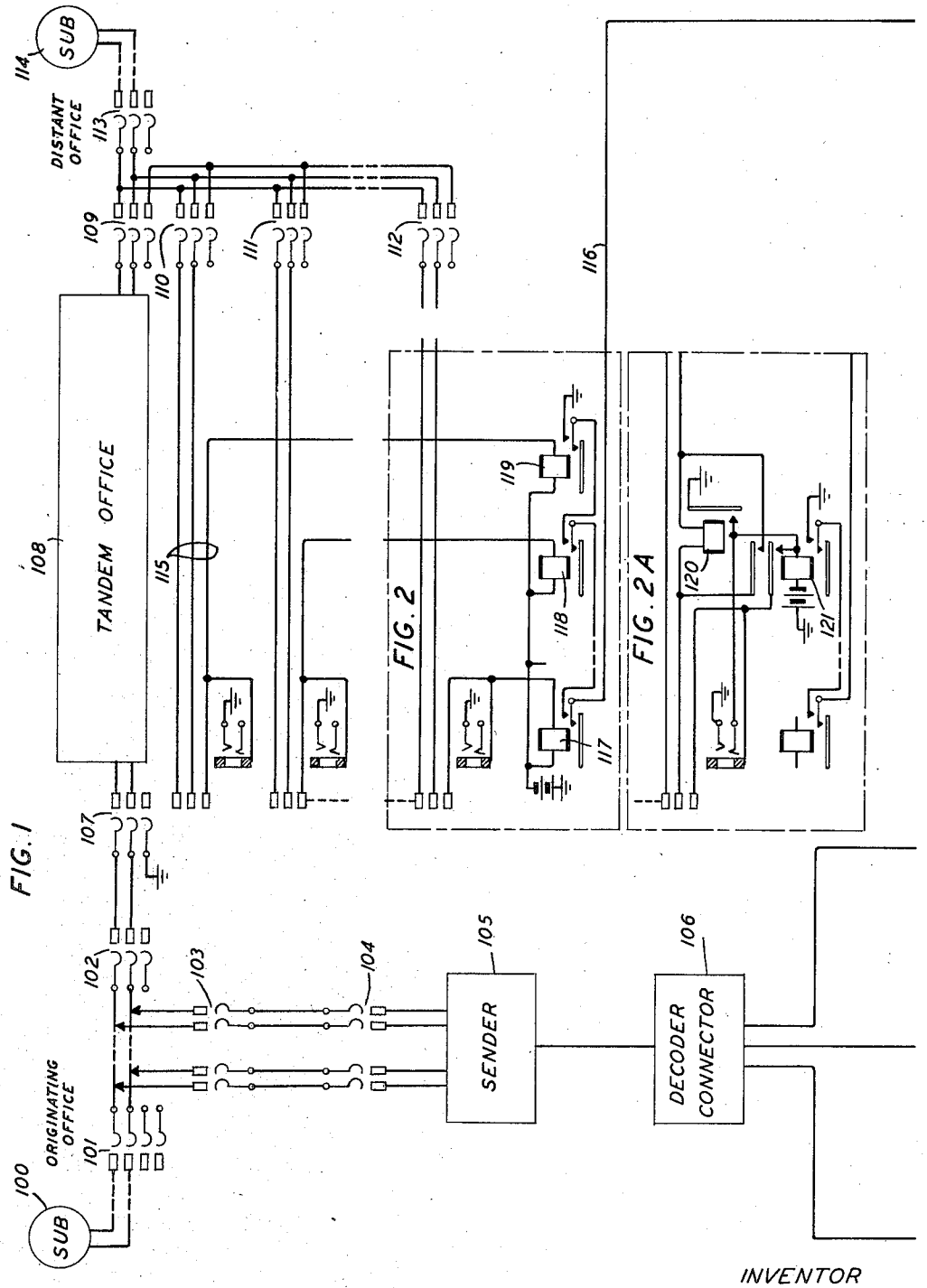
July 2, 1935. W. W. CARPENTER 2,006,438

TELEPHONE EXCHANGE SYSTEM

Filed Oct. 20, 1934 2 Sheets-Sheet 1



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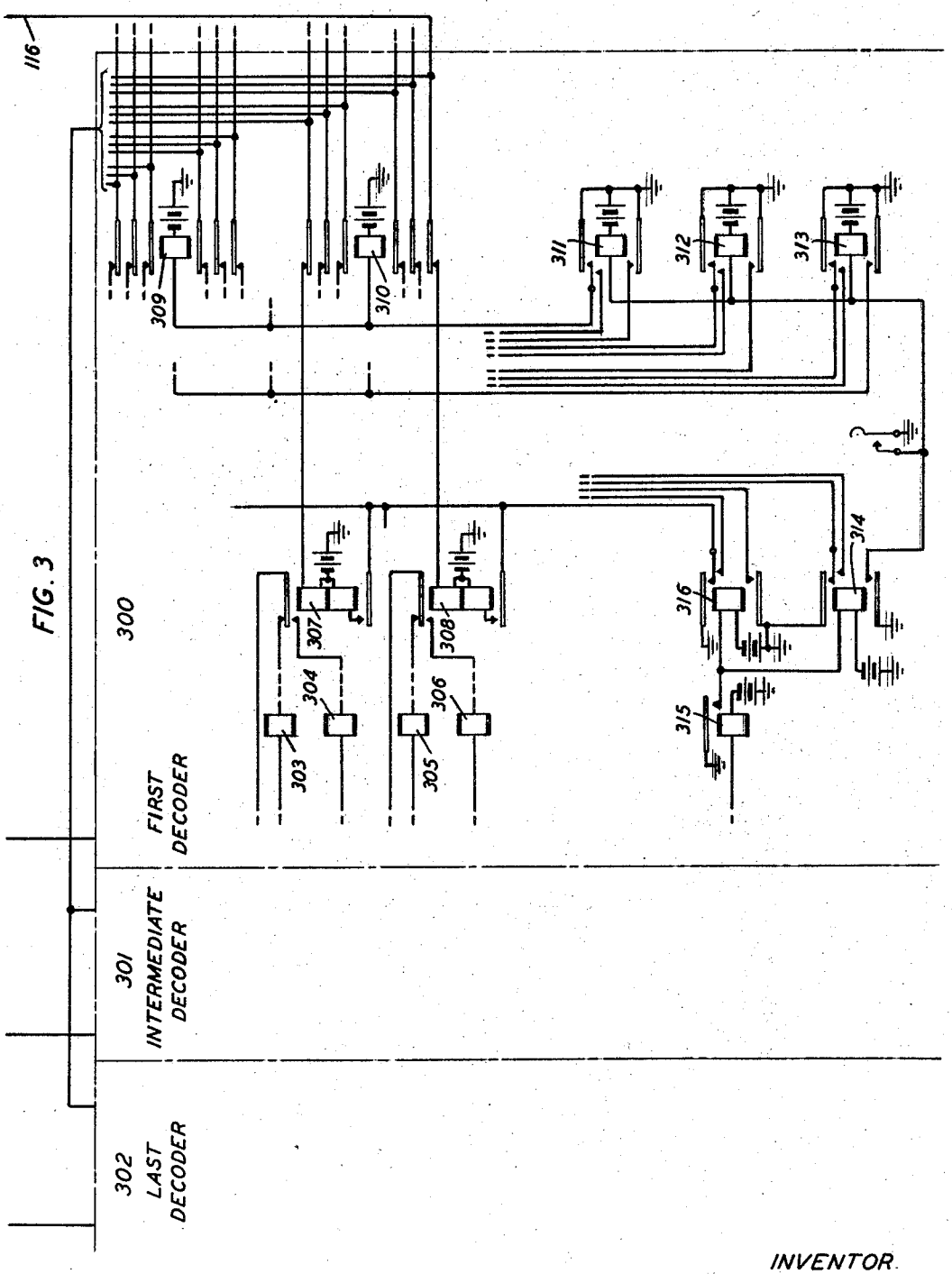

FIG. 3

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TELEPHONE EXCHANGE SYSTEM

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5 Claims. (Cl. 179—18)

This invention relates to telephone exchange systems and more particularly to those systems in which connections between subscribers' lines terminating in different offices of the exchange 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 any two offices of the exchange, particularly where the traffic between certain widely separated offices is very 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 is an object of this invention to render more efficient the comparatively smaller number of trunks in a group directly interconnecting any two offices by reducing the number of the direct trunks to the maximum required for handing normal traffic between the two offices and by automatically rerouting the abnormal or overflow traffic between such offices to a tandem office where it is directly routed to the desired office.

