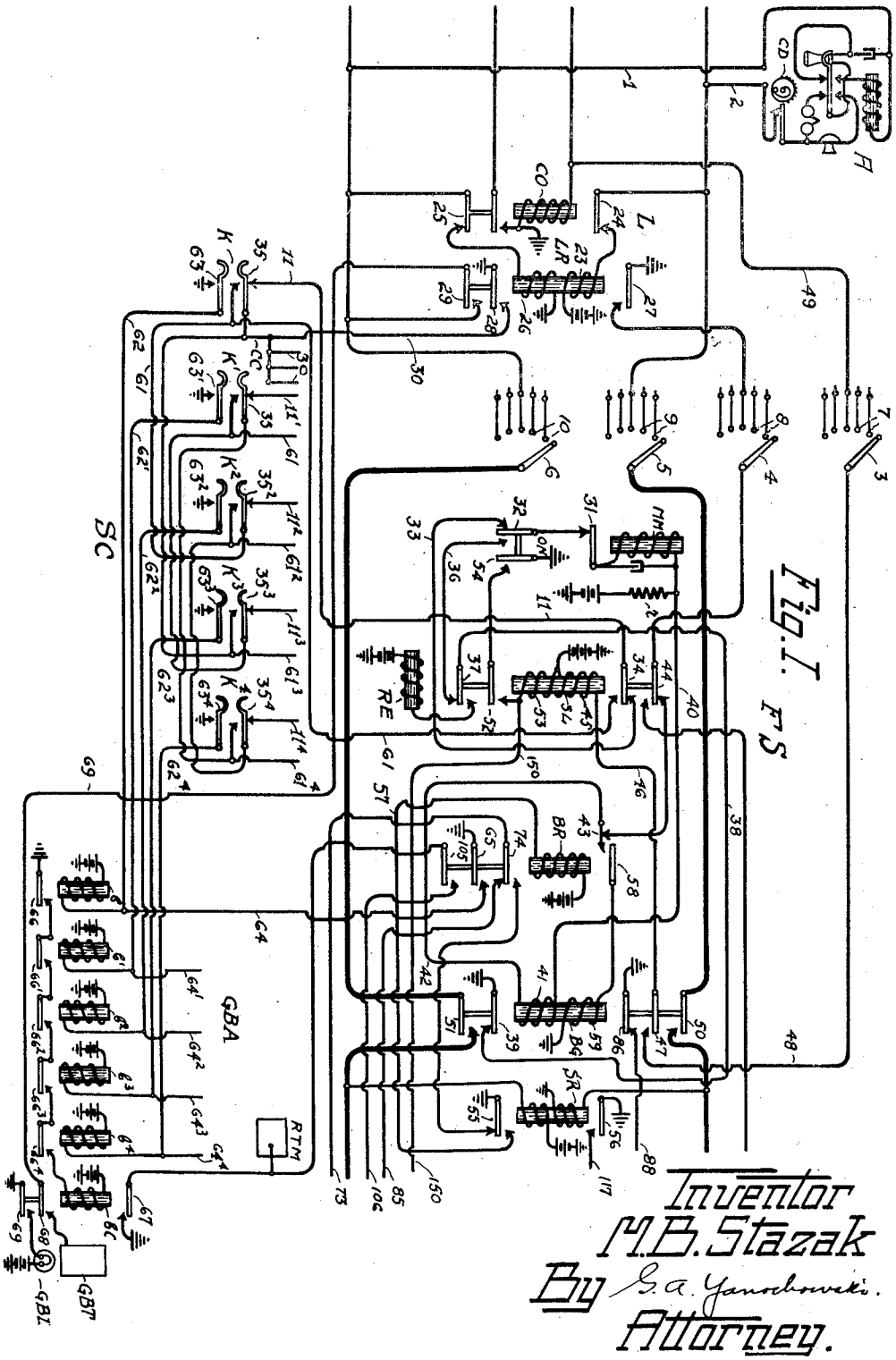
Oct. 27, 1931. M. B. STAZAK 1,829,071

TELEPHONE SYSTEM

Filed Oct. 29, 1929 4 Sheets-Sheet 1



Inventor
M. B. Stazak
By G. A. Yanochowski.
Attorney.

