June 10, 1947. R. C. AVERY 2,421,919

TELEPHONE ROUTING SYSTEM

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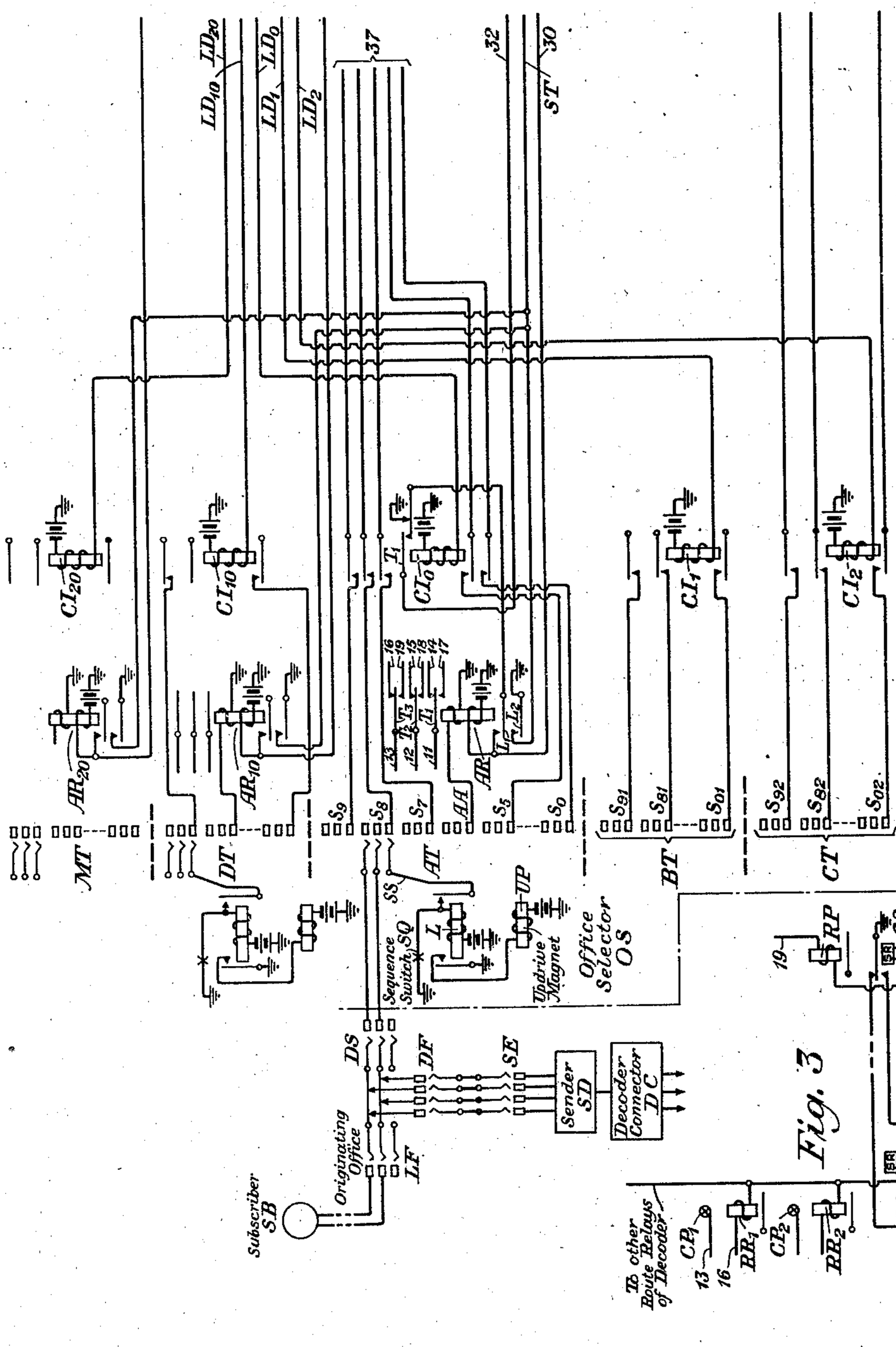

Fig. 1

Fig. 3

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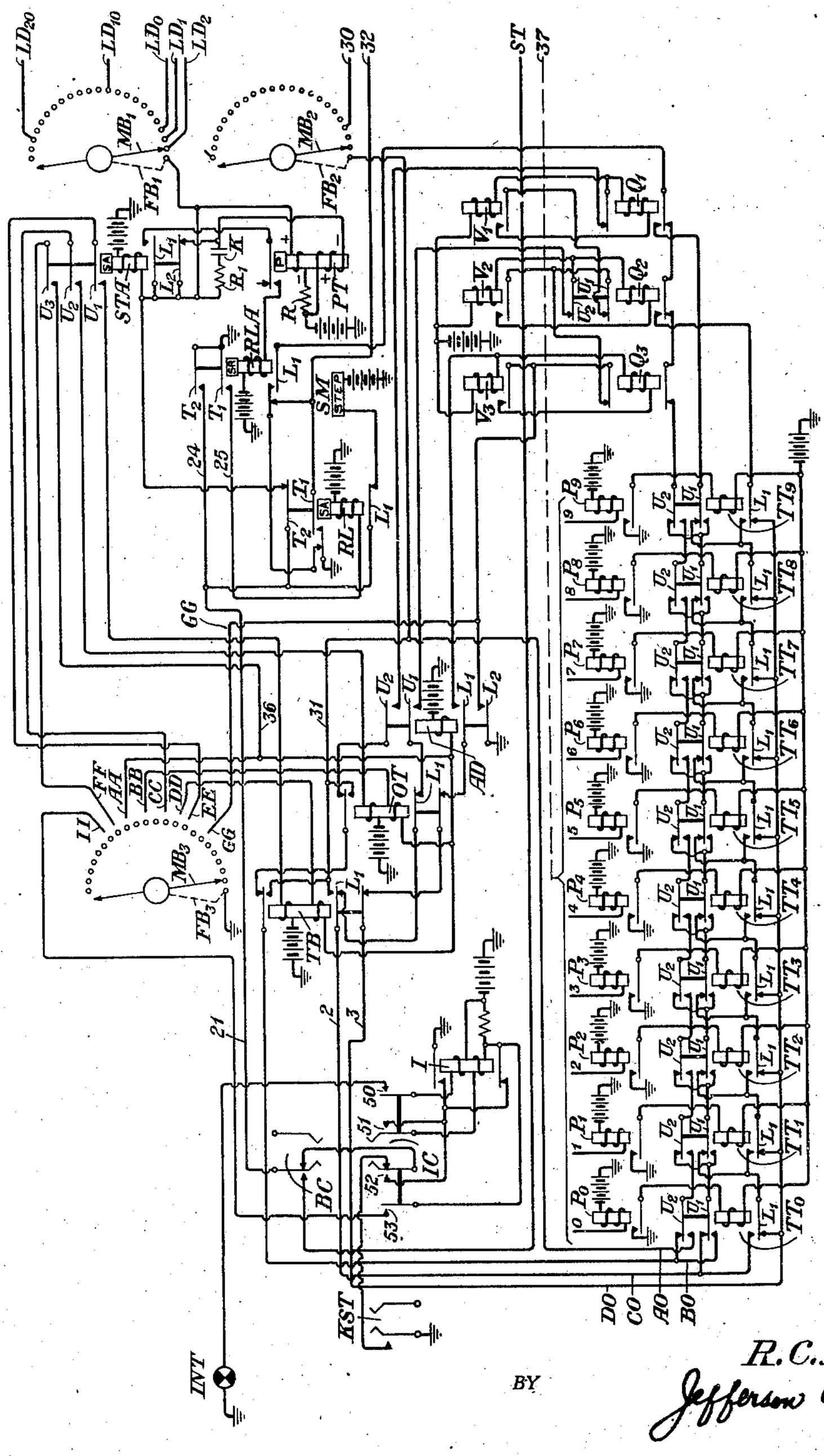

Fig. 2

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TELEPHONE ROUTING SYSTEM

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20 Claims. (Cl. 179—18)

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This invention relates generally to telephone exchange systems and, more particularly, to panel-type dial systems in which connections between subscribers' lines terminating in different offices of the telephone exchange are established by automatic switching mechanisms over groups of interoffice trunks.

