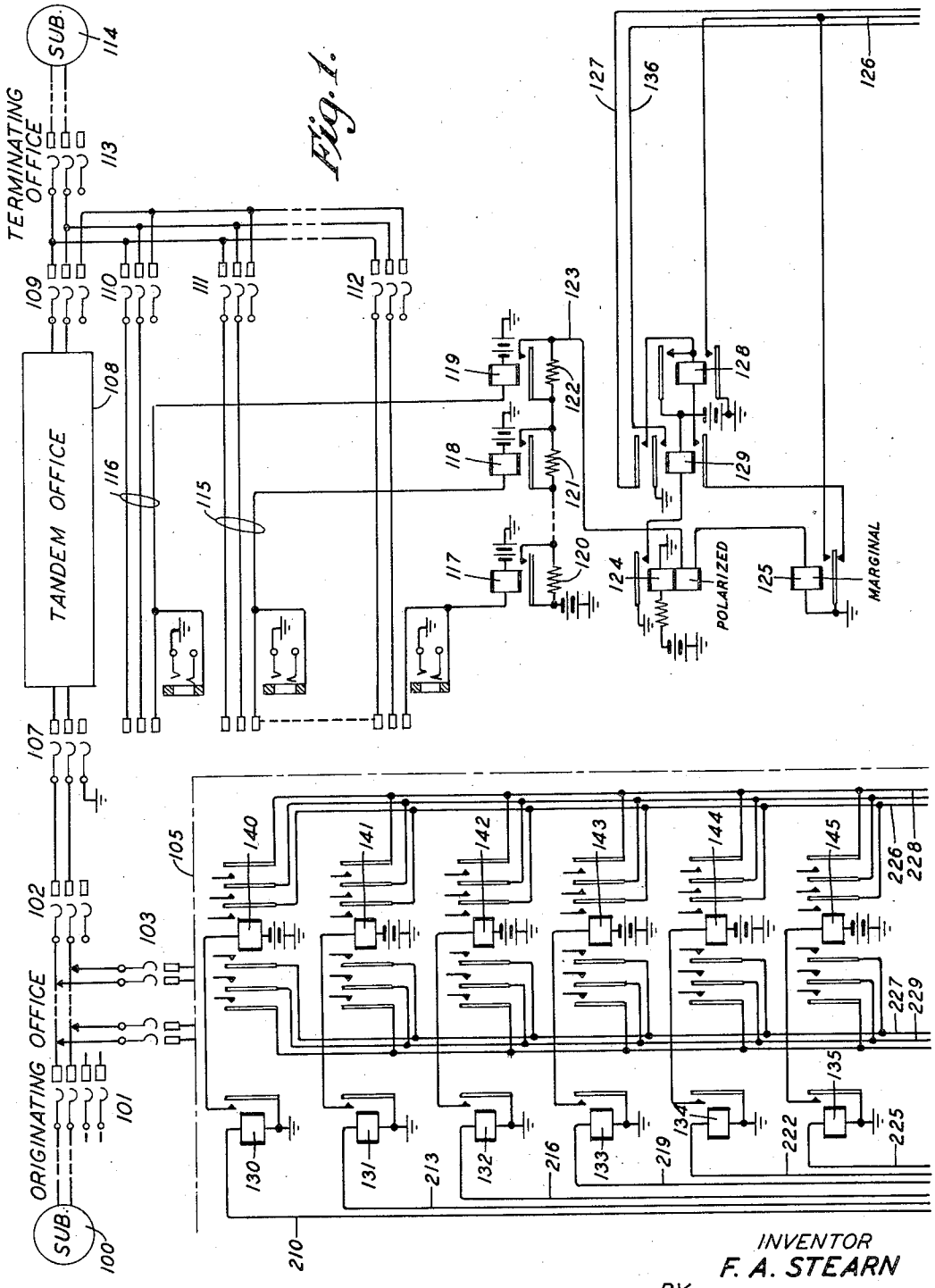
Feb. 11, 1936. F. A. STEARN 2,030,412

TELEPHONE EXCHANGE SYSTEM

Filed Oct. 24, 1934 3 Sheets-Sheet 1



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TELEPHONE EXCHANGE SYSTEM

