery over its contacts, conductor 127, winding of relay 128, back contact of relay 125 to ground at the front contact of relay 124, relay 124 having operated as an indication that there is but one available idle trunk in the group. Relay 128 upon operating locks directly to battery independent of the control of relay 318 and connects ground to conductor 126. The operation of relay 128 therefore makes a count of the fact that there is but one remaining idle trunk in the associated trunk group. Until the decoder has completed its functions and been dismissed by the associated sender, the cut-off relays including relays 309 and 310 will remain operated and therefore the connection of ground to conductor 126 will not operate the reroute relay 308, thereby preventing the mutilation of the routing information at the time being established by the decoder.

When the last idle trunk in the group, for example, the trunk 116 is seized, its sleeve relay 119 shunts the last unshunted resistance from the previously traced circuit through the windings of relays 124 and 125 and relay 125 now operates. With both relays 124 and 125 operated, the locking circuit of relay 128 is opened and ground is connected to conductor 126 independently of relay 128 over the front contacts of relays 124 and 125. In the meantime, the decoder having completed its functions has been dismissed thereby releasing relays 315 and 318. With relay 318 released relay 128 now releases. Relay 315 upon releasing releases the operated cut-off relays such as 309 and 310 and, with ground connected to conductor 126 over the front contacts of relays 124 and 125, the reroute relay 308 is operated to transfer the code point 317 from the direct route relay 305 to the tandem route relay 306. A similar transfer is effected by the corresponding reroute relay in each of the other decoders.

If, now, any of the decoders is seized on another call, as for example decoder 309, and the start relay 315 thereof is operated, relays 314 and 316 will be operated, relay 316 establishing locking circuits for all operated reroute relays of the decoder. Reroute relay 308 will, therefore, be locked operated and, assuming that the information transferred to the decoder from the associated sender signifies that the connection desired is for a line terminating in the same distant office, the decoder will, because of the operated reroute relay 308, cause the operation of the tandem route relay 306 and the transmission of routing information to the sender whereby the sender will cause the setting of the district selector and an office selector to select and idle trunk extending to the tandem office 103. The sender will then transmit the necessary routing information to the sender of the tandem office whereby the connection may be further extended to the distant office. The connection is then completed in the distant office under the control of the tandem sender, for example over the incoming selector 109 and the final selector 113.

Should more than one of the decoders be handling a call for the same direct trunk group, for example, the trunk group disclosed in Fig. 1, at the time relay 124 thereof is operated, then as previously described when the decoders ground the code points 317, both calls will be routed toward the trunk group through the operation of direct route relay corresponding to route relay 305, but since there is but one free trunk in the trunk group, one of these calls will be lost. The relays of both decoders corresponding to relay 318 will also be operated causing the operation of relay 128 which will, in turn, cause the operation of the reroute relay of all decoders corresponding to relay 308 to inform the decoders that any subsequent call to that trunk group should be rerouted. These reroute relays will then remain operated under the control of relays 124 and 125 of the trunk group and decoder start relays as long as all the trunks of the group are busy.

If one of the trunks becomes idle, relay 125 will release in turn releasing the reroute relay, such as relay 308, of all busy decoders as soon as those decoders become idle. The circuits are now ready to count another last call for the trunk group. If more than one trunk becomes idle relays 124 and 125 will both release and the reroute relays of the decoders will release as previously described and the circuits conditioned to count when all but two of the trunks of the trunk group become busy.

From the foregoing it will be apparent that the decoder and any associated sender are given information when there is but one available trunk in a direct trunk group and again when there is no idle trunk, sufficiently in advance of the establishment of a possible call to the trunk group, so that rerouting to a tandem route may be effected without the hazard of losing a call.

This insures satisfactory operation of the rerouting feature of decoders when direct trunk groups do not have more than ten trunks and the proportion of the traffic to be rerouted through a tandem office will not exceed 20 per cent.