In exchange areas having a large number of local offices, it is not always economical to provide direct groups of trunks for interconnecting any two offices of the exchange area, particularly where the traffic between these offices is not heavy. In some exchange areas, therefore, it may be economical to route some or all of the traffic between certain offices through a tandem office which may serve as a common intermediate distributing point.

It has heretofore been proposed to render more efficient the trunking arrangement between any two offices by reducing the number of direct trunks between those two offices and by automatically re-routing the remaining traffic between these offices to a tandem office where this traffic may then be routed to the desired office. To accomplish the re-routing of calls through a tandem office in systems employing central office senders which control the setting of selector switches to establish connections, each sender must receive a signal in order that it may take the necessary steps when such re-routing is required to re-route succeeding connections for that trunk group over a different trunk group extending to the intermediate tandem office. Each sender must also receive another signal to re-employ the direct route between the two offices when the direct route again becomes available.

It is an object of this invention to provide a re-route signal when all trunks of the direct trunk group extending between two offices are busy. It is another object of this invention to provide a re-route signal when all but a predetermined number of the trunks of such a group are busy. Any arrangement to accomplish the latter object will prevent the loss of certain calls which would otherwise occur because of the time interval after selections by the sender are started and before the selector switch controlled by the sender is actually positioned on the terminals of the desired trunk. A sender may be given information to route a call to a trunk of a direct trunk group extending to a desired office and may proceed to cause the selection of a trunk in such a group when there is only one such trunk idle. If the signal to the sender to re-route succeeding calls should be delayed until after the seizure of the last idle trunk such calls would not be completed if these were initiated during the interval after the sender starts its selections and before the selector switch controlled by the sender completes contact with the terminals of the last idle trunk. Hence, the selector switches operated to complete such calls to the desired direct trunk group would be driven to the overflow position. To guard against any such contingency, it is desired to signal the sender for the re-routing of calls when all but a predetermined number of the trunks, such as one or two of the trunks, for example, are busy.

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It is a further object of this invention to set the re-route signal in response to the action of the selector switches as they reach a predetermined terminal near the top of the trunk group contacted by the selector switch.

Another object of this invention is to automatically set the re-routing signal as required and to release it automatically upon the release of the previously busy trunks. This object may be accomplished by the action of a test circuit common to one or more trunk groups, the test circuit being arranged to test the trunks of each of the groups in regular order and to control the re-route signal for each such trunk group. Thus, the test circuit may operate to complete calls by means of the original route, or it may re-route these calls, all of which may be controlled by the information reaching the common test circuit. The use of a test circuit common to a plurality of trunks or trunk groups will materially reduce the amount of equipment heretofore required for re-routing calls.

Another object of this invention is to provide a common test circuit for testing different parts of the trunk group at different times, then to record the results of such tests and thereafter to set the re-route signal in accordance with the cumulative results of the tests of all of the parts of the trunk group.

Another object of this invention is to provide arrangements for transmitting calls through different tandem centers so that calls which would be normally routed over a trunk to any one of such tandem centers may be transmitted over trunks to other of such centers whenever traffic conditions warrant such a change in routing.

The apparatus of the invention is designed to set the re-route signal or to restore the conditions to normal when calls for a particular trunk group are in progress in the decoders without interference with such calls. The apparatus is arranged to effect a change in the

routing information after a route relay in a decoder has operated and before the decoder has completed its functions.

As is disclosed in Patent No. 1,862,549, dated June 14, 1932, to R. Raymond et al., 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 the setting of the district selector 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 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 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 each trunk group extending directly from one office to another office to which it is desirable to apply alternate routing through a tandem office or other type of switching center, is provided with a cut-in relay or relays for connecting the sleeve terminals of the trunks to a test circuit common to a number of such trunk groups. The cut-in relay or relays are operable by the common test circuit which is arranged to determine the busy and idle conditions with respect to the trunks of the group. Each such trunk group is also provided with a relay for setting or restoring the re-route signal in the various decoders. The latter relay may be operated for setting the signal in accordance with the action of the selector switch as it passes a predetermined terminal near the top of the trunk group. It may also be operated to set the signal and it may be released to restore the signal under control of the common test circuit which, as it is connected to the sleeve leads of the various trunks, determines the busy or idle condition with respect thereto. The setting of the re-route signal in response to the action of the selector switch as it reaches the predetermined terminal near the top of the trunk group, assures that the re-routing of traffic will occur only if all preceding terminals of the trunk group have been passed and found busy. Thus, the re-routing of traffic will occur only when all trunks below a predetermined trunk are found busy.

The common test circuit to which the sleeve terminals of the various trunks may be connected through the contacts of the cut-in relay or relays

is arranged to test a number of trunks, such as 10, at any one time. The testing apparatus is also equipped with a rotary selector and an associated relay circuit so that the test circuit may successively test other similar groups of trunks. The test circuit will be shown to control the operation of the cut-in relay for the trunks to be tested. The test circuit will also include a group of auxiliary relays, one common to each of the trunks to be tested, and each such auxiliary relay will be operated if the trunk is found busy. The auxiliary relays are arranged in a chain to close one of a number of different circuits in accordance with the busy conditions of the various trunks. One of these circuits will be closed if all of the trunks are busy. Another circuit will be closed if all but one of the trunks are busy. Still another will be closed if all but one of the trunks are busy. Still another will be closed if all but two of the trunks are busy. And so on. One or more of the latter circuits may be connected to re-route relays for controlling the routing of traffic when such auxiliary relays have become operated.

This invention will be better understood from the more detailed description hereinafter following when read in connection with the accompanying drawing, in which Figure 1 illustrates some of the equipment which may be employed for routing and re-routing telephone calls in accordance with the principles of the invention, Fig. 2 illustrates an arrangement which may be connected to the Fig. 1 arrangement, Fig. 2 including, among other things, a common testing circuit for testing the various trunks of one or more groups of trunks shown in Fig. 1, and Fig. 3 shows some of the apparatus that may be included in a decoder when set up to practice the invention.

Referring now to Figs. 1 and 2 of the drawing, there is shown a calling subscriber SB connected to a line finder LF, a district selector DS, an office selector OS, a district finder DF, a sender selector SE, a sender SD and a decoder connector DC, all of which are of a well-known type. In order to simplify the drawings, these devices have been shown only schematically herein. For a more complete disclosure and description thereof, reference may be had to the R. Raymond et al. patent already recited above. The decoder connector DC may be connected to a number of decoders which will be referred to again in regard to Fig. 3.

In response to dialing, the office code and numerical designations of the called party's telephone station (not shown) are registered in the sender SD in a well-known manner, and following the registration of the office code designation, the decoder connector DC is operated to associate one of a plurality of decoders with the sender SD. Each decoder may be provided with the usual receiving registers to which an associated sender transfers the registered office code designation, 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 the registers of the associated sender which in turn control the functioning of the sender to establish the desired connection over district and office selectors in accordance with the operated route relay of the decoders.