Filed Oct. 24, 1934 3 Sheets-Sheet 2

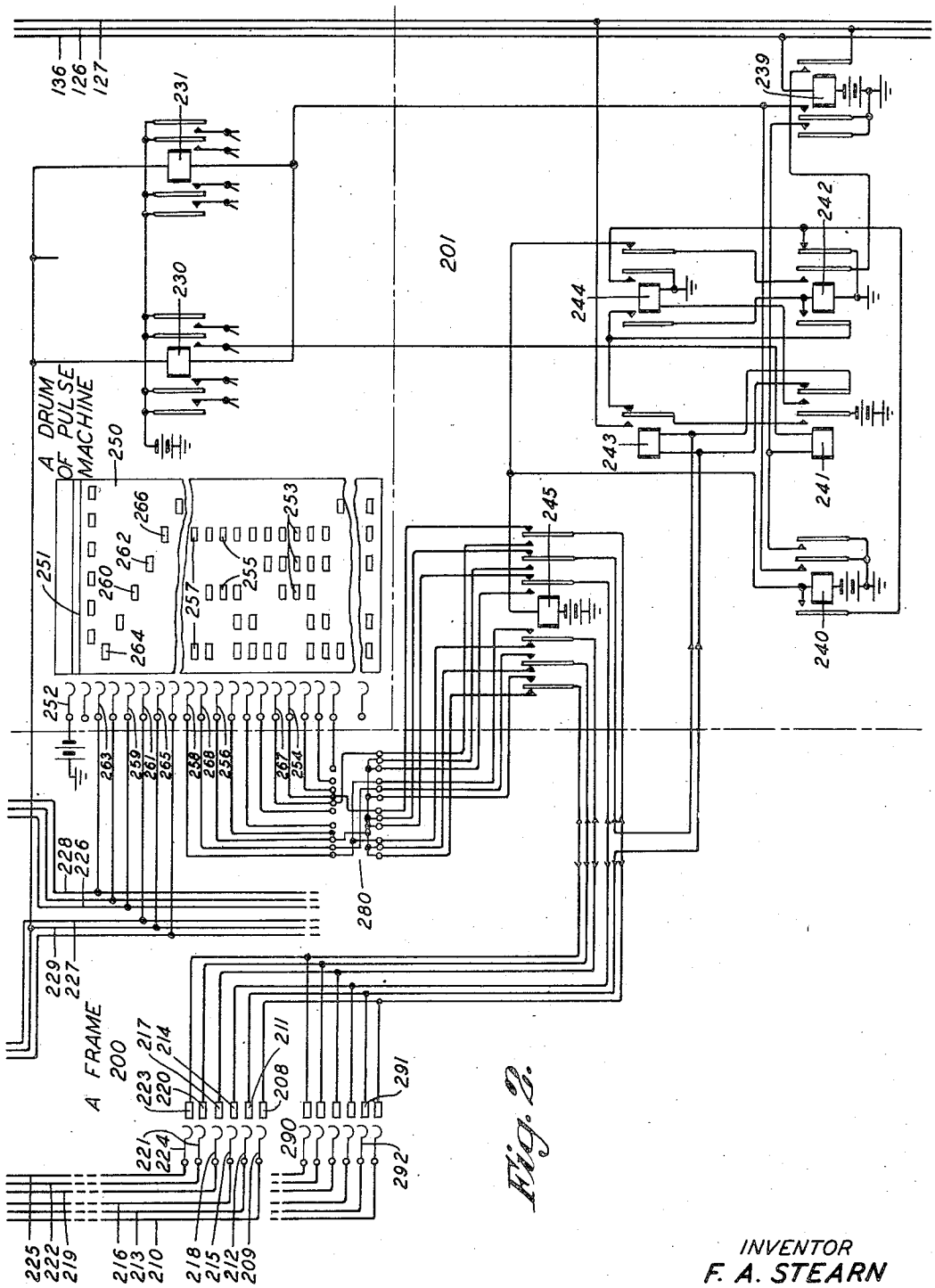

Fig. 2.

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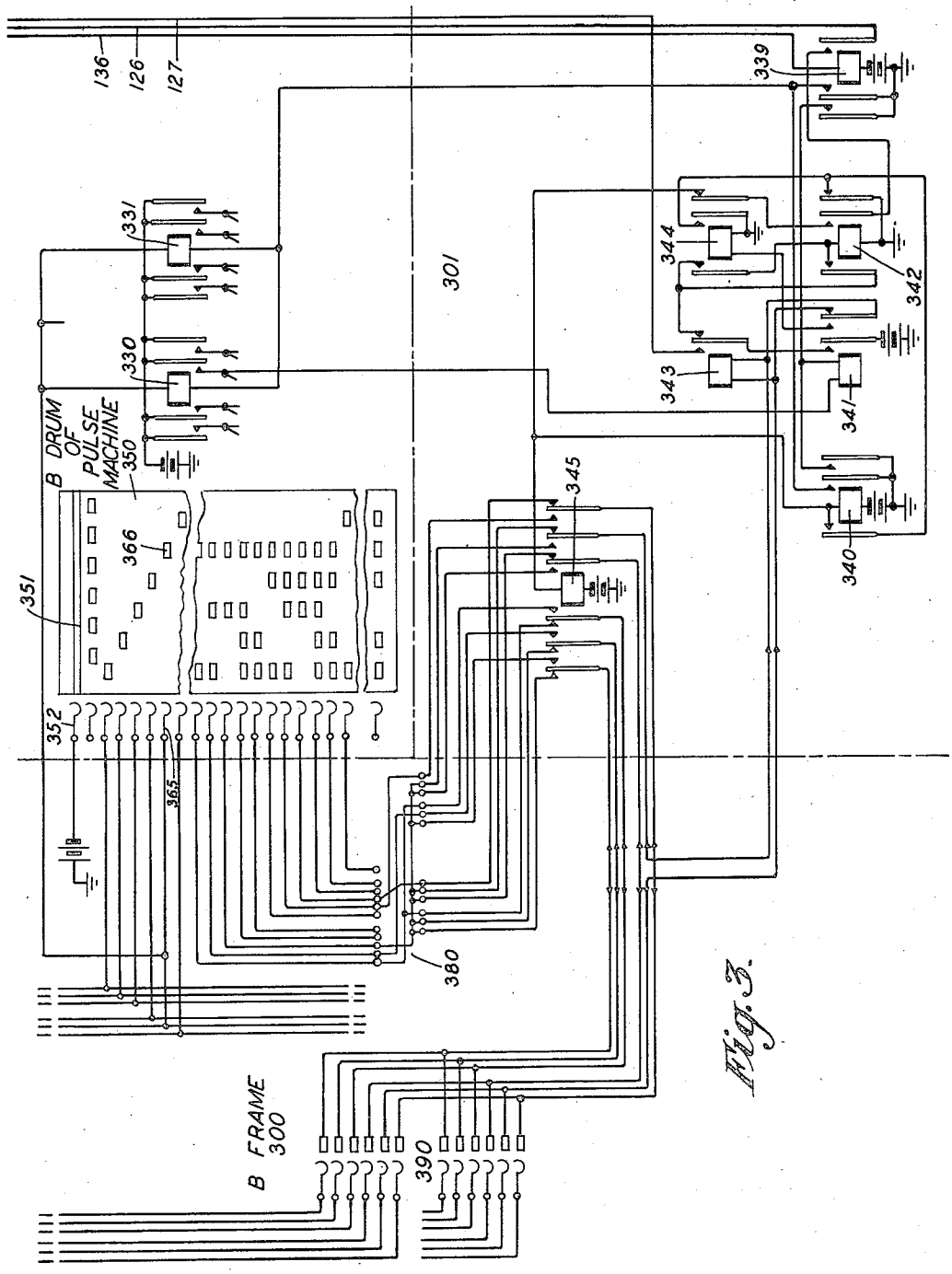