Where direct trunk groups have more than ten trunks and the proportion of the traffic to be rerouted through a tandem office exceeds 20 per cent, a more satisfactory operation of the rerouting feature of decoders may be made by employing the modified counting circuit disclosed in Fig. 2A, in lieu of the counting circuit of Fig. 2, conductors 133, 136 and 137 of Fig. 2 being joined to conductors 123, 126 and 127, respectively, of Fig. 1. Relays 134 and 140 are polarized and electrically biased by the circuits through their upper windings and so adjusted that relay 134 will operate when two resistances are included in the chain circuit over conductors 123 and 133 but will not operate or will release in series with three or more resistances and that relay 140 will operate when one resistance is included in the chain circuit but will not operate or will release in series with two or more resistances. Relay 135 is margined to operate only when all resistances have been removed from the chain circuit. It will thus be apparent that the operation of relay 134 is indicative that there are but two idle trunks in the group, that the operation of relay 140 is indicative that there is but one idle trunk and that the operation of relay 135 is indicative that all trunks of the group are busy.

When all but two of the trunks of the group become busy and relay 134 operates, an obvious circuit is established for relay 141. Should the decoder 300 thereafter receive information for routing a call to this trunk group and ground the code point 317, relay 318 of the decoder will operate and remain operated until the decoder is dismissed and will close the circuit from battery at its contacts over conductors 127 and 137, upper back contact of relay 142, inner upper contact of relay 141, lower back contact of relay 142 to ground through the winding of relay 143. Relay 143 will operate and lock in a circuit from ground through its winding and contacts, the winding of relay 142, the upper front contact of relay 141, to battery, but relay 142 will not operate in this locking circuit since its winding is shunted by battery supplied by relay 318 of the decoder. As soon, however, as the decoder is dismissed after having informed the associated sender to route the call to the trunk group, relay 318 releases permitting relay 142 to operate. Relay 142 upon operating opens at its lower contact the initial operating circuit of relay 143 and at its upper front contact prepares the operating circuit for relay 138.

When the last call which may be extended over the trunk group arrives in a decoder, for example the decoder 300, and the decoder again grounds the code point 317 and reoperates relay 318, the circuit for relay 138 is completed over conductors 127 and 137 and relay 138 operates locking over its lower front contact, the lower contact of relay 141 to battery at the back contact of relay 135. Relay 138 upon operating thus counts the last call that may be extended to the trunk group and places ground on conductors 136 and 126 which is instrumental in operating reroute relay 308 of the decoder as soon as the decoder is dismissed following its functioning to inform the associated sender to route a call to the last available trunk of the trunk group. Thereafter, any subsequent calls intended for this trunk group will be rerouted through a tandem office as previously described.

The arrival of the call to the trunk group at the time there were but two free trunks therein, causes the seizure of one of the remaining idle trunks and the consequent operation of relay 140 which, in turn, closes a shunt around the winding of relay 143 extending from ground at the contact of relay 140, through resistance 144, front contact and winding of relay 143 to ground. Relay 143 now releases but relay 142 remains operated. This is done so that should another trunk become idle before a call directed to the group has seized the last previously indicated idle trunk and relay 140 consequently releases, relay 142 will have no holding circuit and will release and open the previously traced operating circuit for relay 138. Relay 138 will not therefore operate as previously described and the decoder will thus be informed to route two calls to the trunk group.

The arrival of the last call which the trunk group can handle, assuming that all but one of the trunks are at the time busy, will busy the one remaining idle trunk and thus cause the operation of marginal relay 135. Relay 135 upon operating releases relay 138 but maintains ground on conductors 136 and 126 to hold the reroute relay corresponding to relay 308 operated. If thereafter only one trunk becomes idle, relay 138 will release, removing ground from conductor 126 to release the decoder reroute relay such as relay 308 of decoder 300, and to prepare the locking circuit of relay 138 for counting another last call to the trunk group.

If two trunks become idle, both relays 140 and 135 will release, the release of relay 140 permitting relay 142 to release, thus preparing the circuit to count two possible calls for the trunk group. If more than two trunks become idle all of the relays 134, 135, 140, 141, 142, 143 and 138 will be released and will remain released so long as more than two trunks of the group remain idle.