It may be assumed that a call has been started by the sender SD and that a selector switch SS of the office selector OS proceeds to hunt over a group of terminals such as AT which may be

ten in number. The sequence switch SQ will cause the relay L of the selector switch SS to become operated at certain intervals to cause the mechanism to hunt past busy sleeve terminals such as S_0 . . . S_5. Upon reaching a grounded sleeve terminal such, for example, as S_5 of a busy trunk, the relay L (previously operated by the closing of the sequence switch SQ) will be held operated over a holding circuit established through its right armature and make contact and extending to ground at the sleeve terminal S_5. As the relay L becomes operated and held operated, it completes a circuit through its left armature and make contact to energize the up-drive magnet UP, causing the up-drive of the selector switch SS to continue past the grounded sleeve terminal in question. When a sleeve terminal is reached which does not have ground connected thereto such as S_8, for example, the relay L will release, thereby causing the up-drive mechanism of the selector switch SS to stop. When this happens the brushes of the selector will be centered upon the trunk terminals in a well-known manner to advance the calling party's line through the the available or idle trunk.

In the present arrangement of the invention a predetermined terminal such as AA of the group of terminals AT has been set aside for operating the re-route mechanism. Terminal AA is not connected to a trunk. When the selector switch SS in moving upward in search of an ungrounded sleeve terminal reaches the terminal AA, a circuit is completed from battery through the winding of relay L, the make contact of its right armature, the sleeve contact of terminal AA, then over the upper winding of relay AR to ground. Relay AR is the re-route relay of the trunk group AT. It is a fast operating relay and its upper winding is of low resistance. The ground connected to its upper winding acts as a busy condition to the hunting selector switch SS and it holds the relay L operated so as to continue the up-drive past the terminal AA. Although the up-drive continues past terminal AA, the relay AR and relay L, which are connected in series, are both operated. The hunting selector SS will proceed to seize the next upper trunk associated with the sleeve such as S_7 to complete the connection from the calling party's set SB to the called office, provided sleeve S_7 is ungrounded. After relay AR is operated, it is locked in its operated position over a circuit which includes battery, the lower winding of relay AR, the make contact of armature L_1 of relay AR, the normal contacts associated with armature T_1 of relay CI_0 and ground. Relay AR also applies ground at its armature L_2 to a start lead ST which is connected to the associated common test circuit shown in Fig. 2, the purpose of which will be described later. The relay AR also transfers the code leads **11**, **12** and **13** of three decoders (not shown) from the normal route relays connected to conductors **14**, **15** and **16** which are in turn connected to the back contacts of the upper armatures T_1, T_2 and T_3, respectively, to the alternate route relays of the three decoders connected to conductors **17**, **18** and **19**, respectively, the latter relays being associated with the alternate route trunk group. This will be further described with regard to Fig. 3. Thus, when relay AR is unoperated, calls will be directed to the normally associated trunk group, but when relay AR becomes operated, these calls will be transferred to the trunk group for the alternate route.

Terminal AA of the trunk group AT preferably should be so located that there will be one terminal above it for completing the call which may have caused the operation of the re-route relay AR. If desired two or more working terminals may be positioned above terminal AA of group AT for completing calls which may have already been routed to this trunk group but have not reached it at the time when relay AR operates. The number of the additional terminals appearing above terminal AA will depend on the probability of calls being initiated during the critical interval just before relay AR operates. If desired, two terminals such as AA may be connected in parallel for causing the operation of relay AR should relay AR not be sufficiently fast to operate as the selector switch SS passes but one such terminal. When relay AR becomes operated, it will remain operated to cause the rerouting of calls in the associated decoders but relay AR will be released by the common test circuit of Fig. 2 whenever trunks become available again for such calls, as will be explained hereafter. The common test circuit of Fig. 2 is arranged to test the several trunks of group AT at one time. The common test circuit may be arranged to function only when the relay AR is operated, or it may be arranged to operate continuously whether or not relay AR is operated, or it may make busy tests at predetermined intervals. These alternatives are controlled by keys BC, IC and KST of Fig. 2 and will be explained hereinafter.

Assuming that the busy control key BC of Fig. 2 is operated, tests will be made to determine the busy conditions of the trunks of group AT, but these tests will be initiated only after relay AR operates, and the tests will be stopped as soon as the relay AR releases as will now be shown. Upon the operation of relay AR and the connection of ground at its armature L_2 to the start lead ST, a path will be completed to energize the windings of relays STA and CI_0, this path including the grounded start lead ST, the contacts of key BC, conductor **21**, the armature T_2 of relay RL on its back contact, the winding of relay STA to battery and ground. In parallel with the winding of relay STA there is the circuit including the feed brush FB_1 of one arc of a rotary selector, the main brush MB_1 of the same arc of the rotary selector, terminal **3** of the rotary selector upon which its main brush MB_1 may be assumed to be resting, conductor LD_0, the winding of relay CI_0, battery and ground. The ground connected to conductor **21** in the manner above described is also closed through the armature T_2 of relay RL_1, to the upper winding of relay PT and battery. Conductor **21** is also connected through the armature L_2 of relay STA and its back contact to the lower winding of relay PT and battery. Relay PT is employed in this circuit together with condenser K and resistances R and R_1 in order to introduce a time interval in the operation of the connected circuit arrangement. With ground connected to both of its windings as above, the magnetic effect of the lower winding of relay PT is stronger than that of its upper winding and the relay is consequently set on its back contact. A parallel circuit will be provided also from the grounded conductor ST through key BC, conductor **21**, the armature L_1 of relay RL and its back contact, the stepping magnet SM of the rotary selector, battery and ground. Although the stepping magnet SM is energized at this time,

it will not step the rotary selector to its next contact until the stepping magnet becomes released. The energization of the windings of relays STA and CI_0 will cause the relay CI_0 to become immediately operated, but due to the slow-operate property of relay STA, this relay will remain released for a brief interval sufficient to insure that relay PT will be properly positioned on its back contact.

The operation of relay CI_0 will transfer the locking path of relay AR previously completed through the normal contacts associated with armature T_1 of relay CI_0 to lead **32** which is connected to ground through the back contact of armature L_1 of relay RLA and the normal contacts associated with the armature T_1 of relay RL. Thus, relay AR will be held operated as long as both relays RLA and RL remain unoperated. Relay CI_0 also connects the sleeves S_0 to S_9 of the various trunks of trunk group AT through the corresponding make contacts and armatures of relay CI_0 to the windings of relays P_0 to P_9, respectively, the windings of each of the latter relays being also connected to ground through a battery. The latter circuits interconnecting the sleeves of the trunks to the windings of relays P_0 to P_9 are shown only schematically by a dotted line **37**. It will be understood that sleeve S_9 will be connected by one make contact of relay CI_0 to the winding of relay P_9, that sleeve S_8 will likewise be connected through another make contact of relay CI_0 to the winding of relay P_8, and so on for all other sleeve contacts of the trunk group AT. Thus, the operation of relay CI_0 will connect the various trunk sleeve terminals to the windings of the separate relays P_0 to P_9 which are part of the common test circuit for testing the busy conditions of the trunks associated with those sleeve terminals. Inasmuch as each busy trunk has ground connected to its sleeve terminal, the corresponding relays of the group P_0 to P_9 will become operated while relays of the group P_0 to P_9 connected to idle trunks will be released.

The several relays P_0 to P_9 have windings which are of high resistance so that the hunting selector OS may test the various sleeve terminals in the manner already described without any interference arising from the connection of the windings of these relays P_0 to P_9 to these sleeve terminals. Hence, the connection of the winding of any relay, such as P_9, to the sleeve terminal S_9 through the corresponding armature and make contact of relay CI_0 will not interfere with the action of selector switch SS and relay L in detecting the absence of ground on the terminal S_9 when the associated trunk is idle. Each of the relays P_0 to P_9 has but one armature which is employed to control a corresponding relay of the group TT_0 to TT_9. Thus, the several relays P_0 to P_9 control the operation of the corresponding relays TT_0 to TT_9 which are also part of the common test circuit.