Fig. 3.

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UNITED STATES PATENT OFFICE

2,030,412

TELEPHONE EXCHANGE SYSTEM

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Application October 24, 1934, Serial No. 749,716

4 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 mechanisms 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 when 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 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 it may be directly routed to the desired office. This proposal also enables existing direct trunks 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 to a tandem office in systems employing central office senders which control the setting of selecting 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 has direct trunks to the desired office. This signal depends upon the closure of a chain circuit controlled by the trunks of the direct trunk group when all trunks of the group become busy.

In systems of the type disclosed in Patent 1,395,977, granted November 1, 1921, to F. A. Stearn and F. J. Scudder, 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 one 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 for controlling the setting of a district and an office selector to extend a connection to the office in which the line terminates and for controlling other apparatus in the selected office for completing the connection.

Each sender is provided with a translator switch which is set in accordance with the dialed office code registration of any of two hundred routes. The translator switches of part of the senders of the office are mounted on an "A" frame and the translator switches of the remaining senders are mounted on a "B" frame. Common to all translator switches of the "A" frame there are provided as many "A" synchronizing circuits as there are trunk groups which the "A" translator switches serve. Also common to all translator switches of the "B" frame there are provided as many similar "B" synchronizing circuits as there are trunk groups. Common to all of the translator switches of the "A" frame there is provided a pulse machine drum having a plurality of sending drums and a plurality of receiving drums. A similar pulse machine drum common to all of the translator switches of the "B" frame is also provided. The pulse machine drums are instrumental in setting secondary registers of any sender in accordance with the setting of the translator switch of the sender. The secondary registers in turn control the brush and group selection movements of a district selector and of an office selector to select the trunk group indicated by the office code dialed by the calling subscriber.

In order that a sender of this type may be caused to reroute a connection through a tandem office when all trunks of the group extending directly to the office indicated by the office code dialed are busy, it is necessary to prepare all senders of the originating office so that when the translator switch of any of the senders is set to route a connection directly to a desired office, it will cause the pulse machine to set the secondary registers of the sender which has been taken for use to control the selective movements of the district and office selectors to select a trunk extending to the tandem office rather than to select a trunk extending directly to the desired office.

It is further necessary to guard against changing of the routing during the time that the pulse machine may be setting up a routing on the secondary registers of a sender to prevent the mutilation of any call. It is, therefore, the object of

the invention to enable the more efficient use of trunking facilities by rerouting calls through tandem offices during heavy peaks of traffic in systems of the type employing translator switches and pulse machines.

In accordance with the invention, each trunk group extending 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 relays associated therewith one of which operates only when all but one of the trunks of the group are busy and another of which operates when all trunks of the group are busy. A synchronizing circuit which is individualized to a trunk group and to which it is desirable to apply the rerouting feature, is provided having a reroute relay and a group of synchronizing relays.

If it be assumed that a direct trunk group extending between two offices becomes loaded to such an extent that but one trunk in the group is idle, then the chain circuit controlled by relays of the trunks of that group becomes altered in such a manner that one of the relays associated with the chain circuit indicates to the synchronizing circuit common to all senders and allocated to that particular trunk group that there is but one available idle trunk in that trunk group. The synchronizing relays of the synchronizing circuit then function from the pulse machine to insure that no calls to this particular trunk group, which are at the time being routed thereto by the action of the pulse machine, will be mutilated and that as soon as the pulse machine has completed its cycle, the last call which may be routed to the trunk group is counted and the reroute relay is operated preparatory to routing the next call by way of a tandem office. When the last trunk of the direct group is taken for use by a selector switch, the chain circuit associated with the trunk group is further altered to operate the second relay associated with the chain circuit which holds the reroute relay operated until a trunk of the group becomes idle.

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

Fig. 1 shows schematically a calling subscriber's line, a line switch, district selector, office selector, sender selector and a portion of one sender of an originating office; a subscriber's line, incoming selector and final selector of a distant office; a group of direct trunks extending between the offices; and a tandem office indicated by the full line rectangle through which connections may also be established between the originating and distant offices;

Fig. 2 shows schematically two translator switches of the "A" translator frame, one of which is the translator of the sender of Fig. 1 and the other the translator of another sender, the "A" drum of a pulse machine common to all translator switches of the "A" frame and the "A" synchronizing circuit individual to the direct trunk group of Fig. 1; and

Fig. 3 shows schematically two translator switches of the "B" translator frame individual to other senders, the "B" drum of the pulse machine common to all translator switches of the "B" frame and the "B" synchronizing circuits individual to the direct trunk group of Fig. 1.

