July 15, 1941. F. KESSLER 2,249,475

TELEPHONE SYSTEM

Filed Dec. 29, 1939 8 Sheets-Sheet 1

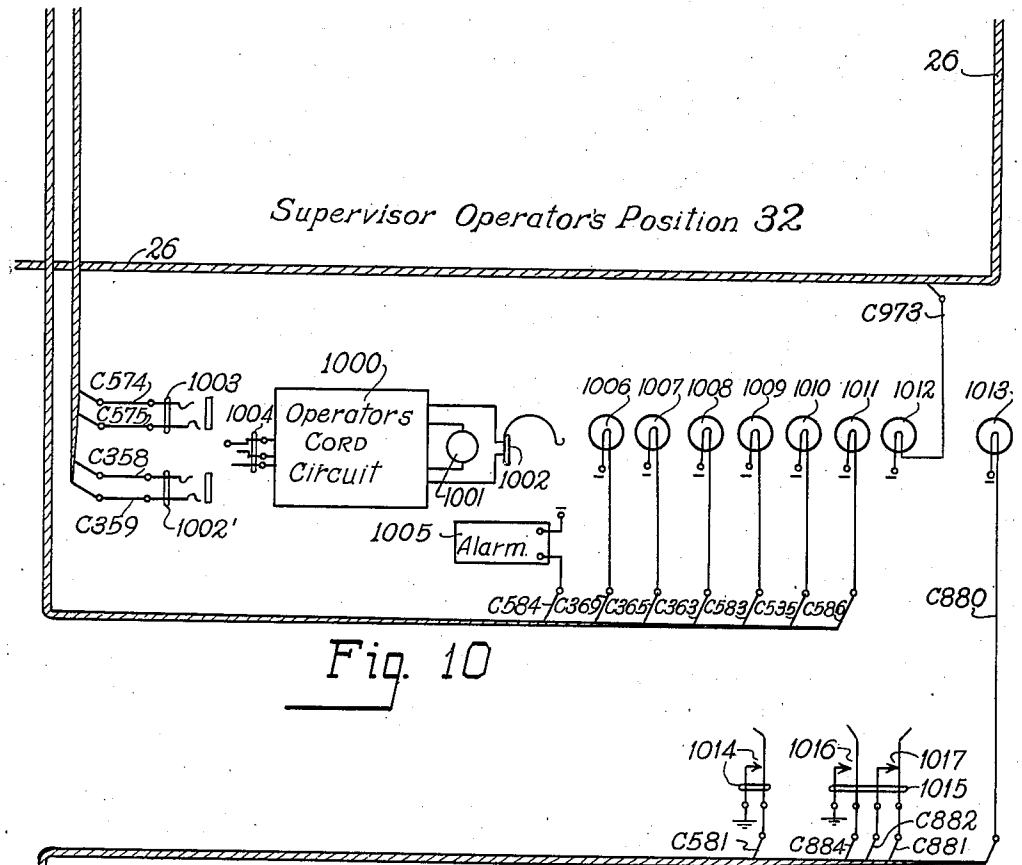


Fig. 10

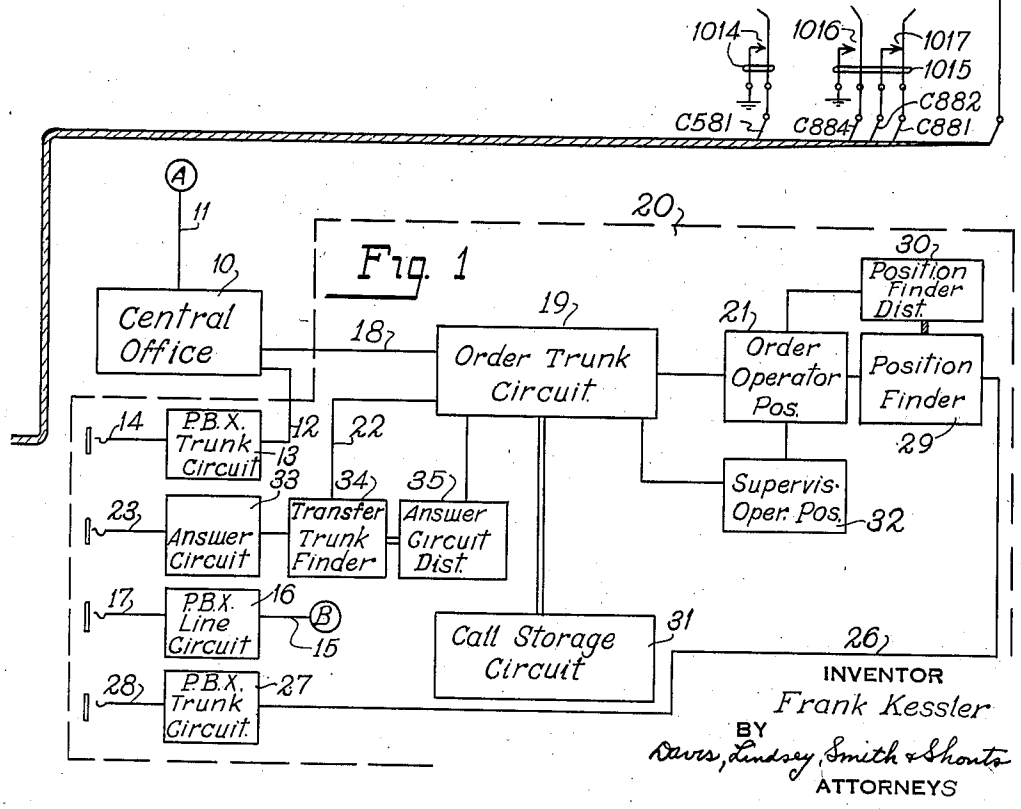


Fig. 1

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TELEPHONE SYSTEM

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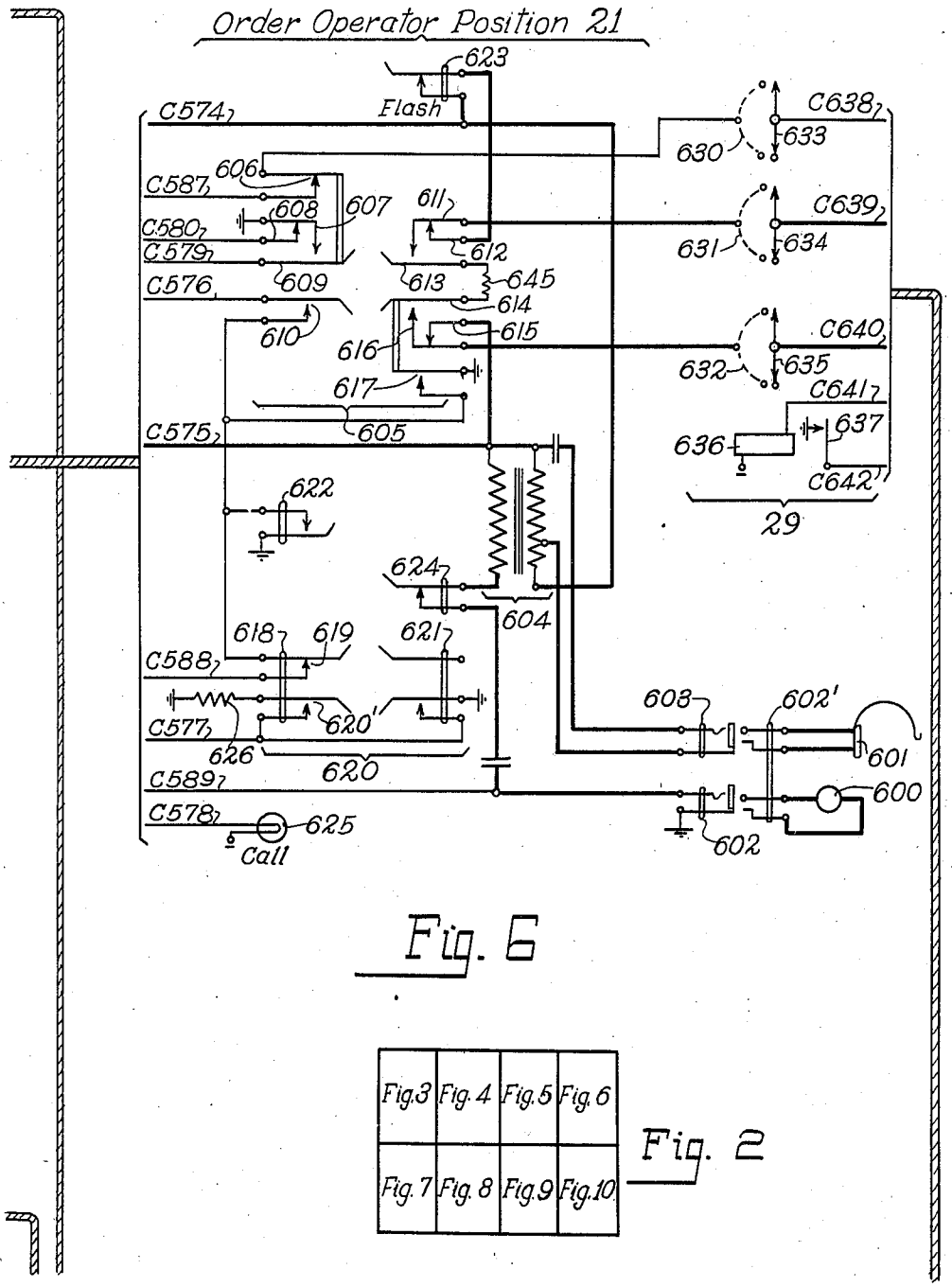


Fig. 6

Fig.3	Fig. 4	Fig.5	Fig. 6
Fig. 7	Fig. 8	Fig.9	Fig.10

Fig. 2

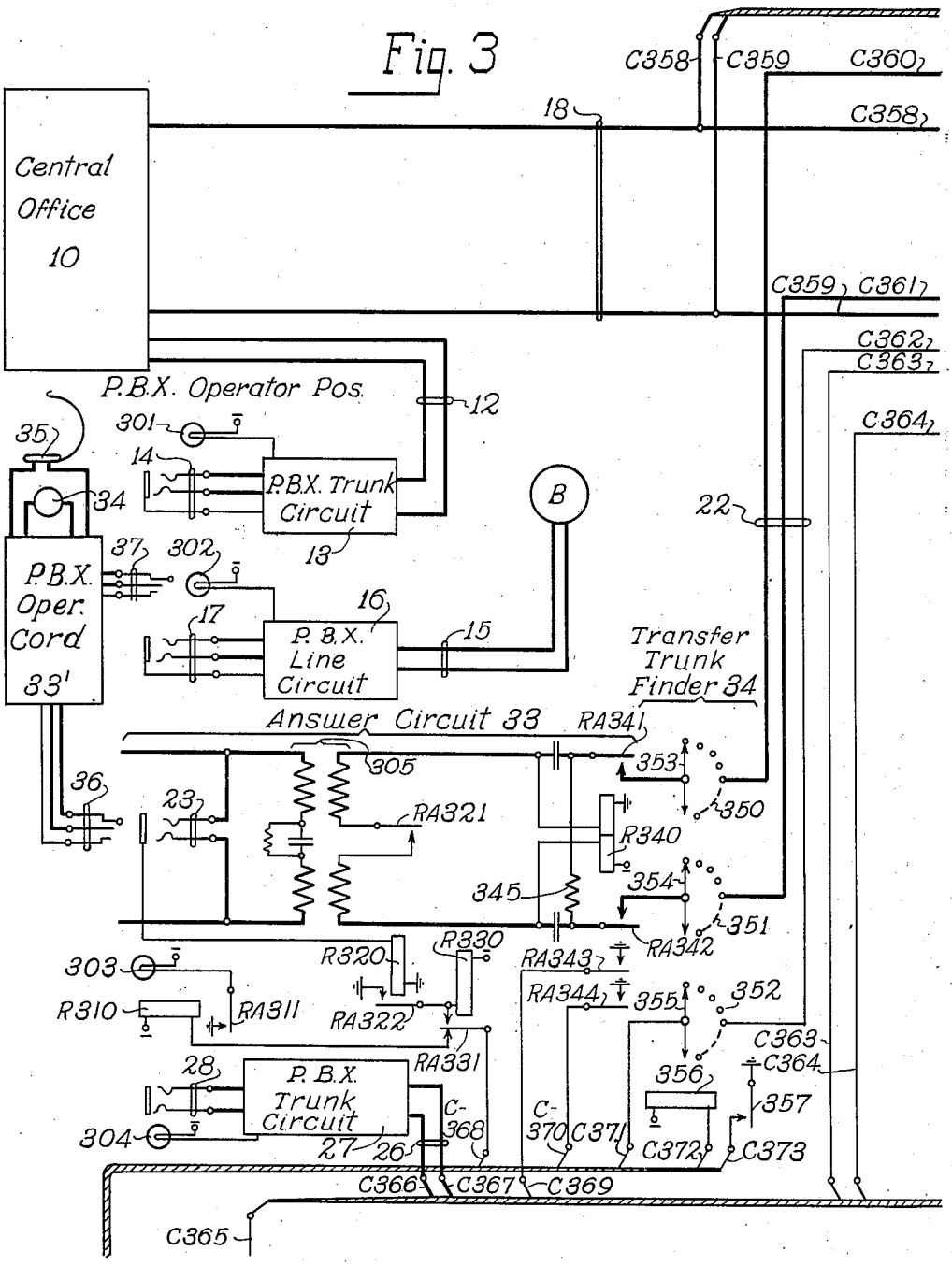
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TELEPHONE SYSTEM

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Fig. 3



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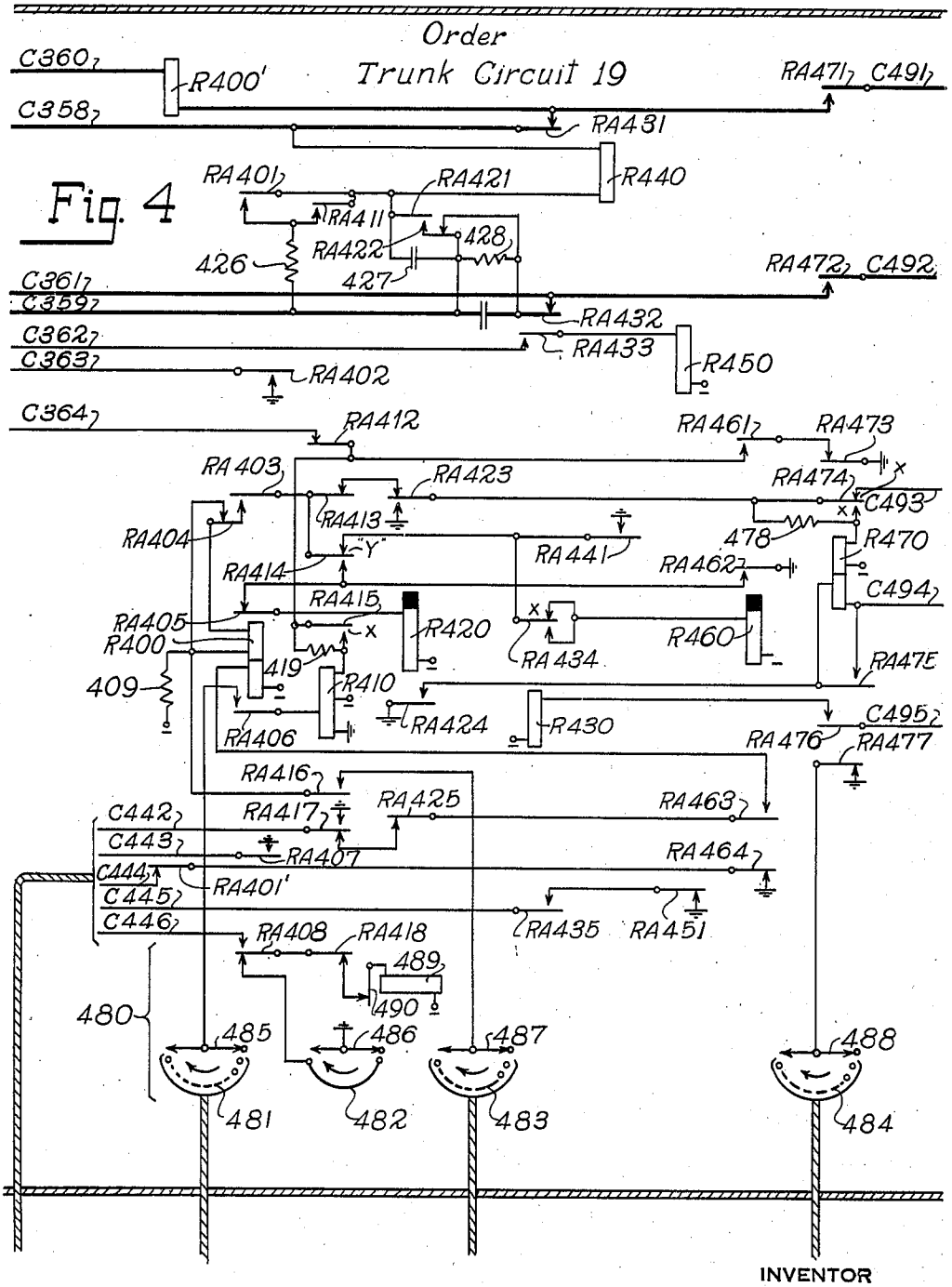
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Fig. 4



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TELEPHONE SYSTEM

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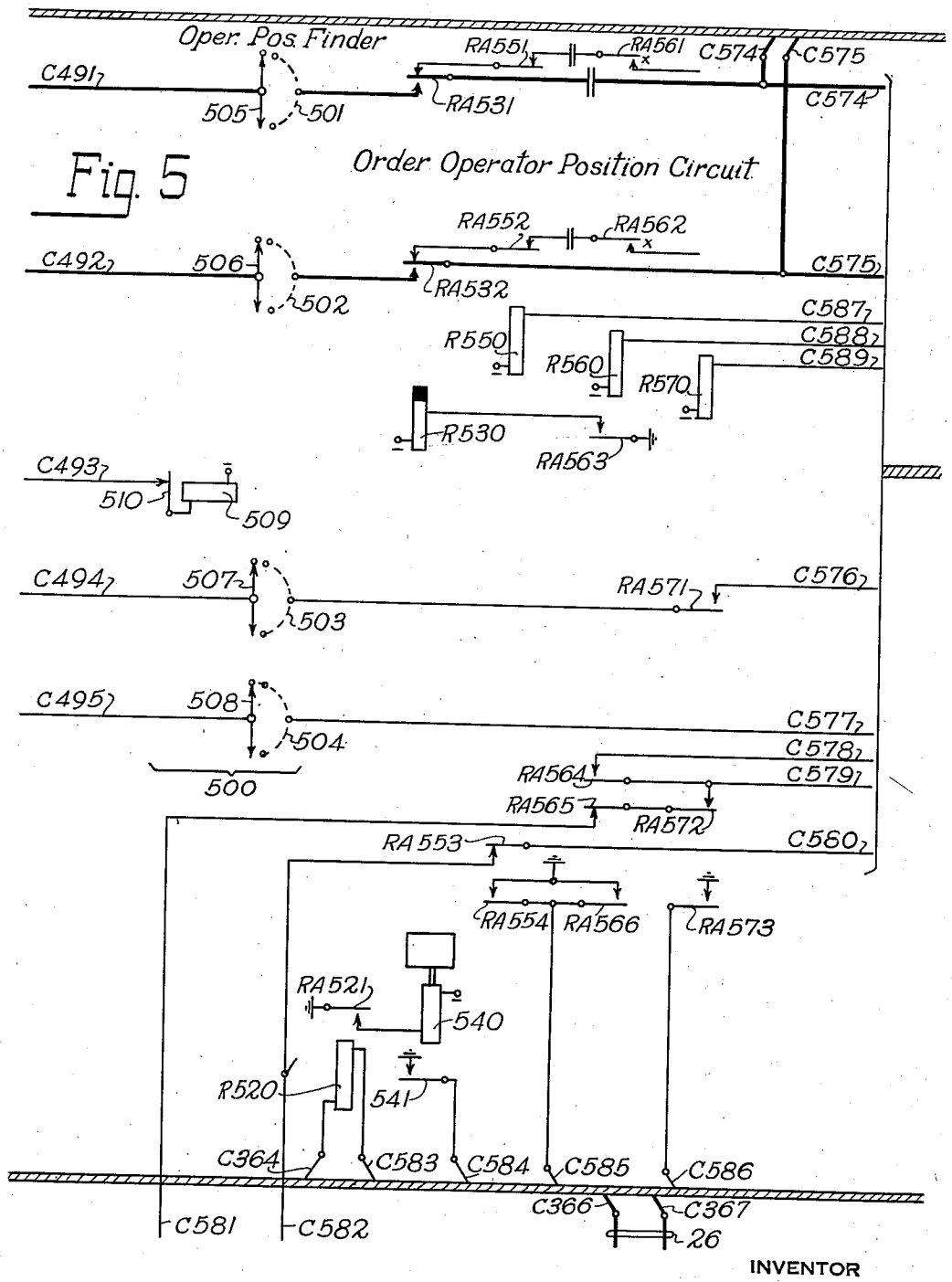


