July 25, 1967 J. S. YOUNG 3,333,062

CENTRALIZED SWITCHING ARRANGEMENTS WITH INWARD DIALING

Filed April 14, 1964 11 Sheets-Sheet 1

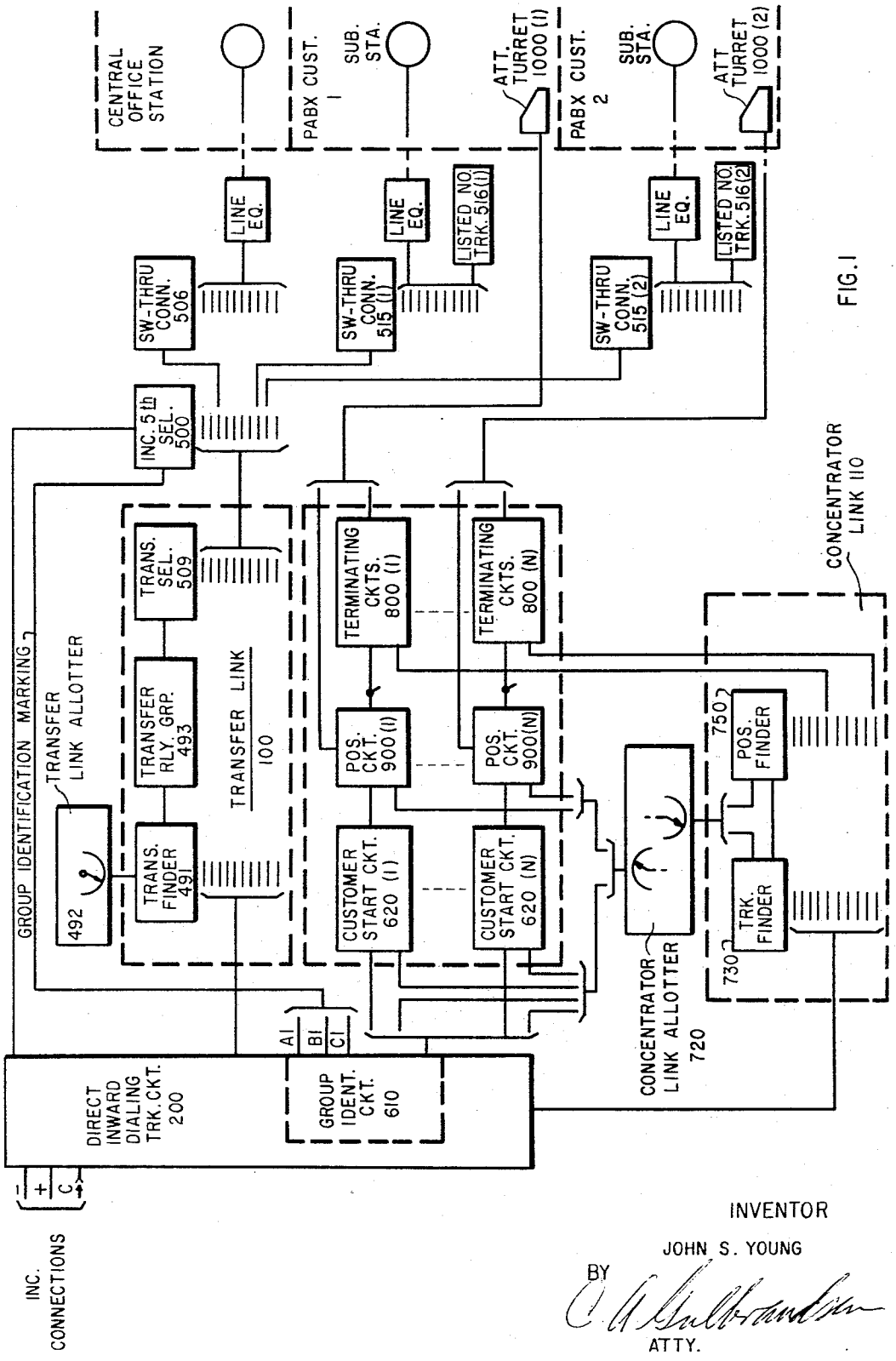

FIG. 1

INVENTOR
JOHN S. YOUNG
BY
ATTY.

CENTRALIZED SWITCHING ARRANGEMENTS WITH INWARD DIALING

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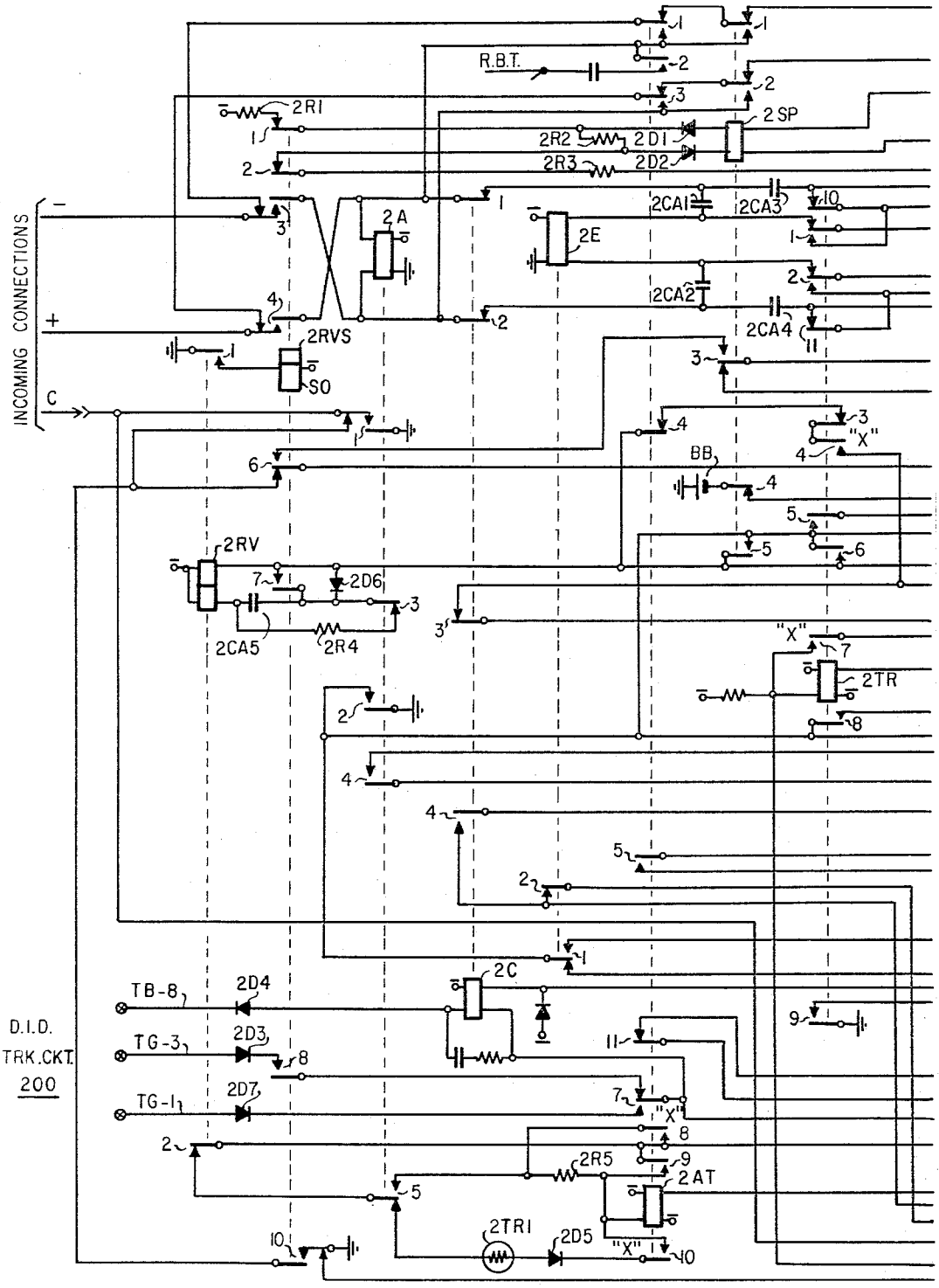

FIG. 2

CENTRALIZED SWITCHING ARRANGEMENTS WITH INWARD DIALING

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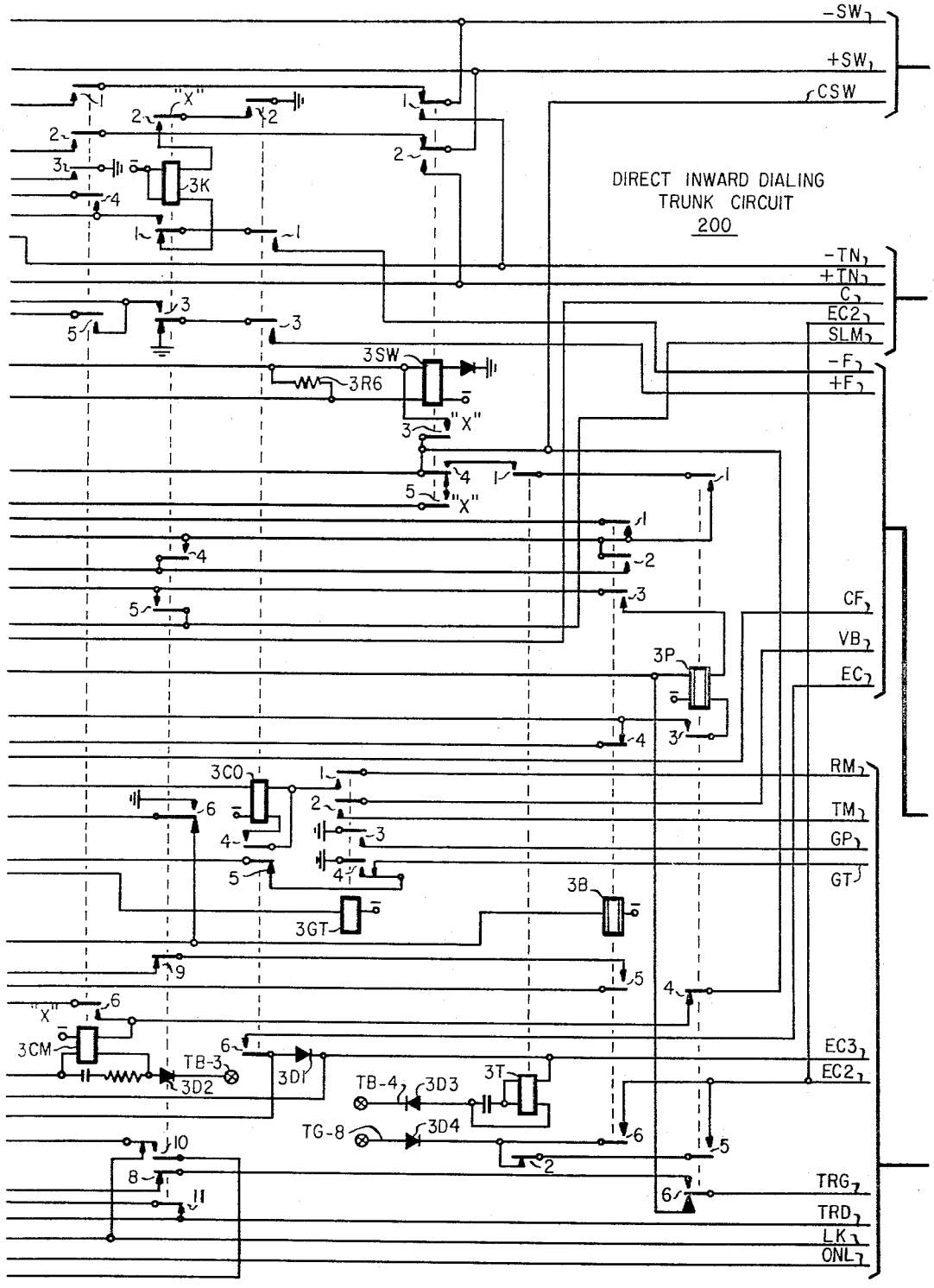

FIG.3

CENTRALIZED SWITCHING ARRANGEMENTS WITH INWARD DIALING

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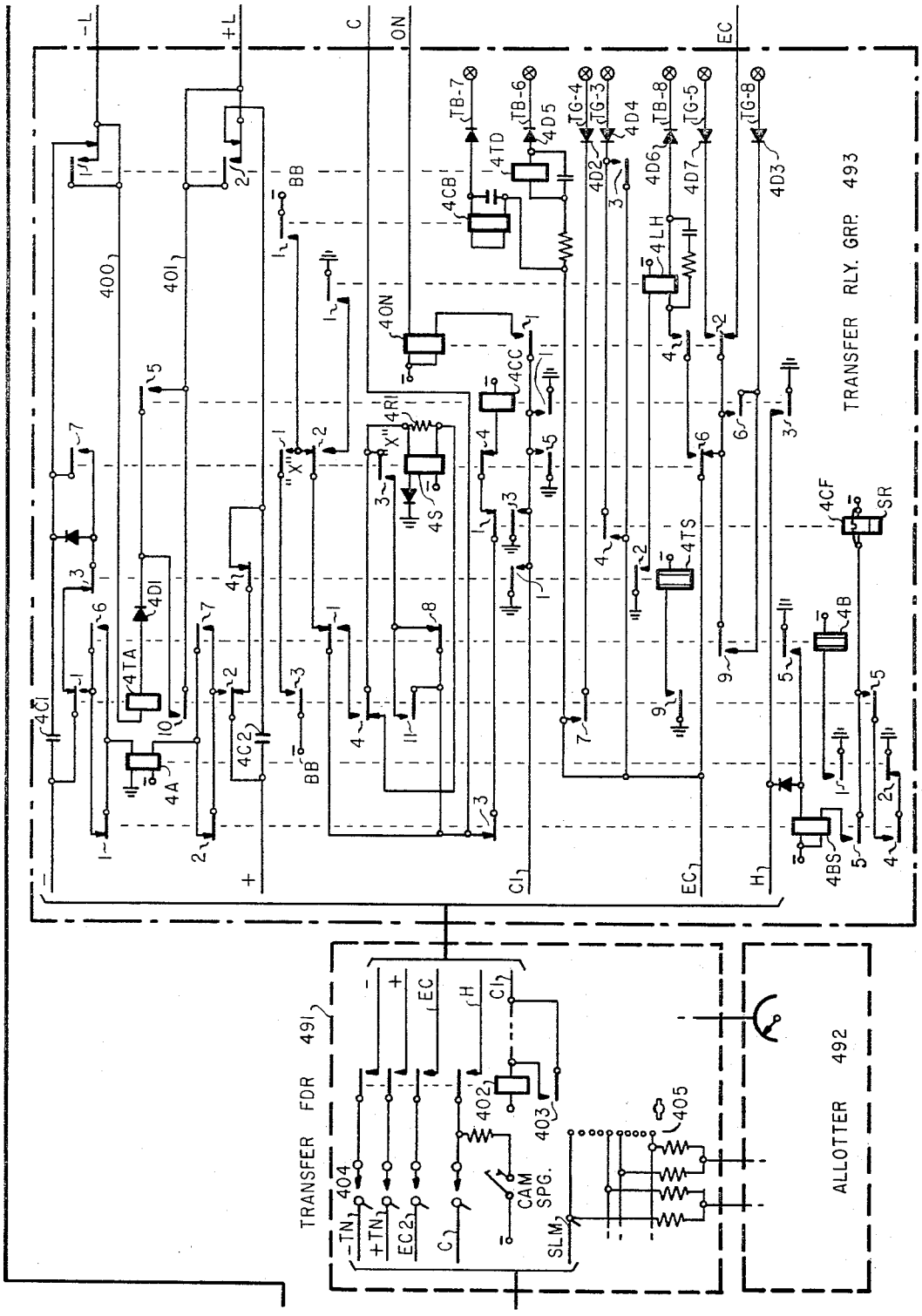