Oct. 27, 1931. M. B. STAZAK 1,829,071

TELEPHONE SYSTEM

Filed Oct. 29, 1929 4 Sheets-Sheet 2

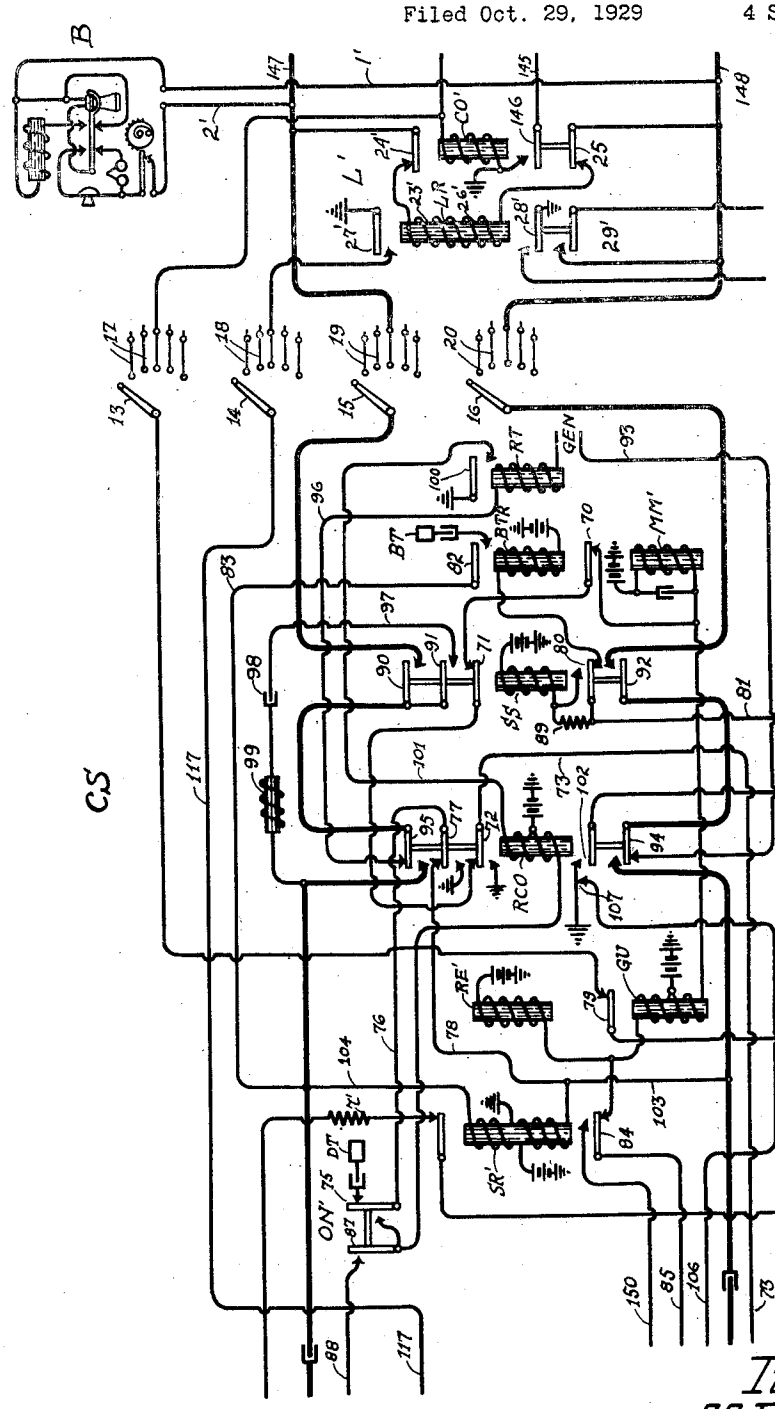


Fig. 2.

Inventor
M. B. Stazak
By S. A. Gawrowski.
Attorney.