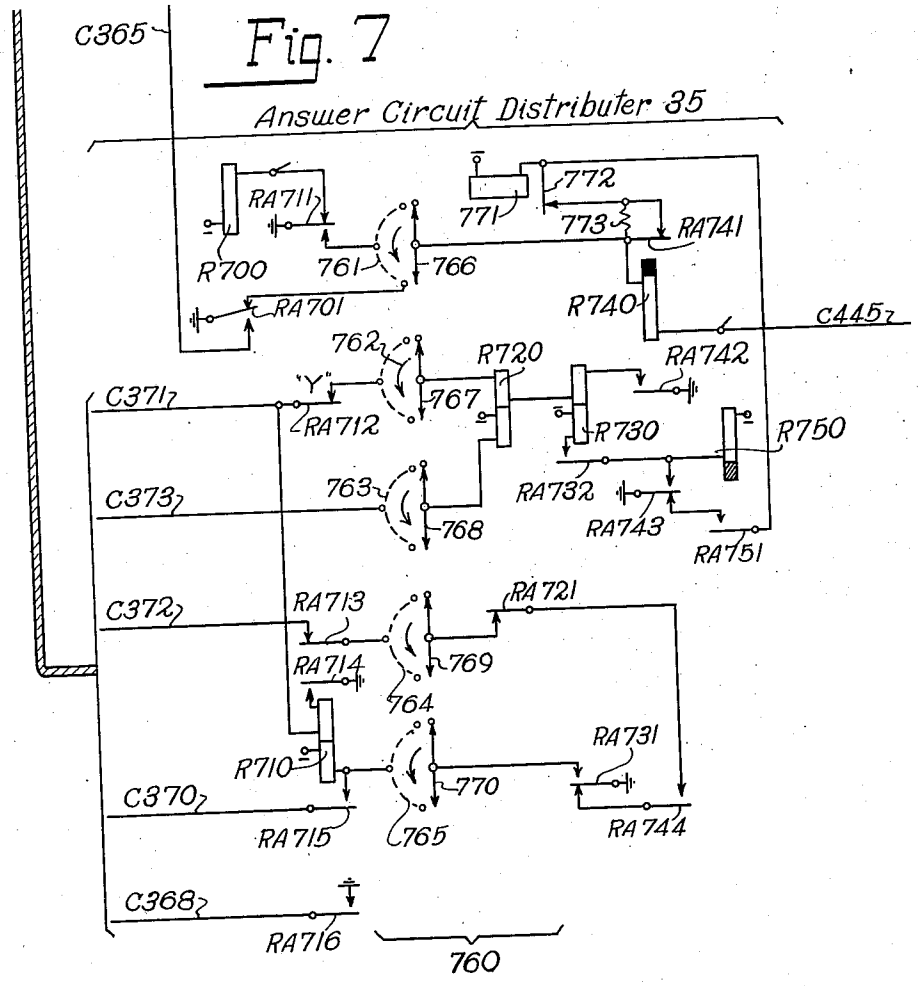
Fig. 5

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TELEPHONE SYSTEM

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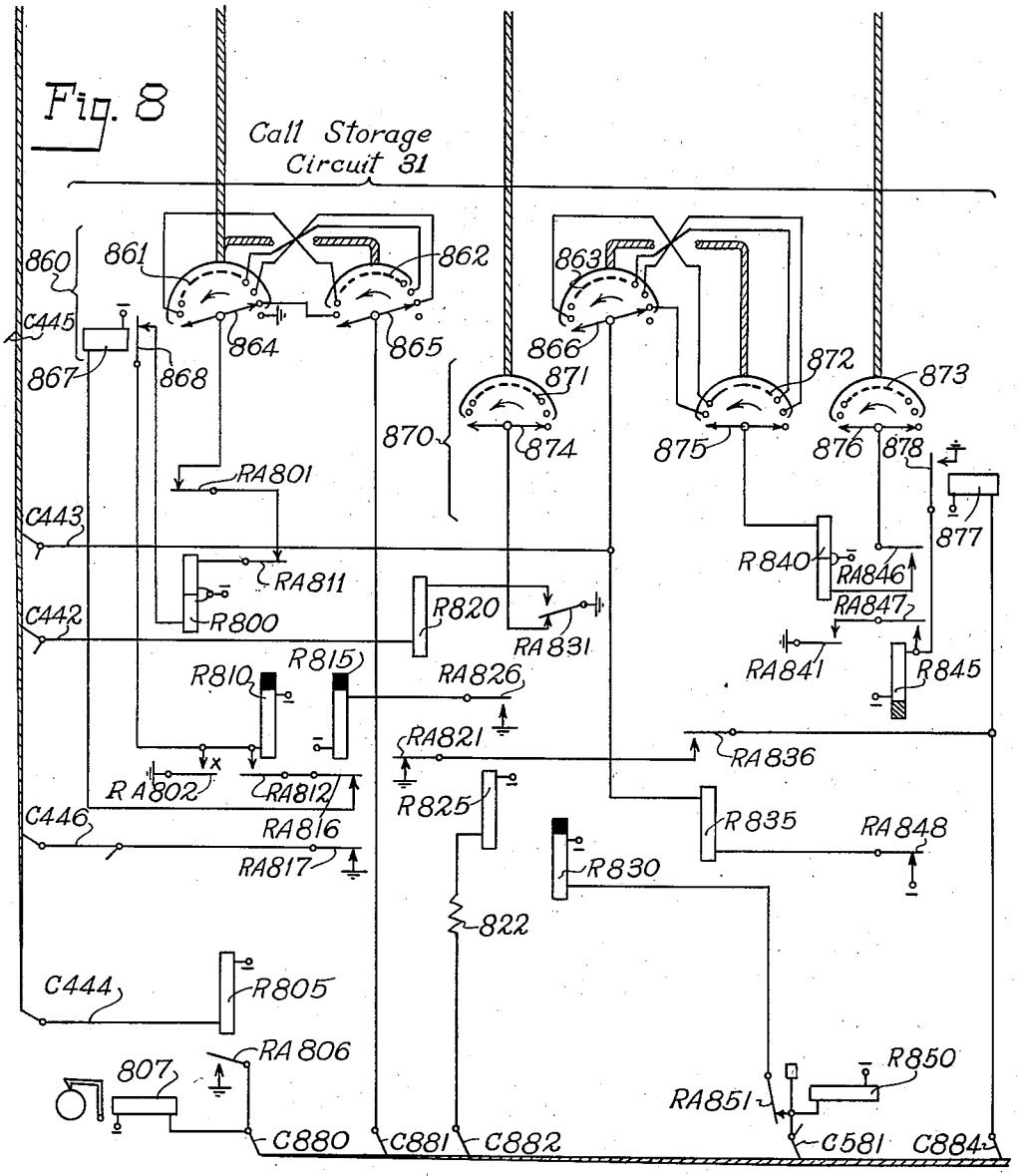
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TELEPHONE SYSTEM

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Fig. 8



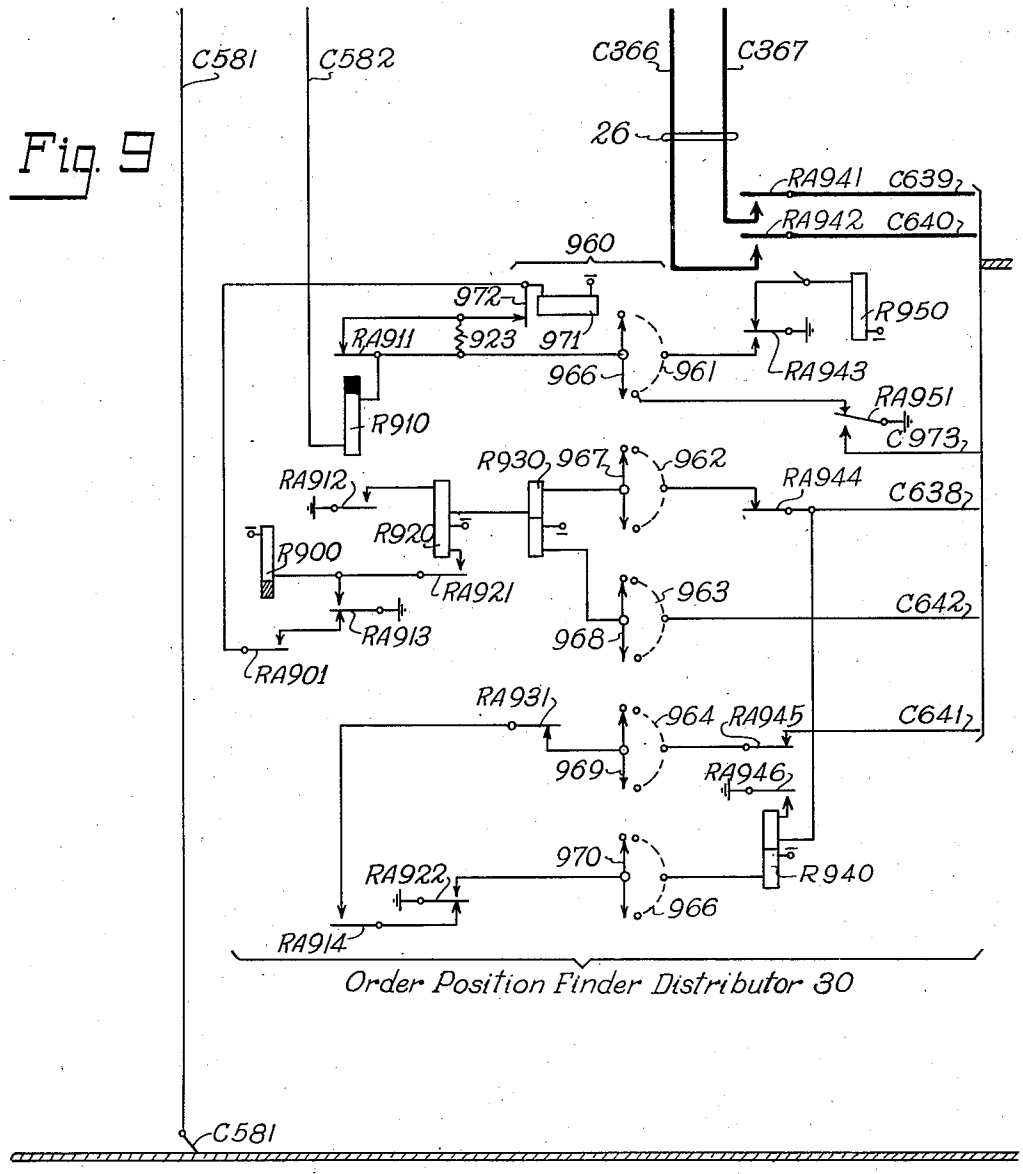
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TELEPHONE SYSTEM

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Fig. 9



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UNITED STATES PATENT OFFICE

2,249,475

TELEPHONE SYSTEM

Frank Kessler, Villa Park, Ill., assignor to Associated Electric Laboratories, Inc., Chicago, Ill., a corporation of Delaware

Application December 29, 1939, Serial No. 311,527

16 Claims. (Cl. 179—27)

The present invention relates to telephone systems and more particularly to improvements in systems of the character disclosed and claimed in copending application Serial 311,546, filed Dec. 29, 1939, Imre Molnar.

As explained in the above-referred to copending application, in certain branch exchange installations a large part of the calls routed to the branch exchange area from the central exchange are of a special character. For example, in large department stores a major portion of the incoming calls are for the purpose of placing orders, or represent inquiries concerning the price of the merchandise on sale. In order more expeditiously to handle the calls incoming to a branch exchange area of this type it is desirable to segregate the calls of special character from the other calls and to route the calls of special character to special information or order operators' positions, which positions are staffed with attendants qualified to dispatch the desired information. In the above-cited copending application, improved apparatus is provided for handling special calls of the character just mentioned, the arrangement being such that so long as any of the special operators' positions are idle the calls of special character are routed directly to idle ones thereof, but when all of the special operators' positions become busy the excess calls are stored and are then released from storage to the special operators' positions in the same order as they were stored.

It is an object of the present invention, therefore, to provide in a telephone system, improved special call handling facilities of the character described which is of simple and economical arrangement and operates in a positive and reliable manner rapidly to route the special calls to the special operators' positions in the order of their initiation under all operating conditions.

It is another object of the invention to provide, in a telephone system, special call handling facilities of the character described wherein an improved and exceedingly simple arrangement, requiring a minimum of circuit equipment, is provided for transferring the calls of special character incoming over the special call trunks from the special operators' positions to an operator's position located at the regular branch exchange switchboard.

It is a further object of the invention to provide, in a telephone system, special call handling facilities of the character described wherein an improved and exceedingly simple arrangement, requiring a minimum of control apparatus at the special operators' positions, is provided for transferring the special calls from the special operators' positions to the regular branch exchange switchboard and for splitting the three-way talking circuits thus established to exclude either the calling or the called ends of such connections from the talking circuits.

In the illustrated embodiment of the invention there is provided a telephone system which comprises a central exchange and a branch exchange area including regular branch exchange facilities. These facilities comprise a branch exchange switchboard at which are terminated a plurality of trunks which extend to the central exchange. Additional facilities are provided for handling calls of special character routed from the central exchange to the branch exchange area. This additional apparatus comprises a plurality of special operators' positions and a plurality of special call trunks which extend to the central exchange and have individually associated therewith trunk circuits, each of which includes apparatus for normally routing calls initiated on the associated trunk to idle ones of the special operators' positions. For the purpose of storing excess or overflow calls until such time as special operators' positions are available, there is provided a call storage circuit which is commonly associated with the various trunk circuits and includes a call storage position distributor and a call release distributor. In accordance with the present invention there is also provided, for the purpose of transferring special calls to answer circuits located at the branch exchange switchboard, transfer trunks which are individually associated with the trunk circuits, and automatic switching means controllable from the special operators' positions for transferring calls present on the special call trunks over the transfer trunks to idle ones of the answer circuits. More particularly, each answer circuit has associated therewith a finder switch which has access to all of the transfer trunks, distributor means being provided for assigning idle ones of the answer circuits and associated finders to the use of the transfer trunks in a predetermined order. This distributor means comprises control apparatus controllable from any one of the special operators' positions for routing a call present on one of the special call trunks over the associated transfer trunk and through an assigned one of the finder switches to the assigned answer circuit. Additional apparatus comprising position finders having access to the special operators' positions and individually terminating

trunks extending to the branch exchange switchboard are provided for routing calls from the special operators' positions to the branch exchange switchboard. The arrangement of this additional apparatus is such that three-way talking circuits including the special operators' positions and the special call trunks may be established. In order to split such connections, keys are provided at the special operators' positions which are operative to exclude either the calling or the called ends of the established three-way connections from the established talking circuits. In accordance with a further feature of the invention, apparatus comprising a slow-acting device embodied in the call storage circuit is provided for causing a predetermined time delay between the release of a special operator's position and the release of a call from storage, thereby to prevent the possibility of calls in storage being assigned operators' positions ahead of an earlier initiated call.

Further features of the invention pertain to the particular arrangement of the circuit elements, whereby the above and additional operating facilities are attained.

The novel features believed to be characteristic of the invention are set forth with particularity in the appended claims. 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 specification taken in connection with the accompanying drawings in which Figure 1 schematically illustrates a telephone system having incorporated therein the features of the invention as briefly outlined above; Fig. 2 illustrates the mode of assemblying the remaining figures of the drawings to form a unified system; and Figs. 3 to 10, inclusive, illustrate the details of the apparatus schematically shown in Fig. 1.

Referring now more particularly to Fig. 1 of the drawings, the telephone system there schematically illustrated comprises a central exchange 10 and a branch exchange area 20 within which are located the substations of a department store, or the like. The central exchange 10 may be of any desired type; that is, it may be of the manual type in which case the subscribers' and trunk lines extending thereto are terminated in line multiples at the operator's switchboard in the usual manner. Alternatively, the exchange 10 may be of any desired automatic type, in which case connections are established between the lines extending thereto through the provision of dial controlled automatic switching apparatus. This exchange is arranged to serve a large number of central office subscribers' lines, one of which is indicated at 11 as extending to the central office subscriber's substation A. For the purpose of routing regular substation calls between the central office and the branch exchange area 20, there are provided a plurality of branch exchange trunks one of which is indicated at 12. The trunk 12 has a trunk circuit 13 of conventional arrangement associated therewith and terminates at a jack 14 which is provided at one of the operators' positions forming a part of the branch exchange operator's switchboard. This switchboard is provided to serve the regular branch exchange substations located within the area 20, one such substation B being connected to the substation line 15 which terminates at the branch exchange switchboard in a jack 17 and has associated therewith a line circuit 16 through operation of which calls involving the line 15 may be supervised.