The line switch **101**, district selector **102**, office selector **107**, sender selector **103**, sender **105**, translator switches **200**, **290**, **300** and **390** and the pulse machine drums **250** and **350** being of the well-known type and functioning in the well-known manner have, in order to simplify the drawings, been disclosed schematically herein. For a complete disclosure and description thereof, reference may be had to Patent No. 1,395,977 granted November 1, 1921 to F. A. Stearn and F. J. Scudder, hereinbefore referred to. The tandem office equipment indicated by the rectangle **108** of Fig. 1 is of the type fully disclosed in Patent No. 1,840,132, granted January 5, 1932 to T. H. Roberts. The incoming selector switches **109** to **112**, inclusive, and the final selector **113** schematically shown, are also of the well-known type disclosed in the patent to Stearn et al. above referred to.

Each sender of the originating office is provided with a translator switch, the translator switches of all of the senders being mounted on two frames approximately one half on each frame. The translator switch of sender **105** mounted on the "A" frame is shown at **290** and the translator of a second sender mounted on the same frame is indicated at **290**. Two translator switches of two other senders are indicated at **300** and **390** and mounted on the "B" frame. Each translator switch has access to two hundred sets of bank terminals each set corresponding to a different trunking group or code point over which a connection may be extended in the originating office. It is thus possible for any translator switch to be set in accordance with the office code digits registered in the sender with which it is associated to determine which of two hundred routes will be employed to route a desired connection.

Some of these routes are employed in the establishment of local connections within the originating office such as connections to local lines and to service operator's positions. Some are used in the establishment of connections to other nearby offices, others to more distant offices and still others to tandem offices through which connections may be further extended to distant offices. Obviously on calls which are local to the originating office, the provision of alternative routing to a tandem office is not necessary and there would be slight, if any, economy in the provision of alternative routing on such routes as handle short haul traffic to nearby offices. It is therefore proposed to provide alternative routing only for such routes as handle long haul traffic to distant offices. In accordance with the present invention this is accomplished by providing for each of such groups two synchronizing circuits, one of which is termed the "A" synchronizing circuit and is associated with the multiplied terminal sets of all translator switches of the "A" frame allocated to that particular group and the other of which is termed the "B" synchronizing circuit and is associated with the multipled terminal sets of all translator switches of the "B" frame allocated to that particular group. The dot-dash rectangles **201** of Fig. 2 and **301** of Fig. 3, show the "A" and "B" synchronizing circuits of one such route or the route including the group of direct interoffice trunks shown in Fig. 1.

Each "A" synchronizing circuit such as **291** is provided with a group of relays **239** to **244**, inclusive, and a reroute relay **245** and similarly each "B" synchronizing circuit such as **301** is provided with a group of relays **339** to **344**, inclusive, and a reroute relay **345**. These relays function in cooperation with the translator

switches and pulse machine drums 250 and 350 in the manner hereinafter described.

In order to distribute the traffic load, a pulse machine having two synchronously driven drums is provided. The "A" drum of the pulse machine disclosed at 250 serves all of the translator switches of the "A" frame and the "B" drum, disclosed at 350, serves all of the translator switches of the "B" frame. To better disclose these drums, portions of them have been shown as developed in a single plane. Each drum is made of insulating material in which a plurality of circumferential rows of contact segments are embedded, these segments being all connected to a common slip ring to which battery potential is applied by means of a brush. On pulse machine drum 250 this slip ring is indicated at 251 and the cooperating brush at 252 and on drum 350, the slip ring is indicated at 351 and the cooperating brush at 352. For contacting with the rows of contact segments on each drum, a plurality of other brushes is provided.

In the sender 105 only the secondary register control relays 130 to 135, inclusive, and the corresponding auxiliary control relays 140 to 145, inclusive, have been disclosed, the relays of the secondary registers having been omitted to simplify the drawings. For a disclosure of the secondary registers reference may be had to the Stearn et al. patent hereinbefore referred to. The relays of the secondary registers are operated over the indicated contacts of relays 140 to 145, inclusive, from the pulse machine drum 250 in accordance with the translated office code for registering the class, district brush and group, office brush and group and talking selection information required by the sender in establishing any desired connection. The circuits for control relays 130 to 135, inclusive, are associable over the brushes of translator switch 200 with any set of terminals upon which the translator switch may be positioned and thence either directly to terminals on the lower side of the cross-connecting rack 280 if the translator brushes are positioned on the terminal set appertaining to a route that is not provided with the rerouting feature, or indirectly to the cross-connecting rack through the front or back contacts of a reroute relay of a synchronizing circuit such as 201 if the translator brushes are positioned on the terminal set appertaining to a route that is provided with the rerouting feature. The terminals on the upper side of the cross-connecting rack 280 are connected, respectively, to the forty sending brushes such as 254, 256, 258, 267 and 268 which cooperate with the forty rows of sending segments of pulse machine drum 250. By the use of jumpers between the terminals on the two sides of the cross-connecting rack the circuits of relays 130 to 135, inclusive, may thus be selectively completed during the rotation of the pulse machine drum 250. The circuits of relays of the secondary registers are completed over contacts of relays 140 to 145, inclusive, to six receiving brushes such as 259, 261, 263 and 265 cooperating with six rows of receiving segments on drum 250. In a similar manner, the corresponding control relays of the senders associated with the translator switches 300 and 390 are connected over the cross-connecting rack 380 either directly or over contacts of the route relay of a "B" synchronizing circuit, such as 301, to the sending brushes of the pulse machine drum 350.