In systems of the type disclosed in Patent No. 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 calling 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 appartus 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 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 the present invention, if at the time the decoder is taken for use by a sender, all trunks of any interoffice group of trunks are at the time busy, indicating that it would not at that time be possible to complete a connection over that trunk group, a chain circuit is established through contacts of operated relays of the trunks of that trunk group which operates a reroute relay in the decoder. When, therefore, an office code registration is set up in the decoder which would normally cause the operation of a direct route relay for routing a connection to that particular trunk group, with the reroute relay of that particular trunk group operated, the circuit for operating the direct route relay is transferred to the winding of a tandem route relay which will cause the rerouting of the connection over another trunk group extending to a tandem office. With the tandem route relay operated, the sender is then caused, in the manner described in the patent to Raymond and Scully, above referred to, to establish a connection to the indicated tandem office from which office the connection is further extended to the desired office. Since the rerouting takes place in the decoder prior to the setting up of the decoded office code registration in the sender and the starting of the sender to control selector switches in accordance therewith, selector switches are not set by the sender to attempt the establishment of a connection to a trunk of the desired busy trunk group, but are set to establish the connection over the alternate trunk group to the tandem office.

The decoder is provided with as many reroute relays as there are interoffice trunk groups over which connections may be established and at any time as many of these reroute relays will be operated as there are corresponding trunk groups in which all trunks are at the time busy. When the start circuit of the decoder is closed following the association of the decoder with a sender all reroute relays which are at the time operated are locked and the chain operating cir-

cuits of all reroute relays are opened until after the decoder has been dismissed.

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 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 the last trunk of the direct trunk group together with the sleeve relays of all trunks of the group and a chain busy circuit controlled thereby;

Fig. 2A shows a modification of a direct trunk; 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 sake of simplification 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 indicated.

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 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 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 the 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 the reroute relays 307 and 308 are disclosed. With the decoder idle, the operating winding of each reroute relay is normally connected to the all-trunks busy conductor of the group of direct inter-office trunks forming a part of the corresponding direct route over the back contacts of a cut-off relay. Nine groups of such cut-off relays of four relays each may be provided, or thirty-six cut-off relays, over the back contacts of which the 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 are 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 decoder start relay 315. Thus, when the decoder is seized and the start relay 315 operates, relays 314, 311, 312, 313 and all cut-off relays such as 309 and 310 become operated in cascade to disconnect the operating windings of all reroute relays of the decoder from the corresponding all-trunks 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 the 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 only trunk 115 of the group of trunks constituting this group is idle and that, therefore, there is no ground potential on the all-trunks busy conductor 116 individual to this group of trunks. Reroute relay 308 of the decoder allocated to the route of which the direct trunk group is a part will therefore be unoperated. When the decoder is seized

and start relay 315 operates, 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 the operation of the proper direct route relay corresponding to the direct trunk group in which the idle trunk 115 is located. This direct route relay will be assumed to be relay 305 and will be operated in a circuit under the control of the receiving registers of the decoder over the back contact of reroute relay 308. With 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. As previously described, the decoder start relay 315 also causes the operation of all cut-off relays, such as 309 and 310, thereby opening the operating circuits of all reroute relays so that no reroute relay may be operated during the time that the decoder is making a routing thereby preventing the mutilation of a routing that is at the time in progress.

The sender after receiving the required routing information then 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, assuming that the trunk 115 of this group is the only idle trunk of the group, the office selector makes connection therewith. The sender then controls the setting of the incoming selector 110 in which this trunk terminates and the final selector 113 to complete the connection to the wanted line 114.

Following the transfer of routing information from the decoder 300 to the sender 105, the decoder is dismissed for use on another call and start relay 315 is released thereby in turn releasing all cut-off relays such as 309 and 310. Any reroute relay such as 308 may now be operated to change the routing on subsequent calls. The sender is also dismissed in the usual manner as soon as it has completed its functions.

Since it was assumed that at the time the previously described call was initiated all but the last trunk 115 of the direct trunk group extending to the office of subscriber's line 114 was busy, and since the previously established call has now busied this last trunk 115, the chain circuit over the all-trunks busy conductor 116 is now established from ground over the serially connected contacts of the operated sleeve relays 117—118 and 119 of all of the trunks of the group, conductor 116, lower back contact of cut-off relay 310 of decoder 300, to battery through the operating winding of reroute relay 308. Similar parallel circuits are established over back contacts of corresponding cut-off relays and to the corresponding reroute relays of all other decoders such as 301 and 302. These reroute relays are thus operated indicating to all decoders that all trunks of the direct route extending from the originating office to that particular distant office are busy and that any subsequent calls to that office should be rerouted thereto through a tandem office.