FIG. 4

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CENTRALIZED SWITCHING ARRANGEMENTS WITH INWARD DIALING

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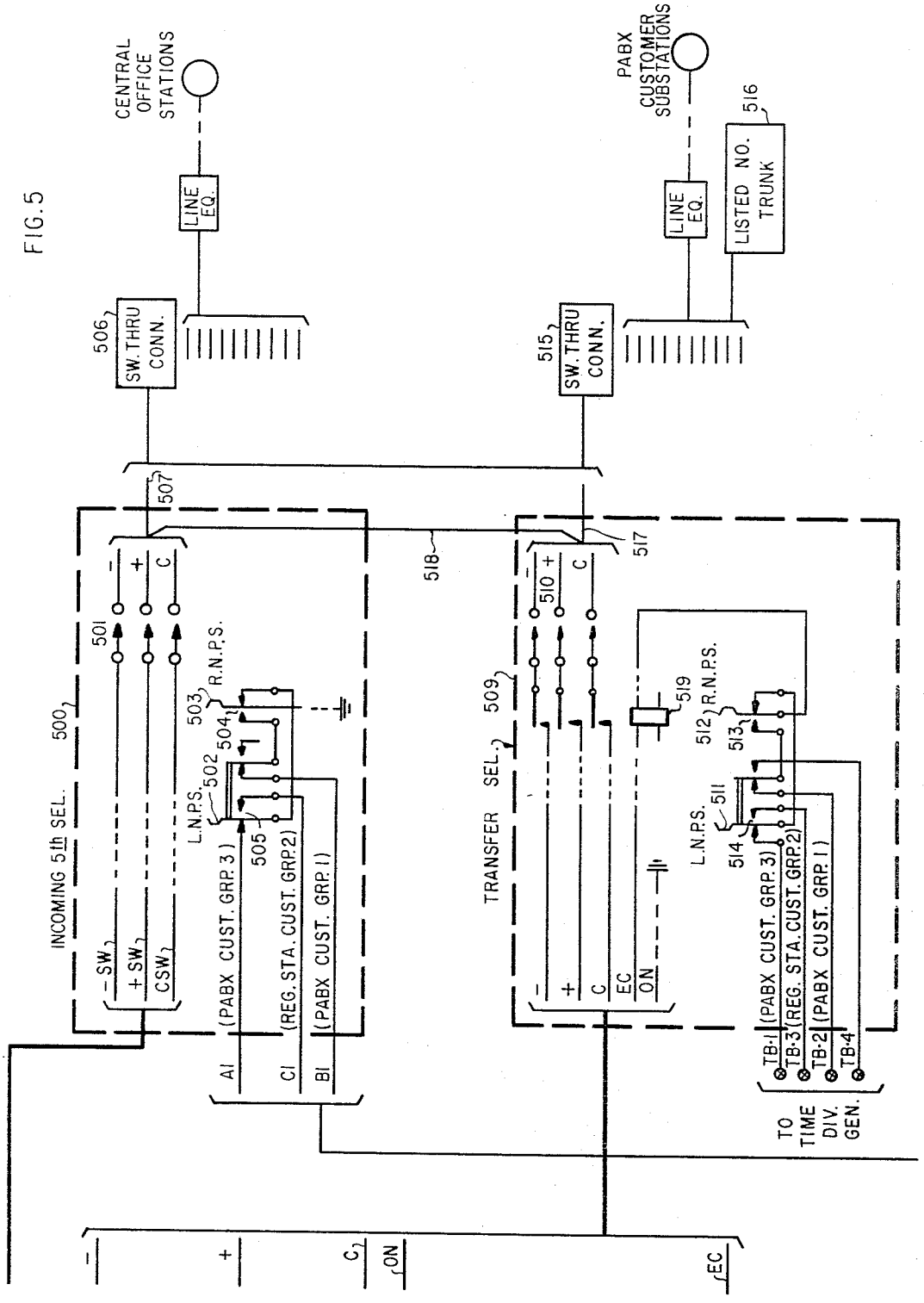
FIG. 5



CENTRALIZED SWITCHING ARRANGEMENTS WITH INWARD DIALING

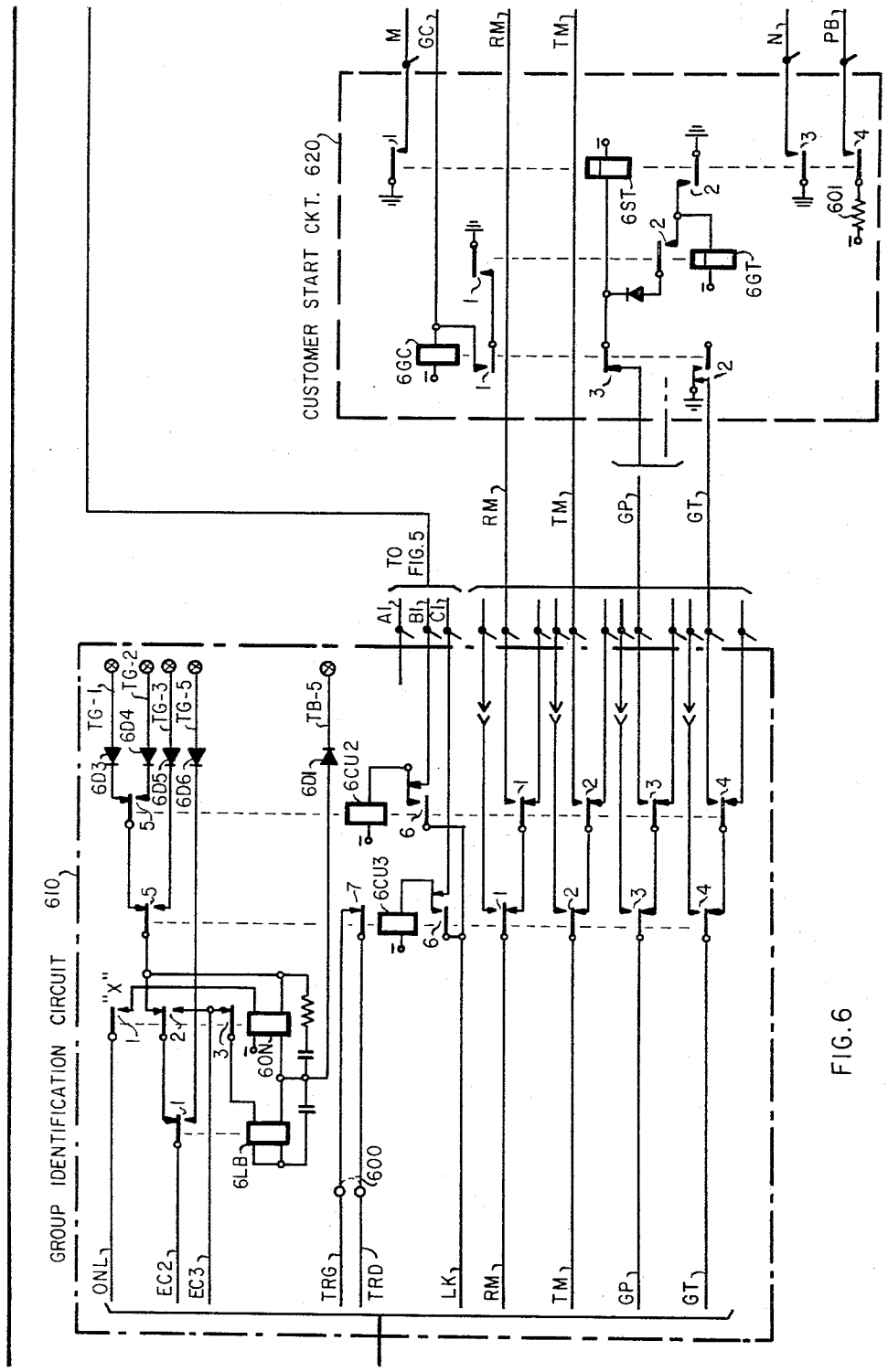


FIG. 6

CENTRALIZED SWITCHING ARRANGEMENTS WITH INWARD DIALING

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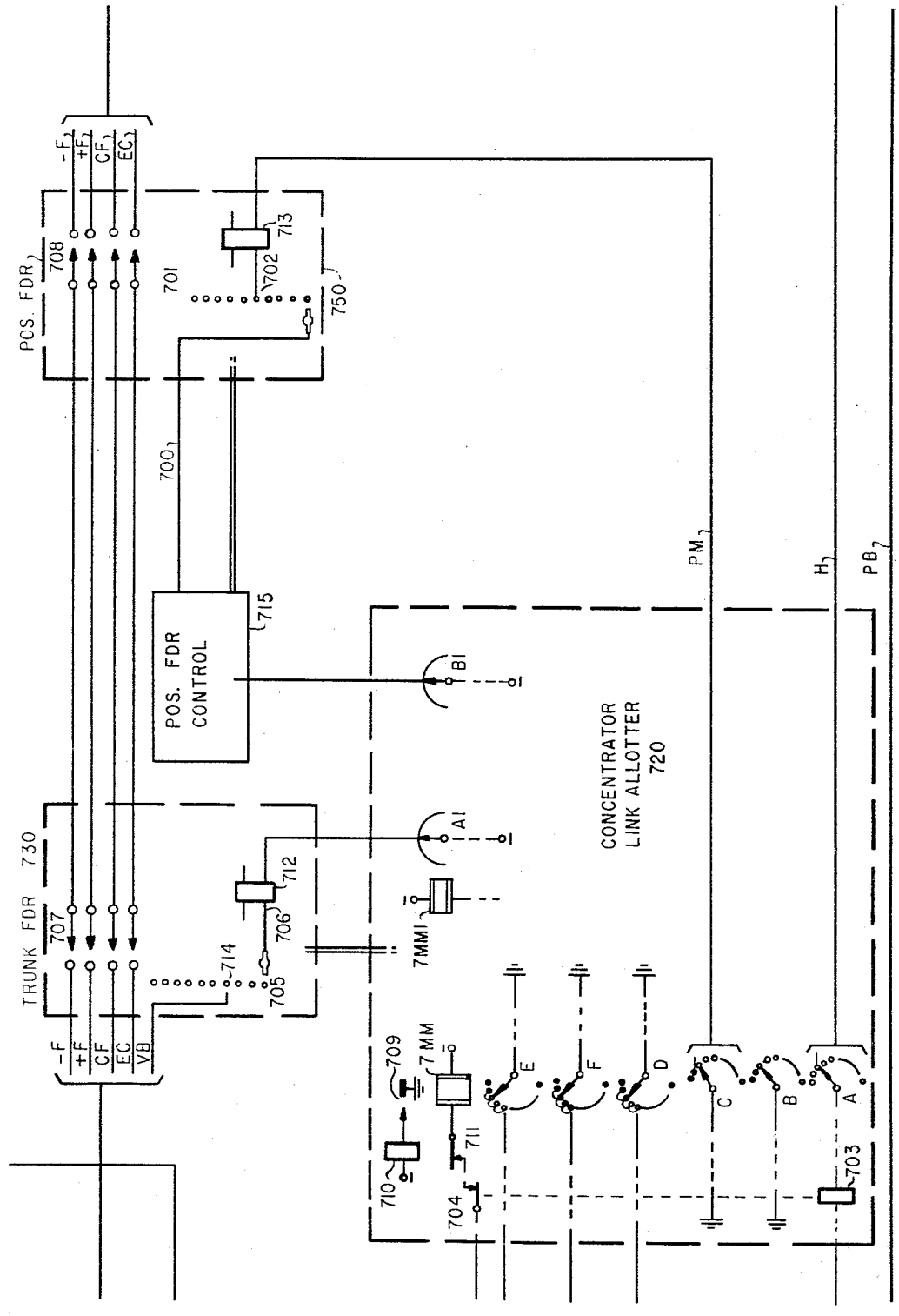

FIG. 7

CENTRALIZED SWITCHING ARRANGEMENTS WITH INWARD DIALING

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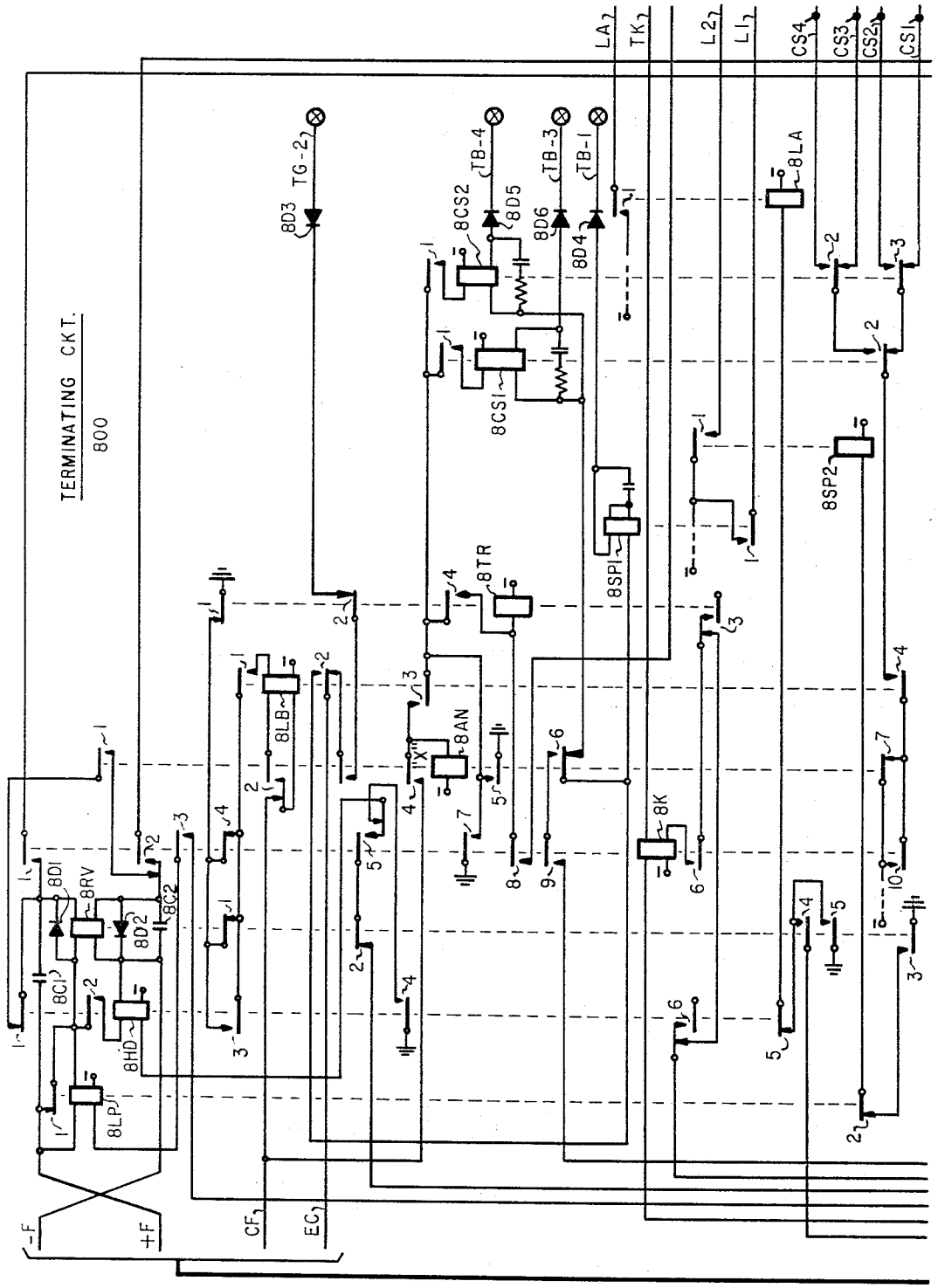

FIG. 8

CENTRALIZED SWITCHING ARRANGEMENTS WITH INWARD DIALING

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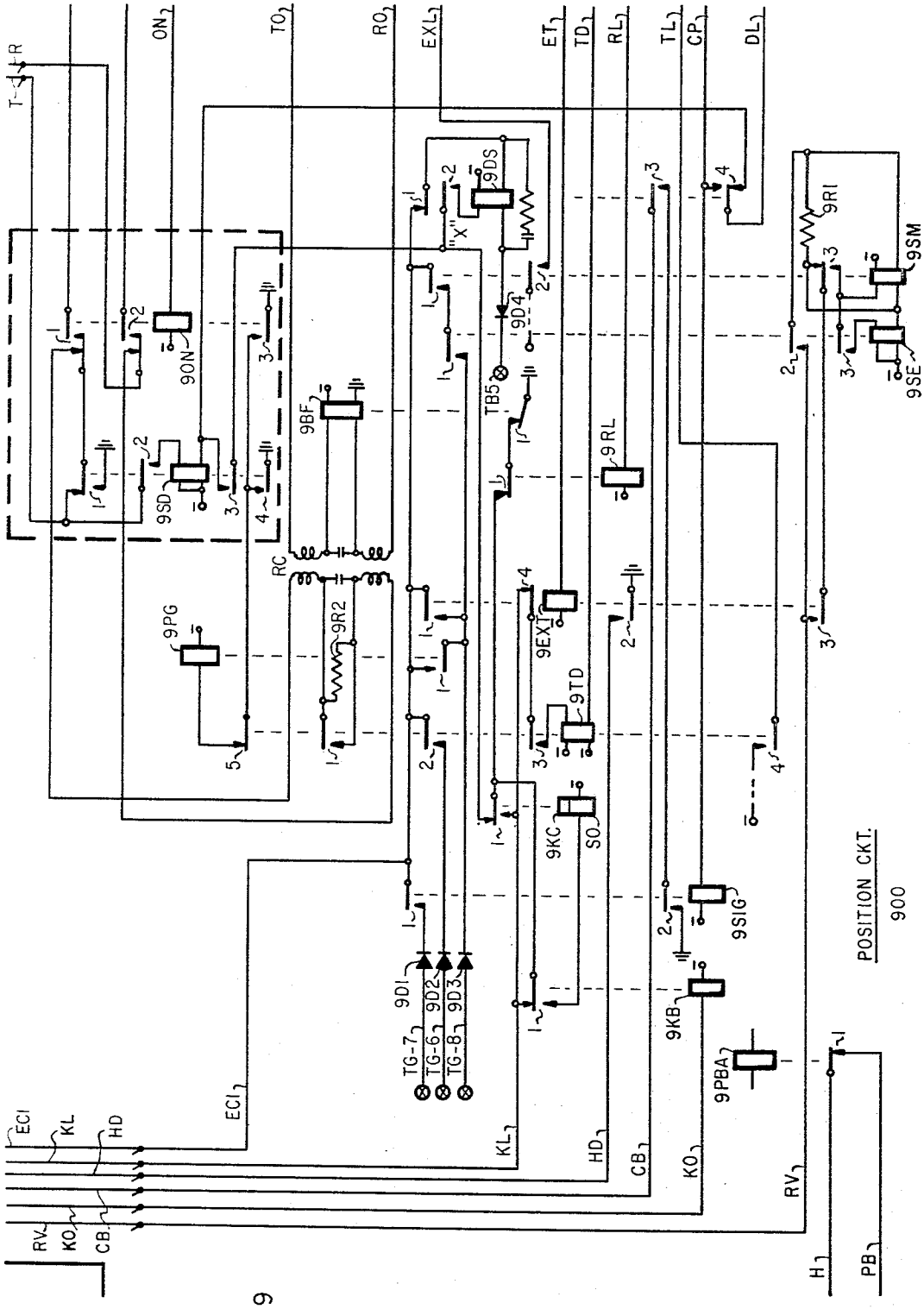