Each trunk of a direct trunk group to which alternative routing is applied, as disclosed in Fig. 1, is provided with a sleeve relay, such as relays 117, 118 and 119, which becomes operated when the trunk is seized. 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 is provided with a normally open shunt extending over the contacts of the associated sleeve relay and all of the resistances, when all trunks of the group are idle, are normally connected in a chain circuit extending from grounded battery therethrough in series to conductor 123 and then 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 of resistances have been excluded 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 sleeve relay of that trunk 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 is therefore indicative that there is but one available or free trunk in the group and the operation of relay 125 is indicative that all 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.

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 the receiver from the switchhook obtains a connection with an idle sender 105 in the originating office through the operation of line switch 101 and sender connector 103 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 translator switch 200 is set in accordance therewith. It will be assumed that the office code dialed indicates that the distant office may be reached over the group of direct trunks shown in Fig. 1 and that the brushes of translator switch 200 are therefore positioned on the set of terminals illustrated, which set of terminals correspond to the synchronizing circuit 201 individual to the direct trunk group of Fig. 1. It will further be assumed that at the time the call is initiated, there are two idle trunks 115 and 116 in this trunk and that, therefore, neither relay 124 nor relay 125 is operated and consequently none of the relays of the associated synchronizing circuits 201 and 301 are operated.

With the reroute relay 245 unoperated, as the pulse machine drum 250 rotates, three impulses are transmitted from grounded battery over brush 252 and slip ring 251, the segments 253, brush 254, jumper on cross-connection rack 280, outer

right back contact of reroute relay 245, terminal 208 and brush 209 of translator switch 200, conductor 210 to ground through the winding of class register control relay 130. Similarly, two impulses are transmitted over segments 255, brush 256, jumper on the cross-connection rack 280, middle right back contact of relay 245, back contact of relay 241, terminal 211 and brush 212 of translator switch 200, conductor 213 to ground through the winding of district brush control relay 131. Two impulses are transmitted over segments 255, brush 256, jumper on cross-connection rack 280, inner right back contact of relay 245, terminal 214 and brush 215 of translator switch 200, conductor 216 to ground through the winding of office brush register control relay 132. In a similar manner two impulses are transmitted over segments 257, brush 258, jumper on cross-connection rack 280, inner left back contact of relay 245, terminal 217 and brush 218 of translator switch 200, conductor 219 to ground through the winding of district group register control relay 133. The circuit of the office group register control relay 134 is twice completed in a similar manner over segments 255, brush 256, jumper on cross-connecting rack 280, middle left back contact of reroute relay 245, terminal 220 and brush 221 of translator switch 200, conductor 222 to ground through the winding of relay 134. The talking selection control relay 135 is also twice operated over a circuit extending from battery on segments 255, brush 256, jumper on cross-connection rack 280, outer left back contact of relay 245, terminal 223 and brush 224 of translator switch 200, conductor 225 to ground through the winding of relay 135.

Control relay 130 upon operating closes the circuit of relay 140 and thus relay 140 operates each time that the pulse machine brush 254 engages one of the segments 253. At the time brush 254 engages the first segment 253, the brush 259 also engages segment 260 thereby establishing a circuit from battery over brush 252, slip ring 251, segment 260, brush 259, conductor 226, inner right contact of relay 140 to the winding of the third relay of the class register. Again when brush 254 engages the next segment 253, brush 261 will engage segment 262 thereby establishing a circuit from battery over segment 262 and brush 261, conductor 227, inner left front contact of relay 140 to the winding of the fourth relay of the class register. When brush 254 engages the next segment 253, brush 265 will engage segment 266 and will apply battery thereover to conductor 229, thence over the middle left contact of relay 140, but since there is no class register relay connected to this contact of relay 140, the establishment of this circuit is without effect at this time.

Control relay 131 upon operating closes the circuit of relay 141 and thus relay 141 operates each time that the pulse machine brush 256 engages one of the segments 255 and, since at the time brush 256 engages the first segment 255, brush 259 engages segment 260, a circuit is completed from battery over brush 252, slip ring 251, segment 260, brush 259, conductor 226, inner right contact of relay 141 to the winding of the third relay of the district brush register. Again when brush 256 engages the second segment 255, the brush 265 will engage segment 266 and will apply battery thereover to conductor 229, thence over the middle left contact of relay 141, but since there is no district brush register relay connected to this contact of relay 141 the establishment of this circuit is without effect at this time.

When control relay 132 operates it closes the circuit of relay 142 and thus relay 142 operates each time that the pulse machine brush 256 engages one of the segments 255 and, since at the time brush 256 engages the first segment 255, brush 259 engages segment 260, a circuit is established as previously traced to conductor 226 and thence over the inner right contact of relay 142, to the winding of the third relay of the office brush register. Again when brush 256 engages the second segment 255, the brush 265 will engage segment 266 and applies battery over conductor 229 and the middle left contact of relay 142, but since there is no office brush register relay connected to this contact of relay 142, the establishment of this circuit is without effect at this time.