In order to handle calls of special character routed from the central office subscriber's substation through the central exchange 10 to the branch exchange area 20, a plurality of special call trunks, one of which is indicated at 18, are provided. Assuming that the central exchange 10 is of the manual type, these trunks extend from the operator's switchboard in the central exchange 10 to the branch exchange area 20 where they terminate in trunk circuits individual thereto. These trunk circuits have access to a group of special operators' positions. In the case under consideration wherein it is assumed, for purposes of explanation, that the branch exchange area 20 constitutes a department store or other merchandise establishment, the special operators' positions may be provided for the purpose of taking orders from the central office subscribers. For convenience in describing the apparatus, the special call trunks will be referred to hereinafter as order trunks, the trunk circuit associated therewith will be referred to as order trunk circuits, and the special operators' positions will be referred to as order operators' positions. More specifically, the order trunk 18 terminates in the branch exchange area 20 in an order trunk circuit 19 which has access to a group of order operators' positions including the position 21. Under certain circumstances and more particularly when all of the order operators' positions are not staffed, the volume of traffic over the order trunks may be in excess of the call handling capacity of the staffed order operators' positions. For the purpose of holding such excess calls until such time as an order operator's position is released or otherwise made available for service, there is provided, in common association with the several order trunk circuits, a call storage circuit 31 which functions to store the excess calls in the order of their initiation and to release the stored calls from storage in the same order, as the order operators' positions become idle. To enable the order operators to transfer calls from their positions to the branch exchange switchboard, whereby they may be extended to the regular branch exchange substation or to the central office, there is provided a group of transfer trunks one of which is indicated at 22 as being individual to the order trunk circuit 19. These transfer trunks are accessible to a plurality of answer circuits provided at the branch exchange switchboard, each answer circuit having associated therewith a transfer trunk finder which has access to all of the transfer trunks. Thus, an answer circuit 33 is provided which includes an answer jack 23 and has associated therewith a transfer trunk finder 34 at which all of the transfer trunks terminate. An answer circuit distributor 35 is provided for selecting the answer circuits and their respective associated transfer trunk finders for use in a predetermined order. The group of transfer trunks and associated answer circuits can only be used for call transfer purposes. Accordingly, additional means comprising a second group of trunks, including the trunk 26, are provided for enabling the order operators to route calls directly from their positions to the branch exchange switchboard. More specifically, these additional trunks terminate in position finders which have access to the various order operators' positions and have associated therewith a position finder distributor 30 which functions to

allot the additional trunks and associated position finders for use in a predetermined order. More specifically, the trunk **26** terminates at the branch exchange switchboard in a trunk circuit **27** which includes an answer jack **28**, and extends to a position finder **29** having access to all of the order operators' positions. For the purpose of supervising calls routed by way of the order trunks to the order operators' positions, there is provided a supervisory operator's position **32** at which are located signal lamps for indicating whether or not the order operators' positions are staffed and, if staffed, whether idle or busy, and also for indicating the idle or busy condition of the various trunks and trunk circuits.

Neglecting for the present the particular arrangement of the circuit elements embodied in the apparatus schematically illustrated in Fig. 1 and considering the operation of the system generally, it will be apparent that interexchange traffic between the central office subscribers' substations and the substations provided at the branch exchange area **20** are handled by the regular branch exchange facilities including the branch exchange operator's switchboard and the group of trunks of which the trunk **12** forms a part. To this end, the branch exchange operator's switchboard is assigned a particular directory number which is different from the directory number assigned to the order operators' positions. By virtue of this directory numbering scheme, the special or order trunk calls may be segregated in the central exchange and routed by way of the order trunks to idle ones of the order operators' positions. For example, a call routed over the order trunk **18** may, through operation of the order trunk circuit **19**, be routed to the order operator's position **21**. If the order operator attending this position is unable to give the calling subscriber the desired information, she may cause the call to be transferred to one of the regular substations provided at the branch exchange area **20** by operating a transfer key located at her position. In response to this operation, the answer circuit distributor **35** operates to initiate the operation of a transfer trunk finder associated with a previously selected idle one of the answer circuits. For example, operation of the transfer trunk finder **34** may be initiated in response to operation of the transfer key provided at the order operator's position **21**. When this transfer trunk finder finds the calling transfer trunk **22** individual to the order trunk circuit **19**, a talking circuit is completed between the order operator's position **21** and the answer circuit **33** and the call signal lamp provided in the answer circuit **33** is energized. The branch exchange operator may, after answering the transferred call, route the call to the desired substation, such, for example, as the substation B. After a call transfer of this character is made, the operator attending the order operator's position **21** may remain connected to the established three-way connection or she may retire from the connection and release her position for use in handling of additional calls. If an operator attending one of the order operators' positions, such, for example, as the position **21** finds it necessary in handling an inquiry to look up certain information and then call a central office subscriber, or to call one of the branch exchange substations, she may secure the desired connection by seizing one of the trunks assigned for use by the position finder distributor **30**, such, for example, as the trunk **26**, thereby to route a connection from her position to the branch exchange switchboard. From this switchboard the call may be routed over one of the regular branch exchange trunks and through the central exchange **10** to the desired substation. In a similar manner the order operators may route calls directly from their positions to the substations located in the branch exchange area **20**, such calls being handled by the operator or operators attending the branch exchange switchboard. The arrangement is such that calls may be routed over the additional trunks just mentioned from the order operators' positions at times when the order operators' positions are engaged in handling order trunk calls. More specifically, the order operators may establish three-way connections including the order trunks extending to the central office and the additional trunks extending to the branch exchange switchboard, and may split such connections to exclude either the calling or the called ends thereof from the established three-way talking circuits. In the event all of the order operators' positions become busy at the same time and special calls routed over the order trunks continue to arrive, operation of the call storage circuit **31** is initiated whereby the excess calls are stored in the order of their initiation. As the order operators' positions are thereafter released and rendered available for use in handling other calls the call storage circuit, in cooperation with the associated trunk circuits, functions to release the stored calls from storage in the same order as they are stored. Supervision of the order operators' positions and of the calls handled at these positions is under the control of a supervisory operator attending the position **32**.

Referring now in greater detail to the circuit arrangement of the apparatus schematically illustrated in Fig. 1 and considering first the order trunk circuit **19**, this circuit is illustrated in Figs. 4 and 5 as comprising an operator's position finder switch **500**, a storage position finder switch **480** and a plurality of associated control relays and control circuits. The switches **500** and **480** are of the well-known rotary type and may be of any desired commercial construction. The number of contact points provided in the position finder switch **500** is determined by the number of available order operators' positions, each setting of this switch being individual to a particular order operator's position. Similarly, the number of contact points provided in the storage position finder switch **480** is determined by the number of storage positions available in the call storage circuit **31**. In the arrangement illustrated twenty-four call storage positions are available in this circuit and, hence, twenty-five sets of contact points are provided in the rotary switch **480**, the first set of contact points being reserved as the normal or home position of the switch. The control equipment associated with the two switches **480** and **500** comprises a line relay **R440** which is normally bridged across the conductors of the order trunk **18** in series with a condenser **427** and is arranged to operate when energized with either alternating or direct current. This equipment further comprises a slow-to-operate position finder start relay **R460**, a slow-to-operate control relay **R420**, a pair of call storage control relays **R400** and **R410**, a combined call transfer and trunk release relay **R430** which is provided with two operating positions in addition to its normal released position, and a combined position finder stop and line switching relay **R470**. There is also provided in the trunk circuit **19** a

control relay R400' which is serially included in one side of the transfer trunk 22, and a position finder stop relay R450 which is individual to the transfer trunk 22 and is arranged to cooperate with the distributor 35 to control the operation of an assigned transfer trunk finder when a call is transferred over the trunk 22 to the branch exchange switchboard.

The order operator's position 21 has associated therewith a position circuit which is illustrated in Figs. 5 and 6 as comprising an induction coil 604 having line terminals connected to the talking conductors C574 and C575. This induction coil has connected thereto transmitter and receiver jacks 602 and 603, respectively, which are arranged to receive the contacts of a multiple plug 602'. The contacts of this plug are connected in the usual manner to a transmitter 600 and a receiver 601 forming an operator's head set. The position circuit individual to the order operator's position 21 also includes a group of control relays, these relays comprising a position marking relay R570, a tone start relay R560, a slow-to-operate tone cut-off relay R530 and a relay R550 which is operative to release the position finder distributor 30 in response to seizure of the order operator's position 21 by one of the position finders in the group including the finder 29. The enumerated relays are also operative to perform additional control functions referred to more specifically hereinafter. For the purpose of enabling an attendant at the order operator's position 21 to perform various control operations incident to the handling of calls involving this position, various keys or switches are embodied in the position circuit individual to this operator's position. These keys comprise a combined talk and split key 605, a combined call transfer and trunk release key 620, a flashing recall key 623 and a key 624 which is operative to disconnect the transmitter 600 from the induction coil 604. A call lamp 625 is also provided at the order operator's position 21, this lamp being connected for energization in response to operation of the relay R560 to indicate that a special call has been routed to the position 21.

As illustrated in Fig. 9 and in the right-hand portion of Fig. 6, the position finder 29, which is individual to the trunk 26 extending to the branch exchange switchboard, comprises a finder switch of the well-known rotary type and a line switching relay R940. The number of contact points provided in this finder switch is determined by the number of associated operators' positions, one set of contact points being reserved for each of the order operators' positions to which it has access. Operation of the position finder 29 and of the other finders individually associated with the other trunks extending to the branch exchange switchboard is under the control of the finder distributor 30 which is illustrated in Fig. 9 as comprising a distributor switch 960, also of the well-known rotary type and having positions individually corresponding to the number of position finders available. This distributor also includes a plurality of control relays which may be identified as a slow-to-operate start relay R910, a pulsing relay R930, a relay R920 for controlling the line switching relays of the respective associated position finders, and a slow-to-release relay R900 which is operative to delay the trunk hunting operation of the distributor switch 960 for a short time interval after a previously selected position finder switch is operated to seize a calling one of the order operators' positions. The distributor 30 also includes an all-trunks-busy relay R950 which is operative when all of the trunks of the group including the trunk 26 are in use to cause the energization of an all-trunks-busy lamp provided at the supervisory operator's position 32.

As pointed out previously, the apparatus provided at one of the branch exchange operators' positions forming a part of the branch exchange switchboard comprises the jacks 14, 17 and 28 at which the lines 12, 15 and 26 respectively terminate. These lines have individually associated therewith call signal lamps 301, 302 and 304 respectively. There is also provided at this branch exchange operator's position an operator's cord circuit 33' which may be of any conventional arrangement. This cord circuit is connected to call and answer plugs 36 and 37, respectively, and includes a transmitter 34 and a receiver 35. The jack 23 individual to the answer circuit 33 is also located at this branch exchange operator's position. More specifically, the answer circuit 33 is illustrated in Fig. 3 as comprising a call lamp 303, a repeating coil 305, and four control relays R310, R320, R330 and R340, respectively. The transfer trunk finder 34, which is individual to the answer circuit 33, is illustrated in Figs. 3 and 7 as comprising a rotary finder switch having access to all of the transfer trunks and a busy marking relay R710. Operation of the finder 34 and of the other similar finders individually associated with the other answer circuits is under the control of the answer circuit distributor 35 which is illustrated in Fig. 7 as comprising a distributor switch 760 also of the well-known rotary type and having positions corresponding to the number of answer circuits available. This distributor also includes a plurality of control relays which may be identified as a slow-to-operate start relay R740, a pulsing relay R720, a relay R730 for controlling the busy marking relays corresponding to and including the relay R710 individual to the transfer trunk finders, and a slow-to-release relay R750 which is operative to delay the trunk hunting operation of the distributor switch 760 for a short time interval after a previously selected transfer trunk finder is operated to seize a calling one of the transfer trunks. This distributor also includes an all-trunks-busy relay R700 which is normally operated and is connected and arranged to be released when all of the answer circuits are busy to cause the energization of an all-busy lamp provided at the supervisory operator's position 32.

The call storage circuit 31 is illustrated in Fig. 8 as comprising a call storage distributor switch 860 and a call release switch 870, each of which is of the well-known rotary type and includes twenty-five sets of contact points, respectively representing twenty-four different call storage positions and a blank or unused position. The operation of these switches is under the control of associated relay equipment which comprises a slow-acting call storage start device including a pendulum type relay R850 and a slow-to-operate relay R830. The relay equipment further includes a call storage stop means comprising a pair of relays R825 and R815, the last of which is of the slow-to-operate type. A pulsing network comprising the relay R800 and the slow-to-operate relay R810 is provided for controlling the operation of the call storage position distributor switch 860, and a similar network including the relays R820, R835 and R845 is provided for controlling the operation of the call release switch

870. The relay equipment also includes a stop relay R840 which functions as a test relay and also to prevent the rotary switch 870 from operating to a storage position in advance of that occupied by the distributor switch 860, all in the manner more fully explained hereinafter. For the purpose of indicating an all-busy condition of the order trunks, there is also provided in the call storage circuit 31 an all-trunks-busy meter 807 which is arranged to be controlled by an all-trunks-busy relay R805.

The apparatus provided at the supervisory operator's position 32 is illustrated in Fig. 10 as comprising a plurality of jacks individual to the order trunks and additional jacks individual to the order operators' positions. Thus, a pair of jacks 1002' and 1003 are provided which are respectively connected to the conductors of the order trunk 18 and to the talking conductors C574 and C575 individual to the order operator's position 21. The apparatus located at the supervisory operator's position 32 also includes a cord circuit 1000 having embodied therein a transmitter 1001 and a receiver 1002. This cord circuit may be of any conventional arrangement and is arranged to be connected to any desired one of the line and position jacks through the provision of a connecting plug 1004. There are also provided at the supervisory operator's position 32 a plurality of signal lamps which enable the supervisory operator to check at all times the condition of the order operators' positions and of the various trunks associated therewith. More particularly, there is provided a position lamp 1011 individual to the order operator's position 21 which is arranged to be energized under control of the relay R570 when this order operator's position is attended. A second lamp 1010 is provided for the purpose of indicating when the order operator's position 21 is engaged in handling a call. A third lamp 1009 is provided for indicating seizure of the trunk circuit 19. The signal lamps provided at the supervisory operator's position 32 also include a lamp 1006 which is operative to indicate the idle or busy condition of the answer circuit 33, a lamp 1007 which is operative to indicate an all-busy condition of the answer circuits, a lamp 1013 which is operative to indicate an all-busy condition of the order trunks, a lamp 1012 which is operative to indicate an all-busy condition of the trunks forming the group including the trunk 26, and a lamp 1008 which is individually associated with the trunk circuit 19 and is operative to indicate that the associated order trunk is occupied with a call which has been placed in storage. There is also provided at the supervisory operator's position 32 an alarm device 1005 which is arranged to be controlled by a slow-acting device comprising a dashpot relay 540 and associated control relay R520, and functions to indicate undue delay in routing an order trunk call to an order operator's position or to storage. In order to enable the supervisory operator to control the call storage circuit 31 in accordance with the conditions indicated by the energized and deenergized conditions of the associated trunk call storage lamps, there are provided two keys 1014 and 1015, the first of which is operative to render the call storage circuit 31 totally inactive. The key 1015, on the other hand, is provided for the purpose of enabling the storage distributor switch 860 to operate through a position occupied by the call release switch 870, thereby to permit those call storage positions in the switch 860 which have been vacated through the abandonment of stored calls to be filled up with additional calls initiated on the order trunks.

Interexchange traffic between central office and branch exchange switchboard

Referring now more particularly to the operation of the apparatus illustrated in Figs. 3 to 10, inclusive, if a call routed from one of the central office subscribers' lines to an operator's position in the central office 10 is to be extended to a substation line terminating at the branch exchange switchboard, the central office operator handling the call may seize the trunk 12 and by operation of the ringing key embodied in her cord circuit project ringing current over this line for the purpose of causing the energization of the call lamp 301 individual to the trunk line 12 in the usual manner. The branch exchange operator, upon observing the lighted condition of the lamp, may answer the call by inserting the plug 36 in the jack 14. In response to this operation, a talking circuit is completed between the calling central office subscribers' substation and the cord circuit 33'. The branch exchange operator may now converse with the calling subscriber and ascertain the identity of the desired branch exchange substation. When the plug 36 is inserted in the jack 14, battery or ground potential is impressed upon the ring contact of this jack to cause the energization and operation of one of the relays included in the trunk circuit 13. The resulting operation of the last-mentioned relay causes the deenergization of the lamp 301 in the usual manner. Insertion of the plug 36 in the jack 14 also results in the completion of a direct current bridge between the tip and sleeve contacts of this jack, thereby to cause the operation of a supervisory relay embodied in the cord circuit in use by the operator handling the call in the central office 10. Operation of this supervisory relay causes the operation of a supervisory lamp individual to the cord circuit in use in the central office 10, in the usual manner. Assuming that the substation B is desired by the central office subscriber, the branch exchange operator may extend the call to the desired substation by inserting the call plug 37 in the jack 17 and operating the ringing key of the cord circuit 33' to cause ringing current to be projected over the line 15 and through the winding of the ringer conventionally provided at the substation B. When the call is answered at the called substation, the branch exchange operator may retire from the connection and rely upon the supervisory lamps embodied in the cord circuit 33' to indicate when the connection is ready to be released. When either of the two supervisory lamps individual to the calling and called ends of the connection is illuminated, indicating that the connection has been released at one end thereof, the branch exchange operator may clear out the connection. For example, if the called party at the substation B hangs up prior to the release of the connection at the calling end thereof, the supervisory lamp of the cord circuit 33, which is individual to the called end of the connection, is energized to inform the branch exchange operator handling the call that the connection may be cleared out. The operator may now release the apparatus in use by withdrawing the plugs 36 and 37 from the jacks 14 and 17 respectively. In response to this operation, the trunk circuit 13 and the line circuit 16 are restored to normal in the usual manner, and the

bridging path established across the conductors of the trunk 12 is opened to cause the energization of the disconnect lamp associated with the trunk 12 and embodied in the cord circuit in use in the central office 10. Upon observing the lighted condition of the last-mentioned lamp, the operator handling the call in the central office may clear out the connection in the usual manner. In the event the call is cleared out at the central office subscriber's substation prior to its release at the substation B, the operator handling the call in the central office 10 receives the first disconnect signal and proceeds to clear out the connection at her position. In response to this operation, a disconnect signal is transmitted over the conductors of the trunk line 12 to cause the energization of the supervisory lamp in the operator's cord circuit 33' which is individual to the calling end of the connection. Energization of this lamp serves to inform the branch exchange operator that the connection has been released at the calling end thereof and may be cleared out at her switchboard. To clear out the connection, the branch exchange operator handling the call withdraws the plugs 36 and 37 from the jacks 14 and 17 respectively, whereby the trunk circuit 13 and the line circuit 16 are restored to normal in the usual manner.

The branch exchange trunk 12 and the other similar trunks may also be used in routing a call from the branch exchange operator's switchboard to the subscribers' lines terminating at the central office 10. For example, if a call is initiated at the branch exchange substation B through removal of the receiver provided at this substation from its associated hook or cradle, the associated hook or cradle switch operates to establish a direct current path between the conductors of the line 15. As a consequence, certain of the relays embodied in the line circuit 16 are operated to complete a circuit for energizing the call lamp 302 individual to the line 15. The branch exchange operator, upon observing the lighted condition of this lamp, may answer the call by inserting the plug 36 in the jack 17. In response to this operation a talking circuit is established between the operator's cord circuit 33' and the subset in use at the substation B. In addition, battery or ground potential is impressed upon the ring contact of the jack 17 to complete a circuit for energizing the signal lamp cut-off relay conventionally embodied in the line circuit 16. The resulting operation of this relay causes the deenergization of the call lamp 302. Upon ascertaining that a central office call has been initiated at the substation B, the branch exchange operator handling the call may forward the connection to the operator's switchboard in the central office 10 by inserting the plug 37 in the jack 14 and operating the ringing key embodied in the cord circuit 33' to project ringing current over the trunk 12. The resulting operation of the signal device individual to this trunk and provided at the operator's switchboard in the central office 10 serves to inform one or more of the central office operators that a call is present on the trunk 12 which should be answered. Upon answering the call, the central office operator may converse with the party at the substation B and ascertain the substation desired by the calling party, following which she may proceed to set up the desired connection in the manner conventionally followed in manual office practice. After the connection has been established, the supervision and release thereof are exactly the same as set forth above with reference to a call routed from a central office subscriber's substation to one of the branch exchange telephone stations.