Oct. 27, 1931. M. B. STAZAK 1,829,071

TELEPHONE SYSTEM

Filed Oct. 29, 1929 4 Sheets-Sheet 3

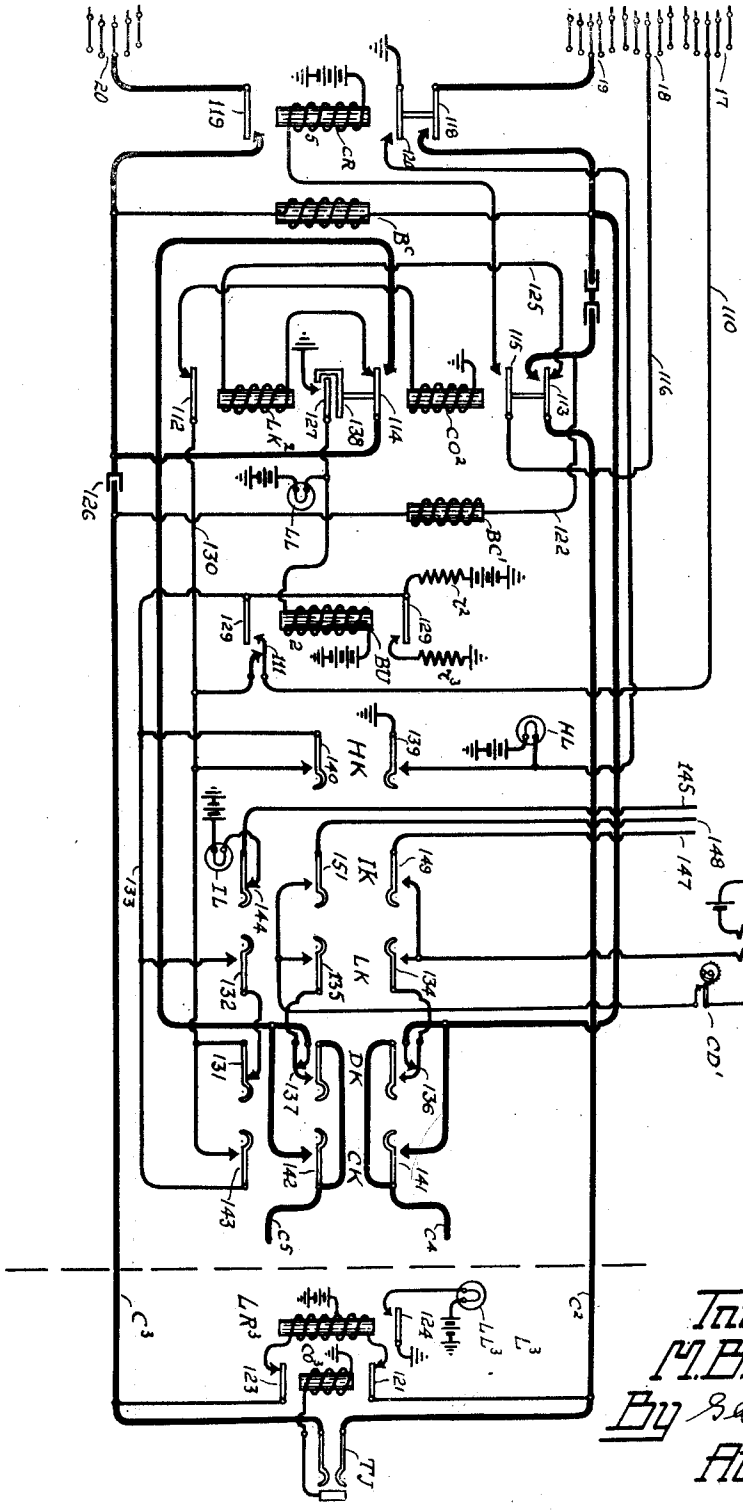


Fig. 3.

Inventor
M. B. Stazak
By S. A. Yanchowski,
Attorney.

Oct. 27, 1931. M. B. STAZAK 1,829,071

TELEPHONE SYSTEM

Filed Oct. 29, 1929 4 Sheets-Sheet 4

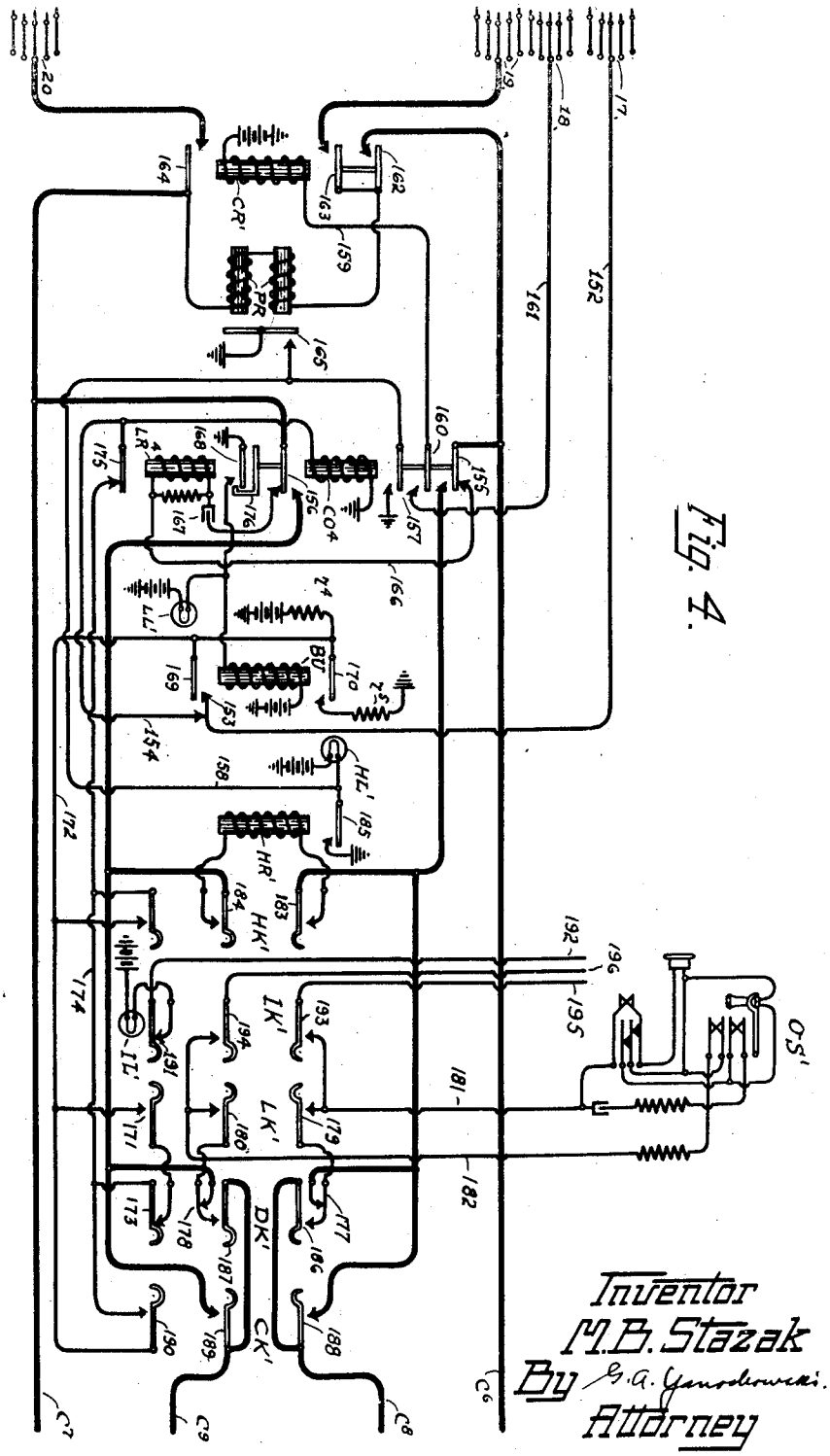


Fig. 4.