When control relay 133 operates it closes the circuit of relay 143 and thus relay 143 operates each time that the pulse machine brush 258 engages one of the segments 257 and, since at the time brush 258 engages the first segment 257, the brush 263 engages segment 264, a circuit is established from grounded battery over brush 252, slip ring 251, segment 264, brush 263, conductor 228, outer right contact of relay 143 to the winding of the first relay of the district group register. Also when brush 258 engages the second segment 257, brush 265 will engage segment 266 and apply battery over conductor 229 and the middle left contact of relay 143, but since there is no district group relay connected to this contact of relay 143, the establishment of this circuit is without effect.

Control relay 134 upon operating closes the circuit of relay 144 and thus relay 144 operates each time that the pulse machine brush 256 engages one of the segments 255 and, since at the time brush 256 engages the first segment 255, brush 259 engages segment 260, a circuit is established from battery as traced to conductor 226, thence over the inner right contact of relay 144 to winding of the third relay of the office group register. Also when brush 256 engages the second segment 255, brush 265 will engage segment 266 and will apply battery over conductor 229 and the middle left contact of relay 144, but without effect as there is no register relay connected to this contact of relay 144.

When control relay 135 operates it closes the circuit of relay 145 and thus relay 145 operates each time that the pulse machine brush 256 engages one of the segments 255 and, since at the time brush 256 engages the first segment 255, brush 259 engages segment 260, a circuit is established over conductor 226 and the inner right contact of relay 145 to the winding of the third relay of the talking selection register. When brush 256 engages the second segment 255, brush 265 will engage segment 266 and will apply battery over conductor 229 and the middle left contact of relay 145, but without effect as there is no register relay connected to this contact of relay 145.

All of the information required by the sender, as translated from the dialed office code designation, has now been registered by the secondary registers of the sender and the sender will then proceed to control the setting of the district selector 102 and office selector 107 in accordance therewith to select the group of direct interoffice trunks extending to the office in which the wanted line 114 terminates. It has been assumed that

all but the last two trunks 115 and 116 of this group are busy. The office selector will therefore hunt over the terminals of the busy trunks and will seize the first of the idle trunks or trunk 115. The sender will then proceed to control the setting of the incoming selector 111 in which the trunk 115 terminates and the final selector 113 in accordance with the numerical designations of the call as registered in the sender to complete the connection to the 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 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 chain circuit through the windings of relays 124 and 125, relay 124 operates, but relay 125 does not. Relay 124 upon operating closes an obvious circuit for relay 129 which also operates to prepare at its lower and upper contacts the operating circuit of relay 128 which is employed to count the last call which may be established over the trunk group, and to close a circuit extending from ground at its inner upper front contact over conductor 136 to battery through the windings of relays 239 and 349 in parallel, individual respectively, to the "A" and "B" synchronizing circuits allocated to the direct trunk group of Fig. 1.

Relay 239 upon operating establishes a circuit for the group of relays including relays 230 and 231 as soon as the pulse machine drum in its continuous rotation has rotated to the position in which brush 265 engages segment 266. This circuit may be traced from grounded battery, brush 252, slip ring 251, segment 266, brush 265, windings of relays 230, 231 to ground at the inner left contact of relay 239. As many relays such as 230 and 231 are provided as are necessary to control the operating circuits for the relays 241 of all "A" synchronizing circuits. A similar circuit is also established by relay 339 for relays 330 and 331 over brush 365 and segment 366 of the "B" pulse machine drum 350. As many relays such as 330 and 331 are provided as are necessary to control the operating circuits for the relays 341 of all "B" synchronizing circuits.

The circuit of relay 241 may be traced from battery at the inner right contact of relay 230, winding of relay 241 to ground at the outer left contact of relay 239 and the circuit of relay 341 may be traced from battery at the inner right contact of relay 330, winding of relay 341 to ground at the outer left contact of relay 339. It is thus apparent that whenever the pulse machine drums 250 and 350 rotate into the position in which brush 365 engages segment 266, or brush 265 engages segment 366, the relays such as 241 and 341 of all synchronizing circuits of the trunk groups in which there is but one available or free trunk will operate.

Relay 241 upon operating closes a circuit from battery over brush 252, slip ring 251, segment 255, brush 256, middle right back contact of reroute relay 245, outer right front contact of relay 241, winding of relay 244 to ground thus operating relay 244 during the time the drum 250 is in the position in which the circuits are closed over the segments 266 and 255. Relay 241 also opens the short circuit from the winding of relay 243.

It will first be assumed that at the time relay 241 operates to remove the short circuit from the winding of relay 243, there is a translator switch, for example 290, standing on the code point or terminal set allocated to the trunk group of Fig. 1 and that, therefore, a translation is being effected and registered on the secondary registers of the sender to which such translator switch belongs for routing a call to the trunk group of Fig. 1. When the sending circuits for effecting this translation are established over the brushes of translator 290 the sending circuit over brush 292 will, when the pulse machine reaches the position to close the previously traced circuits of relays 230 and 231, be established from ground through the office group register control relay corresponding to relay 134, over brush 292, terminal 291, winding of relay 243, middle right back contact of reroute relay 245, jumper on cross-connecting rack 280, brush 256, last terminal 255, slip ring 251, brush 252 to battery. Relay 243 will therefore operate and since relay 241 is also simultaneously operated as previously described, a circuit will be established from battery, inner front contact of relay 241, front contact of relay 243, conductor 127, upper front contact of relay 129, winding of relay 128, lower contact of relay 129 to ground at the back contact of relay 125. Relay 128 will therefore operate, lock in a circuit from battery over its upper contact and winding, lower contact of relay 129 to ground at the back contact of relay 125 and at its lower contact connect ground to conductor 126. While relays 241, 243 and 244 are operated, the operating circuit for relay 242 from battery over the inner contact of relay 241, the back contact of relay 243, and the left contact of relay 244 is not effective since it is open at the back contact of relay 243.