It will be observed that when a sleeve contact such as S_5 is found grounded due to the busy condition of the associated trunk, the corresponding relay P_5 will become operated, and relay P_5 in turn will operate relay TT_5. Consequently, the various relays of group TT_0 to TT_9 will be operated or released depending upon whether or not the corresponding sleeve contacts of the trunk group AT are grounded or ungrounded. If there are ten trunks in the group and if all of the sleeve contacts S_0 to S_9 are grounded, for example, all of the relays P_0 to P_9 will be operated as well as the corresponding relays TT_0 to TT_9. If all of the sleeve contacts, except sleeve S_8 for example, are grounded, then relays P_8 and TT_8 will be the only unoperated relays of the two groups of relays P_0 to P_9 and TT_0 to TT_9 controlled by the sleeves S_0 to S_9. If there should be less than ten trunks in the group, the contacts of relay CI_0 which are not associated with trunks are connected to ground so that the corresponding P and TT relays will be operated in the same manner as for busy trunks. In the present instance the contact of relay CI_0 corresponding to terminal AA of group AT will be so wired, causing relays P_6 and TT_6 to be operated.

Although the winding of relay STA is connected in parallel with the winding of relay CI_0 as already shown, relay STA is slow in operating to insure that relay PT has ample time to close its back contact as hereinbefore described. After this interval of time has elapsed, relay STA operates and disconnects ground from the lower winding of relay PT by the opening of the circuit through its armature L_2 and associated back contact. This allows condenser K to become charged in a circuit extending from battery, through the lower winding of relay PT to ground. As this charge is taking place, the magnetic effect of the lower winding of relay PT is gradually reduced. When the effect of the lower winding is reduced to less than that of the upper winding, the relay PT operates.

Relay PT in operating causes relay RLA to operate in a circuit from the previously mentioned ground already connected to conductor **21**, through armature T_2 of relay RL and its back contact, armature L_1 of relay STA and its front contact, the armature and front contact of relay PT, the winding of relay RLA, battery and ground. The delay introduced in the operation of relay RLA by means of the condenser timing arrangement described above is sufficient to allow relays CI_0, P_0 to P_9 and TT_0 to TT_9 to be fully operated. Relay RLA in operating provides a ground at the make contact of its armature T_2 over conductor **24** and through the armature T_2 and back contact of relay RL, armature L_1 and the corresponding front contact of relay STA and the armature and front contact of relay PT to lock the relay RLA in its operated position. This locking path to ground will also hold relays STA, PT and CI_0 and the stepping magnet SM operated. Furthermore, the operation of relay RLA will cause the energization of the winding of relay RL over a circuit which includes the armature T_1 of relay RLA and its make contact, conductor **25**, the winding of relay RL, battery and ground. Relay RL is of the slow operating type and, therefore, will not respond immediately after relay RLA becomes operated. The operation of relay RLA also opens a path at the normally made contacts associated with its armature L_1 which previously extended to the winding of relay AR, over lead **32** and the armature T_1 and make contact of relay CI_0. The opening of this path will serve to release the relay AR which controls the alternate route control circuit if the relay AR is operated, provided the results of the tests to be described indicate that the associated route has again become available. The operation of relay RLA also connects ground at the normal contacts of armature T_1 of relay RL through its own armature L_1 and make contact, through the lower armature of relay Q_1 and its back contact, through the lower armature

of relay Q_2 and its back contact, and then through the lower armature and back contact of relay Q_3 to the armature U_2 of relay TT_9. The connection of ground to the armature U_2 of relay TT_9 in response to the operation of relay RLA will serve to hold relay AR operated, if it is already operated, or to operate it if it has become released, if the associated route is not available as indicated by the tests performed by relays P_0 to P_9 and relays TT_0 to TT_9. This will now be explained.

The ground connected to the upper armature U_2 of relay TT_9 will be applied through the various contacts of relays TT_0 to TT_9 to one of the four conductors AO, BO, CO or DO in accordance with the number of relays of the group TT_0 to TT_9 that are unoperated at any one time. If all of the relays TT_0 to TT_9 are operated, as would be the case if all the trunks of group AT were busy, ground at the armature U_2 of relay TT_9 will be applied to the conductor AO over a circuit which includes the make contact of armature U_2 of relay TT_9, and then through the other armatures U_2 of relays TT_8, TT_7 . . . TT_0 and their corresponding make contacts. If all of the relays TT_0 to TT_9 except one, such as TT_8, are operated, then ground will be applied to the conductor BO over a circuit which includes the armature U_2 of relay TT_9 and its make contact, the armature U_2 of relay TT_8 and its back contact, then through the armature U_1 of relay TT_7 and its make contact, and through the other armature U_1 of relays TT_6, TT_5 . . . TT_0 and their make contacts to conductor BO. If all of the relays TT_0 to TT_9 are operated except two, such as TT_7 and TT_8, ground at the armature U_2 of relay TT_9 will be applied to conductor CO over a circuit which includes the armature U_2 of relay TT_9 and its make contact, the armature U_2 of relay TT_8 and its back contact, the armature U_1 of relay TT_7 and its back contact, and then through the armature L_1 of relays TT_6, TT_5 . . . TT_0 and their make contacts to conductor CO. If three or more of the relays TT_0 to TT_9 are unoperated, as for example, relays TT_7, TT_8 and TT_9, ground at the armature U_2 of relay TT_9 will be applied to the conductor DO over a circuit which includes the armature U_2 of relay TT_9 and its back contact, the armature U_1 of relay TT_8 and its back contact, the armature L_1 of relay TT_7 and its back contact and then to conductor DO. Thus, ground will be applied to any one of the conductors AO, BO, CO and DO depending upon whether no one of the trunks of group AT is idle or one trunk is idle, or that two trunks are idle, or three or more trunks are idle, respectively. The presence of ground on any one of these four conductors may be employed in this invention to cause relay AR either to be operated or to be released, as desired, to provide either the alternate routes or the normal routes, as will be further explained.

The conductor AO is connected to the lower winding of the relay AR over a circuit which includes the feeder brush FB_2 of the rotary selector, the main brush MB_2 of the same selector, terminal **3** of the arc of the rotary selector, conductor **30** to the lower winding of relay AR. The application of ground to the conductor AO therefore will operate relay AR if it should be released, or hold it operated if it is already operated. Thus, when the common testing circuit applies ground to the conductor AO, the relay AR will be energized so as to connect the alternate route to the system. Should it be desired to employ the alternate route when all of the trunks of group AT but one are busy, as well as when all are busy, then the conductor CC will be wired to the terminal **3** associated with brush MB_3 of the rotary selector. In that case relay OT will be operated over a circuit which includes the feeder brush FB_3 and the main brush MB_3 of the rotary selector and its terminal **3**, conductor CC, the armature U_2 of relay STA and its make contact, the upper winding of relay OT, battery and ground. When so wired, the relay AR will be energized upon the application of ground to the conductor BO whenever all of the trunks but one are busy. The circuit from grounded conductor BO to the winding of relay AR will include in addition to grounded conductor BO, the upper armature of relay TB and its back contact, the upper armature of relay OT and its make contact, conductor **31**, the brushes FB_2 and MB_2 and their associated terminal **3** of the rotary selector, conductor **30** to the lower winding of relay AR. Thus, the relay AR will be operated under these conditions, if it is not already operated. Similarly, if it is desired to provide the alternate route when all of the trunks but two are busy, the conductor EE will be wired between terminal **3** associated with brush MB_3 of the rotary selector and the armature U_1 of relay STA, thereby causing relay TB to become operated. The operation of relay TB will supply ground at conductor CO to the lower winding of relay AR over a circuit similar to that already described to operate that relay AR or hold it operated, whenever all but two of the trunks are busy. Relay TB also connects conductor BO to the lower winding of relay AR if only one trunk should be found idle under these conditions. This arrangement may be extended to provide the alternate route path when any desired proportion of the trunks of group AT are busy.