Inventor
M. B. Stazak
By S. A. Yanoshowski.
Attorney

Patented Oct. 27, 1931 1,829,071

UNITED STATES PATENT OFFICE

MICHAEL B. STAZAK, OF CHICAGO, ILLINOIS, ASSIGNOR TO KELLOGG SWITCHBOARD AND SUPPLY COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF ILLINOIS

TELEPHONE SYSTEM

Application filed October 29, 1929. Serial No. 403,293.

My invention relates to telephone systems and more particularly to systems in which a number of subscribers' lines terminate at a private automatic exchange which is operatively connected to a main exchange of the automatic type or of the manual type. My invention comprises a system in which a group of subscribers' lines terminate in a set of contacts associated with a group of finder switches which locate and seize the calling line and connect it to a connector switch which is set in operation by impulses of current controlled at the calling subscriber's station to select the line associated with the called subscriber or the trunk line extending to the main exchange or the information line which leads to an attendant's station associated with the private automatic exchange.

A feature of my invention is the combination with such a system of a starting circuit whereby any one of the finder switches in the group may be removed from the group without affecting the operation of the other finder switches in the group.

Another feature of my invention is the provision in such a system of a group busy alarm which informs the calling subscriber of the busy condition of the group of finder switches with which he is connected.

Another feature of my invention is the combination of means in such a system which permit a private automatic exchange subscriber to call a subscriber at an automatic or a manual main exchange.

Another feature of my invention is the provision in such a system of means whereby the subscriber at the private exchange may receive calls from either a manual or an automatic main exchange through the medium of an attendant's station.

A feature of my invention is the provision in such a system of means permitting the subscriber at the private exchange upon the termination of a conversation with a called main exchange subscriber to release all the apparatus at the private exchange involved in setting up the connection.

A feature of my invention is the provision of means whereby the called party controls the release of the apparatus on local connections and the party originating the call controls the release on trunk connections.

A feature of my invention is the provision in such a system permitting the use of two way trunk lines to both manual and automatic main exchanges.

Other features of the invention will be disclosed as the description of the system progresses.

For a more complete understanding of my invention reference may be had to the accompanying drawings in which:

Fig. 1 illustrates diagrammatically a calling subscriber's line, a finder switch, a starting circuit and a group busy alarm;

Fig. 2 illustrates diagrammatically a connector switch, and a called subscriber's station and line circuit;

Fig. 3 illustrates diagrammatically a two way trunk line extending to a manual main exchange;

Fig. 4 illustrates diagrammatically a two way trunk line extending to an automatic main exchange.

Referring more particularly to the drawings, Fig. 1 discloses a subscriber's station A of the usual type connected by conductors 1 and 2 to the private automatic exchange where it terminates in line circuit L which consists of the line relay LR and cut off relay CO. The finder switch FS comprises a motor magnet MM which automatically operates when a call is initiated by the subscriber at substation A to step the wipers 3, 4, 5 and 6 over the bank contacts 7, 8, 9 and 10 to select the contacts of the calling line. A bridging relay BG is provided and energizes when the calling line is seized by the switch FS to shunt the motor magnet MM to prevent further advancement of the wipers 3, 4, 5 and 6 and to connect the calling line to the connector switch CS. The sleeve relay SL energizes upon the actuation of relay BG to extend the starting conductor 11 to the next finder switch FS of the group (not shown). A release magnet RE which energizes to restore the wipers 3, 4, 5 and 6 to normal is also provided. A supervisory relay SR is provided and operates when the subscriber actuates his dialing mechanism to operate the connector

switch CS and a busying relay BR is provided to cause the relay b of the group busy alarm GBA to operate.

The starting circuit SC is provided to connect the group of finder switches of which FS is one to ground at whichever of the line relays has operated. A plurality of keys k, k', k^2, k^3 and k^4 are provided and connect the finder switches of the group to a common conductor cc. A group busy alarm GBA is associated with the starting circuit SC and comprises a series of busying relays b, b', b^2, b^3 and b^4, a busy tone connecting relay bc, a group busy lamp GBL and a group busy tone GBT which is connected to the calling subscriber's line when all the finder switches of the group have been rendered busy. A ringing tone machine RTM is also provided. This machine is set into operation when a finder switch FS is selected to provide the ringing current for signaling the desired party and for supplying the different tones to the system.

The connector switch CS shown in Fig. 2 is of a construction substantially similar to that of the finder switch FS and comprises a shaft carrying wipers 13, 14, 15 and 16 which are adapted to be stepped into engagement with the contacts 17, 18, 19 and 20 through the medium of a motor magnet MM'. A release magnet RE' is also provided which when actuated releases the switch wipers 13, 14, 15 and 16 and restores them to normal. The connector switch is of the rotary type and the "tens" contacts of the bank contacts 17, 18, 19 and 20 are left blank, that is, the tenth, twentieth, thirtieth, etc. contacts are not connected to a subscriber's line but are left blank or on open circuit. Assuming that a subscriber is calling a subscriber whose line is connected to the twenty-fifth set of contacts; the subscriber will operate his calling device and send ten impulses which will operate the connector switch CS to cause the wipers to engage the tenth set of contacts in the bank which are blank. The subscriber again actuates his dialing mechanism to send the second group of impulses which will step the wipers of the connector into engagement with the twentieth set of contacts of the bank which are also blank and the final five impulses will step the wipers of the switch into engagement with the twenty-fifth set of contacts which are the contacts of the wanted line. If the tenth and twentieth sets of contacts had a subscriber's line connected thereto which was connected in a conversational circuit there would be interference with the connection when the wipers engaged the tenth and twentieth sets of contacts but by leaving the said contacts blank the wipers will not cause interference with an established connection in setting up another connection. A guard relay GU, a supervisory relay SR', a secret service relay SS, a ringing cut off relay RCO and a ringing trip relay RT are also provided. A calling subscriber's line B is shown connected to a line circuit L' over conductors 1' and 2'. The line circuit L' comprises a line relay LR' and a cut off relay CO'.