FIG. 9

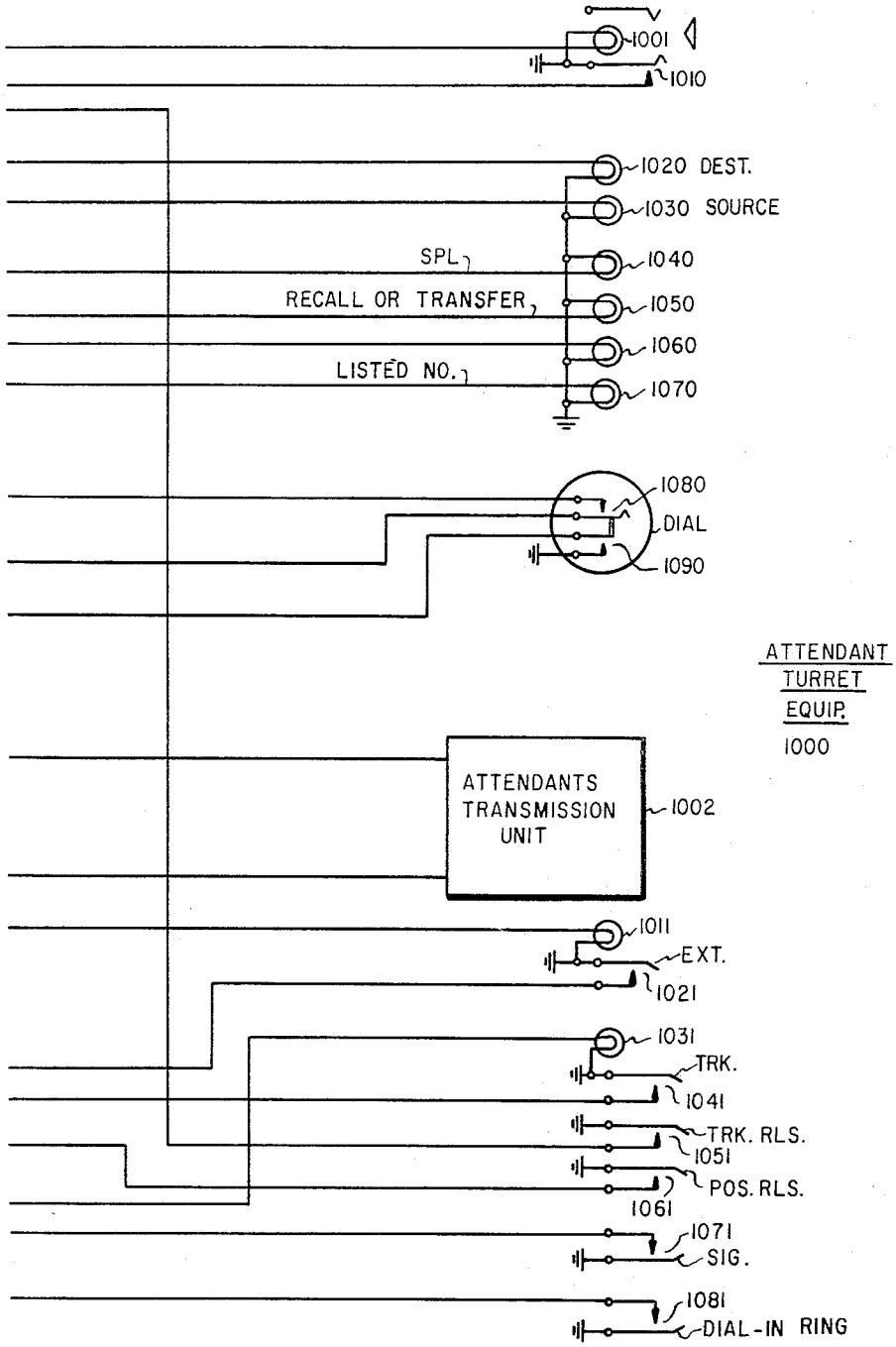
1001
1010
1020 DEST.
1030 SOURCE
SPL
1040
RECALL OR TRANSFER
1050
1060
LISTED NO.
1070
1080
DIAL
1090
ATTENDANT TURRET EQUIP. 1000
ATTENDANTS TRANSMISSION UNIT
1002
1011
EXT.
1021
1031
TRK.
1041
TRK. RLS.
1051
POS. RLS.
1061
1071
SIG.
1081
DIAL-IN RING

FIG. 10

CENTRALIZED SWITCHING ARRANGEMENTS WITH INWARD DIALING

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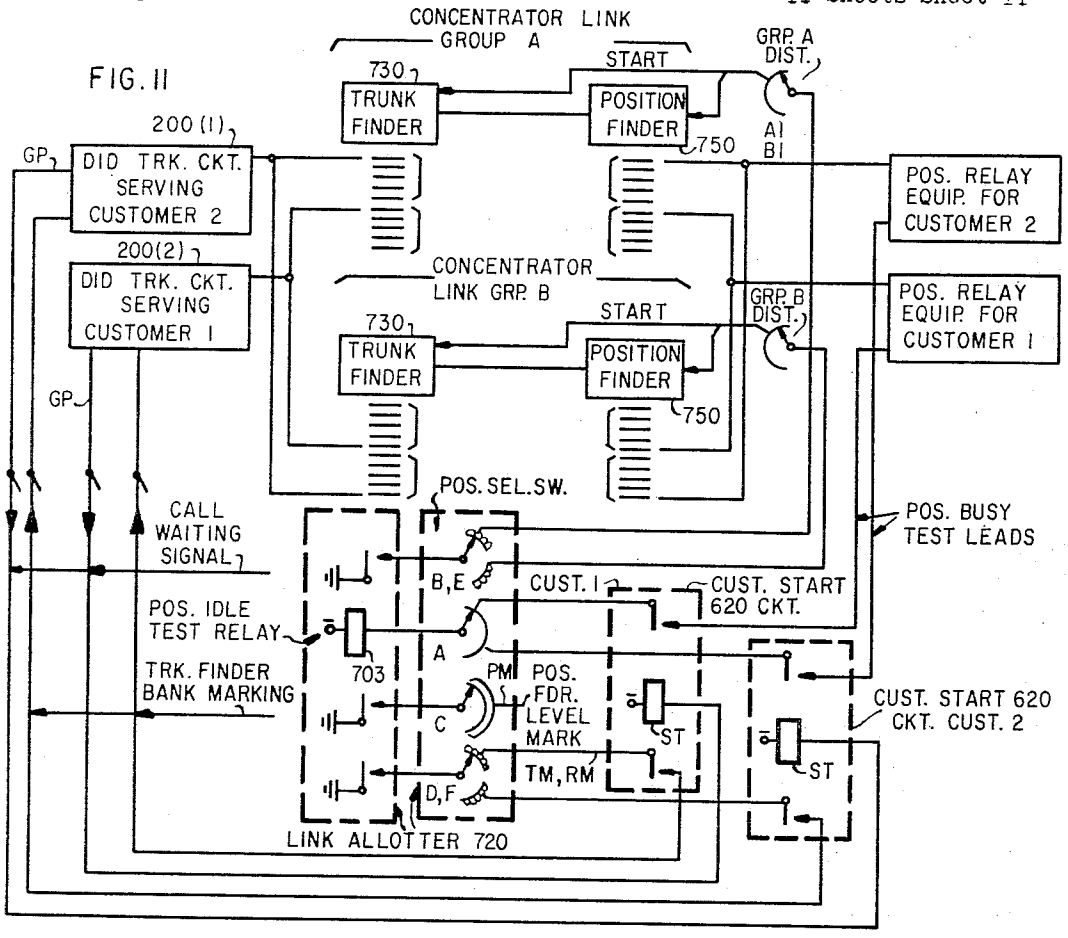
FIG. 11



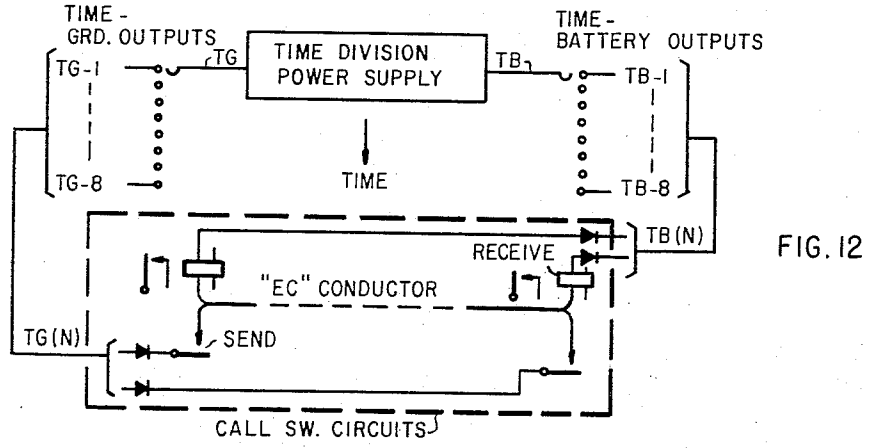


FIG. 12

FIG. 13

FIG. 2	FIG. 3	FIG. 4	FIG. 5	FIG. 8	FIG. 10
		FIG. 6	FIG. 7	FIG. 9	

United States Patent Office 3,333,062 Patented July 25, 1967

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CENTRALIZED SWITCHING ARRANGEMENTS WITH INWARD DIALING

John S. Young, Addison, Ill., assignor to Automatic Electric Laboratories, Inc., Northlake, Ill., a corporation of Delaware

Filed Apr. 14, 1964, Ser. No. 359,626
16 Claims. (Cl. 179—27)

ABSTRACT OF THE DISCLOSURE

A centralized telephone switching system using automatic switching apparatus for completing direct inward dialed calls from local or distant subscriber stations to a plurality of PABX groups, each having a plurality of subscribers and a plurality of attendant positions, and to regular central office non-group subscribers. An incoming connection to a called PABX subscriber is established over a direct inward dialing trunk circuit and switch train, with a marking corresponding to the group identity of the called subscriber being returned back over the switch train to the trunk circuit. A call transfer circuit is taken into use in response to receipt of a call forwarding signal initiated by the called subscriber, with a group discriminating circuit controlled by the group identity marking to allow the transfer circuit to establish a transfer connection only to another subscriber, or attendant, of the same group identity. The call may be consecutively transferred to any number of other subscribers, or an attendant position, having the same group identity by using additional transfer circuits. Time division multiplex signalling apparatus is provided for controlling the establishing of all transfer connections over a single conductor in the switch train by an attendant, an originally called subscriber and a subscriber to whom the original call was transferred or retransferred. The time division signalling apparatus is also used in one instance for signalling the attendant of an incoming call and the type, or class, of service; and in another instance for transmitting "camp-on-busy" or "busy-cut-in" signals under control of the attendant.

This invention relates to telephone switching systems in general and more particularly to improved automatic switching arrangements for establishing direct inward dialed connections to stations in a telephone exchange area. The term "stations," as used in this specification, broadly encompasses telephone users receiving direct inward dialed calls originated locally or from distant points in a nationwide telephone system. These stations may include substations and attendants of private automatic branch exchange (PABX) groups and, optionally, a group or groups of regular stations in a telephone exchange area.

In the past it has been customary to supply separate PABX switching equipment for setting up direct inward and dialed and transfer calls to PABX substations of each customer group. Generally speaking, the switching equipment was located on the PABX customer's premises and interconnected with the central exchange switch trains by trunk lines to which outsiders were connected when making calls to the PABX substations. When inward dialed calls would not be completed automatically, in the preferred manner, facilities were provided for routing the incompleted calls to an attendant, who would then manually complete the call to the desired substation.

As an alternative measure to the above mentioned technique of using individual PABX switching arrangement, it has been proposed to centralize the switching equipment in the central telephone office. This results in improved switch maintenance and it facilitates a more economical use of the switch gear in providing telephone services to stations in a rapidly changing community area. Such a community area may include a member of private branch exchange customer groups. In this centralized arrangement, it is advantageous to terminate PABX substations at the central office in the manner of regular community area stations, that is on line relay equipment terminating line conductors from standard subsets. As a part of this switching plan, each station group of a different class of service, namely the regular stations and the PABX stations, had their own register and marker equipment. The register and marker equipment of each PABX group included provisions for counting and storing dialed digits, thereby distinguishing between calls to be permitted or denied. A switching plan of this nature is relatively complex and, generally speaking, is confined to situations where the concentrated switching equipment is located in the central office.

The above mentioned changes taking place in a community area may not have been anticipated in the planning of the trunking and the layout of equipment in the central telephone office serving that area. For instance the area may be newly developed and include buildings housing private branch exchange customer groups as well as regular telephone customers, either business or residential.

It is therefore an object of this invention to provide an improved automatic telephone switching system with an arrangement permitting direct inward dialed and related telephone calls to telephone stations regardless of whether the concentrated switching equipment is located in the central office or at a distant point from the central office. Such a distant point may be at the PABX customer's premises.

In view of what has been said above, it is a further object of this invention to provide a unitary system for establishing direct inward dialed calls to groups of telephone stations including a plurality of groups of private automatic branch substations and, optionally, a group of regular stations. And furthermore, the switching equipment may be located either in the central exchange office or at the community area.

It is also an object of this invention to provide a direct inward dialing switching system suited to the assignment of substations numbers on a decimal basis. In such a system, station assignments are made in blocks of 100 according to the ranks of the switch train. That is in groups of 100, 1000, etc.

Accordingly, another object of the invention is to provide a switching system wherein the last rank of the switch train used in completing direct inward dialed calls to private automatic branch exchange substations can be shared for local group telephone service.

It is also an object of this invention to permit private branch exchange substations, reached by direct inward dialing call methods, to control the establishment of call-forwarding connections to other substations of that PABX group, thereby minimizing the number of attendant completed calls.

A further object of this invention is to provide in a switching system an arrangement whereby stations of any group, which may also include the regular exchange group, are prevented from establishing transfer connections to stations of other groups served by the switching system.

A principal feature of the invention relates to a centralized switching system with improved circuit arrangements for the establishment of inward dialed connections to groups of stations, facilities being provided whereby the stations of some of these groups may set up transfer connections to other stations in their own group.

One of the features of the invention relates to the provision of group identification facilities, marked in the setting up of the inward dialed connections, for confining the establishment of PABX substation-originated transfer connections to substations of the identified group. This may apply to successive transfers of a given call, when required.

Another feature of the invention relates to an arrangement wherein, on inward dialed calls, the trunk circuit is originally "transparent" and the connector "split." Subsequently this condition is reversed, that is, the trunk circuit is split and the connector rendered transparent. In this fashion, pulse repetition in the setting up of inward dialed and transfer connections is avoided, and transmission between the parties of a call improved.

Yet, because of the above-mentioned retermination of the called loop in the trunk circuit, back dialing of transfer signals by a called substation is facilitated.

In the embodiment described, on an inward dialed call to a station, a two-step relay in the trunk circuit is operated to its first step, upon answering by the called substation, to forward a signal causing the connector to switch the called station loop physically through to the trunk circuit. The relay is then operated to its second position to complete the connection of the called station—be it a PABX substation or a regular central office station—to a split battery feed in the trunk circuit.

A further feature of the invention relates to circuit arrangements wherein the last-mentioned regular central office stations, although switched through to the trunk circuit split battery feed, are kept from effecting call transfers of any sort. This is automatically brought about by the aforementioned marked group identification facilities which prevent seizure of the call-forwarding equipment on such calls.

Another feature of the invention relates to a circuit arrangement wherein answer supervision is returned by the trunk circuit on inward dialed calls to stations but is prevented on PABX group number calls ("listed number calls") until the call has been answered by an attendant. A ringing signal is returned to the calling party until the call has been answered by the attendant.