It is apparent from the foregoing that the operation of relay RLA in response to the operation of relay AR opens the locking path for relay AR at the back contact of the armature L_1 of relay RLA and at the same time closes a path at the make contact of armature L_1 of relay RLA to apply ground to the armature U_2 of relay TT_9 of the common test circuit so as to hold relay AR operated or to reoperate it if it has become released. This in turn will depend upon the number of trunks which have become idle, the idle condition being indicated by the application of ground to one of the various conductors AO, BO, CO or DO. The operation of relay RLA will also complete a path at the make contact of its armature T_1 to operate relay RL, as already pointed out, but the latter relay is of the slow-operate type in order to allow sufficient time for the relay AR to become operated or released.

The operation of relay RL will apply ground at the make contact of its armature T_1 to the lower winding of relay AR if relay AR is operated, over a path which includes conductor **32**, the armature T_1 of relay CI_0 and its make contact, and the armature L_1 of relay AR and its make contact. This ground will lock relay AR in its operated condition. The operation of relay RL also opens the circuit connected to the back contact of its armature T_2 and thereby releases relays CI_0, STA, PT and RLA. The opening of the circuit of the stepping magnet SM at the back contact of armature L_1 of relay RL will release the stepping magnet SM which then causes the main brushes MB_1, MB_2 and MB_3, which are mounted on a common shaft, to be moved to their

next terminal 4. The reason for operating the rotary selector will be explained hereinafter. The release CI_0 also closes the locking path for relay AR previously established, if relay AR is operated at this time, through the armature L_1 of relay AR and its make contact and the normal contacts associated with armature T_1 of relay CI_0. The release of relay CI_0 also disconnects the sleeve contacts S_0 to S_9 of the trunk group AT from the corresponding windings of relays P_0 to P_9 and the release of the latter relays will in turn release the corresponding relays TT_0 to TT_9. The release of relay RLA will remove the supplementary ground previously connected by its armature T_2 to the start lead ST through the path of armature T_2 of relay RLA, conductors 24 and 21 and key BC. The release of relay RLA also releases relay RL by opening the circuit to its winding at the make contact of the armature T_1 of relay RLA. Both relays RL and RLA are slow to release, however, so as to permit all elements of the common test circuit to be returned to normal before another test of the trunks of the group AT is initiated.

The arrangement of this invention may be employed for testing a group of trunks of any size. For example, 30 trunks (only some of which are shown) may be arranged in three groups, such as AT, BT and CT, and three relays, such as CI_0, CI_1 and CI_2, may be employed for separately connecting the sleeves of one of the three trunk groups AT, BT and CT respectively, to the windings of the relays P_0 to P_9. Only one re-route relay such as AR will be associated with the three cut-in relays CI_0, CI_1 and CI_2, and the lower armature L_1 of relay AR will be connected to normal contacts of the relay CI_0 in the manner already considered for a group of ten trunks. The terminals 1, 2 and 3 associated with the main brush MB_1 may be wired through leads LD_2, LD_1 and LD_0 to the windings of the relays CI_2, CI_1 and CI_0, respectively, as shown. Assuming also that the alternate route is to be made available when but two of the trunks of the three groups are idle, then conductors FF, AA and DD will be positioned on terminals 1, 2 and 3 associated with the main brush MB_3 of the rotary selector. All of the main brushes MB_1, MB_2 and MB_3 may be considered to be positioned on terminal 1 at the beginning of a test of such a series of three trunk groups. It is noted, however, that the main brush MB_3 is of the bridging type, being adapted to close one of its terminal before it is completely disconnected from a pervious terminal. The other main brushes MB_1 and MB_2 are of the non-bridging type.

When the selector switch SS of the office selector OS moves upward in hunting for an ungrounded sleeve terminal, it will cause the relay AR to become operated as soon as it reaches the predetermined terminal AA, as already described. Ground at the armature L_2 of relay AR will be applied to the start lead ST and will complete a circuit to operate relay CI_2, this circuit including in addition to the start lead ST, key BC, conductor 21, the armature T_2 and back contact of relay RL, the brushes FB_1 and MB_1 of the rotary selector and the associated terminal 1, lead LD_2, the winding of relay CI_2, battery and ground. The relay CI_2 will now connect the sleeves S_0 to S_9 of the trunk group CT to the windings of the relays P_0 to P_9, respectively, over circuits similar to those generally designated 37 and the relays P_0 to P_9 will then control the corresponding relays TT_0 to TT_9 as already described. Relays STA and

PT will operate and cause the operation of relay RLA as before. Upon the operation of relay STA, relay AD will become operated over a circuit which includes battery, the winding of relay AD, conductor 36, the make contact and armature U_3 of relay STA, conductor FF, terminal 1 and brushes MB_3 and FB_3 of the rotary selector and ground. The relay AD will be employed to control the relays V_1, V_2 and V_3 and relays Q_1, Q_2 and Q_3 for counting the number of idle trunks in the trunk groups to be tested.

If one of the trunks of the group CT is found idle, the conductor BO will be grounded by the relays TT_0 to TT_9 in the manner already described, and this grounded conductor will be connected through the contacts of relay AD to the winding of relay V_1 for operating the latter relay. The operating circuit for relay V_1 will include the grounded conductor BO, the upper armature and back contact of relay TB, the upper armature and back contact of relay OT, the armature U_2 and make contact of relay AD, the upper armature and back contact of relay Q_1, the winding of relay V_1, battery and ground. With relay RL released, relay Q_1 will be short-circuited by the contacts of relay V_1. That is, ground will be connected to the lower terminal of relay Q_1 over a circuit which includes the make contact and armature of relay V_1, the back contact and armature U_1 of relay Q_2, the back contact and upper armature of relay Q_3, the make contact and armature L_2 of relay AD, and ground; and ground will likewise be connected to the upper terminal of the winding of relay Q_1 over a circuit which includes the upper armature and back contact of relay Q_1, the make contact and armature U_2 of relay AD, the back contact and upper armature of relay OT, the back contact and upper armature of relay TB to the grounded conductor BO. However, when relay RL becomes operated in response to the operation of relay RLA, as already pointed out, the ground on conductor BO will be removed from the make-before-break contact of relay RL and hence relay Q_1 will be operated. The operating circuit for relay Q_1 may be considered to include battery, the windings of relays V_1 and Q_1, the make contact and armature of relay V_1, the back contact and armature U_1 of relay Q_2, the back contact and upper armature of relay Q_3, the make contact and armature L_2 of relay AD and ground. Thus, both of the counting relays V_1 and Q_1 will be operated in response to ground applied to the conductor BO by the testing relays TT_0 and TT_9.

Should the testing relays TT_0 to TT_9 apply ground to the conductor CO instead of conductor BO, as would be the case, for example, if two of the trunks of the group CT are found idle, the relay V_2 will then be operated over a circuit which includes battery, the winding of relay V_2, the armature U_2 and back contact of relay Q_2, the make contact and armature U_1 of relay AD, the back contact and armature L_1 of relay OT, the back contact and armature L_1 of relay TB to the grounded conductor CO. The winding of relay Q_2 will also be short-circuited by the contacts of relay V_2, but this short circuit will be removed upon the operation of relay RL to cause the relay Q_2 to be operated. Thus, the relays V_2 and Q_2 of the counting circuit will be operated in response to the application of ground to the conductor CO.