Fig. 3 shows the apparatus used in completing both incoming and outgoing calls to a manual main exchange which consists of a line relay LR^2, a cut off relay CO^2, a connecting relay CR and a busying relay BU. An operator's set OS is furnished and may be connected in circuit with the conductors leading to the main exchange by means of the listening key LK. A dial key DK, a connecting key CK, and a holding key HK are also provided. An information key IK and an information lamp IL are also provided. The apparatus located to the right of the broken line illustrates a line circuit L^3 located at a manual main exchange and comprises a line lamp LL^3, a line relay LR^3, a cut off relay CO^3 and a trunk jack TJ. The contacts 17, 18, 19 and 20 are adapted to be engaged by the wipers 13, 14, 15 and 16 of the connector switch CS.

In Fig. 4 is shown the apparatus for completing trunk calls to and from an automatic main exchange. This comprises a line relay LR^4 adapted to be energized by ringing current from a main exchange over conductors c^6 and c^7 to light a line lamp LL'. A listening key LK' is provided to connect operator's set OS' to the trunk conductors and to energize a cut off relay CO^4 which restores the line relay LR^4 and closes a circuit for a connecting relay CR^4 which closes the talking conductors. A holding key HK' may be operated to hold the trunk line and to energize a holding relay HR' which lights a hold lamp HL' which keeps the attendant informed as to the condition of the call. The usual dial key DK', information key IK' and connecting key CK' are also provided. Contacts 17, 18, 19 and 20 are adapted to be engaged by the wipers of the connector switch CS.

Having described in general the circuit arrangement of the apparatus used in my invention I will next describe the operation of the same in establishing the different connections. Assuming that the subscriber A desires to converse with a subscriber B located at the same private automatic exchange. The removal of the receiver at A closes the switchhook contacts at A which establishes an energizing circuit for the line relay LR of line circuit L, current flowing from battery, through the upper winding 23 of LR, normal closed contact 24 of relay CO, conductor 2, through the now closed switchhook contacts at the subscriber's station A; conductor 1, normal closed contact 25 of CO and to ground through the lower winding 26 of relay LR. The line relay LR energizes and closes its alternate contacts 27, 28 and 29. The closure of contact 28 grounds the conductor 30

and causes the motor magnet MM to operate to step the wipers 3, 4, 5 and 6 into engagement with the first set of contacts 7, 8, 9 and 10. The energizing circuit of motor magnet MM may be traced from battery, resistance *r*, motor magnet MM, normal closed contact 31, normal closed contact 32 of the off normal contacts ON, conductor 33, closed contact 34 of sleeve relay SL, conductor 11, normal closed contact 35 of key *k* of the starting circuit SC, common starting conductor *cc* and conductor 30 to ground at alternate contact 28 of LR. The circuit of the motor magnet MM is opened upon the first step of the wipers 3, 4, 5 and 6 due to the opening of contact 32 of the off normal contacts ON which assume their alternate position upon the first movement of the wipers 3, 4, 5 and 6. A substitute circuit is established if the first set of contacts 7, 8, 9 and 10 are not the contacts of the line of the calling subscriber A. This circuit is traced from battery, resistance *r*, motor magnet MM, closed contact 31, alternate contact 32, conductor 36, normal closed contact 37 of relay SR, conductor 38, to ground at normal closed contact 39 of bridging relay BG. The motor magnet is thus again energized to step the wipers into engagement with the next set of contacts. The contact 31 is moved to its alternate position and thus opens the energizing circuit of the motor magnet MM which immediately releases its armature and again closes contact 31 to establish another energizing circuit for the motor magnet MM to again step the wipers 3, 4, 5 and 6 into engagement with the next set of contacts. The alternate opening and closing of the contact 31 causes the wipers to be stepped over the contacts 7, 8, 9 and 10 in search of the contacts of the calling line. A condenser *x* is bridged across the motor magnet MM to prevent sparking during the rapid opening and closing of contact 31.

When the said contacts 7, 8, 9 and 10 of the calling line are reached the wipers cease further travel because the instant wiper 4 engages the contact 8 associated with the calling line an energizing circuit for the bridging relay BG is closed. It may be traced from battery, through resistance *r*, conductor 40, lower winding 41 of relay BG, conductor 42, closed contact 43 of BR, normal closed contact 44 of SL, wiper 4, contact 8 to ground at alternate contact 27 of line relay LR. The instant wiper 4 engages grounded contact 8 of the calling line the circuit just traced closes a low resistance path through the lower winding 41 of the bridging relay BG to shunt the motor magnet MM and prevent the further operation of the same. Upon energizing BG opens the circuit of motor magnet MM at its contact 39 and establishes an energizing circuit for the sleeve relay SL and cut off relay CO which may be traced from battery through the upper winding 45 of SL, conductor 46, alternate contact 47 of BG, conductor 48, wiper 3, contact 7, conductor 49 to ground through cut off relay CO which energizes and opens its contacts 24 and 25 to deenergize LR which removes ground from contact 8 and conductor 30. The removal of ground from contact 8 allows the wipers of another finder switch to pass over the line of subscriber A should another finder switch of the group be operated while A is connected to finder switch FS. The heavily marked talking conductors are closed at alternate contacts 50 and 51. The closing of contact 52 of relay SL closes a locking circuit for SL traced from battery through the lower winding 53 of SL, alternate contact 52 of SL and to ground at alternate contact 54 of off normal contacts ON. This circuit maintains the sleeve relay SL in its energized condition.