A further feature of the invention is in the trunk circuit arrangement whereby directory listed number calls to a PABX group are automatically routed over a call-forwarding switch train to an attendant of that group. Discrimination between listed number calls and calls to stations is effected according to the duration of the answer supervisory signal returned by the connector to the trunk circuit. After this the switch train between the trunk circuit and the listed number trunk, as well as the last-mentioned trunk itself are released. A listed number trunk returning a momentary answering supervisory signal has been disclosed in U.S. Patent 3,033,938 issued to John S. Young on May 8, 1962.

Timing means are also provided in the direct inward trunk circuit to prevent substation-originated transfer signals from affecting supervision to the outside caller, and to prevent response to a transfer signal if the called party fumbles the handset when answering the call.

A still further feature of the invention relates to a flexible switching arrangement wherein use is made of the novel time division signaling facilities disclosed in the copending U.S. Patent application Ser. No. 295,098 of Robert M. Schildgen and John S. Young filed July 15, 1963, for controlling the establishment of calls forwarded to PABX substations by the attendant or the originally called substations. This technique is also used in controlling the establishment of all call-forwarding connections thereafter originated by a substation to whom the original call was transferred, or re-transferred. In this manner a considerable number of these controls can be executed over the same conductor, for example an extra-control conductor, of the switching equipment in question. Time division signals, assigned in different recurring time slots

to identify the particular station group preferable are also employed for enabling, or denying, the establishment of station-originated connections according to the matching, or mismatch, or corresponding signal output terminals of the time division power supply.

A feature of the invention relates to provisions in the inward dialing trunk circuit or a two step relay controlled both in the establishment of inward dialed calls and in the case of automatic forwarding of listed number calls to the attendant. On inward dialed calls the relay is operated to the first step, and is permitted to operate to its second step in response only to the receipt of a dialed-back digit greater than 1 to forward the call to the attendant. If, on the other hand, the digit 1 is dialed the relay cannot operate to its second step and this permits seizure of the "transfer link" and the remainder of the switch train used in forwarding the call to a substation. It may be mentioned at this point that such forwarding may be elected for purposes of a consultation, of a limited or 3-party conference (the originating substation dials a digit after the other substation has answered) or a transfer (the originating substation disconnects).

According to another feature of the invention, the physical connections from called substations to the inward dialing trunk circuit are automatically extended to the switches successively seized in the forwardly of a call to another substation; after the call has been answered, the connections are re-terminated in the battery feed relay on the calling side of the transfer link used in the forwarding connection.

It is this battery feed relay which responds to a digit-dialed by the first substation for automatically causing the outside party to be connected into a limited conference with both substations. On the other hand, disconnection of the above-mentioned first substation causes the transfer link to automatically forward a signal to the connector switch used in the forwarding (transfer) connection thereby physicaly switching through the second-called substation loop to the aforementioned battery feed relay in the inward dialing trunk circuit. This conditions the trunk circuit for the receipt of transfer initiating signals by the second-called substation.

According to another feature of the invention the call forwarding ararngement described herein, the second-called PABX substation is enabled to in turn establish a forwarding cal to a further substation, namely by seizing a second transfer link in addition to the one over which the second-called substation received the call.

A further feature of the invention relates to a call distribution arrangement wherein trunk circuit seizure of equipment for forwarding initiated substation and listed number calls to an attendant of an identified group depends upon the availability of an idle circuit for terminating the call.

More particularly, the call-forwarding equipment includes group start circuits, one for each substation group which are connected to all trunk circuits, and the above-mentioned seizure of the call-forwarding equipment is made dependent upon return to the trunk circuit from the start circuit of the identified group of a marking ground indicating an open gate for receiving the call being forwarded.

In the embodiment of the invention described herein, the call-forwarding equipment further includes a concentrator link allotter seized by the start circuit, each said concentrator link including a trunk finder and position finder. A rotary switch forming part of this allotter is caused to automatically search for an idle attendant's position of the group in question. The switch provides a marking of the attendant's position on the banks of the position finder switches.

The above-mentioned rotary switch is also instrumental in marking the trunk circuit used in this call on the banks of the trunk finder switches according to a marking potential extended through the group identification circuit.

The concentrator link allotter also has a second rotary switch for selecting an idle concentrator link. This last-mentioned switch has rotary switch bank levels through which controls are effective for causing the position finder and trunk finder of the selected link to find the above-mentioned finder bank markings.

According to a further feature of the invention, the above-mentioned time division signaling technique is used to signal a call and also the type of call, for example a listed number call or a transfer call, before the attendant. The attendant, in completing the last-mentioned call, operates a "dial-in" key and thereby automatically seizes a transfer link in preparation for the transmission to said link of dial impulses for the purpose of forwarding the connection to the desired substation. These are the same transfer links that are used by substations in transferring calls to other substations. The above time division signaling arrangement brings about seizure of the above-mentioned "transfer link" under the control of the attendant.

The concentrator link is released by attendant operation of a "trunk release" key. Following this release the connection is completed between the outside party and the substations last called over the transfer link.

If the attendant is unable to complete a call because the called line is busy, she can momentarily operate a "signal" key and cause the connector switch reached over the transfer link to "camp-on" the busy line. If the key is operated the second time, the connector is caused to "cut-in" on the busy line.

The time division signaling technique referred to above is also instrumental in the transmission under the attendant's control, of the foregoing "camp-on" or "cut-in" signals.

Further features of the invention relate to the particular arrangements of the elements thereof, whereby, the above-outlined and additional operating features are attained.

The invention, both as to its organization and method of operation, together with further objects and advantages thereof, will best be understood by reference to the following detailed description of a preferred embodiment, taken in conjunction with the accompanying drawings. These drawings, FIGURES 1 to 13 inclusive, show, by means of the usual circuit diagrams, a sufficient amount of apparatus to enable the invention to be described and understood.

FIG. 1 shows the schematic diagram of an illustrative example of a system according to the invention. The left hand portion of FIG. 1 shows a direct inward dialing trunk circuit **200** terminating incoming connections from automatic switching equipment, which may be incoming fifth selectors and banks, or two-conductor repeaters, in a central office of a nationwide telephone systems not shown. The operation of the inward dialing trunk circuit is the same in either case, therefore, the switching equipment shown on the FIGURE 1 can be located in the central office or at an outlying location. The inward trunk circuit is connected to a succeeding rank of automatic switching equipment, such as an incoming fifth selector **500**, responsive to direct dialed impulses to set up connections to switch-through connectors **506, 515** for establishing calls to central office stations, substations of PABX groups, or to listed number trunks **516** all as shown at the right hand portion of FIG. 1. The regular subsets used at these stations and substations are connected to subscriber lines terminated on line circuits at the switching equipment. The incoming fifth selector switches, shown at the upper portion of FIG. 1, have group identification marking conductors extending to the group identification circuit **610** at the left of FIG. 1, shown as a portion of the direct inward dialing trunk circuit. The upper block portion of FIG. 1 shows first call-forwarding equipment, here and after referred to as transfer links **100**, each including a transfer relay group **493** connected, on the left, to a transfer-finder **491**, and on the right to a transfer-selector **509**. The transfer-selector switches have banks connected in multiple with the banks of the incoming fifth selectors and therefore have access to the switch-through connectors for establishing calls to stations except as hereafter described. Above the transfer line there is shown a transfer link allotter **492**, with an allotter switch for allotting an idle transfer finder to find the inward dialing trunk circuit requesting service. The remainder of the main body of FIG. 1 shows the second call-forwarding equipment hereafter referred to as concentrator links **110** for forwarding listed number and substation-controlled calls to the attendant **1000**. The attendant may extend these calls to a substation by dialing back over the concentrator link **110** and the inward dialing trunk circuit **200** into a transfer link **100** which in turn gives access to the switch-through connectors **515**.

In the case of listed number calls or of calls to be forwarded by a PABX substation to an attendant which calls will be described in detail herein below, a gating arrangement in the respective customer start circuit **620** permits the inward dialing trunk circuit to seize a concentrator link, if an attendant's position circuit **900** of the PABX customer group signals the availability of an idle terminating circuit **800**. In that event, the concentrator link allotter **720** assigns an idle concentrator link **110**, each comprising back to back a trunk finder **730** and a position finder **750**, to provide a clear path from the inward trunk circuit to the terminating circuit, and hence to the attendant. As shown in detail in FIG. 7, vertical bank markings to the position finder and the trunk finder switches are applied over the banks of rotary switch **7MM** of allotter **720**. Each bank level of the position finder gives access to the terminating circuits of a separate attendant position. As shown more particularly in FIG. 11 the allotted trunk finder switches, as a matter of first choice, search for marked trunk circuits in the lower levels of the finder bank but will be automatically caused to search in the upper half of the bank if necessary. Having switched through the connections between the inward dialing trunk circuit and the attendant, the trunk finder and position finder become locally held for the duration of the call.

As mentioned above, the attendant may further extend these calls, that is, listed number calls or substation-controlled calls, by way of the terminating circuit, and the concentrator link used, to the inward dialing trunk circuit, and thence through a transfer link and a switch-through connector to a desired substation. The group identification circuit portion **610**, of the inward dialing trunk circuit **200** insures that the connection will be established only to substations in the group served by the particular attendant.

FIGS. 2 to 10 inclusive show the circuits of the equipment units illustrated in the schematic diagram, FIG. 1, in detail. More particularly, FIGS. 2 and 3 combined show the inward dialing trunk circuit details and connections with other equipment units.

FIG. 4 shows the switching arrangements of transfer links whereby calls originated by PABX substations and attendants are completed to other substations of a group.

FIG. 5 shows the arrangements of switch-trains for obtaining access to groups of stations or to a listed number trunk in the case of calls directed to a PABX group attendant.

FIG. 6 shows in detail the circuit wherein the group identity of an inward dialed call is stored for the identification of all calls subsequently originated by stations or attendants for some reason. The figure also shows portions of a start circuit, individual to each PABX customer group, arranged upon seizure by the trunk circuit on a listed number call to initiate the forwarding of the call to an attendant of the identified customer.

FIG. 7 illustrates concentrator type call forwarding equipment comprising an allotter controlling the operations of position finders and trunk finders to provide a direct link between an identified trunk circuit and the

corresponding PABX attendant being free to handle the listed number or substation controlled transfer call of the trunk circuit.

FIG. 8 shows the circuit elements required for terminating the above-mentioned direct link paths from the identified trunk circuit establishing calls to the attendant.

FIG. 9 illustrates portions of the attendant's position circuit connected to other units of the call forwarding equipment.

FIG. 10 shows turret equipment whereby an attendant receives and/or completes inward dialed calls which require personal attention.

FIG. 11 schematically shows the call distribution arrangement involving the concentrator link allotter **720** and concentrator link groups **110**, A and B, each serving a different group of trunks and position equipment with preference.

FIG. 12 schematically shows the time division multiplex arrangements used herein for remote control of the operation of various electromechanical relays over a single conductor according to the principles of the above-mentioned copending patent application. Closure of a "send" contact at either end of the EC conductor between predetermined circuits of the present system enables a discrete time ground (TG) signal to be repetitively transmitted over an extra (EC) conductor through the winding of a "receive" relay to the respective time battery (TB) potential. The corresponding receiving relay is, thereby, caused to operate and it may, if desired, become locally held by another winding.

FIG. 13 is a diagram showing the relative arrangement of FIGS. 2 to 10 inclusive.

Detailed operational descriptions will now follow.

Direct inward dialed calls to substations of a PABX customer group

This section of the operational description relates to switching arrangements involved in the establishment of direct inward dialed calls, from local or distant stations, to stations with assigned numbers in a block of 1000 numbers. Particularly, this section relates to switching arrangements whereby inward dialed connections are established to substations of several PABX customer groups. Of the seven digit directory number assigned to the PABX substation, the last four digits, for example, "2322," are significant to the description according to the embodiment of the invention. Impulses of the first digit, "2," set up an access, over the incoming conductors, —, + to the DID trunk circuit **200** FIG. 2, and to the incoming fifth selector switch **500**, FIG. 5, digit "3" impulses step the selector wipers **501** to level "3" to seize the idle connector switch **515**, and impulses of the remaining digits "22" cause the connector switch to step its wipers to bank terminal connections of the desired substation of the PABX customer group.

The above-mentioned access to the trunk circuit extends a dialing loop, not shown, via the incoming connection to the incoming fifth selector switch impulsing relay A, not shown, over a physical path traced from — and + conductors of FIG. 2 to back contacts **3** and **4** of relay **2RVS**, back contacts **1** and **3** of relay **2AT**, back contacts **1** and **2** of relay **2SP**, over physical conductors —SW and +SW in FIG. 3 to the incoming fifth selector switch **500**. The incoming selector is seized and returns ground over the CSW conductor to the trunk circuit FIG. 3 by way of back contacts **4** of relay **3P** to the upper winding of relay **3CM**. Relay **3CM** operates. Ground is also extended back to the incoming C lead for guarding the trunk circuit **200** against other seizures. The group **(300)** of the seized connector is identified when the selector **500** steps its wipers to level "3" at which time the right normal post springs **503** operate and close a path for ground marking through make contacts **504** to the **B1** conductor extending from FIG. 5 to the group identification circuit **610** of FIG. 6. This marking ground causes relay **6CU2** to operate and identify the customer group **1**, corresponding to the "**300**" connector group of the called substation. Relay **6CU2** operated closes a holding path to the trunk circuit **200** through its make contacts **6** over the LK conductor traced back through the trunk circuit to the CSW lead on which ground is standing as has been described above. This holding ground path is traced from the CSW conductor back contacts **6** of relays **2RVS**, FIG. 2, through the back contacts **1** of relay **2A** and over the LK conductor to the group identification relay **6CU2**. Obviously the group identification of the PABX customer no longer depends upon the right normal post springs **503**, as operated relay **6CU2** opens the **B1** conductor marking path.

As mentioned above, the wipers of connector switch **515** now engage bank contacts "22" and ringing current is transmitted to the called PABX substation. In a well known manner, the connector switch returns reverse battery signals over the —SW and +SW conductors to the trunk circuit **200** when the called substation answers. This reverse battery signal is detected by relay **2SP** in the trunk circuit. Relay **2SP** operates in the path traced through back contacts **1** and **2** of relay **3SW**, make contacts **1**, **2** and **3** of relay **3CM**, back contacts **1** and **2** of relay **2RVS**. This path also includes blocking diodes **2D1** and **2D2** in series with the upper and lower windings of relay **2SP** respectively. To the left of these diodes shown on drawing FIG. 2 is a voltage divider arrangement consisting of resistors **2R1**, **2R2**, and **2R3** connected between battery and ground. This voltage divider and diode arrangement insures that relay **2SP** will not respond to impulsing on the —SW and +SW conductors of FIG. 3 but will be operated by reverse battery from the connector when the called substation answers. Relay **2SP** operated, transfers, at its make contacts **1** and **2**, the incoming conductors from a physical connection previously including the incoming selector **500** and connector switch **515** to the upper and lower windings of relay **2A** of the trunk circuit **200**. Relay **2A** operates. When relay **2A** operates its make before break contact **1**, the guarding ground to the incoming C conductor and the holding ground over the LK lead to the group identification relay **6CU2** no longer depends upon the CSW conductor from the incoming first selector switch **500**, as ground is applied at make contacts **1** of relay **2A**. Back contacts **3** of relay **2A** open a resistor shunting path across capacitor **2CA5**, while make contacts **2** complete a path traced through the make contacts **5** of relay **2SP** to a divided circuit, one directly to the upper winding of relay **2RV**, the other being to the diode **2D6**, capacitor **2CA5**, and the lower winding of relay **2RV**. Capacitor **2CA5** becomes charged. The charging current through the lower winding of relay **2RV** opposes the operating current through the upper winding of relay **2RV**. Because of this opposed current condition relay **2RV** is slow to operate. With relay **2A** operated and relay **2RV** not yet operated, a closed path extends from ground through make contact **1** of relay **2A**, back contacts **10** of relay **3K**, back contacts **2** of relay **2RV**, make contacts **5** of relay **2A**, resistor **2R5** and the lower winding of relay **2AT** to battery. Because of this resistance path relay **2AT** operates only to its "X" contacts, thereby closing its holding path through make "X8" contacts. Relay **2AT** is thereby preenergized for faster operation to its second step should the substation initiate a call to an attendant **1000**. In this type of direct inward dialed call the connector switch **515** returns reverse battery for a prolonged period of time enabling trunk circuit relay **2SP** to remain operated. The effects of the current through the upper winding of relay **2RV** prevail over the charging current through the lower winding, causing relay **2RV** to operate. Slow operating relay **2RVS** then operates through the make contacts **1** of relay **2RV**. Make before break contacts **3** and **4** of operated relay **2RVS** complete direct connections from the battery feed relay **2A** to the incoming — and + conductors before opening the previously described op-

erating path for the relay 2A. Relay 2RVS operated also closes its make contacts 6 to complete a path from the ground on the CSW conductor of FIG. 3 through make contact 3 of relay 2SP FIG. 2 to the resistor 3R6 and the lower winding of relay 3SW in FIG. 3. Through this resistor path relay 3SW operates its "X" contacts only. Relay 3SW operated to the first of its two step positions completes a path for passage of a switching signal from the direct inward dialing trunk circuit 200 to the connector switch 515. In the present embodiment of the invention the switching signal is booster battery transmitted over the path traced from BB and the make contacts 4 of relay 2SP through the "X" contacts 5 of relay 3SW to the CSW conductor of FIG. 3 through the corresponding conductor of the incoming fifth selector 500 to the connector switch 515. In response to this switching signal the connector switch disconnects the called PABX substation's loop from the battery feed in the connector switch. Before tracing a path from the called loop to the replacement battery feed relay 2E, in the trunk circuit, certain relay operations in the trunk circuit should now be described. It is recalled that relay 2RVS has operated and its back contacts 1 and 2 have removed the battery and ground potentials from the voltage divider and diode arrangements connected to relay 2SP, and also that due to the switching through of the connector 515 neither normal battery or reverse battery potentials are on the —SW and +SW conductors FIG. 3 of the path traced to the upper and lower windings of trunk circuit relay 2SP FIG. 2. Because these windings are no longer energized, relay 2SP restores. Relay 2SP restored closes a path for the operation of relay 3SW to its second step position, that is fully operated. This path is traced from the ground on the CSW conductor of FIG. 3 through make contacts 3 of relay 3SW to the back contacts of relay 2SP and the lower winding of relay 3SW to battery. Relay 3SW, being now fully operated, closes the path for the called substation loop traced as a loop on the — and + conductors of the incoming selector switch 500 of FIG. 5 extending back over the —SW, +SW conductors to the trunk circuit FIG. 3 where the path continues through make contacts 1 and 2 of the relay 3SW, and the back contacts 1 and 2 of relay 2TR to the upper and lower windings of relay 2E FIG. 2. Relay 2E operates and is the called-party side battery feed split to the calling-party side battery feed relay 2A by way of capacitors 2CA1 and 2CA2. Operated relay 2E closes its make contacts 1 and establishes a path for the operation of relay 3B. Operated relay 3B closes a path for the holding of relay 2RV. This path is traced from ground through make contacts 2 of relay 2A, make contacts 2 of relay 3SB, and the upper winding of relay 2RV to battery.