Should ground be applied to the conductor DO by the testing relays TT_0 to TT_9 by virtue of the idleness of three or more of the trunks of

the group CT, relay V_3 will become operated and thereby short-circuit the winding of relay Q_3. Relay Q_3 will also become operated upon the operation of relay RL.

While the main brushes MB_1, MB_2 and MB_3 are positioned on their respective first terminals designated 1, the relay AR cannot be operated if it is released because lead 30—which extends to the lower winding of relay AR—is on terminal 3 of the rotary selector and terminal 1 is open. For this reason, if ground should be applied to conductor AO at this time due to all trunks of group CT being found busy, this ground has no effect. Similarly, relay AR cannot be released if it is operated at this time because its locking path is controlled by the make-before-break contacts of relay CI_0 and the latter relay has not yet been operated. The relay AR can be controlled only when the rotary selector reaches terminal 3, as will be explained hereinafter.

The counting relays V_1, V_2 and V_3 and Q_1, Q_2 and Q_3 are employed to store the results of the tests made on the 10 trunks of the group CT so that these results may be added to the results subsequently obtained by tests on the other trunk groups BT and AT for determining whether or not the re-route relay AR is to be operated or released after the testing cycle has been completed.

Let it be assumed that in testing the trunks of the group CT only one trunk is found idle, thereby causing the operation of relays V_1 and Q_1. The operation of relay RL will break the circuit of the stepping magnet SM, thereby advancing the main brushes MB_1, MB_2 and MB_3 of the rotary selector to their next terminal designated 2. Moreover, relays RLA, STA, PT, CI_2 and RL will be released in the manner already described. As the main brush MB_3 reaches its terminal 2, it will hold relay AD operated over a circuit which includes battery, the winding of relay AD, the conductor AA, terminal 2 and the brushes MB_3 and FB_3 of the rotary selector and ground. By holding relay AD operated the counting relays V_1 and Q_1 will be held operated while the next group of trunk terminals BT are tested. The relay Q_1 will transfer the ground at the make-before-break contacts of relay RL to the armature U_1 of relay TT_9 over a circuit which includes the armature L_1 of relay RLA and its make contact, and the lower armature and make contact of relay Q_1. This has the effect of increasing by one the number of trunks to be found idle in group BT.

With the main brushes of the rotary selector on their terminals designated 2, the relay CI_1 will become operated over a circuit which includes ground at the armature L_2 of relay AR, the start lead ST, the key BC, conductor 21, the armature T_2 and back contact of relay RL, brushes FB_1 and MB_1 and terminal 2 of the rotary selector, conductor LD_1, the winding of relay CI_1, battery and ground. Relay CI_1 will connect the sleeve terminals of the trunks of the group BT to the windings of relay P_0 to P_9, respectively, which in turn will control the relays TT_0 to TT_9 for testing these various sleeve terminals in the manner already described. Should one of the trunks now be found idle, after let us say only one trunk was found idle in the previous trunk group CT, the ground applied to the lower armature of relay Q_1 by the operation of relay RLA, will be closed through make contacts of relay Q_1 to armature U_1 of relay TT_9 and then

to conductor CO. The application of ground to conductor CO will cause relay V_2 to operate over a circuit similar to that previously traced. Relay Q_2 will likewise become operated after relay RL releases. It seems hardly necessary to state that if a second sleeve terminal were also found grounded in the trunk group BT, the relays V_3 and Q_3 would become operated due to ground being applied to the conductor DO, but this situation will be passed at this time. The operation of relay Q_2 will open the circuit to the windings of relays V_1 and Q_1, releasing them, and in a similar manner if relay Q_3 should be operated instead of Q_2, it would open the circuit either to relays V_1 and Q_1 or V_2 and Q_2, releasing either pair of these relays that may have been operated depending upon the number of trunks previously found idle.

Upon the operation of relay RL at the end of the test, the stepping magnet SM will become deenergized, thereby advancing the main brushes of the rotary selector to their next terminal designated 3. The ground from lead ST closed to the feeder brush FB_1 will then be applied through lead LD_0 to the winding of relay CI_0, thereby operating this relay. Accordingly, the sleeve terminals of the trunk group AT will now be connected to the windings of relays P_0 to P_9 in the manner already described for testing this group of trunks. The sequence of events occurring upon the operation of relay CI_0 have already been outlined and need not be repeated. If relay Q_2 is operated, however, the ground from the back contact associated with armature T_1 of relay RL, through operated contacts L_1 of relay RLA, is closed through the lower armature and back contact of relay Q_1, lower armature and make contact of relay Q_2, to the armature L_1 of relay TT_9. This has the effect of increasing by two the number of trunks to be found idle in group AT. If relay Q_3 is operated, due to three or more trunks having previously been found idle, the circuit described above is disconnected from relay TT_9, so that relay AR cannot be operated, regardless of the number of trunks found idle in group AT.

Upon reaching terminal 3, the relay TB will become operated over a circuit which includes battery, the winding of relay AD, the lower winding of relay TB, conductor DD, terminal 3, and the brushes MB_3 and FB_3 of the rotary selector and ground. This circuit includes the winding of relay AD and, therefore, relay AD is held operated while the main brushes are on their terminal 3. Consequently, the previously operated counting relays will be held operated.

With relay TB operated the re-route relay AR will be energized if it has become deenergized, or will be held operated if it is already operated and if the alternate route is to be cut in when not more than two trunks of the three groups AT, BT and CT have been found idle. In this connection it is observed that the make contact of the armature L_1 of the relay TB is wired to the feeder brush FB_2 and thence through lead 30 to the lower winding of relay AR. In a similar manner, relay AR will be operated or held if only one trunk in the three groups should be found idle, by closure from conductor BO through the upper armature and make contact at relay TB to the feeder brush FB_2.

Were it desired to cut the re-route path into the system upon the location of but one idle trunk, the conductor BB would replace the conductor DD at terminal 3 associated with the main brush MB_3. With conductor BB on terminal 3, the relay OT will be operated instead of the re-

lay TB, the operating circuit for relay OT including battery, the winding of relay AD, the lower winding of relay OT, conductor BB, terminal 3 and the associated brushes MB_3 and FB_3 of the rotary selector and ground. Under these conditions the grounding of conductor BO, in response to the location of a single idle trunk in any of the various trunk groups AT, BT or CT, will be transferred through the upper armature and make contact of relay OT, over conductor 31 and through the brushes FB_2 and MB_2 to lead 30 and to the lower winding of relay AR. In either of the above cases, if all of the trunks in groups CT, BT and AT are found busy, ground will be connected to conductor AO which will cause the relay AR to be operated or held operated as hereinbefore described, without regard to relays TB or OT.

On the other hand, if the alternate route path is to be cut into the system only when all trunks are found busy, conductor GG will be positioned on the terminal 3 associated with the main brush MB_3 of the rotary selector. Ground applied through brushes FB_3 and MB_3 to conductor GG will hold any of the counting relays operated, but relay AD will be released. The system is, therefore, flexible and may be made to respond to any desired or predetermined condition in the trunks of a large group.

Upon the operation of relay AR or its release at the end of the test of the three groups of trunks CT, BT and AT, the re-routing path may be cut in or omitted as determined by the testing apparatus. However, when relay RL operates at the end of the test, the stepping magnet SM will again be released to advance the main brushes MB_1, MB_2 and MB_3 to their next terminal designated 4. When this happens the relays OT or TB will be released if either of these relays has been operated under the separate conditions already referred to, and relay AD will also be released if it is operated. Likewise, all of the counting relays will be released upon the release of relay AD, or upon the removal of ground from conductor GG. If three or more trunks are found idle during the test of any group of trunks, such as CT, or on a cumulative basis during successive tests over all of the three groups CT, BT and AT, in consequence of which counting relays V_3 and Q_3 have become operated, the relay AR will become released and the regular route will therefore be employed for subsequent calls through the system. Should it be desired to use the alternate route for these trunk groups when three or more trunks are found idle, it will be understood that additional counting relays and appropriate wiring may be added to the system for this purpose.