Upon the closure of alternate contacts 50 and 51 of BG an energizing circuit is established for the supervisory relay SR which may be traced from battery through the lower winding of relay SR, alternate contact 51 of BG, wiper 6 and contact 10 over the subscriber's line through the substation A and back through contact 9 and wiper 5, alternate contact 50 and to ground through the upper winding of SR. Relay SR energizes and closes its alternate contact 55 which energizes busying relay BR over a circuit traced from battery through the winding of BR, conductor 57 to ground at alternate contact 55 of SR. The opening of contact 44 of SL interrupted the original energizing circuit of bridging relay BG but a substitute circuit is closed through alternate make before break contact 58 of BR and the bridging relay BG is maintained energized by current flowing from battery through resistance *r*, conductor 40, lower winding 41 of BG, conductor 42, alternate contact 58 to ground through upper winding 59 of BG.

The closing of contact 105 of BR establishes an operating circuit for the ringing tone machine RTM which thereupon operates to supply ringing current, the group busy tone, the regular busy tone and the dial tone. The circuit for RTM may be traced from ground at normal contact 107 of RCO, conductor 106, alternate contact 105 of BR to battery at the ringing tone machine RTM.

When sleeve relay SL operates it closes its alternate contact 34 which extends the common starting conductor *cc* to the next finder switch of the group. Assume that another subscriber of the group wishes to place a call. The removal of the receiver at the substation will operate the line relay of the connected line circuit which will cause ground to be connected through an armature 28 to one of the conductors 30 and thence to the common starting conductor *cc*, through the normal closed contact 35 of the key *k*,

over conductor 11, alternate contact 34 of SL, conductor 61 to contact 35^2 of key k^2 and thence over conductor 11^2 to the motor magnet of the third finder switch of the group. If the third finder switch of the group is in use the ground connection will be extended through the contact 34 of the relay SL of the third switch over conductor 61^2 to the fifth switch through contact 35^4 of key k^4 and conductor 11^4. If the fifth switch is in use the connection will be extended over conductor 62^4 to the second switch and if it is busy the connection will be extended to the fourth switch over conductor 61'. If all the switches are busy the subscriber will receive a group busy tone as will be hereinafter described.

If it is desired to remove any of the finder switches of the group from operation the key of the starting circuit associated with the finder switch to be removed may be moved to its alternate position. For instance if the finder switch FS is the one to be cut out of the group the key k will be operated and contacts 35 and 63 will assume their alternate positions. The common starting conductor cc will in such case be connected directly to conductor 61 through alternate contact 35 of key k and the ground connected to any of the conductors 30, should a subscriber call, will be connected immediately to the next switch of the group and not to switch FS over conductor 11. The closure of contact 63 grounds conductor 62 and causes the operation of busying relay b of the group busy alarm GBA by current flowing from battery through the winding of relay b over conductor 62 to ground at alternate contact 63 of key k.

Upon the operation of busying relay BR of the finder switch FS an energizing circuit is established for the relay b traced from battery through relay b and conductor 64 to ground at alternate contact 65 of relay BR. The relay b operates and closes contact 66 which is grounded. The relays b, b', b^2, b^3 and b^4 are each associated with a finder switch of the group and with the corresponding keys k, k', k^2, k^3 and k^4 of the starting circuit SC and are electrically connected to the same by conductors 64, 64', etc. and conductors 62, 62', etc. Whenever a finder switch is connected to a subscriber's station the busying relay BR of the finder switch will close an energizing circuit for the relay b, b', etc. associated with it. Likewise the operation of any one of the keys k, k', etc. of the starting circuit will operate the associated relay b, b', etc. to cause it to close its contact 66, 66', etc. If all the finder switches are busy or are out of use and the associated key k, k', etc. is operated an energizing circuit for the group busy tone connecting relay bc will be closed. This circuit may be traced from battery through the relay bc, alternate contacts 66^4, 66^3, 66^2, 66' and 66 of relays b^4, b^3, b^2, b' and b to ground. The relay bc will operate and close its contacts 67, 68 and 69. The closure of contact 67 establishes an energizing circuit for the ringing tone machine RTM traced from ground, alternate contact 67 of bc, to battery and ground at the ringing tone machine RTM. The closure of contact 69 operates the group busy lamp GBL and the closure of contact 68 connects a group busy tone device GBT to the subscriber's line to give a distinctive tone to the subscriber to inform the subscriber that all the finder switches are busy. This tone may be traced from the group busy tone GBT. through alternate contact 68, conductor 69, alternate contact 29 of the relay LR, associated with the calling subscriber, conductor 1 to the receiver at the subscriber's substation.