Call to order operator's position

Each of the several order operators, when on duty, maintains the telephone set at her position connected to the position circuit apparatus provided at her position. For example, when an operator is on duty at the order operator's position 21, the terminals of the multiple plug 602' are respectively inserted into the jacks 602 and 603 so that the transmitter 600 is bridged across one winding of the induction coil 604 in series with a condenser and the contacts of the key 624, and the receiver 601 is bridged across a portion of the other induction coil winding in series with a second condenser. With the transmitter 600 connected to the terminals of the jack 602, a circuit is completed for supplying energizing current to the transmitter and for energizing the relay R570, this circuit extending from ground by way of the transmitter 600, C589 and the winding of R570 to battery. This relay, in its operated position, holds completed, at RA571, a battery marking path for identifying the operator's position 21 as idle in the bank contacts of all of the position finder switches having access thereto. As explained more in detail hereinafter, when the position 21 is occupied with a call this idle marking is removed and a busy ground marking is substituted therefor. Thus, under normal conditions certain of the order operators' positions are marked as idle in the bank contacts of the position finder switches, while those engaged in handling calls are marked as busy. When an operator is in attendance at the position 21, the combined talk and split key 605 is maintained in its normal position such that the contact springs 606 are disengaged, the springs 607 and 608 are disengaged, the springs 607 and 609 are engaged and the springs 610 are engaged. With the key 605 occupying this position an operating circuit is prepared for the tone start relay R560. With the relay R570 operated, a circuit is also completed for energizing the position lamp 1011 located at the supervisory operator's position, this circuit extending from ground by way of RA573, C586 and the filament of the lamp 1011 to battery. The energized condition of this lamp serves to inform the supervisory operator that the order operator's position 21 is attended.

Assuming that certain of the order operators' positions are conditioned in the manner explained above to receive incoming calls, if the order trunk 18 is seized at the central office and ringing current is projected thereover the relay R440 is energized by the ringing current traversing its winding and the condenser 427 in series. Upon operating the relay R440 completes, at RA441, a circuit for energizing the relay R460, the upper winding of R470 and the magnet 509 in parallel, one branch of this circuit extending from ground by way of RA441, RA434 and the winding of R460 to battery; and another branch of this circuit extending from ground by way of RA441, RA414, RA413, RA423, RA474, C493, the armature 510 and the winding of the magnet 509 to battery. The branch circuit for energizing the upper winding of the relay R470 extends from ground at RA441 by way of RA414, RA413, RA423, the resistor 478 and the upper winding of R470 to battery. Due to the relatively high resistance of

the resistor 478, the relay R470 does not operate when energized over the circuit just traced, but is rendered exceedingly fast to operate when its lower winding is subsequently energized in the manner described hereinafter. Due to the circuit interrupting action of the armature 510 included in the circuit for energizing the magnet 509, this magnet operates buzzer fashion and in cooperation with its associated ratchet and pawl mechanism functions to drive the wipers 505 to 508, inclusive, over the contacts of the respective associated contact sets 501 to 504, inclusive. The relay R460 operates, after an interval, to complete, at RA461, a circuit extending from ground at RA473 and through the resistor 419 for energizing the upper winding of the relay R410. The resistance value of the resistor 419 is such that the relay R410 does not operate when this circuit is completed. At RA461, the relay R460 also completes a circuit for energizing the relay R520 in series with the signal lamp 1009, this circuit extending from ground by way of RA473, RA461, RA412, C364, the winding of R520, C583 and the filament of the lamp 1009 to battery. Energization of the lamp 1009 serves to indicate to the supervisory operator that the trunk circuit 19 is operating to extend a call to one of the order operators' positions. The relay R520 upon operating completes, at RA521, an obvious circuit for energizing the dashpot relay 540 whereby operation of the last-mentioned relay is initiated.

At RA464, the relay R460 opens one of the multiple paths for impressing ground potential upon the all-trunks-busy conductor C444, this conductor being maintained grounded over similar paths individual to the various order trunk circuits so long as any of these trunk circuits are idle. At RA463, the relay R460 prepares a circuit, traced hereinafter, for energizing the storage start relay R400, this circuit now being open due to the ungrounded condition of the start conductor C442. At RA462, the relay R460 completes a circuit extending by way of RA405 for energizing the slow-to-operate relay R420. The latter relay operates, after an interval, to open, at RA423, the initially completed circuit for energizing the winding of the magnet 509 and the upper winding of R470 in parallel and at this same armature completes an obvious circuit for energizing these two windings. At RA424, the relay R420 prepares a test circuit, traced hereinafter, for energizing the lower winding of the relay R470. At RA425, the relay R420 opens a point in the prepared operating circuit for the relay R400. At RA422 and its associated resting contact, the relay R420 opens the path normally short-circuiting the resistor 428. At RA421 and RA422, the relay R420 completes an obvious path for short-circuiting the condenser 427, thereby to establish a direct current path including the winding of the relay R440 and extending between the conductors C358 and C359 of the trunk 18. The completion of this path results in the energization of the relay R440 over the established direct current loop circuit extending to the central office 10 and the operation of a supervisory lamp embodied in the cord circuit in use by the operator handling the call in the central office. The purpose of providing the time interval which elapses between the operation of the relay R440 and the operation of the relay R420 is to prevent calls from falsely being routed to the order operators' positions as a result of electrical transients appearing on the order trunk 18, the combined operating periods of the two relays R460 and R420 being greater than the period during which an electrical disturbance may persist.

Assuming that the order operator's position 21 is the first idle position tested by the wipers of the switch 500 following the operation of the relay R420, the previously mentioned test circuit is completed for energizing the relay R470 when the wipers 505 to 508, inclusive, are advanced into engagement with the contacts terminating the position circuit conductors individual to the order operator's position 21. More specifically, when the wiper 507 engages the associated contact individual to the position 21, a circuit is completed for energizing the lower winding of the stop relay R470 in series with the winding of the tone start relay R560, this circuit extending from ground by way of RA424, the lower winding of R470, C494, the wiper 507, RA571, C576, the switch springs 610 and 619, C588 and the winding of R560 to battery. When its lower winding is energized over this circuit, the relay R470 first operates to open at the X contacts associated with RA474, the operating circuit for the magnet 509, thereby to arrest the operation of the position finder switch 500. At RA474 and its associated working contact, the relay R470 completes an obvious circuit for short-circuiting the resistor 478, whereby its upper winding is fully energized. At RA475, the relay R470 completes an obvious path for short-circuiting its lower winding, thereby to render itself slow to release and to complete a path extending directly from ground at RA424 for impressing, over the conductor C491 and the wiper 507, busying ground potential upon the guard conductor individual to the operator's position 21 and multipled between corresponding contacts of all of the position finder switches. At RA473, the relay R470 interrupts the previously traced circuit for energizing the upper winding of the relay R410. At RA473, the relay R470 also interrupts the previously traced circuit for energizing the relay R520 in series with the signal lamp 1009, thereby to cause the deenergization of these two circuit elements. Deenergization of the lamp 1009 serves to inform the supervisory operator that the trunk circuit 19 has been successful in its operation to find an idle one of the order operators' positions and to switch the calling order trunk through to this position. The relay R520, upon releasing, interrupts the operating circuit for the dashpot relay 540.

At RA476, the relay R470 prepares a circuit traced hereinafter, for energizing the combined call transfer and trunk release relay R430. At RA477, the relay R470 disconnects the wiper 488 of the storage position finder switch 480 from ground. At RA471 and RA472, the relay R470 connects the trunk conductors C358 and C359 to the link conductors C491 and C492 preparatory to the establishment of a talking circuit between the calling central office subscriber's substation and the order operator's position 21.

As indicated previously, the purpose of providing the signal lamp 1009 and the alarm device 1005 is to bring in an alarm to the supervisory operator in case one of the trunk circuits for some reason fails to find an idle order operator's position within a reasonable time interval after operation thereof is initiated. Thus, in the case just considered if the position finder switch 500 fails to find an idle order operator's position, the relay R470 remains in its restored position and the finder switch 500 continues to operate. After a predetermined time interval, determined by the setting of the dashpot relay 540, this relay

attracts its associated armature 541 to complete a circuit extending by way of C584 for energizing the windings of the alarm device 1005. The resulting operation of this alarm device serves to inform the supervisory operator that one of the trunk circuits is either defective or for some other reason has failed to find an idle order operator's position.

As indicated above, the relay R560 is energized in series with the lower winding of R470 immediately the wipers of the position finder switch 500 are operated to the setting corresponding to the order operator's position 21. When the relay R470 operates to short-circuit its lower winding the relay R560 is energized over a circuit extending directly from ground and is therefore fully energized. The relay R560 operating, completes, at RA564, a circuit for energizing the call signal lamp 625, this circuit extending from ground at the switch spring 607 by way of the spring 609, C579, RA564, C578 and the filament of the lamp 625 to battery. Energization of this lamp serves to inform the operator attending the position 21 that an incoming call should be answered. This visual signal is supplemented by an audible signal which is reproduced by the receiver 601. More specifically, the relay R560 upon operating completes, at RA561 and RA562, a circuit for connecting a zip-zip tone source, not shown, by way of the restored armatures RA531 and RA532 to the talking conductors C574 and C575 individual to the operator's position 21. The resulting current flowing from this source through the windings of the induction coil 604 is reproduced by the receiver 601 audibly to inform the operator attending the position 21 that an incoming call should be answered. At RA565, the relay R560 opens the multiple path individual to the order operator's position 21 over which ground potential is normally impressed upon the storage start conductor C581. Ground potential is maintained on the last-mentioned conductor over similar paths individual to the other order operators' positions so long as any of the positions are idle. At RA566, the relay R560 completes a circuit for energizing the position busy lamp 1010, this circuit extending from ground by way of RA566, C585 and the filament of the lamp 1010 to battery. The resulting illumination of the lamp 1010 serves to inform the operator attending the position 32 that the call routed by way of the trunk circuit 19 has been extended to the order operator's position 21. At RA563, the relay R560 completes an obvious circuit for energizing the slow-to-operate tone cut-off and line switching relay R530. The relay R530 operating, disconnects the talking conductors C574 and C575 from the zip-zip tone current source, thereby to terminate the audible signal being reproduced by the receiver 601, and completes the desired talking circuit between the calling central office subscriber's substation and the operator's position 21.

Following the operation of the relay R530 to establish a talking circuit between the calling subscriber's substation and the order operator's position 21, the order operator attending this position may converse with the calling subscriber and give the calling subscriber the information desired. In order to initiate the release of the connection after the conversation is terminated, the operator attending the position 21 momentarily actuates the combined call transfer and trunk release key 620 to the off-normal position required to open the springs 619 and to close the springs 620'. In response to this operation the previously traced circuit for energizing the lower winding of R470 and the winding of R560 in series is broken, thereby to cause the sequential release of the relays R560 and R530 in the order named. The relay R560 upon restoring interrupts, at RA564, the previously traced circuit for energizing the call signal lamp 625, and recompletes, at RA565, the path individual to the order operator's position 21 over which ground potential is impressed upon the storage start conductor C581 so long as this order operator's position is idle. At RA566, the relay R560 opens the previously traced circuit for energizing the signal lamp 1010 provided at the supervisory operator's position 32, thereby to inform the supervisory operator that the call being handled at the order operator's position 21 has been released. When the springs 620' are moved into engagement, the above-mentioned circuit is completed for energizing the combined call transfer and trunk release relay R430, this circuit extending from ground by way of the resistor 626, the springs 620', C577, the wiper 508, C495, RA476 and the winding of R430 to battery. Due to the relatively high resistance of the resistor 626, the relay R430 only partially operates to open the X contacts associated with RA434 in response to its energization over the circuit just traced. When these X contacts are disengaged, the operating circuit for the relay R460 is interrupted causing this relay, the relay R420 and the relay R470 to restore in the order named. The relay R420, upon restoring, opens, at RA424, a further point in the previously traced circuit for energizing the relays R470 and R560 in series, thereby to prevent the reoperation of these two relays when the combined call transfer and trunk release key 620 is released and permitted to return to its normal position. At RA421, the relay R420 opens the established loop circuit including the winding of R440 and extending to the central office 10, whereby the line relay R440 is permitted to release and a disconnect signal is transmitted to the operator handling the call in the central office. When the central office operator receives this signal she is informed that the connection has been released by the order operator handling the call and may proceed to clear out the connection at her position in the manner conventionally followed in manual office practice. Following the relay operations just described, the order trunk circuit 19 and the position circuit individual to the order operator's position 21 are fully restored to normal.

If the connection routed over the trunk line 18 to the order operator's position 21 is released at the position of the operator handling the call in the central office 10 prior to actuation of the combined call transfer and trunk release key 620, in the manner set forth in the preceding paragraph, the relay R440 restores to open the operating circuit for the relay R460, whereby the relays R460, R420 and R470 are caused sequentially to restore in the order named. When the relay R420 restores, the circuit over which the relay R560 is being held energized is interrupted causing this latter relay and the relay R530 to restore in the order named. Thus, in the case where the connection is first cleared out at the position of the operator handling the call in the central office 10, the trunk circuit 19 and the position circuit individual to the order operator's position 21 are fully released without any operation on the part of the operator attending the order operator's position 21.

Transfer of order trunk call to branch exchange switchboard

In the event the order operator attending the position 21 finds it necessary to converse with a party located at one of the branch exchange telephones in order to obtain the information desired by the calling central office subscriber or to connect the calling central office subscriber directly with one of the branch exchange substations, she may route the call to the branch exchange operator's switchboard by operating the combined call transfer and trunk release key 620 to the off-normal position required to cause engagement of the transfer springs 621. In response to this operation the relay R430 is energized over a circuit extending from ground by way of the springs 621, C577, the wiper 508, C495, RA476 and the winding of R430 to battery. It will be noted that the resistor 626 is excluded from this circuit and, accordingly, the relay R430 is fully energized. Hence, this relay assumes its fully operated position. At RA434, the relay R430 momentarily opens and then recompletes the operating circuit for the relay R460. At RA431 and RA432, the relay R430 disconnects the conductors of the order trunk 18 from the line wipers 505 and 506 of the position finder 500, thereby to interrupt the talking circuit established to the order operator's position 21. At RA433, the relay R430 prepares a circuit, traced hereinafter, for energizing the relay R450 when an assigned one of the transfer trunk finders has operated to seize the transfer trunk 22. At RA435, the relay R430 completes an obvious path for impressing ground potential upon the distributor start conductor C445, thereby to initiate operation of the control relays embodied in the answer circuit distributor 35. As previously indicated, the distributor 35 is so connected and arranged that the wipers of the distributor switch 760 normally stand in engagement with contacts corresponding to an idle one of the answer circuits. Assuming, for example, that the answer circuit 33 and associated transfer trunk finder 34 have previously been selected for use by the distributor switch 760, operation of the finder 34 to search for the transfer trunk 22 is initiated in response to operation of the combined call transfer and trunk release relay R430. More particularly, when ground potential is impressed upon the conductor C445, the distributor start relay R740 is energized over a circuit extending by way of this conductor, the winding of R740, RA741, the armature 772 and the winding of the magnet 771 to battery. Due to the relatively high resistance of the winding of R740, the magnet 771 is insufficiently energized over the circuit just traced to attract its associated operating armature. The relay R740, on the other hand, is sufficiently energized to operate and, upon operating, opens, at RA741, the path normally short-circuiting the resistor 773, thereby further to increase the resistance of the circuit serially including its own winding and the winding of the magnet 771. At RA743, the relay R740 opens a point in the operating circuit for the magnet 771 and completes an obvious circuit for energizing the slow-to-release relay R750. The relay R750 now operates to prepare, at RA751, the operating circuit for the magnet 771. At RA742, the relay R740 prepares a test circuit, traced hereinafter, and serially including the winding of R450 and the respective upper windings of the two relays R720 and R730. At RA744, the relay R740 completes a circuit for energizing the operating magnet 356 of the transfer trunk finder 34, this circuit extending from ground at RA731 by way of RA744, RA721, the wiper 769, RA713, C372 and the winding of the magnet 356 to battery. When energized over this circuit, the magnet 356 attracts its associated armature 357 to complete a circuit for energizing the lower winding of the pulsing relay R720, this circuit extending from ground by way of the armature 357, C373, the wiper 768 and the lower winding of R720 to battery. The relay R720 operating, opens, at RA721, the above-traced operating circuit for the magnet 356, causing this magnet to retract its associated armature 357 to open the above-traced operating circuit for the relay R720, whereby this relay releases to recomplete the operating circuit for the magnet 356. The interrelated operation of the relay R720 and the magnet 356 continues until the wipers of the finder 34 are positioned in engagement with the contacts terminating the conductors of the transfer trunk 22. More specifically, when the wiper 355 engages the associated contact terminating the test conductor C362 individual to the transfer trunk 22, the above-mentioned circuit is completed for energizing the relay R450 in series with the respective upper windings of the relays R720 and R730, this circuit extending from ground by way of RA742, the upper winding of R730, the upper winding of R720, the wiper 767, RA712, C371, the wiper 355, C362, RA433 and the winding of R450 to battery. When its upper winding is energized over this circuit, the relay R720 immediately operates to open, at RA721, the above-traced operating circuit for the magnet 356, whereby further operation of the finder 34 is prevented and the wipers of this finder are left standing in engagement with the contacts terminating the conductors of the trunk 22. The relay R730, upon operating, completes, at RA732, an obvious locking circuit for itself and opens, at RA731, a further point in the operating circuit for the magnet 356. At RA731 and its associated working contact, the relay R730 completes a circuit extending by way of the wipers 770 for energizing the lower winding of the relay R710. The relay R710 now operates to complete a locking circuit for itself and the relay R450, this circuit extending from ground at RA714 by way of the upper winding of R710, C371, the wiper 355, C362, RA433 and the winding of R450 to battery. At RA713, the relay R710 opens a further point in the above-traced operating circuit for the magnet 356. At RA715, the relay R710 prepares an alternative locking circuit for itself. At RA711, the relay R710 opens the circuit individual to the answer circuit 33 over which the all-busy relay R700 is normally energized. At RA711, the relay R710 also completes a path including the wiper 766 for short-circuiting the winding of the distributor start relay R740, thereby to cause the latter relay to restore. At RA716, the relay R710 completes a circuit for energizing the signal lamp control relay R310, this circuit extending from ground by way of RA716, C368, RA331 and the winding of R310 to battery. The relay R310, upon operating, completes an obvious circuit for energizing the call signal lamp 303, whereby the branch exchange operator is informed that an incoming call routed to the answer circuit 33 should be answered. Finally, at RA712, the relay R710 opens the circuit over which the respective upper windings of the relays R720 and R730 are being held ener-

gized in series causing the relay R720 immediately to restore and conditioning the relay R730 to release in response to release of the relay R740. The relay R450 included in the trunk circuit 19 and energized in series with the two relays R720 and R730 and the relay R710 in the manner pointed out above, upon operating, opens, at RA451, the path over which ground potential was impressed upon the distributor start conductor C445.