In summation, called REFERENCE A, the following relays are in an operated condition: FIG. 2, relays 2RV, 2RVS, 2A, 2E, and 2AT to its "X" contacts; FIG. 3, relays 3CM, 3SW, and relay 3B; and in FIG. 6, relay 6CU2.

Direct inward dialed PABX substation establishes connections to a second substation

As mentioned above, the called PABX substation may call other substations in group 1 for consultation purposes. Another section of this specification will be devoted to the case in which the called PABX substation establishes a connection to the attendant 1000(1). In the case of the call to be described, the first substation party dials the prefix "1" plus the local directory number of the other party for example the abbreviated number may then be "1323."

With relays operated as listed in "reference A," it is known that dialing of the prefix "1" causes relay 2E of the trunk circuit 200 to restore and later to reoperate. Relay 2E restored closes a path for the operation of the slow releasing relay 2C. This path is from ground at make contacts 2 of relay 2A, back contact 1 relay 2E, back contacts 9 relay 3K, make contact 5 relay 3B, FIG. 3, and through the upper winding of relay 2C to battery. With relay 2E reoperated and relay 2C not yet released a path is closed whereby relay 2TR operates to its "X" contacts. This path is from ground through make contacts 2 of relay 2A, make contact 1 of relay 2E, back contacts 6 and 11 of relay 3K, make contact 4 of relay 2C and then over the TRD Conductor of FIG. 3 extending to the similar conductor in FIG. 6 where the path passes through back contacts 7 of relay 6CU3 to conductor TRG extending to FIG. 3, through the back contact 6 of relay 3P and the upper winding of relay 2TR to battery. Relay 2C operated has opened the transmission path, at its back contacts 1 and 2, and thereby prevented the prefix digit impulses from affecting the incoming connections to the trunk circuit. A guarding path is provided for holding relay 2TR operated to its "X" contacts before relay 2C restores its back contacts 3 to set a marking on the vertical bank not shown of the transfer finder switch 491. This path extends from ground at make contacts 2 of relay 2A through make contact 2 of relay 3B to the left through back contacts 4 of relay 2AT, back contact 3 of relay 2TR, and "X4" contacts of the same relay to make contacts 3 of relay 3B and the upper winding of relay 3P in series with the upper winding of relay 2TR to battery. This series holding path enables relay 3P to operate. Operated relay 3P opens its back contacts 4 and allows relay 3CM to release. Relay 3P operated makes a contact transfer at its make contacts number 6 as will be referred to in a later section of the specification covering the consultation or transfer of calls to the attendant 1000(1). In that case station-controlled impulsing of relay 2E by digital impulses greater than "1," for instance the digit "0," also causes relay 3P to operate and through its make contact 6 to complete a path for the full operation of relay 2AT.

As mentioned above, relay 2C is released, thereby setting up a marking path to the transfer link finder 491 vertical bank, FIG. 4, not shown and in a manner not shown, to the transfer link allotter 492 shown above. This marking path is from ground at make contact 2 of relay 2A through make contacts 2 of relay 3B, back contact 4 of relay 2AT to relay 2TR back contact 3 and "X4" make contacts, through back contact 3 of relay 2C to the SLM marking conductor extending to the vertical bank and alloter of the FIG. 4. Briefly described, the allotter causes an idle transfer finder switch to find the inward dialing trunk circuit 200 about to make a consultation call to another PABX substation. After finding this trunk circuit, relay 402 of the transfer finder becomes operated and switches through the transmission impulsing and control conductors to succeeding circuits of the transfer link 100. The originally called PABX substation having its loop connected physically to the —SW and +SW conductors of FIG. 3 to the battery feed and impulsing relay 2E of FIG. 2 was also connected to the conductors —TN and +TN of FIG. 3 to the bank contacts 404 of the transfer finder switch 491, FIG. 4. Operation of the relay 402 in the finder switch extends the —TN and +TN conductor loop to the — and + conductors and through contacts of the transfer relay group 493 to the transfer selector switch 509, where the loop terminates in a battery feed inpulsing relay not shown in FIG. 5. This loop impulsing path is partially traced as extending through back contacts 1 and 2 of relay 4TA, back contacts 3 and 4 of relay 4TS, and the back contacts 1 and 2 of relay 4TD to the —L and +L conductors extending to the impulsing relay of the selector switch. Loop seizure of the impulsing relay causes the selector switch to return ground over the C conductor in the normal manner and cause relay 4CC of the transfer relay group 493 to operate. This operating path is through the back contacts 3 of relay 4BS, back contact 1 of relay 4CF, back contacts 4 of relay 4S, then the winding of relay 4CC to battery. Operated relay 4CC returns a ground through its make contact 1 to hold relay 402 of the transfer finder switch 491 operated.

Operated relay 4CC also closes its make contact 3 for applying ground on the H conductor extending back through its finder switch to the C conductor of the trunk circuit 200, FIG. 3, further traced through the "X7" make contacts of relay 2TR and its lower winding to battery.

Closure of this path causes relay 2TR of the trunk circuit to become fully operated to its second step. Operated relay 2TR closes a holding path through its make contacts 8 and the lower winding of relay 3B which had been previously operated. In addition to providing a ground through its make contacts 6 for the holding of relay 2RV, operated relay 2TR opens its back contacts 1 and 2 and removes battery feed relay 2E from the called PABX substation's loop. It is obvious that only the impulsing relay of the transfer selector switch 509, is now directly connected to the called PABX substation. Relay 2E restored also permits relay 3B of the trunk circuit 200 to restore.

At this point in the operation of setting up the so called consultation call the selector switch returns dial tone and is ready to accept the remaining digital impulses of the called number, that is "323". As a matter of reference, known as REFERENCE B, the following relays are in an operated condition: FIG. 2, relay 2RV, 2RVS, 2A, relay 2AT to its "X" contacts, relay 2TR; FIG. 3, relay 3SW, and 3P; FIG. 4, relay 4CC; and in FIG. 6, relay 6CU2.

It is recalled that the originally dialed substation, now making the consultation call, was in the PABX customer group number 1 and permitted to make calls only to other substations within the same group. Upon hearing dial tone, he dials the digit "3" of the call number and causes the selector switch 509, FIG. 5, to step to the third level at which the right normal post springs 512 operate make contacts 513. Closure of contacts 513 completes a path by which unique time division signals transmitted over a single conductor cause electromechanical relays to operate and thereby control the operation of other circuits. The present signaling application follows the general principles typically shown in FIG. 12 in that contacts 513 correspond to the "send" contacts and relay 519 corresponds to the "receive" relay. Furthermore time division signals are transmitted over the EC conductor path between the time ground outputs TG2 and the time battery outputs TB2. For the call being described, the path is traced from the group identification circuit 610 signaling terminal TG2 through the diode 6D4, make contacts 5 of relay 6CU2, the back contacts 5 of relay 6CU3, back contacts 2 of relay 6ON, back contacts 1 of relay 6LB, over the EC2 conductor extending by way of the trunk circuit 200, FIG. 3, to the corresponding EC2 conductor in the transfer finder 491, FIG. 4, through contacts of relay 402 to conductor EC extending to the transfer relay group 493, further through back contacts 6 of relay 4S, back contacts 2 of relay 4ON, extending over the EC conductor into the transfer selector circuit 509 and other equipment, not shown, to the upper winding of relay 519, and make contacts 513 of the right normal post springs to the signaling terminal output TB2 assigned to customer group number 1. Since no change has occurred in the relay 6CU2 in the identification circuit associated with the trunk circuit, it is obvious that identification intelligence has been transmitted to the selector switch for verifying that the present call is being directed to the same PABX customer group 1. Had the selector switch been dialed to other levels, either one or both of the normal post springs 511, 512 could have been operated but relay 519 would not operate because of a mismatch between the output terminals of the signaling arrangement. In the case of the call being described, relay 519 operates and extends the calling substation loop to an idle switch-through type connector 515, FIG. 5. Upon switch-through of the transfer selector 509, ground is returned over the ON lead to relay 4ON of the transfer relay group, FIG. 4, Relay 4ON operates and closes a time division signaling path traced from terminal TG5 through the diode 4D7 and make contacts 2 of relay 4ON, back contacts 6 of relay 4S, over the EC conductor of the transfer finder switch 491 to the EC2 conductor traced through FIG. 3 to the group identification circuit 610, FIG. 6, back contacts 1 of relay 6LB, back contacts 2 of relay 6ON, through the lower winding of relay 6ON and the diode 6D1 to the TB5 terminal. Relay 6ON operates to the first of its two positions closes its "X" contacts, thereby closing make contacts 1 to the ONL conductor extending back through the trunk circuit to the ground which caused relay 2TR to fully operate through its lower winding. Fully operated relay 6ON closes its make contacts 2 and completes a path between the EC2 conductor and the EC3 conductor of the identification circuit and also disconnects the path over which the signaling relay 519 in the transfer selector switch 509 was operated. It is understood that relay 519 remains operated over a locally completed circuit path, not shown. The connector switch 515 is ready to receive the last two impulsing digits "23" of the abbreviated call number "1323." In a known manner the connector rings the called second substration and ringing is cut off when the substation party answers the call. Having answered the call, reverse battery is returned through the selector banks and wipers 510 and the —L and +L conductors of the transfer relay group 493, causing relay 4TA to operate through diode 4D1, by way of make contacts 5 on relay 4CC previously operated. Relay 4TA performs two functions, first, through its make contacts 1 and 2 a physical loop circuit is established from the first PABX substation to a battery feed relay 4A, in the relay group 493 and second the winding in the path through the diode 4D1 provides a holding path for the PABX connector impulsing relay not shown. Operated relay 4TA closes its make contacts 9 to relay 4TS. Relay 4TS operates its make contact 1 and closes a holding ground over the C1 conductor to the transfer finder switch 491. Operated relay 4A closes its make contacts 1 to relay 4B. A path is now conditioned for the operation of relay 4S to the first of its two step positions and thereby closes its "X" contacts. This path is traced from ground standing on the C conductor of the transfer relay group 493 through make contact 1 of relay 4B operated, make contact 4, relay 4TA, and through the resistor 4R1 and the lower winding of 4S to battery. Relay 4S operated only to its "X" contacts is prepared for the closure of a path by which booster battery, for instance, at the relay group 493 can cause the connector switch 515 to be made switch-through. Relay 4B operated closes its make contacts 6 and 7 in preparation for the operation of relay 4BS, which operate from make contact 5. Make contact 5 also provides a holding ground to the H conductor extending to the trunk circuit 200 since back contact 3 of relay 4BS now being operated will open the path to relay 4CC which had previously been described as operated. At this time relay 4A of FIG. 4 is a battery feed to the calling PABX substation, the D relay, not shown, in the connector switch 515 provides battery feed to the called substation; and voice transmission between these substations is by way of capacitors 4C1 and 4C2 of the transfer relay group, of FIG. 4. This is a local conversation path between the PABX substations, as it will be recalled that relay 2TR, fully operated, has operated its back contacts 1 and 2 and disconnected the transmission path to the originator of the inward dialed call.

As a point of reference for the following description, REFERENCE C, the following relays are in an operated condition: FIGURE 2, relays 2RV, 2RVS, 2A, 2AT to its "X" contacts, and 2TR; FIGURE 3, relays 3SW, 3T, and 3P; FIGURE 4, relays 4BS, 4A, 4TA, 4B, 4TS, 4S to its "X" contacts and 4ON; FIGURE 6, relays 6ON, and 6CU2.

Limited conference call between first and second PABX substations and the originator of the did call

The first-called substation engaged in the above-mentioned consultation call, may call in the outside party for a 3 way limited conference. He controls the setting up of a conference connection by merely dialing the digit "1," thereby causing relay 4A of the relay group 493 to fall back momentarily and close a path from ground through back contact 2, make contact 4 of relay 4BS, make contact 5 of relay 4TA and through the winding of 4CF to battery. Relay 4CF operates. Operated relay 4CF closes its make contacts 4 for a path from signaling output TG3 through diode 4D4, over the EC conductor switched-through to the EC2 conductor FIG. 3, which is closed by the group identification circuit 610 of FIG. 6 to the EC3 conductor extending back through the trunk circuit 200 back contacts 11 of relay 2AT, FIG. 2, the lower winding of relay 3CM, FIG. 3 and the diode 3D2 to terminal TB3. Relay 3CM operates to the first of its two positions and thereby closes its "X" contacts. This closes a path from ground through make contacts 9 of relay 2TR, make contacts "X6" of relay 3CM, and the upper winding thereof to battery. Relay 3CM is thereby fully operated, closing its make contacts 4 and 5 for completing the transmission path to the trunk circuit 200 incoming conductors and the outside party who originated the direct inward dial call.

The second-called substation takes over the direct inward dialed call

The first-called PABX substation, having set up the consultation and conference connections as described above, may relinquish control over the direct inward dialed call by merely replacing his handset. This causes battery feed relay 4A of the transfer relay group 493 to restore. Relay 4A restored opens the path to relay 4B, causing relay 4B also to restore. Relay 4B restored closes a path for forwarding a switch-through signal, booster battery for example, from the relay group to the switch-through connector 515, FIG. 5. This path is from booster battery through make contacts 3 of relay 4TA, make contacts 1 of relay 4S, back contacts 2 of the same relay, back contacts 1 of relay 4B to the C conductor extending through the transfer-selector switch 509 to the relays, not shown, in the switch-through connector 515. This booster battery signal causes the connector to switch the second-called PABX substation loop of the connector through the transfer-selector switch to the −L and +L conductors of the transfer relay group, FIG. 4. Relay 4TA responds to this dry loop condition and restores its contacts. Relay 4S, previously operated to its "X" contacts, fully operates from the ground on the C lead of the relay group 493, over a path through "X3" contacts of relay 4S, back contacts 4 of restored relay 4TA, and the lower winding of relay 4S to battery. Make contacts 5 of relay 4S provide a holding ground for the transfer-finder switch 491. Release of relay 4B removes holding ground from the H and C conductor path extending to relays 2TR, FIG. 2, and relay 6ON, FIG. 6. These relays restore. Relay 2TR restored closes its back contacts 1 and 2 and sets up a closed path to relay 2E in the trunk circuit 200 from the loop path of the second-called substation taking over this call. Relay 2E reoperated, thereby causing relay 3B to operate as has been previously described, is now the battery feed and impulsing relay for the second-called PABX substation who may set up further transfer calls. Operated relay 3B closes make contacts 6 in a path traced from terminal TG8, the EC2 conductor connected with the EC conductor of the transfer relay group, FIG. 4, through make contacts 6 of relay 4S, make contacts 4 of relay 4ON and through the lower winding of relay 4LH to terminal TB8. Relay 4LH remains operated through this winding after relay 4TS has opened the path through the upper winding. Operated relay 4LH closes its make contacts 1 in a ground holding path for relay 4S and the C conductor extending to relays, not shown, in the connector switch. From what has been said above, it is obvious that the following relays will now restore: Relays 3CM, 3SW, 3T, 3P, 4B, and 4TS; also relay 6ON of the group identification circuit, FIG. 6. The incoming fifth selector switch 500 and the switch-through connector 515 in FIG. 5, used in establishing the original inward dialed call, are no longer in use and will release.