It will be remembered that the relay BG had energized to connect the subscriber's set at A to the connecting switch CS. As soon as the relay BG operates to connect the finder switch FS to the connector switch CS the subscriber will receive a dialing tone which informs the subscriber that the dialing may be started. This tone may be traced from the dial tone mechanism DT, normal contact 75 of off normal springs ON', conductor 76, normal contact 77 of RCO, conductor 78 to the heavily marked talking conductor and thence to substation A over the line. The subscriber at A operates the calling device CD which interrupts the energizing circuit of supervisory relay SR causing it to restore its contacts to normal each time the energizing circuit therefor is opened. As soon as contact 55 of SR is restored to normal an energizing circuit is established for the motor magnet MM' and the guard relay GU traced from battery through the lower winding of relay GU and from battery through the winding of the motor magnet MM', normal contact 70 of the busy tone relay BTR, normal contact 71 of secret service relay SS, normal contact 72 of ringing cut off relay RCO, conductor 73, alternate contact 74 of BR, normal contact 55 of SR. The motor magnet MM' energizes over this circuit each time the relay SR restores and steps the wipers 13, 14, 15 and 16 into engagement with the next set of contacts. The guard relay GU energizes and opens its contact 79 to prevent the secret service relay SS from operating as the wipers 13, 14, 15 and 16 pass over the contacts associated with unwanted substations. The guard relay GU is slow to release and remains energized during the interruptions caused by the opening and closing of the contact 55. Relay BR is of the slow to release type and the rapid flickering of contact 55 has no effect upon the relay BR which remains energized during the dialing by the subscriber. After the dialing has been completed and the contacts of the wanted line have been engaged by the wipers of

the connector switch CS the guard relay GU returns to normal as its energizing circuit has been opened at the contact 55.

If the desired line is busy the closure of contact 79 of GU establishes an energizing circuit for the busy tone relay BTR traced from battery through the winding of BTR, normal contact 80 of relay SS, conductor 81, normal contact 79 of GU, wiper 13, contact 17 to ground through the cut off relay CO' of the line circuit L' to which subscriber B is connected. Relay BTR operates and connects a busy tone to the calling subscriber's line to indicate that the called line is busy. This tone may be traced from the busy tone device BT, alternate contac 82, conductor 83 to the heavily marked conductor and thence over the line to the subscriber at A. The opening of contact 70 of BTR opens the energizing circuit of motor magnet MM' and prevents the subscriber from again operating the motor magnet and its associated wipers. The release magnet RE' is prevented from restoring the wipers 13, 14, 15 and 16 to their normal position because the energizing circuit for release magnet RE' is open at alternate contact 74 of BR. The subscriber at A hangs up the receiver which opens the energizing circuit of relay SR which restores its contacts 55 and 56 to normal. The opening of contact 55 causes the deenergization of relay BR which opens the locking circuit of BG at contact 58 and BG restores closing its contact 39 which energizes the release magnet RE. Current flowing from battery, through RE, alternate contact 37 of SL. conductor 38, normal contact 39 to ground. Release magnet RE restores the wipers 3, 4, 5 and 6 and off normal springs ON to normal. The opening of off normal contact 54 opens the locking circuit of SL and it restores to normal opening its contact 34 which again puts the finder switch in condition to be seized by another subscriber. The opening of contact 65 of BR opens the energizing circuit of relay b of the group busy alarm GBA and it opens its contact 66. The restoring to normal of contact 86 of BG establishes an energizing circuit for the ringing cut off relay RCO of the connector switch CS which may be traced from battery through the lower winding of relay RCO, alternate contact 87 of off normal springs ON' which assumed their off normal position upon the first movement of the wipers 13, 14. 15 and 16. conductor 88 to ground at normal contact 86 of BG. This establishes an energizing circuit for the release magnet RE' traced from battery, through the winding of RE', normal contact 84 of SS. conductor 85. normal contact 74, conductor 73, to ground at alternate contact 72 of RCO. The release magnet RE' operates and restores the wipers 13. 14, 15 and 16 and the off normal contacts ON' to normal. The opening of off normal spring 87 opens the energizing circuit of RCO which deenergizes and opens the circuit of RE'. The energizing circuit of relay BTR is interrupted when wiper 13 returns to normal so all the apparatus used is now at normal.

Assume now that the called line was idle. The restoring to normal of contact 79 of GU upon the cessation of dialing establishes an energizing circuit for the secret service relay SS which may be traced from battery through the winding of relay SS, high resistance winding 89, conductor 81, normal contact 79, wiper 13, and contact 17 to ground through the winding of the cut off relay CO' of the line circuit L' associated with the called subscriber's line. As soon as relay SS operates a locking circuit is established for the relay SS through its alternate contact 80. This substitute circuit shunts out the high resistance winding 89 and allows the cut off relay CO' of the called subscriber's line to operate to cut off the line relay LR' from the called subscriber's line. The shunting of the high resistance winding 89 prevents another connector switch of the group from placing a call at the subscriber's substation B because the relay SS in the second connector switch which has its wipers engaging the contacts of the called line will fail to operate due to the high resistance winding 89 of the second connector being in the energizing circuit. The relay SS of the second connector failing to operate the relay BTR of the second switch will operate and the process will be as before described. The energizing of SS also closed contacts 90, 91 and 92 which immediately connects ringing current to the called subscriber's line. The circuit for the ringing current may be traced from a source of interrupted generator current, conductor 93. normal contact 94 of ringing cut off relay RCO, alternate contact 92 of SS, wiper 16, contact 20, over the subscriber's line and through the bell at the substation B, contact 19, wiper 15, closed contact 90 of SS, normal contact 95 of RCO, conductor 96 and through the winding of ringing trip relay RT back to the source of generator current. A revertive ringing system is provided to inform the calling subscriber A that the signaling of B has commenced. This circuit may be traced from alternate contacts 90 and 91 of SS, conductor 97, condenser 98, retard coil 99 and over the heavily marked conductors to the receiver at station A. The ringing current is applied intermittently until the called subscriber B answers or the calling subscriber abandons the call. Upon the removal of the receiver at station B an energizing circuit is established for the ringing trip relay RT traced over the ringing current path but through the closed switchhook contacts at B. Relay RT energizes and closes its contact 100 which establishes an energizing circuit for ringing cut off relay RCO which may be traced from bat-