As soon as the pulse machine drum 250 rotates further it breaks the circuit previously traced over the sending segment 255 and brush 256 and relay 243 releases in turn releasing relay 244 and .024 second later, breaks the circuit previously traced over its receiving segment 266, brush 265 thus releasing relays 230 and 231 in turn releasing relay 241. The last call which the direct trunk group of Fig. 1 can handle has thus been counted and the sender upon receiving the routing information will proceed to set district and office selectors to select this group of trunks. If a sender having a translator switch such as 300 and 390 had positioned its translator switch on the code point of the trunk group of Fig. 1 instead of the translator switch 290, as previously described, then the relays of synchronizing circuit 301 would have functioned in conjunction with pulse machine drum 350 in a similar manner.

If additional senders set their translator switches of frame "A" on this code point after drum 250 advances beyond the position in which the receiving segment 266 breaks contact with brush 265, but before the next reclosure over this segment, the above described cycle of relay operations will be repeated on each closure as long as sender translator switches are connected to the code point. Similarly, if additional senders whose translator switches are on frame "B" set their translator switches on this code point after the drum 350 advances beyond the position in which the receiving segment 366 breaks contact with brush 365, but before the next reclosure over this segment, the above cycle of operations of the relays of synchronizing circuit 301 will be repeated on each closure so long as sender translator switches of frame "B" are connected to the code point. However, the calls being handled by

such senders will be lost as there will be no trunk of the trunk group available.

When the pulse machine 250 rotates to the position in which its receiving segment 266 and sending segment 255 again contact with brushes 265 and 256, respectively, after the last call to the trunk group of Fig. 1 has been counted as previously described and no sender has positioned its translator switch on the code point corresponding to this trunk group, relays 230, 241 and 244 will operate as previously described, but since there is no register control relay connected to the previously traced circuit over brush 256 and segment 255 through the winding of relay 243, relay 243 will not operate. With relays 241 and 244 operated and relay 243 not operated, a circuit is now closed for relay 242 extending from battery, inner contact of relay 241, back contact of relay 243, left contact of relay 244, winding of relay 242 to ground. Relay 242 will therefore operate and lock in a circuit through its winding and left contact, back contact of relay 243 to battery at the inner contact of relay 241. As soon as the pulse machine rotates to break the circuit over its sending segment 255, relay 244 will release and close a circuit from battery in parallel through the windings of relay 240 and reroute relay 245, back contact of relay 244, right front contact of relay 242, right contact of relay 239, conductor 126 to ground at the lower contact of relay 128. Shortly after the circuit over sending segment 255 is broken or in .024 second, the circuit over receiving segment 266 is also broken thereby releasing relays 230, 241 and 242. Relays 240 and 245 are now locked over a circuit extending from ground, back contact of relay 242, left contact of relay 240 and thence to battery in parallel through the windings of relays 240 and 245.

When the last call has reached the trunk group of Fig. 1 relay 125 will operate indicating that all trunks of the group are busy and will cause the release of relay 128. Relay 128 upon releasing removes ground from conductor 126, but relay 125 has upon its operation connected ground to this conductor so that should relays 242 and 244 subsequently operate in the manner previously described, relays 240 and 245 will still be maintained operated from ground on conductor 126 so long as all trunks of the group remain busy.

With reroute relay 245 operated, the sending circuits from the code point or multiple terminal set of the "A" frame corresponding to the trunk group of Fig. 1 will be transferred from the sending brushes 254, 256 and 258 to other sending brushes in accordance with the translation necessary for rerouting any calls directed to this code point for the distant office of Fig. 1 to a group of indirect trunks extending to a tandem office through which a call may be extended to the same distant office. It will be assumed that the registrations which must be set up on the secondary registers of any sender are the same as previously described with the exception of the class and office group registrations. If, for example, the sender 105 is now seized for a call to the distant office of Fig. 1 and the translator switch 200 is set on the code point corresponding to this office, the sending circuit from the class register control relay 130 will be extended as previously traced to terminal 208, thence over the outer right front contact of reroute relay 245, jumper on cross-connecting rack 280 to sending brush 267 of the pulse machine drum 250. The sending circuit for the district brush, office brush and district group register control relays 131, 132 and 133 will be extended over the middle right, inner right and inner left front contacts of relay 245 to the cross-connecting rack 280, thence by jumper connections, as previously traced, to sending brushes 256 and 258. The sending circuit from the office group register control relay 134 will be extended as previously traced to translator switch terminal 220, middle left front contact of reroute relay 245, jumper connection on cross-connection rack 280, thence to the sending brush 268, and the sending circuit for the talking selection control relay 135 will be extended as previously traced to translator terminal 223, thence over the outer left front contact of reroute relay 245, jumper on cross-connection rack 280 to sending brush 256.

In the manner previously described, the sender will register on its secondary registers the necessary routing information and will then proceed to set the district selector 102 and office selector 107 to select an idle trunk extending to the tandem office 108. 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. All subsequent calls to the distant office of Fig. 1 will be rerouted in this manner so long as all trunks of the direct route remain busy and reroute relay 245 is thus maintained operated.