Following the relay operations just described, operation of the answer circuit distributor switch 760 is initiated to select another idle answer circuit. Thus, when the relay R740 restores, it opens, at RA743, the operating and locking circuits for the relays R750 and R730, respectively. At RA741 and RA743, the relay R740 simultaneously completes two parallel operating circuits for the magnet 771, one of these circuits extending from ground at RA711 by way of the wiper 766, RA741, the armature 772 and the winding of the magnet 771 to battery; and the other extending from ground at RA743 by way of RA751 and the winding of the magnet 771 to battery. At RA742, the relay R740 opens a further point in the above-traced circuit serially including the windings of the relays R720 and R730. At RA744, the relay R740 opens a further point in the previously traced operating circuit for the magnet 356. When the two operating circuits traced above for the magnet 771 are completed, this magnet attracts its associated armature 772 to open the first-traced circuit. Shortly thereafter, the relay R750 restores to open the other operating circuit and thus permit the magnet 771, in cooperation with its associated ratchet and pawl mechanism, to step the wipers 766 to 770 inclusive, into engagement with the set of contacts terminating the circuit conductors individual to the next answer circuit. If the answer circuit thus selected is busy, ground potential is maintained on the test wiper 766 because of the operated condition of the test relay corresponding to the relay R710 and individual to the selected answer circuit. Accordingly, the operating circuit for the magnet 771 is again completed at the armature 772 and this magnet is caused to step the wipers 766 to 770, inclusive, a second step. The step by step operation of the distributor switch 760 continues until such time as the wipers thereof are positioned on the contacts corresponding to an idle answer circuit, at which time the wiper 766 is disconnected from ground and no further circuit is available for energizing the magnet 771. Thus, operation of the distributor switch 760 is arrested with the wipers of this switch standing in engagement with the contacts terminating the circuit conductors individual to an idle one of the answer circuits.

In the event all of the answer circuits are busy at the time the hunting operation of the distributor switch 760 is initiated, the wipers of this switch are operated to engage their associated eleventh contacts at which the operating circuit for the magnet 771 is opened and further operation of the distributor switch is prevented. More specifically, when all of the answer circuits are busy all of the relays corresponding to and including the test relay R710, and individual to the answer circuits, are operated. Accordingly, the operating circuit for the all-busy relay R700 is interrupted. This relay releasing completes, at RA701, a circuit for energizing the all-busy lamp 1007 associated with the answer trunk circuits. The circuit just mentioned extends from ground at RA701 by way of C365 and the filament of the lamp 1007 to battery. The resulting energization of the lamp 1007 serves to inform the supervisory operator that all of the answer circuits provided at the branch exchange switchboard are occupied with calls which have been transferred from the order operators' positions to the branch exchange switchboard. At RA701, the all-busy relay R700 also disconnects ground from the eleventh contact associated with the wiper 766. Hence, when the wipers of the distributor switch 760 have been operated to engage their respective associated eleventh contacts, the operating circuit for the magnet 771 is interrupted and no further operation of the distributor switch wipers occurs. Thereafter and when one of the answer circuits, such, for example, as the circuit 33 is released, the holding circuit for the test relay R710 individual thereto is interrupted in the manner hereinafter explained, causing this relay to restore and recomplete, at RA711, the operating circuit for the all-busy relay R700. Reoperation of the relay R700 results in the deenergization of the lamp 1007 and in the connection of ground to the eleventh contact of the contact set associated with the wiper 766. As a result, the magnet 771 is again energized and operation of the distributor switch 760 is initiated. The hunting operation of this switch continues until such time as the wipers thereof are positioned in engagement with the contacts terminating the conductors individual to the answer circuit which has been vacated or released. When these contacts are located, the operating circuit for the magnet 771 is interrupted and operation of the distributor switch 760 is arrested.

The branch exchange operator may answer the call routed to the answer circuit 33 in the manner just described by inserting the answer plug 36 in the jack 23. In response to this operation, battery potential is impressed upon the ring contact of the jack 23 in the usual manner to complete an obvious circuit for energizing the relay R320. The relay R320 operating, completes, at RA322, an obvious circuit for energizing the relay R330. At RA321, the relay R320 completes an obvious circuit for energizing the line switching relay R340. The relay R330, upon operating, opens, at RA331, the previously traced operating circuit for the relay R310, causing the latter relay to restore and open the circuit for energizing the signal lamp 303. At RA331, the relay R330 also completes a locking circuit for itself, this circuit extending from ground at RA716, by way of C368, RA331 and the winding of the relay R330 to battery. At its armatures RA341 and RA342, the relay R340, upon operating, connects the line terminals of the repeating coil 305 to the line wipers 353 and 354 of the transfer trunk finder 34, thereby to establish a talking circuit extending between the operator's cord circuit 33' and the head set in use at the order operator's position 21, this talking circuit including the transfer trunk 22. In completing this talking circuit, the relay R340 also prepares a circuit, traced hereinafter, for energizing the relay R400'. At RA343, the relay R340 completes a circuit for energizing the signal lamp 1006 individual to the answer circuit 33, this circuit extending from ground at RA343 by way of C369 and the filament of the lamp 1006 to battery. The resulting illumination of the lamp 1006 serves to inform the supervisory operator attending the position 32 that the answer circuit 33 is occupied with a call. At RA344,

the relay R340 completes the previously mentioned alternative locking circuit for the test relay R710, this circuit extending from ground by way of RA344, C370, RA715 and the lower winding of R710 to battery.

Following the relay operations just described, the operator attending the order operator's position 21 may converse with the branch exchange operator and direct the latter operator to extend the connection to the desired line. Assuming, for example, that the substation B is desired by the order operator, the branch exchange operator may route the connection to this substation by inserting the call plug 37 in the jack 17 and operating the ringing key provided in the cord circuit 33' to cause ringing current to be projected over the line 15 and through the windings of the ringer provided at the substation B. When the call is answered at the substation B, the desired talking circuit may be established through the operator's cord circuit 33' between this substation and the head set in use at the order operator's position 21. Following the completion of this talking circuit the operator attending the position 21 may converse with the answering party at the substation B to obtain the desired information and during the course of this conversation the calling central office subscriber is excluded from the connection because of the operated position occupied by the call transfer and trunk release relay R430.

If the operator attending the position 21 desires, she may establish a three-way talking circuit between her substation, the central office subscriber's substation and the substation B. To this end, the combined call transfer and trunk release key 620 is restored to its normal position. In response to this operation the call transfer and trunk release relay R430 restores to open the completed holding circuit for the relay R460 and to recomplete the operating circuit for this relay. At RA433, the relay R430 opens the holding circuit for the relay R450 causing the latter relay to restore. At RA435, the relay R430 opens a further point in the path, individual to the trunk circuit 19, for impressing ground potential upon the distributor start conductor C445, this path being prepared at RA451 in response to the release of the relay R450. At RA431 and RA432, the relay R430 connects the conductors of the order trunk 18 to the talking conductors of the transfer trunk 22, thereby to establish a three-way talking circuit between the calling central office subscriber's substation, the order operator's position 21 and the substation B. In response to the completion of this three-way talking circuit, the relay R400' is energized in parallel with the line relay R440 over a circuit extending by way of the order trunk 18 to the terminals of the exchange battery provided in the central office 10. More specifically, the relay R400' is bridged across the conductors of the order trunk 18 over a path extending from the conductor C358 by way of RA431, the winding of R400', C360, the wiper 353, RA341, the resistor 345, RA342, the wiper 354, C361, RA432 and the resistor 428 to the opposite conductor C359 of the order trunk 18. The resistance of this path is such that the series relay R400' does not operate at this time.

After the connection is established between the substation B and the substation of the calling central office subscriber in the manner just explained, the operator handling the call at the order operator's position 21 may retire from the connection and release the trunk circuit apparatus 19 and the equipment provided at the position 21 by operating the call transfer and trunk release key 620 to the position required for disengagement of the springs 619 and engagement of the springs 620'. The manner in which the trunk circuit apparatus 19 and the position circuit individual to the order operator's position 21 are released in response to this operation of the call transfer and trunk release key 620 is exactly the same as explained previously. During the release of the trunk circuit apparatus 19 and when the relay F420 restores, the resistor 428 is short-circuited at the armature RA422 and its associated resting contact, thereby to exclude this resistor from the above-traced series path including the winding of the relay R400'. In response to this operation the relay R400' is sufficiently energized to operate and, upon operating, opens, at RA401', the path individual to the trunk circuit 19 over which ground potential is normally impressed upon the all-trunks-busy lead C444. Following the release of the trunk circuit 19 and the position circuit individual to the order operator's position 21, supervision of the call as extended through the operator's cord circuit 33 to the substation B is under the control of the operator handling the call at the branch exchange switchboard, supervisory lamps provided in the cord circuit 33' being utilized to indicate when the connection is no longer desired. More specifically, when the operator handling the call at the branch exchange switchboard receives a disconnect signal caused by the release of the connection at the central office or the substation B, she may clear out the connection by withdrawing the call and answer plugs 37 and 36, respectively, from the jacks 17 and 23, respectively. In response to this operation battery potential is removed from the ring contact of the jack 23 to cause the deenergization and release of the relay R320. This relay releasing opens, at RA321, the established circuit for energizing the relay R340 and interrupts, at RA322, the operating circuit for the relay R330. The relay R340 releasing interrupts, at RA341 and RA342, the established loop circuit extending through the winding of the relay R400' and over the order trunk 18 to the central office switchboard. Interruption of this loop circuit also results in deenergization of the relay R400', which relay releasing recompletes, at RA401', the path individual to the trunk circuit 19 over which ground potential is normally impressed upon the all-trunks-busy lead C444. At RA343, the relay R340 opens the above-traced circuit for energizing the signal lamp 1006 whereby the supervisory operator is informed that the answer circuit 33 has been released. At RA344, the relay R340 opens the previously traced holding circuit for the relay R710. The relay R710 restoring opens, at RA716, the locking circuit for the relay R330, causing the latter relay to restore. Following the release of the relay R330 the answer circuit 33 and associated transfer trunk finder 34 are fully restored to normal.

Call from order operator's position to branch exchange switchboard

If, for any reason, the operator attending the order operator's position 21 finds it necessary to obtain information from one of the clerks or employees normally attending one of the branch exchange substations or to route a call from her position to one of the central office subscribers'

substations, she may establish a connection to the branch exchange operator's switchboard by operating the key 605 to the off-normal position required to cause engagement of the springs 606, disengagement of the springs 607 and 609, engagement of the springs 607 and 608 and disengagement of the springs 610. When the springs 610 are disengaged the marking path including the winding of the relay R560 and over which battery potential is normally impressed on the contact associated with the wiper 507 for marking the position 21 as idle in the position finder switch 500, is interrupted. When the springs 607 and 609 are disengaged the path individual to the order operator's position 21 over which ground potential is normally impressed upon the storage start conductor C581, is interrupted. At the springs 606 a circuit is prepared for energizing the relay R550 when an assigned one of the position finder switches is operated to the position corresponding to the order operator's position 21. At the springs 607 and 608 a path is completed for impressing ground potential upon the distributor start conductor C582, thereby to energize the distributor start relay R910. More specifically, the operating circuit for the relay R910 extends from ground by way of the springs 607 and 608, C580, RA553, C582, the winding of R910, RA911, the armature 972 and the winding of the magnet 971 to battery. Due to the relatively high resistance of the winding of the relay R910, the magnet 971 is insufficiently energized to operate when the circuit just traced is completed. The relay R910, however, operates to initiate operation of a previously selected idle one of the position finder switches. Assuming, for example, that the wipers of the distributor switch 960 are standing in engagement with the contacts individual to the trunk 26, operation of the position finder 29 is initiated. More specifically, the relay R910, upon operating opens, at RA911, the path normally short-circuiting the resistor 923, thereby further to increase the resistance of the circuit serially including its own winding and the winding of the magnet 971. At RA912, the relay R913 prepares a circuit for energizing the winding of R550 in series with the respective upper windings of R920 and R930. At RA913, the relay R910 completes an obvious operating circuit for the slow-to-release relay R900 and opens a point in the operating circuit for the magnet 971. The relay R900 operating, prepares, at RA901, the circuit for energizing the magnet 971. At RA914, the relay R910 completes a circuit for energizing the operating magnet 636 of the position finder 29, this circuit extending from ground by way of RA922, RA914, RA931, the wiper 969, RA945, C641 and the winding of the magnet 636 to battery. When energized over this circuit, the magnet 636 completes, at its armature 637, a circuit for energizing the pulsing relay R930. This circuit extends from ground by way of the armature 637, C642, the wiper 968 and the lower winding of R930 to battery. The relay R930 operating, opens, at RA931, the above-traced operating circuit for the magnet 636, causing this magnet to retract its armature 637 and thus open the operating circuit for the pulsing relay R930. When the magnet 636 is deenergized it also operates, in cooperation with its associated ratchet and pawl mechanism, to advance the wipers 633 to 635, inclusive, one step. The interrelated operation of the pulsing relay R930 and the magnet 636 continues until such time as the wipers of the finder 29 are positioned in engagement with the contacts terminating the circuit conductors individual to the calling order operator's position 21. More specifically, when the wiper 633 is advanced into engagement with the test contact individual to the position 21, the above-mentioned circuit is completed for energizing the relay R550 in series with the respective upper windings of the two relays R920 and R930. This circuit extends from ground by way of RA912, the upper winding of R920, the upper winding of R930, the wiper 967, RA944, C638, the wiper 633, the springs 606, C587 and the winding of R550 to battery. When this circuit is completed the relay R930 immediately operates to open, at RA931, the above-traced operating circuit for the magnet 636, thereby to arrest operation of the position finder 29 with the wipers of this finder standing in engagement with the contacts individual to the order operator's position 21. The relay R920 also operates when its upper winding is energized in the circuit traced-above and, upon operating, completes, at RA921, an obvious locking circuit for itself. At RA922, the relay R920 opens a further point in the above-traced operating circuit for the magnet 636 and completes a circuit extending by way of the wiper 970 for energizing the lower winding of the line switching relay R940.

The line switching relay R940, upon operating, opens, at RA943, the circuit, individual to the trunk 26, for energizing the all-trunks-busy relay R950. At RA945, the relay R940 opens a further point in the above-traced operating circuit for the magnet 636. At RA946, the relay R940 completes a locking circuit for itself, this locking circuit extending from ground by way of RA946, the upper winding of R940, C638, the wiper 633, the contact springs 606, C587 and the winding of R550 to battery. At RA943, the relay R940 also marks the trunk 26 as busy in the contacts of the distributor switch 960. At RA944, the relay R940 opens the above-traced circuit for energizing the respective upper windings of the relays R920 and R930 in series, causing the relay R930 immediately to restore and the relay R920 to restore in response to the release of the distributor start relay R910. At RA941 and RA942, the relay R940 connects the talking conductors C639 and C649 to the talking conductors C367 and C366, respectively, thereby to establish a loop circuit between the order operator's position 21 and the trunk circuit 27. When this loop circuit is established one of the relays embodied in the trunk circuit 27 is caused to operate to complete a circuit for energizing the signal lamp 304, whereby the branch exchange operator is informed that a call present on the trunk 26 should be answered. The relay R550, upon operating, opens, at RA551 and RA552, two points in the above-traced circuit for transmitting zip-zip tone current to the receiver 601 provided at the order operator's position 21. At RA553, the relay R550 disconnects ground from the distributor start conductor C582. At RA554, the relay R550 completes the previously traced circuit for energizing the position signal lamp 1010 individual to the order operator's position 21, there to inform the supervisory operator attending the position 32 that the order operator's position 21 is busy.

As indicated above, the distributor start relay R910 is deenergized in response to operation of the two relays R550 and R940. This relay restoring, initiates the operation of the distributor switch 960 to search for an idle one of the trunks forming the group including the trunk 26, pro-

viding an idle one of these trunks is available. More specifically, the relay R910 upon restoring opens, at RA912, a further point in the circuit serially including the upper windings of the two relays R920 and R930; opens, at RA914, a further point in the operating circuit for the magnet 636; and interrupts, at RA913, the operating and holding circuits for the relays R900 and R920, respectively, causing both of these relays to restore. At RA911 and RA913, the relay R910 simultaneously completes two parallel operating circuits for the operating magnet 971, one of these circuits extending from ground by way of RA943, the wiper 966, RA911, the armature 972 and the winding of the magnet 971 to battery; and the other circuit extending from ground by way of RA913, RA901 and the winding of the magnet 971 to battery. The magnet 971, upon operating, opens, at its armature 972, the first of the two circuits traced above but is held energized over the second traced circuit until the slow-acting relay R900 releases. When the magnet 971 is deenergized it operates to advance the wipers 966 to 970, inclusive, into engagement with the set of contacts terminating the conductors of the next trunk. In the event the trunk thus selected is also busy, ground potential is present on the contact engaged by the wiper 966 so that the magnet 971 is again energized and operates to advance the distributor switch wipers a second step. In this regard it will be apparent from the foregoing explanation that when each of the trunks is occupied with a call the relay individual thereto and corresponding to the relay R940 is operated so that the corresponding contact in the set associated with the wiper 966 is grounded. As a result, the stepping operation of the distributor switch 960 continues until the wiper 966 engages a contact which is ungrounded and thus corresponds to an idle trunk. When the wipers of the distributor switch 960 are advanced to such a position, no further circuit is available for energizing the magnet 971 and operation of the switch 960 is arrested.

In the event all of the trunks in the group including the trunk 26 are busy at the time the trunk hunting operation of the distributor switch 960 is initiated the wipers of this switch are operated to engage their respective associated eleventh contacts at which time operation of the switch is arrested. More specifically, if all of the relays corresponding to and including the relay R940 are operated, the several parallel circuits for energizing the all-trunks-busy relay R950 are opened and this relay is deenergized. With the relay R950 in its restored position, the eleventh contact of the set associated with the wiper 966 is disconnected from ground at RA951 and, accordingly, when the wipers of the distributor switch 960 are advanced to engage their associated eleventh contacts, no circuit is available for further energizing the magnet 971 and operation of this switch is arrested. With the all-trunks-busy relay R950 restored, a circuit is also completed for energizing the all-trunks-busy lamp 1012 provided at the supervisory operator's position 32, this circuit extending from ground by way of RA951, C973 and the filament of the lamp 1012 to battery. Energization of this lamp serves to inform the operator attending the supervisory operator's position 32 that all of the trunks in the group including the trunk 26 are occupied with calls. When one of these trunks, such, for example, as the trunk 26 is released in the manner explained hereinafter the line switching relay R940 individual thereto is caused to restore to recomplete, at RA943, the operating circuit for the all-trunks-busy relay R950. At this same armature, the relay R940 also disconnects ground from the test contact individual to the trunk 26 and provided in the contact set associated with the wiper 966. The all-trunks-busy relay R950, upon reoperating, opens, at RA951, the circuit for energizing the all-trunks-busy lamp 1012, whereby the supervisory operator is informed that the all-busy condition of the trunks forming the group including the trunk 26 has terminated. At RA951, the relay R950 also completes a circuit extending by way of the wiper 966 for again energizing the operating magnet 971 of the distributor switch 960. Thus, operation of the distributor switch 960 is again initiated, the step by step operation of this switch continuing until such time as the wipers thereof are positioned in engagement with the contacts individual to the trunk which has been released. When this trunk is located, the wiper 966 is disconnected from ground to prevent the reoperation of the magnet 971 and thus arrest the operation of the switch 960. From the foregoing explanation it will be apparent that the distributor switch 960 operates to preselect an idle one of the trunks in the group including the trunk 26 for use immediately a preselected trunk has been seized at one of the order operators' positions.