As a reference, REFERENCE D, for the following call about to be described, the relays in operated condition are listed as following: FIG. 2, relay 2RV, 2RVS, 2A, 2E, 2AT to its "X" contacts; FIG. 3, relay 3B; FIG. 4, relay 4S fully operated, 4LH, and relay 4ON; FIG. 6. relay 6CU2.

The second PABX substation establishes connections to a third substation

In the course of the conversation with the outside party, the second PABX substation may call another substation referred to as the "third" substation, for consultation purposes.

This section of the specification points to the use of two transfer link 100 switch trains, each including a transfer relay group 493, for establishing this consultation call. The first of the two trains is presently engaged in the call as just described, and the second transfer link 100 will be seized when the second PABX substation dials the prefix digit "1." In this case the abbreviated call number is the prefix digit "1" plus a local directory number "324" of the party desired.

On the basis of the above "reference D" listing the relays operated at this time, it is obvious that the dialing of the prefix "1" causes relay 2E of trunk circuit 200 to restore and later to reoperate. Relay 2E restored closes a path for the operation of the slow releasing relay 2C. This path is traced from ground at make contacts 2 of relay 2A, back contacts 1 of relay 2E, back contacts 9 of relay 3K, make contacts 5 of relay 3B, FIG. 3, and through the upper winding of relay TC to battery. With relay 2E reoperated and relay 2C not yet released a path is closed whereby relay 2TR operates to its "X" contacts. This path is from ground through make contacts 2 of relay 2A, make contacts 1 of relay 2E, back contacts 6 and 11 of relay 3K, make contacts 4 of relay 2C, over the TRD lead of FIG. 3 extending to a similar lead in FIG. 6 where the path passes through back contacts 7 of relay 6CU3 to lead TRG, FIG. 3, through the back contacts 6 of relay 3P, and the upper winding of relay 2TR to battery. It is obvious that relay 2C operated has opened the transmission path to the outside party at its back contacts 1 and 2 and thereby prevented the prefix digit impulses from affecting the incoming connections to the trunk circuit 200. Before relay 2C restores its contacts, and particularly contact number 3, to set a marking on the vertical bank, not shown, of the transfer finder switch 491, FIG. 4, a guarding path is provided for holding relay 2TR operated to its "X" contacts. This path extends from ground at make contacts 2 of relay 2A through make contacts of relay 3B to the left through back contacts 4 of relay 2AT, back contacts 3 of relay 2TR and the "X4" contacts of the same relay to make contacts 3 of relay 3B, and the upper winding of relay 3P in series with the upper winding of relay 2TR to battery. This series holding path through relay 3P causes relay 3P to operate. Operated relay 3P makes a contact transfer at its back and make contact 6 as will be referred to in a later section of this specification dealing with the consultation or transfer of calls to the attendant 1000(1). In that case the station controlled impulsing of relay 2E by digital impulses greater than "1," for instance the digit "0," also operates relay 3P and through its make contacts 6 completes a path for the operation of relay 2AT in the trunk circuit 200.

Restored relay 2C sets up a marking circuit to the transfer finder vertical bank, FIG. 4, and to the allotter circuit 492 shown on the drawing below the transfer finder 491. This marking path is from ground at make contacts 2 of relay 2A through make contacts 2 of relay 3B, back contacts 4 of relay 2AT, relay 2TR back contacts 3 and 4, through back contacts 3 of relay 2C to the SLM marking conductor extending to the vertical bank and allotter of FIG. 4. Described briefly, the allotter causes an idle transfer finder switch to search for the vertical bank marking and also the inward dialing trunk circuit 200 engaged in making this consultation call by way of the first mentioned transfer link 100 switch train which had established the connection to the second PABX substation. It is recalled that the first transfer-finder switch 491 was held operated from the ground through make contacts 5 of relay 4S over the C1 conductor extending back by way of make contacts 403 of the finder switch and the winding of relay 402 to battery. This holding arrangement of the first transfer-finder switch permits its banks and wipers to be used in setting up the consultation call being described. After finding this trunk circuit, relay 402 of the second transfer-finder switch 491 operate and switches through the transmission impulsing and control conductors from the first transfer-finder bank multiples 404 of FIG. 4 extending through the second transfer relay group 493 to the second transfer-selector switch 509 of FIG. 5 and its impulsing relay not shown. In response to seizure of the impulsing relay, the second selector switch returns a guarding ground on the C lead, FIG. 4, to the second relay group, thereby causing relay 4CC to operate over an obvious path. Relay 4CC operated closes its make contacts 1 for holding the second finder switch relay 402 operated. As in the case of the first described consultation call, relay 4CC operated closes its make contacts 3 and causes relay 2TR of the trunk circuit 200 to become operated through its "X" contact 7. It is obvious that the operating ground path causing the operation of relay 2TR can also be traced back through the group identification circuit 610 of FIG. 6 and specifically the ONL conductor. Fully operated relay 2TR disconnects relay 2E from the previously described path extending back to the second PABX substation loop, disconnects the marking ground to the transfer-finder switch banks, 404, and also provides a holding ground for relay 3P of the trunk circuit.

The relays in an operated condition are summarized, REFERENCE E, as follows: FIG. 2, relays 2RV, 2RVS, 2A, 2AT to its "X" contacts, and 2TR fully operated; FIG. 3, relay 3P; FIG. 4, first transfer relay group, relays 4S, 4LH, and 4ON; FIG. 4, second transfer relay group, relay 4CC; and FIG. 6, relay 6CU2. At this point in the establishment of the consultation call, the second transfer-selector switch 509 returns dial tone and is ready to accept digital impulses of the called number, that is "324." The group identification and time division signaling techniques now effected as the second PABX substation controls the establishment of the consultation call connections, by way of the first and second switch trains, to the third substation of that PABX group 1 is generally the same as described above. This refers to the portion of the operational description following the "REFERENCE B" listing of operated relays in the section relating to the establishment of the first consultation call connections from the first PABX substation to the second substation.

Upon establishment of the present consultation call, the relays in operated condition and listed, as REFERENCE F, according to figures of the drawings are as follows: FIG. 2, relay 2RV, 2RVS, 2A, 2AT to its "X" contacts, and 2TR; FIG. 3, relay 3P; FIG. 4 first transfer relay group, relays 4S, 4LH, and 4ON; FIG. 4 second transfer relay group, relays 4BS, 4A, 4TA, 4B, 4TS, 4S, to its "X" contacts, and 4ON; FIG. 6, relays 6ON, and 6CU2.

The third-called substation disconnects from the consultation call

The third-called substation party, engaged in consultation with the second substation party, may restore his handset and thereby release the connector by which he was called. Connector switch 515, FIG. 5, restored removes the battery feed by which the relay 4TA of the second transfer relay group 493 had remained operated. The second transfer-selector switch and relays are now restored and ground is removed from the ON conductor back to the relay group, thereby causing relay 4ON to also restore. From what has been said above in regard to the holding paths for the transfer relay group and the transfer finder switch, it is obvious that relays 4BS, 4A, 4B, 4TS, and 4S, of the second transfer relay group now restore, as well as the second transfer switch, FIG. 4. Relay 4B restored opens its make contacts 5 and removes the holding ground which permits relay 2TR of the trunk circuit 200, FIG. 2, and relay 6ON of the identification circuit 610, of FIG. 6 to restore. Relay 2TR restored reconnects relay 2E to the path previously traced to the second PABX substation loop. Relay 3B, FIG. 3, of the trunk circuit reoperates, but relay 3P restores.

At this time the relays in an operated condition are summarized, REFERENCE G, as follows: FIG. 2, relays 2RV, 2RVS, 2A, 2E, 2AT to its "X" contacts; FIG. 3, relay 3B; FIG. 4, first transfer relay group, relays 4S, 4LH, and 4ON; FIG. 6, relay 6CU2.

Automatically forwarding a directory listed number call to a PABX attendant

This portion of the specification relates to call forwarding arrangements, in the switching system serving groups of private branch exchanges, wherein the inward dialed connection set up to a PABX group directory number, and terminating in a listed number trunk 516 rather than to individual substation numbers of the PABX, automatically forwards the call to an idle attendant 1000(1) of the PABX group 1 selected. Of the seven digit directory number listed, the last four digits, such as "2325," are significant to the description according to the embodiment of this invention. This number represents the PABX group, that is customer group number 1, of the inward dialed substation called by abbreviated number "2322" according to the description in the forepart of this specification. It is found that upon dialing the last two digits "22," the connector switch 515, FIG. 5, established connections with the called PABX substation, while in the present case the last digits "25" will cause the connection to terminate on the listed number trunk circuit 516, FIG. 5. Upon seizure of the listed number trunk reverse battery is returned to the calling connection for a period of time less than for the inward dialed call to the substation. In view of the above, is evident that the inward dialing and PABX group marking techniques already described in detail in connection with the establishment of a call to a substation also applies to the listed number call. The present description will therefore diverge from the point at which "relay 2SP operated, transfers etc." A recapitulation of the relays in an operated condition is as follows: FIG. 2, relay 2SP; FIG. 3, relay 3CM; FIG. 6, relay 6CU2.

Relay 2SP operated, transfers, at its make contacts 1 and 2, the incoming conductors from a physical connection through the incoming selector 500 to a connector switch 515 to the upper and lower winding of relay 2A of the trunk circuit 200. Relay 2A operates. It is obvious that relay 2A provides normal polarity battery feed through its windings to the incoming connection conductors until relay 2RV operates to reverse the polarity and provide answer supervision to the incoming connection. As in the case of the previous description of an inward dialed call, relay 2A operated closes its make contacts 2 and opens its break contacts 3 and sets up a divided circuit condition

whereby the charging current of capacitor 2CA5 through the lower winding of relay 2RV opposes the current through its upper winding. A path is also closed so that relay 2AT operates to its "X" contacts as previously traced. In the case of the present listed number call being described listed number trunk circuit 516 of FIG. 5 now removes reverse battery from the path traced back to the relay 2SP of the trunk circuit 200, FIG. 2, thereby allowing relay 2SP to restore. Restored relay 2SP opens its make contacts 5 and thereby prevents relay 2RV from operating through its upper winding. Relay 2SP restored opens its make contacts 1 and 2 and thereby permits relay 2A to also restore. Restored relay 2A closes a path by which relay 2AT becomes fully operated to its second position. This path is traced from the ground back from the incoming switch train over the CSW conductor of FIG. 3 extending back to FIG. 2 through back contact 6 of relay 2RVS, back contact 1 of relay 2A, back contact 10 of relay 3K, extending to back contact 2 of relay 2RV, back contact 5 of relay 2A, through the thermal element device 2TR1, diode 2D5 make "X" contacts 10 of relay 2AT and through the lower winding of that relay to battery. After a period of time characteristic of the thermal element 2TR1, relay 2AT becomes fully operated. Operated relay 2AT closes its make contacts 1, 2 and 3, and thereby closing the paths over which relay 2A is again operated, and another path by which ringback tone is returned to the party making this listed number call. The trunk circuit 200 is now conditioned for forwarding the inward dialed call to the PABX attendant of customer group number 1 only as the group identification relay 6CU2, identifying that group, remains operated over the LK conductor extending to the trunk circuit.

As an interjection at this point in the description of the listed number call, all attendants of customer group number 1 may be engaged in other calls and therefore unable to accept the call being made. In other words the gating circuit arrangement with the customer start circuit would be closed, that is relay 6GC of the customer start circuit 620, FIG. 6, would remain operated and hold its contacts 2 and 3 open. When an attendant's position 900(1) of this group became idle and could accept this call relay 6GC would restore and close a path by which relay 3GT, FIG. 3 of the trunk circuit 200 operated. This closed path is traced from ground through back contacts 2 of relay 6GC over the GT conductor through make contacts 4 of relay 6CU2 of the identification circuit 610, back contact 4 of relay 6CU3, the GT conductor extending to the trunk circuit, FIG. 3 where it continues through back contacts 4 of relay 3GT, back contact 5 of relay 3CO, make contact 5 of relay 2AT, and through the winding of relay 3GT to battery. Relay 3GT operates, and remains temporarily held through its make contacts 4. Its make contact 3 closes an operating path over the GP conductor extending through the group identification circuit, FIG. 6, to the customer start circuit relay 6ST. Operated relay 6ST closes its make contacts 1 for a path over the M conductor to the link allotter 720, contacts 704 through other equipment, not shown, back contact 711 of relay 710 and through the rotary magnet winding 7MM, FIG. 7 to battery. Interrupter contact 709 of the rotary switch cooperate with the relay 710 and its back contacts 711 in such a way that the rotary switch steps until it finds the position circuit 900(1) of the attendant 1000(1) free to accept this call. This position circuit is found at the point on rotary switch level A at which a path is closed from the ground at make contact 3 of relay 6ST, FIG. 6 over the N conductor extending through the winding of relay 703 of the link allotter 720, FIG. 7, other equipment not shown, through the A level bank and wiper set to the H conductor extending to the position circuit of FIG. 9, where the path continues through break contacts 1 of relay 9PBA, over the PB conductor back to the customer start circuit, FIG. 6, through make contacts 4 of relay 6ST and resistor 601 to battery. Relay 703 of the link allotter, FIG. 7 operates and opens its contacts 704 to open the self interrupting circuit to the rotary switch 7MM. Having found the idle attendant's position circuit, one of the four assigned to customer group number 1 in this case, the rotary switch wipers come to rest in the position shown in the link allotter, FIG. 7. Ground potential through other equipment, not shown, extends through level C wiper and bank contacts to the PM conductor extending to the position finder 750 through the lower winding of relay 713 to the vertical bank contact 702 thereby providing a marking at the bank levels at which the position finder switch can establish connections from the trunk circuit 200 to the position circuit 900(1). Rotary switch level D extends a ground through other equipment not shown over the TM conductor extending back through the group identification circuit 610, FIG. 6 to the similar conductor in the trunk circuit, FIG. 3 where it passes through make contacts 2 of relay 3GT, now operated, to the vertical bank conductor VB, and to the trunk finder 730 vertical bank contact 714. Having marked the vertical bank level multiples of the position finder and trunk finder equipment, as described above, the link allotter 720 allots an idle position finder 750 and an idle trunk finder 730 to find these markings respectively. The link allotter controls the operation of the rotary switch 7MM1 so that its levels A1 and B1 become associated with the allotted trunk finder and position finder switches, respectively. The position finder switch steps vertically under the control of the position finder control circuit 715 until the vertical bank wiper associated with conductor 700 engages contact 702. At this time a circuit for relay 713 of the position finder switch is completed over a path traced from the marking ground on vertical bank contact 702 over the conductor 700 extending through the position finder control relays and the B1 level of the rotary switch 7MM1 to other equipment not shown to battery. Relay 713 operated controls a rotary hunting operation of the position finder until an idle terminating circuit 800(1) of FIG. 8 is found on that level. As mentioned above, the link allotter controls the operation of the trunk finder causing it to step vertically until its vertical bank wiper comes to rest on the marking contact 714 and closes a path further traced through the conductor 706, the lower winding of relay 712 to the link allotter rotary level A1, other equipment, not shown, to battery. Relay 712 controls a rotary hunting operation of the trunk finder 730 until a switch becomes associated through its bank contacts and wipers 707 with the trunk circuit 200, forwarding this listed number call to the attendant 1000(1). With their finding operations completed the position-finder and the trunk-finder form a call-forwarding concentrator link 110 directly connecting the terminating circuit 800, FIG. 8 to the inward dialing trunk circuit 200, FIG. 3, by way of conductors —F, +F, CF and EC. The switch through link completes a path over which relay 8LB of the terminating circuit now operates. This path is traced from the link allotter 720, FIG. 7, by way of rotary bank F traced from ground through other equipment, not shown, extending over the RM conductor through the group identification circuit 610, FIG. 6 to the trunk circuit 200 with the same conductor extending through make contact 1 of relay 3GT operated, the upper winding of relay 3CO, make contact 4 of relay 2A operated, to the CF conductor extending through the link path to the terminating circuit 800(1) in FIG. 8 by way of back contacts 2 of relay 8AN and the lower winding of relay 8LB to battery. Operated relay 8LB closes its make contacts 4 for a path traced from battery through other equipment, not shown, back contact 7 of relay 8AN, make contact 4 of relay 8LB, back contact 2 of relay CS1, back contact 3 of relay CS2, to the CS1 conductor extending to the turret equipment 1000(1), specifically lamp 1070 to ground which indicates that this is a listed number call being forwarded to the attendant. Operated relay 8LB also closes a path for a time division signal which indicates to the attendant the

terminating circuit over which this listed number call will be received. This closed path is traced from the TG1 terminal in the trunk circuit **200**, FIG. 2, through diode **2D7**, make contact **7** of relay **2AT** fully operated, make contact **6** of relay **3CO**, FIG. 3, to the EC conductor extending through the concentrator link **110** to the terminating circuit **800(1)**, FIG. 8, conductor EC, through make contact **2** of relay **8LB** operated, to the winding of relay **8SP1**, diode **8D4**, to the time division signal output terminal TB1. Relay **8SP1** operates. Operated relay **8SP1** closes its make contacts **1**, completing a path to the source lamp **1030** at the attendant turret **1000(1)**. The attendant thereby knows that the listed number call in progress will be received at that terminating circuit.