If now another call to that particular office is initiated and for example, the decoder 300 is seized, relay 315 operates to start the functioning of the decoder in turn operating the relays 314, 311, 312 and 313 and cut-off relays such as 309 and 310 in cascade and also operating relay 315. Since at this time reroute relay 308 is operated, a locking circuit is therefore closed through its locking winding and lower contact to ground at a front contact of relay 316 before the cut-off relay 310 becomes operated to open its initial operating circuit. With reroute relay 308 locked operated, the decoder proceeds to register the office code information transferred thereto from the sender and to set the tandem route relay 306 in a circuit over the upper front contact of reroute relay 308 under the control of the receiving registers of the decoder. With a tandem route relay operated the transmitting registers of the decoder are selectively set and cause routing information to be transmitted to the sender whereby the sender controls the setting of district selector 102 and office selector 107 to trunk the call over the tandem route corresponding to the operated tandem route relay 306 or to the tandem office 108. In the well-known manner the sender 105 then transfers the required routing information to the tandem office sender which proceeds to further extend the connection to the distant office and to set selector switches therein such as 109 and 113 to select the wanted line.

As illustrated in Figs. 2 and 2A, either of two types of direct trunk groups may be employed. As disclosed in Fig. 2, each trunk of the group is provided with a sleeve relay such as 119 which becomes operated as soon as the trunk is seized by an office selector or by a district selector, the all-trunks busy conductor 116 being grounded over the serially connected contacts of the sleeve relays of all trunks of the group as soon as all trunks of the group have been seized and made busy in the establishment of connections. If, because of operating requirements, it is not desirable to employ a relay operated over the sleeve terminal of the trunk, the circuit arrangement disclosed in Fig. 2A may be employed. In accordance with the alternative arrangement, relay 120 operates over a trunk loop comprising the tip and ring conductors of the trunk when the trunk is seized for use and upon operating, establishes an obvious operating circuit for relay 121. Relay 121 upon operating locks to ground supplied from the office or district selector over the sleeve terminal of the trunk, shunts the winding or relay 120 and closes one point in a chain circuit which may be extended to an all-trunks busy conductor such as conductor 116.

From the preceding description of the invention, it will be apparent that all decoders of an originating office are kept informed of the availability of all direct routes extending to other offices of the exchange area and that therefore prior to the functioning of a sender to establish a connection over any direct route to a desired office, the sender is given rerouting information whereby the connection may be routed indirectly to the desired office if there is no idle trunk available in the direct route. This obviates the necessity of breaking down a partially completed connection which can not be completed because of unavailable direct trunking facilities and the reestablishment of a new connection over an available indirect route thereby saving wear and holding time of equipment, current drain, and increasing the speed of establishment of connections.

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, 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, and reroute relays in said decoder corresponding to all groups of paths extending from said switching mechanism, each of said reroute relays being operable when all paths of its corresponding group of paths are busy to transfer the circuit normally effective for operating the route relay corresponding to that group of paths to a route relay corresponding to said group of indirect paths.

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 designations of wanted lines and for controlling said switching mechanism to select a path to the calling 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, and reroute relays in said decoder corresponding to all groups of paths extending from said switching mechanism, each of said reroute relays being operable when all paths of its corresponding group of paths are busy to transfer the circuit normally effective for operating the route relay corresponding to that group of paths to a route relay corresponding to said group of indirect paths prior to the functioning of said sender to control said switching mechanism.

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 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, 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, and reroute relays in said decoder corresponding to all groups of paths extending from said switching mechanism, each of said reroute relays being operated over a chain circuit closed when all paths of its corresponding group of paths are busy to transfer the circuit normally effective for operating the route relay corresponding to that group of paths to a route relay corresponding to said group of indirect paths, prior to the functioning of said sender to control said switching mechanism.

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 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, 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 following the association of said sender with said decoder in accordance with the office designations registered in said sender, and reroute relays in said decoder corresponding to all groups of paths extending from said switching mechanism, said reroute relays being operable when all paths of their corresponding groups of paths are busy to transfer the circuits normally effective for operating the route relays corresponding to busy groups of paths to a route relay corresponding to said groups of indirect paths.

5. 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, 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 following the association of said sender with said decoder in accordance with the office code designation registered in said sender, reroute relays in said decoder corresponding to all groups of paths extending from said switching mechanism, said reroute relays being operable prior to the association of said decoder with said sender over circuits closed when all paths of their corresponding groups of paths are busy to transfer the circuits normally effective for operating the route relays corresponding to busy groups of paths to a route relay corresponding to said group of indirect paths, and means operable upon the association of said decoder with said sender to lock all operated reroute relays and to open the operating circuits of all of said reroute relays.

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