When the branch exchange operator observes the illuminated condition of the lamp 304, indicating that a call is present on the trunk 26, she may answer the call by inserting the answer plug 36 in the jack 28. In response to this operation a talking circuit is completed between the cord circuit 33' and the order operator's position 21. In addition, the call signal lamp cut-off relay conventionally embodied in the trunk circuit 27 is energized and operates to open the circuit for energizing the lamp 304. The branch exchange operator, after conversing with the order operator attending the position 21 to ascertain the desired substation, may extend the connection to the desired line by inserting the call plug 37 in the jack terminating this line and actuating the ringing key embodied in the cord circuit 33' to project ringing current over the line thus selected. For example, if the substation B is desired by the order operator attending the position 21, the branch exchange operator may insert the calling plug 37 in the jack 17 and actuate her ringing key, thereby to cause the operation of the ringer provided at the substation B. After the call is answered at the substation B, the operator at the branch exchange switchboard may retire from the connection leaving the desired talking circuit established between the substation B and the order operator's position 21 and relying upon the supervisory lamps embodied in the cord circuit 33' to indicate when the connection is no longer desired.

If, for any reason, the operator attending the order operator's position 21 desires to recall the operator at the branch exchange switchboard, she may do so by momentarily operating the key 623 one or more times for the purpose of interrupting the established loop circuit extending by way of the trunk 26 to the cord circuit 33'. In response to each operation of this key, the supervisory lamp individual to the calling end of the connection and embodied in the cord circuit 33' is either energized or deenergized momentarily and the resulting flashing of this lamp serves to

inform the branch exchange operator that she is being recalled.

The arrangement of the position circuit individual to the order operator's position 21 is such that a call routed over one of the order trunks, such, for example, as the trunk 18 to this position, may be transferred by use of one of the trunks in the group including the trunk 26 to the branch exchange switchboard. In such case, the operator attending the position 21 would actuate the hold key 622 to its off-normal position prior to operation of the key 605 to the position required to initiate operation of one of a selected one of the position finder switches, such, for example, as the switch 29. With the key 622 operated, an alternative circuit is completed for holding the relay R560 energized. This alternative circuit extends from ground by way of the springs of the key 622, the springs 619, C588 and the winding of R560 to battery. Following operation of this key to its off-normal position, the key 605 may be operated to the off-normal position required to extend a call by way of one of the trunks, such, for example, as the trunk 26 to the branch exchange switchboard, in the manner set forth above. From this switchboard the call may be routed to the substation B, for example, as described above. Thus, a three-way talking circuit involving the order operator's position 21, the called substation B, and the calling central office subscriber's substation is established. If the order operator attending the position 21 desires, she may exclude the substation B from this talking circuit by operating the key 605 to the off-normal position in which the springs 611 and 612 are disengaged, the springs 611 and 613 are engaged, the springs 614 and 616 are engaged, the springs 615 and 616 are disengaged and the springs 617 are engaged. In response to this operation the resistor 645 is included in the loop circuit extending to the operator's cord circuit 33' to prevent a disconnect signal from being transmitted to the operator at the branch exchange switchboard. At the springs 611, 612, 615 and 616, the talking conductors of the trunk 26 are disconnected from the talking conductors C574 and C575, whereby the called substation B is excluded from the talking circuit. At the contact springs 617 an obvious multiple circuit is completed for holding the relay R560 energized. Obviously, by operating the key 605 from the off-normal position just described, the three-way talking circuit between the central office subscriber's substation, the operator's position 21, and the called substation B may be reestablished. If the operator handling the call at the order operator's position 21 desires to split the connection so that the calling central office subscriber's substation is excluded from the talking circuit, she may restore the key 622 to normal, thereby to interrupt the above-traced alternative holding circuit for the relay R560. When this circuit is interrupted, the relays R560 and R530 are sequentially restored. When the relay R530 restores its armatures RA531 and RA532, the talking conductors C574 and C575 are disconnected from the talking conductors C491 and C492, thereby to exclude the central office subscriber's substation from the established three-way connection. Obviously, by again operating the key 622 to its off-normal position to cause the reoperation of the two relays R560 and R530, the operator handling the call at the position 21 may reestablish the three-way talking circuit.

If the order operator attending the position 21, after obtaining a connection by way of the trunk 26 to one of the branch exchange substations, such, for example, as the substation B desires a second connection with another of the branch exchange substations without releasing the first connection, she may obviously obtain the second connection by operating the key 620 to the call transfer position, thereby to cause a call to be routed over one of the transfer trunks to the branch exchange switchboard from which it may be extended to the desired substation, all in the manner previously explained. The order operator attending the position 21 may also release the trunk circuit 19 without releasing the connection established by way of the trunk 26 to the substation B by operating the key 620 to its trunk release position. The manner in which the trunk circuit 19 is released in response to this key operation is exactly the same as previously described.

In order to release the apparatus including the position finder 29 and the trunk 26 over which the call was routed from the operator's position 21 to the branch exchange switchboard, the order operator attending this position restores the key 605 to its normal position to cause the disengagement of the contact springs 606, the engagement of the springs 607 and 609, the disengagement of the springs 607 and 608 and the engagement of the springs 610. Obviously, this operation may be carried out to initiate the release of the finder 29 and associated trunk 26 without causing the release of the trunk circuit 19 in the event a call routed by way of the order trunk 18 and the trunk circuit 19 is also being handled by the operator attending the position 21. When the key 605 is restored to normal to cause disengagement of the contact springs 606, the circuit serially including the lower winding of R940 and the winding of R550 is interrupted causing both of these relays to restore. The relay R550, upon restoring, reprepares, at RA553, the above-mentioned path individual to the order operator's position 21 for impressing ground potential upon the distributor start conductor C582. At RA554, the relay R550 opens one of the multiple circuits for energizing the signal lamp 1010. At RA551 and RA552, the relay R550 reprepares the circuit for transmitting zip-zip tone current to the receiver 601. The relay R940 releasing opens, at RA946, a further point in the above-traced holding circuit for itself and the relay R550. At RA941 and RA942, the relay R940 opens two points in the completed loop circuit extending to the operator's cord circuit 33', the interruption of this loop circuit causing the energization of the disconnect signal lamp provided in the cord circuit 33' which is individual to the calling end of the connection, thus indicating to the operator at the branch exchange switchboard that the connection is ready to be released. At RA943, the relay R940 disconnects the marking lead individual to the trunk 26 and associated position finder 29 from ground, thereby to mark this finder and its associated trunk as idle in the bank contacts of the distributor switch 960. At this same armature and its associated resting contact the relay R940 recompletes the circuit, individual to the trunk 26, for energizing the all-trunks-busy relay R950. The operator at the branch exchange switchboard, upon observing the lighted condition of the disconnect lamp included in the cord

circuit 33', may clear out the connection by withdrawing the plugs 36 and 37 from the jacks 28 and 17 respectively. Thus, the apparatus utilized in routing the connection from the order operator's position 21 to the substation B is fully released.

Call storage

As indicated previously, the call storage circuit 31 and the call storage position finders individual to the order trunk circuits, are provided for the purpose of storing calls initiated on the order trunks when all of the order operators' positions are busy and of releasing the calls from storage as the order operators' positions are released in the same order as the calls are stored. Normally, and so long as any of the available order operators' positions are idle, ground potential is maintained on the call storage start conductor C581 over the paths individual to the various order operators' positions. Thus, so long as the order operator's position 21 is attended and idle, the call storage start conductor C581 is connected to ground over a path individual to this order operator's position and extending by way of RA565, RA572, C579 and the switch springs 609 and 607 to ground. When, however, all of the order operators' positions are busy, all of the multiple paths individual thereto are broken and the conductor C581 is disconnected from ground. When this occurs, the normally energized pendulum type call storage start relay R850 restores, to open, at RA851, the normally completed circuit for energizing the relay R830. The relay R830 now restores to disconnect the wiper 874 from ground and to prepare a circuit for energizing the relay R820. Following the release of the relay R830 the call storage circuit 31 is conditioned to cause the storage of the next order trunk call originating in the central exchange 10. Since the distributor switch 860 is of the non-homing type, this switch may occupy any one of its twenty-four active storage positions or settings at the time the relay R830 restores. Similarly, the call release switch 870, being of the non-homing type, may occupy any one of its twenty-four active positions, although under normal operating conditions this switch will occupy a setting one or two steps behind that occupied by the distributor switch 860.

With the apparatus in this condition if a call is routed from the central office 10 over the order trunk 18 to cause the operation of the relay R440 in the manner previously explained, the winding of the relay R460, the upper winding of R470 and the winding of the magnet 509 are energized in parallel. When the relay R460 operates it completes, at RA461, the previously traced circuit for energizing the upper winding of R410 in parallel with a branch circuit serially including the relay R520 and the lamp 1099 provided at the supervisory operator's position 32. At RA462, the relay R460 also completes the operating circuit for the slow-to-operate relay R420. In this case the relay R460 also completes, at RA463, a circuit for energizing the lower winding of R400 in series with the relay R320, this circuit extending from ground by way of the restored armature RA831, the winding of R320, C442, RA417, RA425, RA463 and the lower winding of R400 to battery. Due to the slow-to-operate characteristic of the relay R420 and the relatively fast operating characteristic of the relay R460, the last-mentioned relay operates to interrupt, at RA405, the operating circuit for the relay R420 before the latter relay can operate. At RA401, the relay R400 completes an obvious path for bridging the winding of the relay R440 across the conductors of the trunk 18 in series with the resistor 426, the resistance of this path being such that the relay R440 is held operated but the supervisory relay included in the operator's cord circuit in use at the central office and provided for the purpose of giving answering supervision is not operated. At RA402, the relay R400 completes a circuit extending by way of C363 for energizing the storage lamp 1008 individual to the trunk circuit 19 and provided at the supervisory operator's position 32. Energization of this lamp serves to inform the supervisory operator that a call routed by way of the order trunk 18 is being placed in storage. At RA404 and its associated resting contact the relay R400 interrupts the path normally short-circuiting its uper winding. At RA403 and RA404, the relay R400 completes a circuit for energizing its upper winding, this circuit extending from ground at RA441 by way of RA414, RA403, RA404, the upper winding of R400 and the resistor 409 to battery. At RA406, the relay R400 prepares a test circuit including the lower winding of R410 and traced hereinafter. At RA407, the relay R400 completes a circuit for energizing the relay R835, this circuit extending from ground by way of RA407, C443, the winding of R835 and RA848 to battery. Ground as extended to C443 over this circuit is also impressed upon the wiper 866 of the call storage distributor switch 860. The relay R820 operates when energized in series with the lower winding of R400 and opens, at RA821, a point in the circuit traced hereinafter for energizing the call release switch operating magnet 877. Shortly thereafter the relay R835 operates to prepare, at RA836, the operating circuit for the magnet 877.

The relay R400, upon operating, also completes, at RA408, a circuit, controlled by the relay equipment of the call storage circuit 31, for energizing the operating magnet 489 of the call storage position finder 480, this circuit extending from ground at RA817 by way of C446, RA408, RA418, the armature 490 and the winding of the magnet 489 to battery. Due to the circuit interrupting action of the armature 490 the magnet 489 operates buzzer fashion when the circuit just traced is completed and in cooperation with its associated ratchet and pawl mechanism advances the wipers 485 to 488, inclusive, one step each time it is energized and deenergized. The step by step operation of the wipers embodied in the switch 480 continues until such time as these wipers find the position which has been marked in the contacts of the call storage distributor switch 860. For example, if the wipers of the switch 860 stand in engagement with their respective associated fourth contacts at the time operation of the finder 480 is initiated, the wipers of this finder are advanced three steps at which time they also engage their respective associated fourth contacts. When the wiper 485 is operated to engage its associated fourth contact the above-mentioned test circuit is completed for energizing the lower winding of R410 in series with the upper winding of R800, this circuit extending from ground through the lower winding of R410 and by way of RA406, the wiper 485, the wiper 864, RA801, RA811 and the upper winding of R800 to battery. Immediately this circuit is completed, the relay R410 operates to open, at RA418, the operating circuit for the magnet

489, whereby operation of the storage position finder 430 is arrested with the wipers of this finder standing in engagement with their respective associated fourth contacts. At RA415, the relay R410 completes an obvious path for short-circuiting the resistor 419 and in so doing completes a holding circuit for itself, which holding circuit extends from ground at RA473 by way of RA461, RA415 and the upper winding of R410 to battery. At RA411, the relay R410 completes an obvious multiple path for bridging the winding of the relay R440 across the conductors of the order trunk 18 in series with the resistor 426. At RA412, the relay R410 opens the above-traced circuit for energizing the relay R520 in series with the signal lamp 1009, whereby both of these circuit elements are deenergized. At RA413, the relay R410 opens the previously traced branch circuit for energizing the upper winding of R470 in parallel with the magnet 509, whereby the stepping operation of the position finder switch 500 is arrested. At RA416, the relay R410 prepares a path, traced hereinafter, for short-circuiting the upper winding of R400 when one of the order operators' positions is released or otherwise rendered available for use in handling an order trunk call. At RA417, the relay R410 interrupts the above-traced operating circuit for the relay R400 and completes a path extending by way of C442 for short-circuiting the winding of R820 to cause the latter relay to restore. At RA414, the relay R410 opens the initially completed holding circuit for the relay R400 and completes an alternative holding circuit for this relay, this alternative circuit extending from ground at RA462 by way of RA414, RA403, RA404, the upper winding of R400 and the resistor 409 to battery.

When the relay R800 is energized in series with the lower winding of R410 it operates to complete, at RA802, an obvious circuit for energizing the slow-to-operate relay R810 in parallel with its own lower winding. At RA801, the relay R800 interrupts the above-traced circuit serially including its own upper winding and the lower winding of R410. The slow-to-operate relay R810 operates after an interval to open, at RA811, a further point in the circuit for energizing the two relays R800 and R410 in series. At RA812, the relay R810 completes a circuit extending through RA816 for energizing the magnet 867. When thus energized, the magnet 867 attracts its associated armature 868 to open the circuit through the winding of R800, thereby to cause the sequential release of the relays R800 and R810 in the order named. The relay R810 releasing opens the circuit for energizing the magnet 867 and reprepares the storage position test circuit extending to the wiper 864. When the magnet 867 is thus deenergized, it functions in cooperation with its associated ratchet and pawl mechanism to step the wipers 864 to 866, inclusive, to the next storage position. Under normal circumstances this next storage position will not be occupied with a stored call so that the wiper 864 engages an open-circuated contact and no further operation of the relays R800 and R810 and the magnet 867 occurs. The purpose of stepping the wiper of the switch 860 one step in the manner just explained is to mark the next storage position of this switch as the position to be assigned to the next call routed over one of the order trunks at a time when all of the order operators' positions are busy. If, for reasons explained hereinafter, the next storage position of the distributor switch 860 is occupied with a stored call, ground potential will be present upon the contact engaged by the wiper 864 so that the cyclic operation of the two relays R800 and R810 and the magnet 867 again occurs to advance the wipers of the distributor switch 860 a second step. More specifically, this stepping operation of the distributor switch 860 continues until such time as the wiper 864 engages an open-circuited contact corresponding to a vacant or idle storage position.

As indicated above, the relay R820 is deenergized and restores in response to operation of the relay R410. The relay R820, upon restoring, completes, at RA821, the prepared operating circuit for the magnet 877 of the call release switch 870. This magnet attracts its armature 878 to complete an obvious circuit for energizing the slow-to-release relay R845. The relay R845 in turn operates to prepare, at RA847, a holding circuit for itself; to prepare, at RA846, a circuit for energizing the lower winding of the relay R840; and to open, at RA848, the established operating circuit for the relay R835. The relay R835 releasing opens the operating circuit for the magnet 877, causing this magnet to release its associated armature 878, thereby to interrupt the operating circuit for the relay R845, and to advance the wipers 874 to 876, inclusive, one step. The relay R845 releasing recompletes the operating circuit for the relay R835 which reoperates to again complete the operating circuit for the magnet 877. The interrelated operation of the two relays R845 and R835 and the magnet 877 continues until the wipers of the switch 870 are positioned on the contact marked by the setting of the call storage position finder switch 480. More specifically, in the case assumed, the wipers of the switch 480 are rapidly advanced to engage their respective associated fourth contacts in response to operation of the relay R400. Accordingly, the wipers of the switch 870 are advanced to engage their respective associated fourth contacts. When the wiper 876 engages its associated fourth contact, a circuit is completed for energizing the lower winding of R840, this circuit extending from ground at RA477 by way of the wiper 488, the wiper 876, RA846 and the lower winding of R840 to battery. This circuit is completed while the relay R845 occupies its operated position and, accordingly, when the relay R840 operates, the above-mentioned locking circuit for the relay R845 is established, this circuit extending from ground through RA841, RA847 and the winding of R845 to battery. Thus, the two relays R840 and R845 are locked up under the control of the relay R470 to prevent any further operation of the relay R835 and the magnet 877. At this point it is noted that in the trunk circuit 19 the relays R400, R416, R440 and R460 are operated, while in the call storage circuit 31 the relays R840 and R845 are operated. With the apparatus in this condition no further operation thereof occurs until one of the order operators' positions is released, the stored order trunk call on the trunk 18 is abandoned, or a second call is routed over one of the order trunk lines.

If the call present on the order trunk 18 is abandoned at the central office subscriber's substation prior to the release of one of the order operators' positions and the established connection to the line 18 is cleared out at the central office switchboard in the exchange 10, the relay R440 is released. Upon releasing, this relay, at

RA441, opens the operating circuit for the relay R460. The relay R460 releasing opens, at RA461, the established locking circuit for the relay R410 and, at RA462, the established locking circuit for the relay R400, causing both of these relays to restore. At RA464, the relay R460 applies multiple ground to the all-trunks-busy conductor C444. The relay R400 releasing opens, at RA402, the circuit for energizing the trunk call storage lamp 1008; reprepares, at RA405, the operating circuit for the relay R420; opens, at RA407, the path individual to the trunk circuit 19 over which ground potential is impressed on the conductor C443, thereby to interrupt the previously traced operating circuit for the relay R835; and, at RA408, opens a point in the initially completed operating circuit for the magnet 489 and prepares an alternative circuit for this magnet. The relay R410 releasing disconnects the winding of the relay R440 from across the conductors of the order trunk 18; disconnects the conductor C442 from ground; reprepares, at RA417, the operating circuit for the relay R400; opens, at RA415, a further point in its own holding circuit; reprepares, at RA413, the branch circuit for energizing the upper winding of the relay R470 in parallel with the magnet 509; opens, at RA416, the prepared path for short-circuiting the upper winding of R400; and completes, at RA418, the prepared alternative circuit for energizing the magnet 489, this latter circuit extending from ground by way of the wiper 486, the multipled contacts numbered from 2 to 25, inclusive, of the contact set associated with the wiper 486, and RA408, RA418, the armature 490 and the winding of the magnet 489 to battery. Due to the circuit interrupting action of the armature 490, the wipers of the switch 480 are advanced step by step to the home position, at which time the wiper 486 engages its associated open-circuited first contact and the circuit for energizing the magnet 489 is interrupted. Thus, the wipers of the switch 480 are left standing in their respective home positions. During this stepping operation of the switch 480 and when the wiper 488 is disengaged from its associated fourth contact, the previously traced operating circuit for the relay R840 is interrupted causing this relay to restore and open the locking circuit for the relay R845. As a result, the relay R845 restores, after an interval, to reprepare the operating circuit for the relay R835. Under the circumstances described wherein only the call originating on the order trunk 18 has been stored, ground potential is not present on the common conductor C443 when the relay R845 restores. Accordingly, the relay R835 is not caused to operate to initiate operation of the call release switch 870. Following the operations just described the order trunk circuit 19 and the call storage circuit 31 are fully restored to normal.