The attendant answers this call by momentarily depressing the terminating circuit key and thereby cause a transmission path to be set up between herself and the calling party. The depressed key closes its make contacts **1010**, FIG. 10, of a path traced from ground through the upper winding of relay **8K** of the terminating circuit, FIG. 8 to the KO conductor extending to the position circuit **900(1)** through the winding of relay **9KB** to battery. Both relays operate, and in the case of relay **8K** a holding path is traced from battery through the lower winding and its make contact **6**, through the back contacts **3** of relay **8TR**, back contact **6** of relay **8HD**, over the KL conductor extending to back contacts of relay **9KB**, now released, through back contacts **1** of relay **9RL**, and the normally operated make contacts **1** of relay **9BF** to ground. Relay **8K** held operated, closes a path to make contact **7** for the operation of relay **8AN** through make contact **3** of operated relay **8LB**. Operated relay **8K** closes its make contacts **10** to maintain the path of the listed number lamp circuit so that the attendant is reminded that a listed number call is in progress. Relay **8AN** operated closes its holding path through the make contacts **5**, and through its make contacts **2** sets up the holding path for relay **8LB** by way of ground over the back contact **1** of relay **8TR**. The holding ground through the make contact **5** of relay **8AN** also is returned over the "X4" contacts of that relay to the CF conductor extending through the concentrator link **110** to the trunk circuit **200** over a path previously traced through relay **3CO** of the trunk circuit for holding relay **3CO** operated through its make contacts **4** and **5** the lower winding to battery. Operated relay **3CO** opens the back contacts **5** in the operating path for relay **3GT**, thereby permitting it to release its contacts and sever connections with the customer start circuit **620(1)**, FIG. 6, and the link allotter **720**, FIG. 7. Returning briefly to the terminating circuit, FIG. 8, relay **8K** operated closes its make contacts **1** and **2** and completes a path, through the windings of repeat coil RC connected by resistor **9R2**, in the position circuit **900(1)**, FIG. 9, over which relay **3K**, FIG. 3, in the direct inward dialing trunk circuit operates. Traced from the upper and lower repeat coil windings RC of the position circuit, FIG. 9, this closed path further includes back contacts **1** and **2** of relay **9ON**, back contact **1** of relay **9SD**, to the terminating circuit, FIG. 8, where it passes make contacts **1** and **2** of relay **8K** through diodes **8D1** and **8D2** to back contact **1** of relay **8LB**, to the −F and +F conductors extending through the link equipment to the trunk circuit, FIG. 3, through make contacts **1** and **3** of relay **3CO** held operated, back contacts **1** and **3** of relay **3K** and the lower winding of that relay to battery. Relay **3K** operates. Operated relay **3K** closes its "X" contacts **2** for the holding path including the make contacts **2** of relay **3CO**.

At this point, it is recalled that the attendant **1000(1)** has answered the call and that the inward dialing trunk circuit **200** has not removed the ringback tone from the calling subscriber's transmission path. It is also recalled that the following relays, as a REFERENCE H, are in an operating condition, namely FIG. 2, relays **2A**, and **2AT** fully operated; FIG. 3, relays **3K**, and **3CO**; FIG. 6, relays **6CU2**; FIG. 8, relays **8K**, **8AN**, **8LB**, **8SP1**; FIG. 9, relay **9PF**.

Upon to this point in the description of the call, relay **2RV** in trunk circuit **200** did not operate, first because of the charging current of the lower winding, and second because of the release of relay **2SP** which opened its make contacts **5**. With relay **2A** held operated as noted above, relay **3K** operated closes its make contacts **4** and provides a path through the upper winding of relay **2RV**, whereby causing the relay to operate. According to the description of the inward dialed call, relay **2RV** operated closes its make contacts **1** allowing relay **2RVS** to operate and thereby establish direct connections between the incoming connection conductors — and + and the battery feed relay **2A** of the trunk circuit **200**. It is obvious that this returns reverse battery to the incoming connections for signaling the outside party that the call has been answered. Operated relay **2RVS** opens its back contacts **10**, and removes the ground holding relay **2AT** through make contacts **10** of relay **3K**. Relay **2AT** restored removes ringback tone from the calling connection. The transmission path is now complete between the calling party and the attendant **1000(1)** with relay **2A** in the trunk circuit **200** being the battery feed to the calling party and relay **9BF** in the position circuit **900(1)** the battery feed to the attendant. These two paths are coupled by means of the repeat coil RC of the position circuit, FIG. 9 over the path previously traced through to the inward dialing trunk circuit, FIGS. 2 and 3 to the capacitors **2CA3** and **2CA4** of FIG. 2.

The PABX attendant extends the listed number call to a substation

The following relays are operated as the attendant initiates the establishment of connections between the calling party and the desired PABX substation, assumed to have a number including the last three digits "326." The relays are summarized, as REFERENCE J: FIG. 2, relays **2RV**, **2RVS**, **2A**; FIG. 3, relays **3K**, and relay **3CO**; FIG. 6, relay **6CU2**; FIG. 8, relays **8K**, **8AN**, **8LB**, and **8SP1**; FIG. 9, relay **9BF**.

The attendant operates the "dial-in" key at her turret **1000(1)**, FIG. 10 causing the closure of ground through the make contacts **1081**, through the back contacts **4** of relay **9DS**, and the lower winding of relay **9SD** to battery. Relay **9SD** of the position circuit operates and closes a holding path through its make contacts **3** to the ground at make contacts **1** of the battery feed relay **9BF**. Operated relay **9SD** closes its make contacts **4** of a path traced through back contacts **5** of relay **9TD** to the winding of relay **9PG** to battery. Relay **9PG** operated closes a path by which relay **2C** of the trunk circuit **200** operates for disconnecting the transmission path to the calling party. This path is traced from the position circuit **900(1)**, FIG. 9, time division signaling output terminal TG8, through diode **9D3**, make contact **1** of relay **9PG** operated, over the EC1 conductor multiple extending to the terminating circuit **800(1)**, where the path continues through make contacts **9** of relay **8K**, make contact **6** of relay **8AN**, to the make contact **2** of relay **8LB**, over the EC conductor extending through the link equipment **110** to the trunk circuit **200** EC conductor, FIG. 3, through make contact **6** of relay **3CO**, and the lower winding of relay **2C** and the diode **2D4** to terminal TB8. Relay **2C** operates from the time division signal transmitted over this path. Operated relay **2C** in this case closes a path, not yet described, which results in the operation of relay **2TR** to its "X" contacts. This path is traced from the ground through make contact **6** of relay **3K**, back contacts **4** of relay **2C**, back contact **2** of relay **2E**, to FIG. 3 over the TRD conductor extending through the group identification circuit **610**, through back contact **7** of relay **6CU3**, then over the TRG conductor extending back to FIG. 3, where the path continues through back contact **6** of relay **3P**, to the upper winding of relay **2TR**, FIG. 2, and battery. Relay **2TR**

operated to the first of its two step positions closes the "X" contacts and completes a new path for setting a ground marking on the SLM conductor extending to the vertical banks and allotter of the transfer finder equipment **491**, FIG. 4. This marking path originates at the ground through make contact **2** of relay **2A** of the trunk circuit, through make contact **4** of relay **3K**, further traced through back contact **4** of relay **2AT**, then back contact **3** of relay **2TR**, "X" contact **4** of that relay, make contact **5** of relay **3K**, to the SLM conductor in FIG. 3, to the vertical bank **405** of this transfer finder switch **491**.

The call forwarding techniques used in establishing connections for this attendant-controlled call is the same as that used in establishing connections to the above-mentioned second and third PABX substation, for consultation purposes, except using different arrangements for seizing and impulsing the transfer selector and connector switches as will be described. Briefly, the attendant **1000(1)** dials the digits "326" and sets up a connection to the desired substation party in PABX customer group **1**, identified by time division signaling (TG2 and TB2) between the group identification circuit **610** and the transfer-selector switch **509** being employed in this call. Furthermore, the group identification circuit relay **60N** is operated by a time division signal (TG5 to TB5) from the seized transfer relay group **493**, FIG. 4.

In dialing the above-mentioned call number "326" the attendant, FIG. 10, operates the dial, thereby, closing the off-normal contacts **1090** in the path traced over the ON conductor to relay **9ON** of the position circuit **900(1)**, FIG. 9.

Relay **9ON** operates and is held operated each time the dial is off normal in preparation for dialing of the digits. During the period it is held operated, relay **9ON** closes a path through the dial impulse spring contacts **1080** for seizure of the impulsing relay, not shown, in the transfer selector switch **509**, FIG. 5, and again in the connector switch **515** as the call-forwarding switch train establishes the connections. It is understood that normal polarity of the above-mentioned seizure-impulsing relay is directly connected to the T and R multiple conductors of the position circuit **900(1)**, and that the closed path can be partially traced as follows: Ground potential on the T conductor is connected through make contacts **2** and the upper winding of relay **9SD** to battery; battery potential on the R conductor is connected through make contacts **2** of relay **9ON**, contacts **1080** of the dial, make contacts **1** relay **9ON**, make contacts **1** of relay **9SD** to ground. Closure of this path results in seizure of the impulsing relay at the switch train and release of the position circuit relay **9SD** as the current through the upper winding opposes the current in the lower winding of the relay. Restored relay **9SD** closes the impulsing path to the switch train traced partially from the T conductor, through back contacts **1** relay **9SD**, make contacts **1** relay **9ON**, dial springs **1080** make contacts **2** relay **9ON**, to the R conductor. Relay **9ON** restores after each series of digital impulses for disconnecting the dial path and reconnecting the repeat coil RC. Relay **9PG** restores and opens the time division signaling path to relay **2C**, FIG. 2, of the trunk circuit.

A summary, REFERENCE K, of the operated relays at this point in the description is as follows: FIG. 2, relays **2RV**, **2RVS**, **2A**, and **2TR** fully operated; FIG. 3, relays **3K**, and **3CO**; FIG. 4, relays **4CC**, and **4ON**; FIG. 6, relays **6ON** and **6CU2**; FIG. 8, relays **8K**, **8AN**, **8LB**, and **8SP1**; FIG. 9, relays **9BF**.

When the called substation answers this call, reverse battery is returned to the —L and +L conductors of the transfer relay group **493**, FIG. 4, and passes over conductors **400** and **401** to the path traced through the relay **4TA** and the diode **4D1**. Operated relay **4TA** closes its make contacts **1** and **2** in a closed path to relay **4A**. Relay **4A** operates. In this call, relay **4A** is not a battery feed relay to any party, but it is the means for providing a reverse battery signal, representative of the called substation's reverse battery, over a closed loop traced through the — and + conductors of the relay group, FIG. 4, back through the trunk circuit **200** FIGS. 2 and 3, to the —F and +F conductors through the concentrator link **110** switch train to the terminating circuit **800(1)**, FIG. 8 where the path continues through back contact **1** of relay **8LP**, the upper and lower windings of relay **8RV**, through make contacts **1** and **2** of relay **8K**, over the T and R conductors of the position circuit, **900(1)**, FIG. 9 through back contacts **1** and **2** of relay **9ON**, back contact **1** of relay **9SD**, through the upper and lower windings of the repeat coil and the resistor **9R2**. Relay **8RV** of the terminating circuit responds to the current flowing through its upper and lower windings and therefore operates. Operated relay **8RV** closes its make contacts **3** of a path traced through back contacts **2** of relay **8LP** to the winding of relay **8SP2** to battery. Relay **8SP2** closes a path from battery, through other equipment shown, and its make contacts **1** connected to conductor **L2** extending to the turret "destination" lamp **1020** to ground. The lighted lamp **1020** signals the attendant that the call has been established to the PABX substation. Operated relay **8RV** also closes its make contacts **4** and **5** in a path traced through back contact **5** of relay **8HD** to the winding of relay **8LA** to battery. Relay **8LA** closes a path from battery, through other equipment not shown, by way of its make contacts **1** to conductor **LA** and the turret lamp **1001** to ground. This lamp indicates the terminating circuit used in establishing the call.

As in the case of other answered calls through the transfer relay group **493**, FIG. 4, the following relays also are operated, see "REFERENCE C" for example: FIG. 4, relays **4BS**, **4A**, **4TA**, **4B**, **4TS**, **4S** to its "X" contacts, and **4ON**. In the other calls described, the originator of the transfer-call connection maintained control over the connection up to the point that the call was forwarded to the transferee substation. Likewise, the attendant maintains the control until her services are no longer required.

The attendant may complete this listed number call, thereby establishing direct connections between the originator of the inward dialed call and the last-called PABX substation, by merely depressing the trunk release key at her turret, FIG. 10. This key closes its make contacts **1051** of a path through make contacts of relay **8K** and the winding of relay **8TR** to battery. Operated relay **8TR** closes its make contacts **4** for a holding circuit and also opens its back contacts **1** and **3** thereby permitting relays **8LB** and **8K** to release. Restored relay **8LB** opens its make contacts **2** so that relay **8SP1** restores, and through its make contact **1** opens the path to the source lamp **1030** at the attendant's turret, FIG. 10. Restored relay **8LB** opens its make contacts **3**, thereby permitting relay **8AN** to restore as well as relay **3CO** of the trunk circuit **200**, FIG. 3 which had been held over the CF conductor extending from the terminating circuit **800(1)** back to the trunk circuit **200** over the concentrator link equipment **110**. The loss of holding ground on this CF conductor from the terminating circuit, FIG. 8, also permits the position finder and the trunk finder switches to restore. Restored relay **8LB** opens its make contacts **4** and the path to the listed number lamp **1070** on the attendant's turret. Restored relay **8K** opens the make contacts **7** and allows relay **8TR** to also release. Restored relay **8K** opens its make contacts **1** and **2** of the transmission path thereby permitting relay **8RB** to restore. Restored relay **8RV** opens the paths of relays **8LA** and **8SP2** so that the terminating circuit lamp **1001** and the destination lamp **1020** at the turret will also go dark. Relay **4A** of the transfer relay group **493**, FIG. 4, is no longer connected to the position circuit loop and therefore restores. Restored relay **4A** closes its back contacts **2** and provides a closed path to relay **4CF**. Relay **4CF** operates and by its make contacts **3** provides a holding ground over the **C1** conductor extending back to the transfer finder switch **491**.

Restored relay 4A opens its make contacts 1 and permits relay 4B to also restore. Relay 4B restored opens the holding ground through its make contacts 5 of a previously described path extending to relay 2TR, FIG. 2 of the trunk circuit, and through the make contacts number 1 of the 6ON and the upper winding of that relay to battery, as seen in the group identification circuit 610, FIG. 6. Both relays restore. It is recalled that relay 4S in the transfer relay group, FIG. 4 was operated to its "X" contacts. With relay 4B just restored, a path is closed for transmission of a switching signal from the transfer relay group 493, to the connector 515, FIG. 5, used in the establishment of this listed number call to the PABX substation. The switching signal is booster battery passing through make contacts 3 of relay 4TA, make contact 1 of relay 4S, through the back contacts 2 of the same relay, back contact 1 of relay 4B, over the C conductor extending through the transfer selector switch 509, FIG. 5 to the connector switch where it becomes effective to cause the connector to physically switch through the substation loop to the —L and +L conductors of the transfer relay group, as has been described before. Because of this dry loop condition on the —L and +L conductors relay 4TA restores and closes a path for fully operating relay 4S through its lower winding. Operated relay 4S closes its make contact 7 and extends the called subscriber loop through the transfer link 100, FIG. 4, to the —TN and +TN conductors of the trunk circuit 200, FIG. 3 extending by way of back contacts 1 and 2 of relay 2TR, now restored, to relay 2E, FIG. 2. Relay 2E operates and is the battery feed to the called substation.

A summary, REFERENCE L, of the operated relays upon completion of this listed number call is as follows: FIG. 2, relays 2RV, 2RVS, 2A, and 2E; FIG. 3, relay 3B; FIG. 4, relays 4S, 4LH, and 4ON; FIG. 6, relay 6CU2. It is obvious that this summary is like that given as "reference D," except that relay 2AT did not operate to its "X" contacts, at the time the second-called substation party had taken over the direct inward dialed call.