What is claimed is:

1. In a telephone exchange system, a calling office, called offices, an intermediate office, switching mechanism located in said calling office, a group of direct paths extending from said switching mechanism to each of said called offices, a group of indirect paths extending from said switching mechanism through said intermediate office to each called office, a register sender for recording the office code designations of wanted lines and for controlling said switching mechanism to select a path to the called office in which a wanted line terminates, translating means associated with said sender for translating office code registrations to enable said sender to control said switching mechanism, reroute relays in said translating means corresponding to the groups of direct paths, each of said reroute relays being operable to change the translation normally effective for routing a call to the corresponding group of direct paths to a translation effective for routing the call to said group of indirect paths, and means effective for operating the reroute relay corresponding to a particular group of direct paths when all but one of that group of paths are actually busy and the translating means has completed the direction of an initiated call to the last idle path in that group.

2. In a telephone exchange system, a calling office, called offices, an intermediate office, switching mechanism located in said calling office, a group of direct paths extending from said switching mechanism to each of said called offices, a

group of indirect paths extending from said switching mechanism through said intermediate office to each called office, a register sender for recording the office code designation of wanted lines and for controlling said switching mechanism to select a path to the called office in which a wanted line terminates, a decoder associable with said sender having route relays corresponding to all groups of paths extending from said switching mechanism, operating circuits for said route relays controlled from said sender in accordance with the office code designation registered therein, reroute relays in said decoder corresponding to the groups of direct paths, each of said reroute relays being operable to transfer the circuit normally effective for operating the route relay corresponding to a group of direct paths to a route relay corresponding to said group of indirect paths, and means effective for operating the reroute relay corresponding to a particular group of direct paths when all but one of that group of paths are actually busy and the decoder has completed the direction of an initiated call to the last idle path in that group.

3. In a telephone exchange system, a calling office, a called office, an intermediate office, switching mechanism located in said calling office, a group of direct paths extending from said switching mechanism to said called office, a group of indirect paths extending from said switching mechanism through said intermediate office to said called office, a register sender for normally controlling said switching mechanism in response to the dialing of the office code of said called office to route a connection to said called office over an idle one of said direct paths, a chain circuit for said group of direct paths including as many resistances as there are paths in the group, a relay associated with each direct path and operable upon the seizure of that path by said switching mechanism to short-circuit one of said resistances, a relay in said circuit margined to operate only when all but one of the paths have been seized and all but one of said resistances have become short-circuited, and means associated with said sender controlled by said marginal relay for causing said sender to reroute all calls destined for completion to said called office over said group of direct paths by way of said group of indirect paths only after said sender has completed the routing of a call to the last idle one of said group of direct paths.

4. In a telephone exchange system, a calling office, a called office, an intermediate office, switching mechanism located in said calling office, a group of direct paths extending from said switching mechanism to said called office, a group of indirect paths extending from said switching mechanism through said intermediate office to said called office, a register sender for recording the office codes designation of a wanted line terminating in said called office and for controlling said switching mechanism to select an idle path to said called office, translating means associated with said sender for translating said office code registration to enable said sender to control said switching mechanism, a reroute relay in said translating means allocated to said group of said paths, said reroute relay being operable to change the translation normally effective for routing a call to the group of direct paths to a translation effective for routing the call to said group of indirect paths, a group relay operable when all but one of said direct paths is busy, a code point relay in said translating means operable whenever said translating means is functioning to cause a call to be routed to said group of direct paths and an operating circuit for said reroute relay controlled jointly by said group relay and said code point relay and effective only following the complete functioning of said translating means to route a call to the last idle one of said group of direct paths.