If the order operator's position 21, for example, is released while the call originating on the order trunk 18 is in storage, the relay R560 embodied in the position circuit individual to the operator's position 21 is released and the position 21 is marked as idle in the bank contacts of the position finders individual to the order trunk circuits. The relay R560 releasing completes, at RA565, its associated path for impressing ground potential upon the call storage start conductor C581, thereby to energize the winding of the pendulum type relay R850. Vibratory movement of the weighted armature carried by this relay is thus initiated. After an interval required for operation of this armature to be reduced to a negligible value, the contacts controlled by RA851 are engaged to maintain completed the circuit for energizing the slow-to-operate relay R830. The relay R830 operating opens, at RA831, and its associated resting contact, the path short-circuiting the winding of the relay R820. At RA831 and its associated working contact, the relay R830 connects the wiper 874 to ground, thereby to short-circuit the upper winding of the relay R400 over a path extending from ground by way of RA831, the wiper 874, the wiper 487, RA416, the upper winding of R400, RA404, RA403 and RA414 back to ground at RA462. When thus deenergized, the relay R400 releases to short-circuit its upper winding and open, at RA403, the short-circuiting path just traced. At RA402, the relay R400 opens the previously traced circuit for energizing the call storage lamp 1008, thereby to inform the supervisory operator attending the position 32 that the call present on the order trunk 18 has been released from storage. At RA406, the relay R400 opens a further point in the previously traced circuit for energizing the lower winding of R410. At RA407, the relay R400 opens the path individual to the trunk circuit 19 over which ground is connected to the conductor C443. At RA408, the relay R400 opens the initially completed operating circuit for the magnet 489 and prepares the previously traced circuit for energizing this magnet during the release of the storage position finder switch 480. At RA405, the relay R400 completes the previously traced operating circuit for the relay R420. The relay R420 operating, bridges the winding of the relay R440 directly across the conductors of the trunk 18, thereby to cause the operation of the supervisory answer relay provided in the operator's cord circuit in use in the central office 10, in the manner previously explained. The relay R420 operating further initiates operation of the position finder switch 500 to search for the order operator's position 21 which has been released, all in the manner previously described. When the wipers of the position finder switch 500 are positioned on the contacts corresponding to the operator's position 21, the relays R470 and R560 are energized and operate. Thus, the call is released from storage and routed to the order operator's position 21 where it may be handled in the manner set forth previously. When the relay R470 operates to extend the call stored on the order trunk 18 to the order operator's position, it performs the functions previously described and, in addition, opens, at RA477, the established locking circuit for the relay R840, thereby to cause the sequential release of the relays R840 and R845 in the order named. Thus, the apparatus provided in the call storage circuit 31 is fully restored to normal. It is to be noted that if none of the other order operators' positions are released substantially simultaneously with the release of the order operator's position 21, the relay R560, upon operating opens, the only established path for impressing ground potential upon the call storage start conductor C581. As a result, the operating circuit for the relay R850 is interrupted, causing this relay and the relay R830 sequentially to restore. With the relay R830 in its restored position any further calls routed over the order trunks to the order operators' positions are stored through operation of the call storage circuit 31 until such time as an order operator's position is released.

At RA473, the relay R470 also opens the holding circuit for the relay R410. The relay R410

releasing opens, at RA414 and RA416, two additional points in the previously traced path for short-circuiting the upper winding of R400; opens, at RA417, the path individual to the trunk circuit 19 over which ground potential is impressed upon the conductor C442; opens, at RA415, a further point in its own locking circuit; reprepares, at RA412, the circuit for energizing the relay R520 and the signal lamp 1009 in series; opens, at RA411, the initially completed path for bridging the winding of the relay R440 across the conductors of the trunk 18; and completes, at RA418, the previously traced circuit for energizing the magnet 489 by way of the wiper 486. When this latter circuit is completed the wipers of the storage position finder switch 480 are driven to their respective home positions in the manner previously explained. Following the operations just described, the desired connection between the central office subscriber's line and the order operator's position 21 is fully established. This connection may be routed to the branch exchange switchboard or through this switchboard to one of the branch exchange substations or may be released, all in the manner previously described.

In the event a plurality of calls intended for the order operator's position are routed over the order trunk at a time when all of the order operators' positions are busy, these calls are assigned successive storage positions by the distributor switch 860. In this regard it will be recalled from the previous explanation, that the wipers of the switch 860 are advanced to a vacant call storage position in response to the storage of the call routed over the order trunk 18. More specifically, these wipers were advanced to engage their respective associated fifth contacts. If, with the wipers of the switch 860 standing in this position a second order trunk call is initiated prior to the release of one of the order operators' positions, the trunk circuit apparatus of the order trunk in use operates in substantially the same manner as described above with respect to the trunk circuit 19 except that the wipers of the call storage position finder switch embodied in the second trunk circuit are operated to engage their respective associated fifth contacts and are left standing in this position. Following such operation of the second call storage position finder the wipers of the switch 860 are advanced an additional step and left standing in engagement with their respective associated sixth contacts. With these wipers in this position a third order trunk call initiated prior to the release of any of the order operators' positions is assigned the sixth storage position under the control of the wipers embodied in the switch 860. It will thus be apparent that the order trunk calls initiated when an all-busy condition of the order operators' positions prevails are assigned successive storage positions under the control of the switch 860. The purpose of the switch 870 and its associated control apparatus is to release the calls from storage in the order in which they are stored. Thus, if in the case considered above, a plurality of order trunk calls are stored prior to the release of the order operator's position 21 and the call on the order trunk 18 is the first call stored, the order operator's position 21 is assigned to the use of the order trunk 18. This is true for the reason that the relays R840 and R845 are held locked up under the control of the relay R470 regardless of the number of steps taken by the wipers of the switch 860 following the locking up of these two relays as a consequence of the first order trunk call stored. Under these circumstances, when the relay R470 operates in response to operation of the position finder switch 500 to seize the order operator's position 21, it opens the established operating circuit for the relay R840 causing the sequential release of the two relays R840 and R845 in the order named. The relay R845 restores, after an interval, to recomplete, at RA848, the operating circuit for the relay R835. The relay R835 operating completes the circuit for energizing the magnet 877. The magnet 877, in turn, completes the operating circuit for the relay R845 which opens the operating circuit for the relay R835. When the magnet 877 is thus deenergized it functions to advance the associated wipers 874 to 876, inclusive, into engagement with their respective associated fifth contacts which corresponds to the second stored call. If this call has not been abandoned, ground potential is present upon the fifth contact associated with the wiper 876 as a consequence of the setting of the call storage position finder individual to the order trunk over which the second stored call was routed. Accordingly, the relay R840 reoperates to close the locking circuit for the relay R845 and thus prevent further operation of the relay R835 and further operation of the call release switch 870. Thus, the relays R840 and R845 are locked up under the control of the relay corresponding to the relay R470 and embodied in the trunk circuit individual to the order trunk over which the second stored call is routed. These relays remain locked up until a second order operator's position is thereafter released. In the event the second stored call is abandoned prior to the release of the order operator's position 21 and the resulting operation of the order trunk circuit 19, in the manner set forth above, ground potential is removed from the fifth contact associated with the wiper 876, namely, the contact corresponding to the second stored call. Accordingly, a second cycle of operation of the two relays R845 and R835 and the magnet 877 occurs so that the wipers of the call release switch 870 are advanced to engage their respective associated sixth contacts. If the stored call corresponding to this setting of the switch 870 has also been abandoned, the cyclic operation of the two relays R845 and R835 and the magnet 877 continues so that the wipers of the switch 870 are advanced into engagement with their associated seventh contacts. When the position of the switch 870 corresponding to the next stored call, not abandoned, is found the relays R840 and R845 are locked up under the control of the relay which corresponds to the relay R470 and is embodied in the trunk circuit associated with the order trunk on which the stored call is present.

If a stored order trunk call next to be released from storage by the call storage circuit 31 is abandoned before an order operator's position becomes available, the call release switch 870 is automatically operated to advance its wipers to the position corresponding to the next stored call, assuming that additional order trunk calls are in storage. Thus, if the above-described order trunk call originating on the trunk 18 is one of a number of order trunk calls in storage, the switch 870 occupies a position corresponding to the call on the trunk 18 and this call is abandoned, the trunk circuit apparatus 19 is released in the manner previously explained. During the release of this apparatus the wipers of the switch

480 are restored to normal under the control of the magnet 489. This homing operation on the part of the switch 480 results in the removal of ground potential from the contact engaged by the wiper 876 and hence the relay R840 is de-energized and restores. The relay R840 releasing initiates the cyclic operation of the two relays R845 and R835 and the magnet 877 in the manner previously explained, thus causing the wipers of the switch 870 to be operated step by step until the contacts corresponding to the next stored call are engaged thereby. When the wipers of the switch 870 reach the position corresponding to the next stored call, the relays R840 and R845 are locked up under the control of the relay which corresponds to the relay R470 and is embodied in the trunk circuit associated with the order trunk on which the next stored call is present.

In order to prevent useless operation of the switch 870 and to prevent later initiated calls from obtaining preferred storage positions, an arrangement comprising a slip multiple between the contact sets 861 and 862 of this switch is provided. More specifically, this slip multiple is such that the wiper 864 is connected by way of an associated engaged contact and one of the conductors of the multiple to the contact in the set 862 which next succeeds the engaged contact in the contact set 861. To this end, the number two contact of the set 861, corresponding to the first storage position of the switch 860, is connected to the twenty-fifth contact of the set 862 and the contacts numbered from 3 to 25, inclusive, of the contact set 861 are respectively connected to the contacts numbered from 2 to 24, inclusive, of the contact set 862. With this arrangement if call storage is started and all but one of the twenty-four available storage positions are subsequently filled at a time when no order operators' positions are available, the wiper 865 will, during the operation of the switch 860, be connected to a grounded contact in the contact set 861. For example, if the wipers 864 to 866, inclusive, occupy positions in engagement with their associated third contacts when the next to last storage position is filled, these wipers will not be advanced from this position. Under these circumstances, if the wipers of the switch 480, for example, occupy positions in engagement with their associated fourth contacts corresponding to the fourth storage position of the switch 860, ground potential is extended through the lower winding of R410 and by way of RA406 and the wiper 485 to the fourth contact of the contact set 861. Accordingly, a circuit is completed for energizing the relay R825, this circuit extending from the grounded fourth contact of the set 861 by way of the third contact of the set 862, the wiper 865, C881, the contact springs 1017, C882, the resistor 822 and the winding of R825 to battery. The relay R825 operating completes an obvious circuit for energizing the slow-to-operate relay R815. The relay R815 operates, after an interval, to open, at RA816, a point in the operating circuit for the magnet 867, thereby to prevent further operation of the distributor switch 860 until the relays R825 and R815 are released in response to the release of one of the order operators' positions. At RA817, the relay R815 disconnects ground from the common start conductor C446, thereby to prevent any of the storage position finder switches individual to the order trunk circuits and having access to the call storage circuit 31 from operating in response to calls initiated on their respective associated order trunks. With the apparatus in this condition if an order trunk call is initiated the relays embodied in the trunk circuit associated with this trunk line which correspond to the relays R440, R460, and R400 of the trunk circuit 19 are caused to operate, the last-mentioned thereof functioning to complete a locking circuit for itself. Following the operation of these three relays, the trunk circuit in use remains locked up until the call routed thereover is abandoned or until a call storage position becomes available in the switch 860 through the release from storage of one of the previously stored calls.

In the event all of the order trunks become busy at the same time, all of the multiple paths individual to the order trunks and over which ground potential is impressed upon the conductor C444 are opened causing the deenergization and release of the all-trunks-busy relay R805. This relay releasing completes, at RA806, an obvious circuit for energizing the metering device 807 whereby the all-busy condition of the order trunks is registered. At RA806, the relay R805 also completes a circuit extending by way of C880 for energizing the all-trunks-busy lamp 1013 provided at the supervisory operator's position 32, whereby the supervisory operator is informed of the all-busy condition of the order trunks. When one of the order trunks is thereafter released, the conductor C444 is again connected to ground to cause the energization and operation of the all-trunks-busy relay R805. This relay operating, opens the circuit for energizing the metering device 807 and the signal lamp 1013 in parallel.

The relays R825 and R815 remain operated until such time as the stored call corresponding to the storage position of the switch 860 next succeeding that occupied by the wipers of this switch is released from storage. This stored call will, of course, be the next one to be released from storage under the control of the switch 870. Assuming that this call is present on the order trunk 18 and is released from storage, the switch 480 is automatically restored to its home position and the relays R400 and R410 are deenergized and release, all in the manner previously explained. The relay R400 releasing disconnects ground from the third contact of the contact set 862 and in so doing interrupts the previously traced operating circuit for the relay R825, thereby to cause the sequential release of the relays R825 and R815 in the order named. The relay R815 releasing reprepares, at RA816, the operating circuit for the magnet 867 and, at RA817, connects the start conductor C446 to ground. If, with the conductor C446 grounded, a call is waiting on one of the order trunks for a storage position, a circuit is completed for energizing the magnet of the call storage position finder embodied in the trunk circuit associated with the trunk upon which the call is waiting. This finder operates to advance its wipers into engagement with their respective associated third contacts, at which time the relay operations previously described and required to put the associated trunk circuit apparatus into a call storage condition occur. Incident to the operation of this trunk circuit apparatus, ground potential is impressed upon the third contact of the contact set 861 to cause the sequential operation of the relay R800 and the magnet 867 followed by the release of these two circuit controlling devices so that the wipers of the switch 860 are advanced one step into engagement with their respective asso-

ciated fourth contacts. At this time ground is again applied over the slip multiple connection between the contact sets 861 and 862 to the wiper 865 so that the relays R825 and R815 are reoperated to perform the functions previously described. From the foregoing explanation, it will be apparent that while twenty-four storage positions are actually provided in the distributor switch 860 only twenty-three of these positions can, under normal circumstances, actually be used simultaneously. It will further be apparent that the slip multiple arrangement between the contact sets 861 and 862 prevents useless operation of the switch 860 and in addition prevents later initiated order trunk calls from obtaining preferred storage positions, thus insuring the release of the calls from storage in the same order as the calls are stored.

In order to prevent any possibility of useless operation on the part of the call release switch 870, an arrangement comprising a slip multiple extending between the contacts of the contact set 863 embodied in the switch 860 and the contacts of the contact set 872 embodied in the switch 870 is provided. More specifically, the twenty-fifth contact of the set 872 is connected to the second contact of the contact set 863 and the contacts numbered from 2 to 24, inclusive, of the contact sets 872 are respectively connected to the contacts numbered from 3 to 25, inclusive, of the contact set 863. With this arrangement, an alternative circuit is provided for energizing the stop relay R840 each time the wipers of the switch 870 are advanced to a position one step behind the position occupied by the wipers of the switch 860 at a time when one or more calls are in storage. Thus, if a call originating on the order trunk 18 is assigned the sixth storage position of the switch 860, operation of the switch 870 is initiated in response to release of the relay R820 following operation of the switch 860 to its seventh storage position. If, for any reason, the circuit extending through the wiper 488 of the switch 480 for energizing the stop relay R840 is not completed, operation of the switch 870 is arrested through completion of the above-mentioned alternative circuit for energizing the stop relay R840. This alternative circuit extends by way of the grounded conductor C443, the wiper 866 and its associated seventh contact, the wiper 875 and its associated sixth contact and the upper winding of R840 to battery. When this circuit is completed the relay R840 operates to complete the locking circuit for the relay R845, thereby to arrest the stepping operation of the switch 870 in the manner previously described. When thereafter the wipers of the switch 860 are advanced to the next succeeding storage position, in the manner previously explained, the alternative circuit for energizing the relay R840 is interrupted at the wiper 866 and its associated seventh contact. If ground potential is still present upon the conductor C443 when the relay R840 releases, the relays R845 and R835, in cooperation with the operating magnet 877, function to cause the wipers of the switch 870 to be advanced to the position corresponding to the next stored call. From the foregoing explanation it will be apparent that the provision of the slip multiple between the contact sets 863 and 872 positively precludes the possibility of the wipers of the switch 870 being advanced to a position ahead of the position occupied by the wipers of the switch 860.

The purpose of providing the relays R850 and R830 in the call storage circuit 31 to introduce a time delay between the release of an order operator's position and the release of an order trunk call from storage, is to permit a call which has not been placed in storage to be routed to an order operator's position prior to the release of a stored call from storage. More specifically, if two order trunk calls are simultaneously initiated at a time when only one of the order operators' positions is idle the trunk circuit position finders, corresponding to the finder 500 and individual to the trunk circuits to which the two simultaneously initiated calls are routed, will start operating simultaneously. Since these position finder switches are of the non-homing type, they will probably occupy different settings at the time operation thereof is initiated and, hence, one of the two finders will seize the available order operator's position and busy this position before the other finder can operate to the position corresponding to the idle operator's position. Assuming, for example, that the trunk circuit 19 is one of the two trunk circuits in use and, further, that the position finder 500 is the finder last to operate to the position corresponding to the one idle order operator's position available, the relay R420 will be operated prior to seizure of the idle order operator's position by the other operating position finder switch. Hence, by the time the idle order operator's position has been seized and ground potential removed from the storage start conductor C581 to cause the release of the relays R850 and R830 and the consequent preparation of the operating circuit for the storage relay R400, the relay R420 has operated to open, at RA425, the operating circuit for this storage relay. Thus, the call present on the order trunk 18 has missed its opportunity to be placed in storage. As a result, the position finder switch 500 continues to operate in search of an idle order operator's position. In the absence of the time delay introduced by the operation of the relays R850 and R830 the call present on the order trunk 18 might conceivably wait indefinitely for an idle order operator's position since the calls in storage can be released to the order operators' positions as they became idle before the position finder switch 500 has an opportunity to seize one of these positions. By virtue of the time delay introduced in the manner explained, however, the position finder switch 500 has an opportunity to test all of the idle operators' positions and select any position which had been released, before the call storage circuit can operate under the control of the relays R850 and R830 to release a call from storage. In such case, the seizure of the released operator's position by the switch 500 would result in the removal of ground potential from the call storage circuit conductor C581 prior to operation of the relay R830. Hence, the relay R850 would assume its restored position to prevent operation of the relay R830 and none of the calls in storage would be released.