The other terminals 4, 5, 6, etc., of the rotary selector switch may be wired to additional cut-in relays such as CI_{10}, CI_{20}, etc., and corresponding re-route relays such as AR_{10}, AR_{20}, etc., in accordance with the principles already outlined with respect to a group of trunks such as CT. One route relay and one cut-in relay may be associated with each trunk group. As the main brushes of the rotary switch are moved from terminal to terminal, the trunks of a trunk group such as DT associated with another of the cut-in relays, such as CI_{10}, will be tested and the re-route path controlled by the re-route relay, such as AR_{10}, may be added or omitted as determined by the testing apparatus. Further description along these lines would be merely repetitious and has, therefore, been omitted.

The rotary selector is arranged to pass by spare terminals which are not required for actuating alternate route control circuits. When such a terminal is reached, relays STA and PT operate as before, thereby causing relay RLA to become operated and in turn cause the relay RL to become operated. The operation of the relay RL will, of course, release the stepping magnet and advance the main bushes of the rotary selector beyond any such spare terminal.

To allow the common test circuit to make continuous tests regardless of whether or not any associated trunk group is busy, the keys BC and IC will be left unoperated and key KST will be operated. In that case the operation of relay AR upon contact with terminal AA of Fig. 1 is not required and the wiring for such operation may be omitted.

If it is desired to make tests at periodic intervals, the interrupter control key IC will be operated. An interrupter INT is shown connected through contacts 50 of the key IC and through the upper winding of relay I to battery and ground. Hence relay I will be operated at the intervals determined by the interrupter INT. Upon the operation of relay I this relay will be locked over a locking circuit provided by its lower winding, contacts 51 of the key IC and the make contact and upper armature of relay I and ground. Ground will also be applied to the contacts associated with armatures L_1 and T_2 of relay RL over a circuit which includes the upper armature and make contact of relay I, contacts 52 of key IC, the normal contacts of key BC and conductor 21. The conductor II will be wired to any particular terminal associated with the brush MB_3 of the rotary selector. With relay I operated, the tests will be made and repeated at the intervals determined by the interrupter INT for all selector terminals prior to the one to which conductor II is connected. When the terminal to which conductor II is wired is reached, the relay I will be released. This is because ground is applied to the lower winding of relay I over a circuit including the brushes FB_3 and MB_3, conductor II, contacts 53 of key IC and to the armature and lower winding of relay I, thereby short-circuiting the lower winding of relay I. The release of relay I will disconnect ground from the contacts associated with armatures L_1 and T_2 of relay RL and replace this ground with the ground connected to brush FB_3. The new ground is applied over a circuit including the brushes FB_3 and MB_3, conductor II, contacts 53 of key IC, lower armature and back contact of relay I, contacts 52 of key IC, the normal contacts of key BC and conductor 21 to the armatures L_1 and T_2 of relay RL. However, when the selector passes the terminals to which conductor II is connected, this ground is disconnected and therefore no further tests will be made until the interrupter again causes the relay I to be re-operated.

Fig. 3 illustrates a modification of certain of the apparatus of each decoder circuit of the telephone system to permit the setting and restoring of the normal and alternate routes at any time without causing interference with calls already in progress. Here the two route relays designated RR_1 and RR_2 are shown which, when operated, establish the normal routes for calls. One of these relays, such as RR_1, would be associated with the re-route relay AR of Fig. 1, and the other would be associated with a similar re-route relay, such as AR_{10}, for example. The

conductors 13 and 16 of Fig. 1 are shown connected to the code point CP_1 and one terminal of the winding of the relay RR_1, respectively. The other code point CP_2 and one terminal of the winding of relay RR_2 are likewise connected to contacts of their associated re-route relay. These relays RR_1 and RR_2 are connected in parallel with respect to the winding of a relay GS_1 so that relay GS_1 will be operated if either of the relays RR_1 or RR_2 becomes operated. In other words, if the relay AR of Fig. 1, for example, is released, the relay RR_1 will be operated to establish normal routing for the calls received by the trunk group associated with relay AR, and the relay GS_1 will also be operated. However, when the relay AR becomes operated, relays RR_1 and GS_1 will both be released.

Fig. 3 also shows the conductor 19 associated with relay AR of Fig. 1 connected in series with the winding of an alternate route relay RP and another relay GS_2 which is similar to relay GS_1. Relays RP and GS_2 will be operated only when the corresponding re-route relay AR has been operated. It is to be noted that both relays GS_1 and GS_2 are of the slow-release type. Consequently, upon the operation of relay AR, the relay GS_1 will remain operated for a predetermined time interval so that both relays GS_1 and GS_2 will simultaneously hold their back contacts open. Hence, the connection of ground at the armature of relay GS_2 to the point RLX will be interrupted for the time during which it takes relay GS_1 to become fully released. The terminal RLX is connected in the ground supply circuit which is part of the apparatus for advancing the sender (not shown). Thus the operation of the sender will be delayed and this will allow sufficient time for the route relay RR_1 to release, and in turn to release any relays which it may have operated for routing the call to the normal trunk group. However, upon the release of the relay GS_1 calls will be routed under control of the re-route relay RP.

While this invention has been shown and described in certain particular embodiments merely for the purpose of illustration, it will be understood that the general principles of this invention may be applied to other and widely varied organizations without departing from the spirit of the invention and the scope of the appended claims.

What is claimed is:

1. In a telephone system, the combination of a plurality of trunks over which calls may be transmitted, a plurality of testing relays each corresponding to one of said trunks, means for simultaneously connecting said testing relays to the corresponding trunks, each testing relay being energized when its corresponding trunk becomes busy, a re-route relay, and means connecting said re-route relay to said testing relays to operate said re-route relay when a predetermined number of said trunks become simultaneously busy.

2. In a telephone system, the combination of a plurality of trunks each having a sleeve terminal, a plurality of testing relays each corresponding to one of said trunks, an intermediate relay having a plurality of contacts each of which interconnects the sleeve terminal of one of said trunks with the winding of the corresponding testing relay, a re-route relay, and means for connecting said re-route relay to said testing relays to operate said re-route relay when a predetermined number of said testing relays are simultaneously operated.

3. In a telephone system, the combination of a plurality of trunks each having a sleeve terminal, said trunks being divided into separate groups, a plurality of testing relays each of which corresponds to one of the trunks of a group, an intermediate relay having a plurality of contacts each of which connects the sleeve terminal of one of said trunks to the winding of the corresponding testing relay, a re-route relay, means controlled by said testing relays for registering the number of trunks that are idle in all of said groups, and means controlled by said registering means for operating said re-route relay when the number of idle trunks is below a predetermined number.

4. In a telephone system, the combination of a plurality of trunk sleeve terminals corresponding to different telephone trunks, a selector adapted to hunt successively over said sleeve terminals to locate an ungrounded terminal, a re-route relay connected to a predetermined one of said sleeve terminals, said re-route relay being operated when said predetermined sleeve terminal is reached by said selector, means responsive to the operation of said re-route relay to simultaneously test all of said sleeve terminals to determine whether said sleeve terminals are grounded or ungrounded, and means for operating said re-route relay when a predetermined number of said sleeve terminals are grounded and for releasing said re-route relay when less than said predetermined number of said sleeve terminals are grounded.