Should any trunk in the direct route now become idle, relay 125 will release thus removing ground from conductor 126 to open one holding circuit for reroute relay 245. Relay 245 will not, however, immediately release at this time since it will be held operated over the back contact of relay 242 or the front contact of relay 244. It can only release at such times as the synchronizing circuit 201 reaches the point in its cycle of operations when relay 244 is released and relay 242 is operated. This provision is made so that relay 245 will not be released to change the routing from tandem routing back to direct routing if any tandem routing is at the time being set up in an associated sender thus preventing mutilation of the routing. Assuming that the sender 105 is receiving such a tandem routing at the time a trunk in the direct route of Fig. 1 becomes free, when the segment 266 closes with brush 265, the circuit of relay 230 will be completed as previously described in turn causing the operation of relay 241. Relay 241 will establish the previous traced circuit for relay 244 over the sending segment 255 and remove the shunt from the winding of relay 243 which will operate since the sender translator switch 200 is still standing on the code point of the trunk group of Fig. 1. With relays 241 and 243 both operated, relay 128 will reoperate, lock and reconnect ground to conductor 126, but since relay 244 is operated, this ground is not effective to hold relays 240 and 245 operated. However, these relays are maintained operated from ground supplied over the right front contact of relay 244 and the back contact of relay 242. As soon as the pulse machine drum rotates to first open the circuit over its sending segment 255, relays 243 and 244 will release. Shortly thereafter the circuit over the receiving segment 266 will be opened and relays 230 and 241 will release.

When thereafter the pulse machine drum 250 rotates to the position in which receiving segment 266 is again closed and relays 230 and 241 again operate and the sender 105 employed in establishing the previous standard call has been dismissed, there will be no circuit for relay 243 over brush 212 of translator switch 200 and the sending segment 255 and therefore, when relay 244 operates over the sending segment 255, relay 242 will operate in a circuit over the left contact of relay 244, back contact of relay 243 and inner left contact of relay 241. Thereafter relay 244 will release when the circuit over segment 255 is opened. With relay 244 released and 242 now operated, there will be no holding circuit for relays 240 and 245 and these relays will release, relay 245 changing the routing from tandem routing back to direct routing so that any subsequent calls to the distant office of Fig. 1 will be routed directly thereto over the trunk of the direct route which has become idle.

It will now be assumed that at the time all but one of the trunks of the direct trunk group of Fig. 1 are busy and relays 124, 129, 239 and 339 are operated, there are no senders having translator switches standing on the code point of the trunk group. When, therefore, the pulse machine drum 250 rotates to the position in which circuits are closed over its receiving segment 266 and its sending segment 255, relays 230, 241 and 244 will operate as previously described, but relay 243 will not operate. A circuit will therefore be established from battery, inner contact of relay 241, back contact of relay 243, left contact of relay 244, winding of relay 242 to ground and relay 242 will operate and lock under the control of relay 241. When thereafter the pulse machine drum 250 rotates to first break the circuit over the sending segment 255, relay 244 will release, but serves no useful purpose since neither relay 125 nor 128 is operated to furnish operating ground over conductor 126 for operating relays 240 and 245. When the pulse machine rotates further to break the circuit over its receiving segment 266 which occurs .024 second after the opening of the circuit over the sending segment 255, relays 230, 241 and 242 are released in cascade without function. Thus, relays 230, 241, 242 and 244 will continue to operate and release so long as relay 124 remains operated and there are no sender translator switches positioned on the code point corresponding to the trunk group.

The synchronizing circuit 301 and pulse machine drum 350 function on calls from sender translator switches over the "B" frame in the manner previously described in connection with synchronizing circuit 201 and pulse machine drum 250 on calls from sender translator switches over the "A" frame.

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 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, a translating means including a pulse machine 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 said pulse machine has completed a cycle to route a call to the last idle path of 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 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, a translating means including a pulse machine for translating office code registrations to enable said sender to control said switching mechanism, reroute relays and associated synchronizing 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, a group relay for each group of direct paths operable when all but one of the paths of the group are busy, means for operating the synchronizing relays appertaining to a group of direct paths under the joint control of said pulse machine and the corresponding group relay to determine when said pulse machine has completed a cycle to route a call to the last path of said group and a circuit for the reroute relay corresponding to said group thereupon controlled by said group relay and said synchronizing relays.

3. 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 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, a translating means including a pulse machine for translating office code registrations to enable said sender to control said switching mechanism, reroute relays in said translating means corresponding to 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, 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 said pulsing means has completed a cycle to route a call to the last idle path of that group, and means to hold said reroute relay operated should an idle direct path become free until said pulse machine has completed its

cycle in routing any call intended for said particular group of direct paths by way of said group of indirect paths.

4. 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 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, a translating means including a pulse machine for translating office code registrations to enable said sender to control said switching mechanism, reroute relays and associated synchronizing 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, a group relay for each group of direct paths operable when all but one of the paths of the group are busy, means for operating the synchronizing relays appertaining to a group of direct paths under the joint control of said pulse machine and the corresponding group relay to determine when said pulse machine has completed a cycle to route a call to the last path in said group, a circuit for the reroute relay corresponding to said group thereupon controlled by said route relay and said synchronizing relays, and a locking circuit for said reroute relay maintained by said synchronizing relays until said pulse machine has completed its cycle in routing any call intended for said particular group of direct paths by way of said group of indirect paths.

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