Supervision

As indicated previously, apparatus is provided at the supervisory operator's position 32 whereby the operator attending this position may maintain a close check on the condition of the order operator's positions and the volume of traffic routed over the order trunks. Thus, provisions are made whereby the operator may monitor any connection involving any one of the order operators' positions or any of the order trunks. To

this end, the jack 1003 is provided which is connected by way of the conductors C574 and C575 to opposite sides of the talking conductors embodied in the position circuit individual to the order operator's position 21. Similar jacks individually connected in a similar manner to the substation apparatus at the other order operators' positions are also provided. Further, a jack 1002' having terminals connected to the talking conductors C358 and C359 of the order trunk 18 is provided to enable the supervisory operator to monitor the connection involving this order trunk at a point ahead of the trunk circuit 19. This connecting jack may be utilized to enable the supervisory operator to monitor calls which have been transferred from an order operator's position over the transfer trunk 22 to the branch exchange switchboard. Similar jacks individual to the other order trunks and connected in the same manner as the jack 1002' are also provided at the supervisory operator's position. It will be apparent that the supervisory operator by inserting the plug 1004 in any desired one of the several jacks may supervise any connection involving one of the order trunks. As previously indicated, the lamps 1010 and 1011 are individual to the order operator's position 21 and similar lamps are provided which are individually associated with the other order operators' positions. The lamps 1007, 1013 and 1012, on the other hand, are all-busy lamps provided to indicate all-busy conditions of the answer circuits, the order trunks and the additional trunks including the trunk 26, respectively. The lamp 1006 is individual to the answer circuit 33 provided at the branch exchange switchboard, similar lamps being provided in association with the other answer circuits. Finally, the storage lamp 1008 is individual to the order trunk 18 and associated trunk circuit 19, similar storage lamps being provided in association with each of the other order trunks. These storage lamps are so arranged that by observing the condition thereof the supervisory operator is informed as to the number of calls which are in storage.

The arrangement is such that the supervisory operator attending the position 32 may also control the call storage circuit 31. More specifically, if conditions are such that the call storage circuit should not be used or is not required, the supervisory operator may operate the no-storage key 1014 to its off-normal position to complete a branch circuit extending by way of C581 for maintaining the relays R850 and R830 energized independently of the condition of the order operators' positions. With this key in its off-normal position the call storage start relays R850 and R830 cannot restore even though all of the staffed order operators' positions are busy and overflow calls are coming in over the order trunks. With the relay R830 operated, the common conductor C442 is disconnected from ground and, accordingly, none of the relays corresponding to and including the relay R400 embodied in the various trunk circuits can operate. Under these circumstances, the position finders having access to the order operators' positions and individual to the trunk circuits associated with order trunks on which the overflow calls are present are operated continuously in search of an idle order operator's position until such time as one or more of these positions become idle. If, under conditions of extremely heavy traffic or if a large number of order trunk calls in excess of the storage capacity of the circuit 31 are present on the order trunks so that a long waiting interval is involved before each call is released from storage, many of the calls may be abandoned thus leaving unoccupied storage positions in the bank contacts of the distributor switch 860. Under such conditions it may be desirable to fill up the vacated storage positions occasioned by the abandoned calls and also to utilize the twenty-fourth storage position, which normally cannot be used, for the purpose of storing an additional call. These operating features are realized by providing at the supervisory operator's position 32 a key 1015 which is designated a step-on key. As previously explained the contacts 1017 of this key are normally engaged to close one point in the operating circuit for the call storage position busy relay R825 so that when the wipers of the switch 860 are operated to a position one step behind another position corresponding to a stored call, the relay R825 operates to prevent the storage of further calls including the storage of a call in the last available free position. Under the conditions stated, if the key 1015 is operated to the off-normal position required for disengagement of the contact springs 1017, the operating circuit for the relay R825 is interrupted and the two relays R825 and R815 are sequentially restored in the order named. The relay R815 releasing connects the start conductor C446 to ground and prepares, at RA816, the operating circuit for the magnet 867. If, at the time the relay R815 is released a call is waiting to be stored the call storage position finder embodied in the trunk circuit associated with the order trunk on which the waiting call exists is operated to a position corresponding to that occupied by the switch 860 in response to the application of ground potential to the conductor C446, whereby the waiting call is stored in the last available storage position of the switch 860. Following the storage of the waiting call, the relays R800 and R810, in cooperation with the magnet 867, function to advance the wipers 864 to 866, inclusive, step by step over their associated contacts in search of an idle storage position. As stated above, if certain of the stored calls have been abandoned prior to this searching operation on the part of the switch 860, movement of the wipers of this switch is arrested when the first idle storage position corresponding to an abandoned call is reached. More particularly, when the wipers of the switch 860 are moved to engage contacts which correspond to a storage position released as a result of an abandoned call, the operating circuit for the relay R800 is opened at the wiper 864 and the contact engaged thereby so that further stepping of the switch wipers 864 to 866, inclusive, cannot occur. If additional order trunk calls are initiated, the storage positions of the switch 860 which correspond to calls previously stored but abandoned, are filled up in the order in which they are reached by the wipers 864 to 866, inclusive. The supervisory operator attending the position 32 can easily tell when all of the twenty-four available storage positions of the storage circuit 31 are filled by observing the condition of the trunk call storage lamp 1008 and the other similar lamps individual to the order trunks. Thus, when twenty-four of these lamps are energized, the supervisory operator is informed that all of the twenty-four available storage positions in the

call storage circuit 31 have been filled. If certain of these positions have been filled through operation of the step-on key 1015 and this step-on key occupies its off-normal position at the time the twenty-fourth trunk call storage lamp is energized, the supervisory operator should immediately restore the step-on key to its normal position in order to prevent useless operation of the distributor switch 860. More specifically, if all of the storage positions of the call storage circuit 31 are occupied with stored calls, all of the contacts of the contact sets 861 and 862 are connected to ground and, accordingly, the relays R800 and R810 will interact with the magnet 867 continuously to drive the wipers of the switch 860 without interruption until one of the call storage positions is released either by the release of a call from storage or by the abandonment of a stored call. Under these circumstances, the call storage position switches associated with order trunks on which further calls are initiated will be caused continuously to operate in search of a storage position by virtue of the presence of ground potential upon the common conductor C442. If, however, the step-on key is restored to normal immediately all of the available call storage positions are filled, the relays R825 and R815 are caused sequentially to operate in the order named. The relay R815 operating opens, at RA816, a point in the operating circuit for the magnet 867, thereby to arrest operation of the distributor switch 860, and to disconnect the conductor C446 from ground, thereby to prevent useless operation of any one of the call storage finder switches.

Provisions are made whereby the call release switch 870 may also be controlled from the supervisory operator's position 32. More specifically, if the step-on key 1015 is operated to its other off-normal position to move the springs 1016 into engagement a circuit extending by way of C884 is completed for directly energizing the operating magnet 877 of the switch 870. Thus by repeatedly operating the step-on switch 1015 to cause engagement and disengagement of the springs 1016, the supervisory operator may cause the wipers of the switch 870 to be advanced to any desired setting.

While there has been described what is at present considered to be the preferred embodiment of the invention, it will be understood that various modifications may be made therein, and it is contemplated to cover in the appended claims all such modifications as fall within the true spirit and scope of the invention.

What is claimed is:

1. In a telephone system, a central exchange, a branch exchange area including a plurality of special operators' positions and branch exchange switching means, regular trunks extending from said central exchange to said switching means, special call trunks extending from said central exchange to said branch exchange area, trunk circuits individual to said special call trunks and including means for routing calls on the associated trunks to idle ones of said special operators' positions, transfer trunks individually associated with said trunk circuits, and automatic switching means having access to said transfer trunks and controllable from said special operators' positions for transferring calls present on said special call trunks over said transfer trunks to said branch exchange switching means.

2. In a telephone system, a central exchange, a branch exchange area including a plurality of special operators' positions and a branch exchange switchboard provided with answer circuits, regular trunks extending from said central exchange to said switchboard, special call trunks extending from said central exchange to said branch exchange area, trunk circuits individual to said special call trunks and including means for routing calls on the associated trunks to idle ones of said special operators' positions, transfer trunks individual to said trunk circuits and extending between said trunk circuits and said switchboard, automatic switches having access to said transfer trunks and operative to connect said transfer trunks to said answer circuits, and means at said special operators' positions for controlling said automatic switches to transfer calls present on said special call trunks over said transfer trunks to idle ones of said answer circuits.

3. In a telephone system, a central exchange, a branch exchange area including a plurality of special operators' positions and a branch exchange switchboard provided with answer circuits, regular trunks extending from said central exchange to said switchboard, special call trunks extending from said central exchange to said branch exchange area, trunk circuits individual to said special call trunks and including means for routing calls on the associated trunks to idle ones of said special operators' positions, transfer trunks associated with said trunk circuits, finder switches individually associated with said answer circuits and each having access to said transfer trunks, and means for controlling said finder switches from said special operators' positions to route calls present on said special call trunks over said transfer trunks to idle ones of said answer circuits.

4. In a telephone system, a central exchange, a branch exchange area including a plurality of special operators' positions and a branch exchange switchboard provided with answer circuits, regular trunks extending from said central exchange to said switchboard, special call trunks extending from said central exchange to said branch exchange area, trunk circuits individual to said special call trunks and including means for routing calls on the associated trunks to idle ones of said special operators' positions, transfer trunks associated with said trunk circuits, finder switches individually associated with said answer circuits and each having access to said transfer trunks, distributor means for assigning idle ones of said answer circuits to the use of said transfer trunks in a predetermined order, and means controllable from any one of said special operators' positions for routing a call present on one of said special call trunks over one of said transfer trunks and through an assigned one of said finder switches to the associated answer circuit.

5. In a telephone system, a central exchange, a branch exchange area including a plurality of special operators' positions and a branch exchange switchboard provided with a plurality of answer circuits, regular trunks extending from said central exchange to said switchboard, special call trunks extending from said central exchange to said branch exchange area, trunk circuits individual to said special call trunks and including means for routing calls on the associated trunks to idle ones of said special operators' positions, transfer trunks individually associated with said trunk circuits, finder switches individually associated with said answer circuits and each having access to said transfer trunks, distributor

means for assigning idle ones of said answer circuits to the use of said transfer trunks in a predetermined order, transfer switches provided at said special operators' positions, and transfer relays individual to said trunk circuits and each operative to cause an assigned one of said finder switches to seize the associated transfer trunk in response to operation of the transfer switch provided at the one of said special operators' positions which is connected to the associated special call trunk, whereby calls may be transferred from said special operators' positions to said branch exchange switchboard.

6. In a telephone system, a central exchange, a branch exchange area including a plurality of special operators' positions and a branch exchange switchboard provided with a plurality of answer circuits, regular trunks extending from said central exchange to said switchboard, special call trunks extending from said central exchange to said branch exchange area, trunk circuits individual to said special call trunks and including means for routing calls on the associated trunks to idle ones of said special operators' positions, transfer trunks individually associated with said trunk circuits, finder switches individually associated with said answer circuits and each having access to said transfer trunks, distributor means for assigning idle ones of said answer circuits to the use of said transfer trunks in a predetermined order, transfer switches provided at said special operators' positions, transfer relays individual to said trunk circuits and each operative to cause an assigned one of said finder switches to seize the associated transfer trunk in response to operation of the transfer switch provided at the one of said special operators' positions which is connected to the associated special call trunk, whereby calls may be transferred from said special operators' positions to said branch exchange switchboard, and means at said special operators' positions for controlling said transfer relays to release their respective associated trunk circuits.

7. In a telephone system, a central exchange, a branch exchange area including a plurality of special operators' positions and a branch exchange switchboard provided with a plurality of answer circuits, regular trunks extending from said central exchange to said switchboard, special call trunks extending from said central exchange to said branch exchange area, trunk circuits individual to said special call trunks and including means for routing calls on the associated trunks to idle ones of said special operators' positions, transfer trunks individual to said trunk circuits, each of said transfer trunks normally being connected to its associated special call trunk, finder switches individually associated with said answer circuits and each having access to said transfer trunks, distributor means for assigning idle ones of said answer circuits to the use of said transfer trunks in a predetermined order, transfer switches provided at said special operators' positions, and transfer relays individual to said trunk circuits and each operative under the control of said transfer switches to disconnect the associated trunk from the associated special call trunk and to cause an assigned one of said finder switches to seize the associated transfer trunk, whereby calls may be transferred from said special operators' positions to said branch exchange switchboard.

8. In a telephone system, a central exchange, a branch exchange area including a plurality of special operators' positions and a branch exchange switchboard provided with a plurality of answer circuits, regular trunks extending from said central exchange to said switchboard, special call trunks extending from said central exchange to said branch exchange area, trunk circuits individual to said special call trunks and including means for routing calls on the associated trunks to idle ones of said special operators' positions, transfer trunks individual to said trunk circuits, each of said transfer trunks normally being connected to its associated special call trunk, finder switches individually associated with said answer circuits and each having access to said transfer trunks, distributor means for assigning idle ones of said answer circuits to the use of said transfer trunks in a predetermined order, transfer switches provided at said special operators' positions, transfer relays individual to said trunk circuits and each operative under the control of said transfer switches to disconnect the associated trunk from the associated special call trunk and to cause an assigned one of said finder switches to seize the associated transfer trunk, whereby calls may be transferred from said special operators' positions to said branch exchange switchboard, and means at said special operators' positions for controlling said transfer relays to release said trunk circuits.

9. In a telephone system, a central exchange, a branch exchange area including a plurality of special operators' positions and a branch exchange switchboard provided with answer circuits, regular trunks extending from said central exchange to said switchboard, special call trunks extending from said central exchange to said branch exchange area, trunk circuits individual to said special call trunks and including means for routing calls on the associated trunks to idle ones of said special operators' positions, transfer trunks associated with said trunk circuits, automatic switching means having access to said transfer trunks and controllable from said special operators' positions for transferring calls present on said special call trunks over said transfer trunks to idle ones of said answer circuits, and additional means including position finders having access to said special operators' positions and controllable from special operators' positions for routing calls directly from said special operators' positions to said branch exchange switchboard.

10. In a telephone system, a central exchange, a branch exchange area including a plurality of special operators' positions and a branch exchange switchboard provided with answer circuits, regular trunks extending from said central exchange to said switchboard, special call trunks extending from said central exchange to said branch exchange area, trunk circuits individual to said special call trunks and including means for routing calls on the associated trunks to idle ones of said special operators' positions, transfer trunks associated with said trunk circuits, finder switches individually associated with said answer circuits and each having access to said transfer trunks, means for controlling said finder switches from said special operators' positions to route calls present on said special call trunks over said transfer trunks to idle ones of said answer circuits, and additional means including position finders having access to said special operators' positions and controllable from said special operators' positions for routing calls directly from

said special operators' positions to said branch exchange switchboard.

11. In a telephone system, a central exchange, a branch exchange area including a plurality of special operators' positions and a branch exchange switchboard provided with answer circuits, regular trunks extending from said central exchange to said switchboard, special call trunks extending from said central exchange to said branch exchange area, trunk circuits individual to said special call trunks and including means for routing calls on the associated trunks to idle ones of said special operators' positions, transfer trunks associated with said trunk circuits, automatic switching means controllable from said special operators' positions for transferring calls present on said special call trunks over said transfer trunks to idle ones of said answer circuits, additional means including position finders having access to said special operators' positions and controllable from said special operators' positions for routing calls directly from said special operators' positions to said branch exchange switchboard, whereby three-way talking circuits including said special operators' positions may be established, and means provided at each of said special operators' positions for splitting a three-way talking circuit established by way of one of said special trunks and one of said position finders to exclude either the calling or the called end of the connection from the established talking circuit.

12. In a telephone system, a central exchange, a branch exchange area including a plurality of special operators' positions and a branch exchange switchboard provided with answer circuits, regular trunks extending from said central exchange to said switchboard, special call trunks extending from said central exchange to said branch exchange area, trunk circuits individual to said special call trunks and including means for routing calls on the associated trunks to idle ones of said special operators' positions, transfer trunks associated with said trunk circuits, finder switches individually associated with said answer circuits and each having access to said transfer trunks, means for controlling said finder switches from said special operators' positions to route calls present on said special call trunks over said transfer trunks to idle ones of said answer circuits, additional means including position finders having access to said special operators' positions and controllable from said special operators' positions for routing calls directly from said special operators' positions to said branch exchange switchboard, whereby three-way talking circuits including said special operators' positions may be established, and means provided at each of said special operators' positions for splitting a three-way talking circuit established by way of one of said special trunks and one of said position finders to exclude either the calling or the called end of the connection from the established talking circuit.

13. In a telephone system, a central exchange, a branch exchange area including a plurality of special operators' positions and branch exchange switching means, regular trunks extending from said central exchange to said switching means, special call trunks extending from said central exchange to said branch exchange area, trunk circuit apparatus associated with said special call trunks and including means for routing calls on the associated trunks to said special operators' positions, means including automatic switches controllable from said special operators' positions for routing calls from said special operators' positions to said switching means, whereby three-way talking circuits including said special operators' positions may be established, and means provided at each of said special operators' positions for splitting a three-way talking circuit established by way of one of said special trunks and one of said automatic switches to exclude either the calling or the called end of the connection from said talking circuit.

14. In a telephone system, a central exchange, a branch exchange area including a plurality of special operators' positions and branch exchange switching means, regular trunks extending from said central exchange to said switching means, special call trunks extending from said central exchange to said branch exchange area, trunk circuit apparatus associated with said special call trunks and including means for routing calls on the associated trunks to said special operators' positions, switches individually provided at said operators' positions and each having two operating positions, position circuits individual to said operators' positions and each including means only operated when the associated position switch occupies one of its positions for rendering the associated operators' position accessible to said trunk circuit apparatus, and means including position finders having access to said operators' positions and operative in response to operation of said switches to their other positions for routing calls from said special operators' positions to said branch exchange switching means.

15. In a telephone system, a central exchange, a branch exchange area including a plurality of special operators' positions and branch exchange switching means, regular trunks extending from said central exchange to said switching means, special call trunks extending from said central exchange to said branch exchange area, trunk circuits individual to said special call trunks and including means for routing calls on the associated trunks to idle ones of said special operators' positions, transfer trunks individual to said trunk circuits, automatic switching means controllable from said special operators' positions for transferring calls present on said special call trunks over said transfer trunks to said branch exchange switching means, an all-busy signal control device common to said special call trunks, multiple marking paths individual to said trunk circuits for controlling said device, each of said paths being altered in one manner in response to operation of the associated trunk circuit, and means individual to said transfer trunks for altering the associated paths in the same manner when a call is present on the associated transfer trunk and the associated trunk circuit is released.

16. In a telephone system, a central exchange, a branch exchange area including a plurality of special operators' positions and branch exchange switching means, regular trunks extending from said central exchange to said switching means, special call trunks extending from said central exchange to said branch exchange area, trunk circuits individual to said special call trunks and including means for routing calls on the associated trunks to idle ones of said special operators' positions, transfer trunks individual to said trunk circuits, means controllable from

said special operators' positions for transferring calls present on said special call trunks over said transfer trunks to said branch exchange switching means, an all-busy signal control device common to said special call trunks, multiple marking paths individual to said trunk circuits for controlling said device, each of said paths being altered in one manner in response to operation of the associated trunk circuit, and means individual to said transfer trunks for altering the associated paths in the same manner when a call is present on the associated transfer trunk and the associated trunk circuit is released.

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