5. In a telephone system, the combination of a plurality of trunk sleeve terminals corresponding to different trunks, said sleeve terminals being arranged in separate groups, a selector adapted to hunt successively over said sleeve terminals, a re-route relay connected to a predetermined one of said sleeve terminals and being operated when said predetermined sleeve terminal is reached by said selector, means controlled by said re-route relay to separately test all of the sleeve terminals in the various groups in succession and to register the number of ungrounded sleeve terminals detected, and means for operating said re-route relay when the number of sleeve terminals found ungrounded is less than a predetermined number and for releasing said re-route relay when the number of ungrounded sleeve terminals equals or exceeds said predetermined number.

6. In a telephone system, the combination of a plurality of trunks arranged in groups, a testing circuit which may be connected to all of the trunks in any one group at one time, said testing circuit being capable of simultaneously testing all of the trunks in each group to determine the number of idle trunks in the group, means for successively connecting said testing circuit to said groups of trunks, and means for additively indicating the number of idle trunks in all of said groups of trunks.

7. In a telephone system, the combination of a plurality of trunks arranged in groups, testing apparatus which may be connected to all of the trunks in any one group at one time, said testing apparatus serving for simultaneously testing all of the trunks of any one group to determine the number of idle trunks in the group, said testing apparatus including means for preventing interference with service over said trunks of the group while they are being tested, and

means for additively indicating the number of idle trunks in all of said groups.

8. In a telephone system, the combination of a plurality of trunks arranged in groups, testing apparatus for simultaneously testing all of the trunks in any one group to determine the number of idle trunks in the group, said testing apparatus including means for preventing interference with service over said trunks of the group while they are being tested, means for additively indicating the number of idle trunks in all of said groups, and routing means controlled by the number of idle trunks in all of said groups.

9. In a telephone system, the combination of a plurality of trunks which may be transmitting telephone messages simultaneously, testing apparatus for simultaneously testing all of said trunks to determine the number of idle trunks without interfering with service over said trunks, means for momentarily applying said testing circuit to all of said trunks, said testing apparatus including a plurality of relays each having a winding of large impedance which is connected to one of said trunks, and routing means responsive to the number of idle trunks to control the routing of calls involving said trunks.

10. In a telephone system, the combination of a plurality of trunks each having tip, ring and sleeve terminals, a selector switch for progressively moving over said sleeve terminals and stopping when it reaches an ungrounded sleeve terminal, a main relay connected to a predetermined sleeve terminal, said main relay being operated when said selector switch reaches said predetermined sleeve terminal, a testing circuit for simultaneously testing all of the sleeve terminals to determine the number of ungrounded sleeve terminals, said testing circuit including a plurality of relays each of which has a winding of high resistance which is connected to one of the sleeve terminals, said resistance being of a magnitude which will not substantially change the potential of said sleeve terminal, and means controlled by said main relay to initiate the operation of said testing circuit.

11. In a telephone system, the combination of a plurality of trunks each having tip, ring and sleeve terminals, a selector switch for progressively moving over said sleeve terminals and stopping when it reaches an ungrounded sleeve terminal, a main relay connected to a predetermined sleeve terminal, said main relay being operated when said selector switch reaches said predetermined sleeve terminal, a testing circuit for simultaneously testing all of the sleeve terminals to determine the number of ungrounded sleeve terminals, said testing circuit including a plurality of relays each of which has a winding of high resistance which is connected to one of the sleeve terminals, said resistance being of a magnitude which will not substantially change the potential of said sleeve terminal, and means controlled by said testing circuit to hold said main relay operated when the ungrounded sleeve terminals are less than a predetermined number and for releasing said main relay when said predetermined number of ungrounded sleeve terminals is equaled or exceeded.

12. In a telephone system, a combination of a plurality of trunks arranged in groups, a testing circuit capable of simultaneously testing all of the trunks in any one group to determine the number of idle trunks therein, means for successively connecting said testing circuit to the different groups of trunks, means for additively indicating the number of idle trunks in all of said groups of trunks, and means for routing calls received over said trunks over their normal routes when more than a predetermined number of trunks are found idle and for changing the routing of said calls when said predetermined number or less than said predetermined number of trunks are found idle.

13. In a telephone system, the combination of a plurality of trunks arranged in groups, a testing circuit capable of simultaneously testing all of the trunks in any one group to determine the number of idle trunks therein, a plurality of re-route relays one corresponding to each group of trunks, means for successively connecting said testing circuit to said groups of trunks and for operating the corresponding re-route relays when the number of busy trunks in the respective groups exceeds a predetermined number.

14. In a telephone system, the combination of a plurality of groups of trunks, a plurality of re-route relays one associated with each group of trunks, a testing circuit capable of testing all of the trunks in any one group to determine the number of idle trunks therein, a rotary selector for successively connecting said testing circuit to the different groups of trunks, means controlled by the re-route relay corresponding to any trunk group to operate the testing circuit and connect it to the corresponding trunk group, and means for controlling the operating of the re-route relay corresponding to any trunk group in accordance with the number of busy trunks registered by the testing circuit at said trunk group.

15. In a telephone system, the combination of a plurality of trunks over which calls may be transmitted, a plurality of testing relays each corresponding to one of said trunks, means for simultaneously connecting said testing relays to the corresponding trunks, a battery in common with all of said testing relays, the windings of said testing relays being of high resistance so that the potential applied to the terminals of the trunks will not be substantially changed by the connection thereto of said testing relays, each testing relay being energized when its corresponding trunk becomes busy, a re-route relay, and means for operating said re-route relay when a predetermined number of said testing relays are simultaneously operated.

16. In a telephone system, the combination of a plurality of groups of trunks, a plurality of re-route relays, a plurality of cut-in relays, a testing circuit having a plurality of testing relays equal in number to the number of trunks in any one group, one of the re-route relays and one of the cut-in relays being associated with each group of trunks, each cut-in relay interconnecting the trunks of any one group with the corresponding testing relays of the testing circuit, and means responsive to the simultaneous operation of a predetermined number of testing relays connected to the trunks of any one group to operate the corresponding re-route relay and to release said re-route relay when the number of testing relays simultaneously operated falls below said predetermined number.

17. In a telephone system, the combination of a plurality of groups of trunks, a plurality of re-route relays, a plurality of cut-in relays, a testing circuit having a plurality of testing relays equal in number to the number of trunks in any one group, one re-route relay and one cut-in relay being associated with each group of trunks, each re-route relay controlling the routing of the

trunks of the associated group, a rotary selector, and means controlled by each re-route relay for stepping said rotary selector and for connecting the trunks of each group to the relays of said testing circuit through the contacts of the corresponding cut-in relay, said re-route relay being also controlled by said testing circuit.

18. In a telephone system, the combination of a plurality of groups of trunks each having a sleeve terminal, a plurality of re-route relays one corresponding to each trunk group and being connected to a predetermined sleeve of the trunk group, a selector which may be progressively moved over the sleeve terminals of the trunks of a group, said re-route relay being operated when said selector reaches the sleeve terminal to which the re-route relay is connected, means controlled by said re-route relay for registering the number of idle trunks in the corresponding trunk group, and means for changing the route of said trunks when the registered number of idle trunks is less than a predetermined number.

19. In a telephone system, the combination of a plurality of groups of trunks each having a sleeve terminal, a plurality of re-route relays one corresponding to each trunk group and being connected to but one of the sleeve terminals of

the corresponding trunk group, a plurality of selectors each capable of moving progressively over the sleeves of the corresponding trunk groups, each re-route relay being operated when the corresponding selector reaches the sleeve terminal to which the corresponding re-route relay is connected, a testing circuit, and means controlled by the said re-route relays for connecting said testing circuit to the various trunk groups for determining the number of idle trunks in said trunk groups.

20. A claim according to claim 14 in which there is additional means for changing the routing of the trunks of any group when the idle trunks as registered by said testing circuit is less than a predetermined number.

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