5. In a telephone exchange system, a calling office, a called office, an intermediate office, switching mechanism located in said calling office, a group of direct paths extending from said switching mechanism to said called office, a group of indirect paths extending from said switching mechanism through said intermediate office to said called office, a register sender for recording the office code designation of a wanted line terminating in said called office and for controlling said switching mechanism to select an idle path to said called office, translating means associated with said sender for translating said office code registration to enable said sender to control said switching mechanism, a reroute relay in said translating means allocated to said group of direct paths, said reroute relay being operable to change the translation normally effective for routing a call to the group of direct paths to a translation effective for routing the call to said group of indirect paths, a first group relay operable when all but one of said direct paths is busy, a second group relay operable when all of said direct paths are busy, a code point relay in said translating means operable whenever said translating means is functioning to cause a call to be routed to said group of direct paths, a third group relay operable under the joint control of said first group relay and said code point relay and maintained operated until said second group relay operates, an operating circuit for said reroute relay controlled by said third group relay and effective only following the complete functioning of said translating means to route a call to the last idle one of said group of direct paths, and a holding circuit for said reroute relay established by the operation of said second group relay.

6. In a telephone exchange system, a calling office, a called office, a group of trunks extending between said offices, switching mechanism in said calling office for extending connections over said trunks to said called office, a chain circuit for said group of trunks including as many serially connected resistances as there are trunks in the group, a relay associated with each group and operable upon the seizure of said trunk to short-circuit one of said resistances, a first relay in said circuit margined to operate only when all but two of the trunks of said group have been seized, and all but two of said resistances have become short-circuited, and a second relay in said circuit margined to operate only when all but one of said trunks have been seized and all but one of said resistances have become short-circuited.

7. In a telephone exchange system, a calling office, a called office, an intermediate office, switching mechanism located in said calling office, a group of direct paths extending from said switching mechanism to said called office, a group of indirect paths extending from said switching mechanism through said intermediate office to said called office, a register sender for normally controlling said switching mechanism in response to the dialing of the office code of said called office to route a connection to said called office

over an idle one of said direct paths, a chain circuit for said group of direct paths including as many resistances as there are paths in the group, a relay associated with each direct path and operable upon the seizure of that path by said switching mechanism to short-circuit one of said resistances, a first relay in said circuit margined to operate only when all but two of the paths have been seized and all but two of said resistances have become short-circuited, a second relay in said circuit margined to operate only when all but one of the paths have been seized and all but one of said resistances have become short-circuited, and means associated with said sender and controlled by the operation of said first and second relays for causing said sender to reroute all calls destined for completion through said called office over said group of direct paths by way of said group of indirect paths only after said sender has completed the routing of a call to the last idle one of said groups of direct paths.

8. In a telephone exchange system, a calling office, a called office, an intermediate office, switching mechanism located in said calling office, a group of direct paths extending from said switching mechanism to said called office, a group of indirect paths extending from said switching mechanism through said intermediate office to said called office, a register sender for recording the office code designation of a wanted line terminating in said called office and for controlling said switching mechanism to select an idle path to said called office, translating means associated with said sender for translating said office code registration to enable said sender to control said switching mechanism, a reroute relay in said translating means allocated to said group of direct paths, said reroute relay being operable to change the translation normally effective for routing a call to the group of direct paths to a translation effective for routing the call to said group of indirect paths, a first group relay operable when all but two of said direct paths are busy, a code point relay in said translating means operable whenever said translating means is functioning to cause a call to be routed to said group of direct paths, a second relay operable under the control of said first group relay and said code point relay as soon as said translating means has completely functioned to route a call to one of the two remaining idle paths of said group of direct paths, a third relay operable jointly under the control of said second relay and said code point relay, and an operating circuit for said reroute relay controlled by said third relay effective only following the complete functioning of said translating means to route a call to the last idle one of said group of direct paths.

9. In a telephone exchange system, a calling office, a called office, switching mechanism located in said calling office, a group of preferred trunks accessible to said switching mechanism for extending connections from said calling office to said called office, a group of alternate trunks accessible to said switching mechanism and to the switching mechanism of other calling offices for extending connections from said calling offices to said called office and to other called offices, a register sender for controlling said switching mechanism, and means for adjusting the selection control within said sender to cause said switching mechanism to route one call for said called office to said preferred group of trunks when all but one of said preferred group of trunks are busy and to route succeeding calls for said called office to the alternate group of trunks as long as all but one of said preferred trunks are busy even though the last trunk has not been seized by switching mechanism and made busy by said one call.

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