Called PABX substations establish connections to the attendant

Each of the above called substations engaged in conversation with the outside party, who originated the inward dialed call, could establish connections to the PABX attendant, for consultation or transfer purposes, by simply dialing a digit substantially greater than "1," for example the digit "0," as previously mentioned in this operational description. It is understood that relay 2E, of the trunk circuit 200, FIG. 2, is the battery feed impulsing relay for each of these substations as heretofore summarized in: reference A (inward dialed call to first substation); reference D (second substation takes over call); reference G (third substation disconnects from the connection); and reference L (listed number call completed).

In each case, relay 2E responds to the impulses and controls the operation of relays 2C, 2TR to its "X" contacts, 3P through the upper winding, and 3B which remains operated, as heretofore described in connection to the substation controlled impulsing by the digit "1." It is known that the first impulse of a call number caused relay 3P to operate its make contacts 6 and thereby close a path partially traced from conductor TRG, FIG. 3, through back contacts 8 of relay 3K, the upper winding of relay 2AT to battery. With relay 3P slow to release, additional impulses apply ground to this path and operate relay 2AT. Operated relay 2AT closes a holding path through its lower winding, this path being later opened when relay 3K operates. Operated relay 2AT opens it back contacts 4 and prevents ground marking the SLM conductor and thereby causing the allotter 492, FIG. 4, to allot an idle transfer finder switch 491 to find this trunk circuit 200. Operated relay 2AT closes its make contacts 5 in a path whereby relay 3GT of FIG. 3 became operated if there was an open gate circuit condition between the customer start circuit 620 FIG. 6 and the trunk circuit as heretofore described in connection with the establishment of a listed number call to an idle attendant of a PABX. Trunk circuit relay 3GT FIG. 3 operated closes a path through the group identification circuit 610 to the relay 6ST of the customer start circuit. The substation originated call will thereafter be automatically forwarded to the attendant in the same manner as was described in connection with the listed number call. The attendant knows this is a recall or transfer call, rather than a listed number call, because of the lighted lamp 1050 at the attendant turret, FIG. 10. The path to this lamp was closed by make contacts 2 of relay 8CS1 of the terminating circuit 800(1), FIG. 8. This relay became operated because of a closed path, through its lower winding, between output terminals of the time division signaling arrangement. This path is partially traced as extending from terminal TG3 of the trunk circuit 200, FIG. 2 through diode 2D3 and the make contacts 8 of relay 2RVS operated, back contact 7 of relay 2AT, now restored, and through the concentrator link equipment 110 to the terminating circuit 800(1), FIG. 8, and the output terminal TB3. It is recalled that relay 2TR of the trunk circuit operated only to the first of its two positions and therefore did not open the transmission path between the attendant and the originator of this call. This transmission path is by way of back contacts 10 and 11 of relay 2AT, capacitors 2CA1, 2CA2, 2CA3, and 2CA4.

The attendant camps on a busy substation connection

In setting up a connection for extending the above described listed number call, the attendant may have received busy tone indicating that the desired substation was already engaged in conversation with another party. The attendant may either camp on this busy connection or, if necessary, cut-in on the connection. As a recapitulation of "reference K," the following relays are in an operated condition: FIG. 2 relays 2RV, 2RVS, 2A, and 2TR; FIG. 3, relays 3K, and 3CO; FIG. 4, relays 4CC, and 4ON; FIG. 6, relays 6ON, and 6CU2; FIG. 8, relays 8K, 8AN, 8LB, and 8SP1; FIG. 9, relay 9BS.

The attendant may camp on this busy connection by momentarily depressing the signal key at her turret, FIG. 10, thereby closing the path through its make contacts 1071 and thereby cause relay 9SIG to operate. Operated relay 9SIG of the position circuit 900(1), FIG. 9, closes its make contacts 2 of a path through back contacts 3 of relay 9DS, over the CB conductor extending to the terminating circuit 800(1), FIG. 8, through make contacts 3 of relay 8K, and the lower winding of relay 8LP to battery. Operated relay 8LP opens its back contacts 1 and inserts the upper winding of that relay in the loop path previously described from the position circuit, through the terminating circuit conductors, to the impulsing relay at the connector 515. Relay 8LP remains operated through its upper winding as the shunt has been removed at its back contacts, 1. Relay 9SIG of the position circuit, FIG. 9, also closes its make contacts 1 of a time division signaling path extending from output terminal TG7 through the diode 9D1 to the EC1 conductor which has been traced to the EC conductor at the transfer relay group 493, FIG. 4, where the path further continues through the both windings of relay 4CB and the diode to output terminal TB7. Relay 4CB operates. Operated relay 4CB closes its make contacts 1 in a closed path for transmission of booster battery to the connector switch 515, FIG. 5. This booster battery switching signal causes a connector to camp on the busy connection, remove the busy tone from the circuit, and apply a dial tone indicating to the attendant that the circuit is camped on the busy connection.

The remaining relay operations, whether the attendant waits until the substation has concluded his conversation

or if she finds it necessary to override the busy connection to complete the call, are similar to that fully described just following the operated relay summation of reference K. In each case the relay operations are dependent upon the reversal of battery on the —L and +L conductors of the transfer relay group **493**, FIG. 4.

The attendant could cause the connector to cut-in on and override the busy connection by simply operating the signal key **1071** the second time and again control the transmission of booster batery from the transfer relay group **493** to the connector switch **515**.

Direct inward dialed calls to regular central office exchange stations

The switching and group identification techniques employed in the establishment of direct inward dial call connections from outside parties to regular central office stations are generally the same as detailed for direct inward dialed calls established to substations of a PABX customer group. These regular stations are assumed as being in the "800" connector group reached by connector **506** of FIG. 5, and that the individual station being called is assigned the directory number of which the last four digits are "2822." In establishing the connection for this inward dialed call, the calling party will dial the digit "8" and cause the incoming fifth selector **500**, FIG. 5, to operate its left normal post springs **502** and close its make contacts **505**. This closes a group identification marking path traced from ground through the back contacts **504** of the right normal post springs **503**, through make contacts **505** of the left normal post springs **502** to the C1 conductor extending to the group identification circuit **610**, FIG. 6, where the path continues through back contact **6** of relay **6CU3** and that winding to battery. Relay **6CU3** operates, rather than relay **6CU2** as was the case of the described substation call. Operated relay **6CU3** closes its make contact **6** in a holding path over the LK lead extending back to the trunk circuit **200**. Operated relay **6CU3** opens its back contact **7** and thereby prevents any ground on the TRD conductor from being effected to operate relays in the trunk circuit if the called station should attempt to make a trensfer call either to another station, a PABX substation, or an attendant. It is obvious that the connection of a strap **600**, in the identification circuit, FIG. 6, between the TRD and the TRG conductors would permit the "800" connector group to be assigned as a PABX customer group and enable all of the above described substation transfer calls.

Regular station answering of this call returns reverse battery over the —SW and +SW conductors of the trunk circuit, FIG. 3, and thereby causes the relays of trunk circuit **200** to operate in the same manner as has been described in connection with the inward dialed PABX substation call. In other words relay **2A** will be the battery feed to the calling party, relay **2E** will be the battery feed to the called party, and the relays will be in an operated condition as cited in "reference A" except that in this case relay **6CU3** of the group identification circuit **610** will be operated rather than relay **6CU2**.

It is recalled that the establishment of calls subsequent to the inward dialed station or listed number call depended upon the circuit arrangement in the group identification facilities of the trunk circuit. Group identity of the call was stored therein in the nature of a relay initially operated from a marking potential set upon it by selectively operated apparatus in the switch train establishing the call. Upon answer, or simulated answer of the call, as in the case of a listed number call, the identification relay was thereafter held from the trunk circuit.

The above-mentioned identification relay provided closed portions of a number of signaling paths made effective according to other controls set on the paths by circuits establishing connections for forwarded calls. Such paths included paths for the flexible and non-destructible signaling arrangement disclosed in the co-pending U.S. patent application of Robert M. Schildgen and John S. Young, as mentioned above.

According to the embodiment of this invention it is obvious that inward dialed calls can be readily switched freely between stations of groups of stations entitled to such calls.

Having fully described the features of my invention, what I consider to be new will be pointed out in the appended claims.

What is claimed is:

1. In a telephone system, a central exchange having: incoming connections terminated by a trunk circuit; automatic switching equipment including connector switches: an attendant's position; groups of substations connected to said connector switches and arranged to receive calls incoming to said exchange over said connections and said trunk circuit by way of said switching equipment both under the listed number of said group and under the number individual to the substation; and a listed number circuit also connected to said connector switches; said listed number circuit including: means operated upon seizure of said last-mentioned circuit by one of said connector switches for automatically returning to said trunk circuit an answering signal of less than a predetermined duration; and said trunk circuit including: answering signal responsive apparatus; timing means; and means jointly controlled by said apparatus and said timing means for returning a supervisory signal to said incoming connections if said answering signal is of more than said predetermined duration, and for signalling said attendant and preventing the return of said supervisory signal in response to the receipt of said answering signal if said answering signal is of less than said predetermined duration.

2. The combination in a telephone system as claimed in claim **1**, wherein said listed number trunk circuit also includes: timing means effective subsequent to operation of said jointly controlled means in the last-mentioned case for releasing said connector switch and said trunk circuit signal responsive apparatus.

3. The combination in a telephone system as claimed in claim **1**, wherein both said connector switches and said trunk circuit include: split battery feeds as well as physical switch-through connections for bypassing said battery feeds; wherein normally the split battery feeds in said connector switches and the physical connections in said trunk circuit are enabled whereby a physical circuit is normally provided from said incoming connections directly to the battery feed on the calling side of the connector switch used; and wherein said jointly controlled means in said trunk circuit, upon receipt of said answering signal of more than said predetermined duration, cause said physical connections in said trunk circuit to be replaced by the split battery feeds therein and cause the split battery feeds in said connector switch to be replaced by said physical connections in said connector switch.

4. The combination in a telephone system as claimed in claim **3**, wherein said trunk circuit includes: switching means controlled by said jointly controlled means for replacing said physical connections by said split battery feeds in said trunk circuit and for applying a switching signal to said connector switch; and wherein said connector switch includes means responsive to said signal for replacing said split battery feeds by said physical connections in said connector switch.

5. The combination in a telephone system as claimed in claim **4**, wherein said switching means comprises: a two-step relay, said relay operating to its first step responsive to the operations of said jointly controlled means and of said answering signal responsive apparatus for applying said switching signal to said connector switch; said relay in said connector switch being responsive to said signal for replacing said split battery feeds by said physical connections in said connector switch; and wherein said answering signal responsive apparatus in said trunk circuit, upon release responsive to the last-mentioned re-

placement, causes said relay to operate to its second step for removing said signal from said connector switch and completing the physical connections from said connector switch to the battery feed on the called side of the said trunk circuit, thereby preparing the last-mentioned feed for the direct receipt of back-dialed pulses originating at the called side of said connector switch.

6. The combination in a telephone system as claimed in claim 5, wherein said automatic switching equipment includes: first switching means for forwarding an answered call to another substation; and second switching means for automatically forwarding an answered call to an attendant's position; and wherein said trunk circuit includes: means prepared by said jointly controlled means upon receipt of said answering signal of more than said predetermined duration, and operated responsive to a back-dialed digit of one value for making said first switching means effective, and operated responsive to a back-dialed digit of another value for making said second switching means effective.

7. In a telephone system, a central exchange comprising: a direct inward dialing trunk circuit; a switch train including connector switches accessible to said trunk circuit; a plurality of groups of telephone stations connected to said connector switches for the receipt of calls incoming thereto; call forwarding means controllable by a called one of said stations for forwarding said call to another station; means in said trunk circuit for controlling the seizure of said call forwarding means responsive to the receipt of call-forward initiating signals from said one called station subsequent to answering of said incoming call; group marking means connected to said switch train for returning a marking corresponding to the group identity of said one called station over said switch train to said trunk circuit; group discriminating means connected to said trunk circuit and including means operable under the control of said marking for rendering said call forwarding means ineffective to establish a connection to a telephone station of a group other than that of said one called station; a supervisory conductor in said switch train; and a time division signalling arrangement extending signals over said supervisory conductor between said switch train and said group discriminating means to render said call forwarding means ineffective for establishing intergroup connections.

8. Apparatus in accordance with claim 7, wherein said time division signalling arrangement includes: a time division power supply including a plurality of output terminal pairs selectively connected to said supervisory conductor under the control of said group discriminating means for providing switched signal potentials, to each said pair in a cyclic manner during discrete recurring time intervals, corresponding to said plurality of groups of telephone stations; and switching means connected to said supervisory conductor responsive only to the connection of a matching pair of said potentials to said conductor to permit the establishment of a connection by said forwarding means.

9. In a telephone system, a central exchange having: a direct inward dialing trunk circuit; automatic switching equipment including selector switches and connector switches; a plurality of groups of substations connected to said connector switches for the receipt of calls incoming thereto; a plurality of attendant positions each assigned to one of said groups, said switching equipment also including first and second call forwarding means controllable by a called one of said substations for establishing a connection for forwarding said call to another substation and an attendant position respectively; means in said trunk circuit responding to the receipt of call-forward initiating signals from said called substation subsequent to the answering of said incoming call for controlling the seizure of said first and second call forwarding means; group marking means connected to said selector switches for extending to said trunk circuit a marking corresponding to the group identity of said substation receiving said incoming call; and group discriminating means connected to said trunk circuit and operable under the control of said marking for permitting said first and second call forwarding means to establish said connection only to another substation and an attendant position, respectively, of the same group as said called substation.

10. In a telephone system, a central exchange comprising: a plurality of substations arranged in a plurality of different groups; a plurality of direct inward dialing trunk circuits for extending connections representing calls to said substations; a group discriminating circuit connected to each said trunk circuit and including means for storing the group identity of said substations when called; a plurality of attendant positions each assigned to different ones of said substation groups; a plurality of call-forwarding links; a trunk finder and a position finder in each said link; means operated by one of said trunk circuits in response to receipt of a call-forwarding signal from a called one of said substations for seizing an idle one of said links; means controlled by said group discriminating circuit associated with said one trunk circuit for operating said position finder of said seized link to forward the call from said one called substation to seize an attendant position in the group corresponding to said stored identity of said one called substation; and means controlled by said group discriminating circuit for operating said trunk finder of said seized link to seize only said trunk circuit associated with the group corresponding to that of said seized attendant position.

11. In a telephone system, a central exchange comprising: a plurality of substations arranged in a plurality of different groups; a plurality of direct inward dialing trunk circuits for extending connections representing calls to called ones of said substations; a group discriminating circuit connected to each said trunk circuit and including means for storing the group identity of said substations when called; a plurality of attendant positions each assigned to different ones of said substation groups; a plurality of call-forwarding links common to said groups; a supervisory path in each of said links; means operated by one of said trunk circuits in response to receipt of a call-forwarding signal from a called one of said substations for seizing an idle one of said links; means controlled by said group discriminating circuit associated with said one trunk circuit for operating said seized link to forward the call from said one called substation to seize an idle attendant position in the group corresponding to that of said one called substation; and a time division signaling arrangement for signaling said forward call to said seized attendant position over said supervisory path in said seized link.

12. Apparatus in accordance with claim 11, wherein said time division signaling arrangement includes: a time division power supply including a plurality of output terminal pairs selectively connected to said supervisory path under control of said group discriminating means for providing switched signal potentials to each said terminal pair in a cyclic manner during discrete recurring time intervals; means for connecting a predetermined matching pair of said potentials to said supervisory path of said seized link; and means included in said seized attendant position and connected to said supervisory path of said seized link, operated in response only to said connection of said predetermined matching pair of said potentials to said path, for automatically signaling said forwarded call to said attendant position.

13. In a telephone system, a central office having: a plurality of direct inward dialing trunk circuits; a plurality of substations; a plurality of attendant positions; automatic switching equipment including a supervisory path interconnecting said trunk circuits and said attendant positions; and a time division signalling arrangement extending over said path for providing two-way supervisory signalling upon the establishment of a connection between

one of said trunk circuits and one of said attendant positions.

14. The combination in a telephone system as claimed in claim **13**, wherein there is provided: a time division power supply including a plurality of terminal pairs connected respectively to said trunk circuits and said attendant positions, for providing switched signal potentials to each said pair in a cyclic manner during discrete recurring time intervals; and wherein said signaling arrangement includes: a plurality of signal sending means at one end of said connection for selectively connecting a first terminal of one of said pairs to said supervisory path; and a like plurality of signal receiving means at the other end of said connection, each connected between said supervisory path and an individual second terminal of said pairs, and each operated responsive to the connection by the corresponding sending means of said first terminal to said supervisory path for indicating receipt of the corresponding signal at said other end.

15. The combination in a telephone system as claimed in claim **14**, wherein one of said signal sending means and the corresponding signal receiving means is effective upon the initiation of a call request in one of said trunk circuits to transmit a calling signal from said trunk circuit to one of said attendant positions.

16. The combination in a telephone system as claimed in claim **15**, wherein said central office comprises: automatic switching means accesible by said trunk circuits for use by said attendants in completing a forwarding connection to one of said substations; and wherein one of said signal sending means and the corresponding signal receiving means is effective upon the operation of a control means at said attendant position to transmit to said trunk circuit a signal instrumental in the completion of said forwarding connection.

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