tery through the upper winding of RCO, conductor 101, and alternate contact 100 of RT to ground. Relay RCO closes a locking circuit for itself which may be traced from battery through the lower winding of RCO, alternate contacts 87 and 75 of ON′, conductor 76, and alternate contact 77 of RCO to ground. The ringing current is cut off from the subscriber's line by the opening of contacts 94 and 95 and the subscribers at A and B are connected in a conversational circuit by the closing of alternate contacts 94 and 95 over the heavily marked conductors. An energizing circuit for the supervisory relay SR′ is also established by the closing of alternate contacts 94 and 95 of RCO. This circuit may be traced from battery through the lower winding of SR, conductor 103, alternate contact 94 of RCO, alternate contact 92 of SS, wiper 16, contact 20, over the subscriber's line and closed switchhook contacts, back through contact 19 and wiper 15, alternate contact 90 of SS, alternate contact 95 of RCO, conductor 104 to ground through the upper winding of supervisory relay SR′. Relay SR′ energizes and attracts its armature 84 to control the operation of the release magnet RE′. The opening of normal contact 102 of relay RCO opens the operating circuit for the ringing tone machine RTM and the same discontinues further operation until another finder switch FS is seized by a calling subscriber. Battery is supplied to the talking circuit of the calling subscriber A through the windings of the supervisory relay SR and to the talking circuit of the subscriber B through the supervisory relay SR′.

Upon the termination of the conversation the subscribers at A and B replace their receivers upon their respective switchhooks. The replacement of the receiver at A opens the energizing circuit of SR which restores to normal opening its alternate contact 55 which breaks the energizing circuit of relay BR which restores its contacts to normal. This last restoration opens the energizing circuit for relay *b* of the group busy alarm GBA which restores its contact 66 to normal. The restoration of contact 58 to normal opens the locking circuit of bridging relay BG which restores thereby opening the talking circuit at contacts 50 and 51 and establishing an energizing circuit for the release magnet RE as previously traced. The release magnet RE operates and restores the wipers 3, 4, 5 and 6 and off normal contacts ON to normal. The locking circuit of SL is broken at 54 of ON but a substitute circuit is closed at normal contact 74 of BR. This circuit may be traced from battery, through the lower winding of relay SL, conductor 150, alternate contact 84 of SR′, conductor 85, normal contact 74 of BR, conductor 73, to ground at alternate contact 72 of RCO. The sleeve relay SL and release magnet RE remain energized and under the control of the subscriber B by means of relay SR′.

The replacing of the receiver at B breaks the circuit of supervisory relay SR′ which restores its contact 84 to open the circuit of relay SL which restores to normal and opens the circuit of release magnet RE which restores. All the apparatus of the finder switch FS is now at normal and the opening of alternate contact 34 of SL places the switch FS in position to seize another calling line. The closure of normal contact 84 of SR′ establishes a circuit for the release magnet RE′ which circuit may be traced from battery through the winding of RE′, normal contact 84 of SR′, conductor 85, normal contact 74 of BR, which restored to normal as above described, conductor 83, to ground at alternate contact 72 of RCO. It will be noted that the release magnet of the connector switch CS cannot operate until the subscriber A has replaced his receiver to restore the relay BR. Release magnet RE′ restores the wipers 13, 14, 15 and 16 and off normal contacts 75 and 87 to normal. The restoration of contact 75 of ON′ breaks the locking circuit of RCO which restores its contacts thereby breaking the energizing circuit of release magnet RE′ at contact 72 which restores. The circuit for relay SS is broken at wiper 13 which restores when the release magnet RE′ operates and all the apparatus of the connector switch is at normal.

Certain of the contacts 17, 18, 19 and 20 are connected to trunk lines which interconnect the private automatic exchange and main exchanges of both the manual and automatic type. In fact the contacts 18 are only connected in the circuit when the trunk lines are used. Other contacts 17, 19 and 20 lead to information lines which terminate at the attendant's station in the information key. The trunk lines used are of the two-wire type; that is only two conductors extend between the exchanges for each trunk line, and both incoming and outgoing calls may be handled over the same trunk line. The apparatus shown in Fig. 3 is used in interconnecting the private automatic exchange with a manual exchange over the conductors c^2 and c^3 which terminate in a trunk jack TJ located at the manual main exchange. It is possible by my circuit arrangement for a subscriber at the private exchange to complete a call to a manual main exchange subscriber unassisted; or to signal the attendant over the information line and have the attendant secure the main exchange subscriber. Calls originating at the main exchange can be completed only by the attendant extending the call to the private exchange subscriber.

Should a subscriber such as A desire to call a subscriber at the manual main exchange he will proceed in the same manner as in calling

a local subscriber except that he will dial the number of the trunk line. The connector switch CS steps the wipers 13, 14, 15 and 16 into engagement with contacts 17, 18, 19 and 20 associated with the trunk line shown in Fig. 3. The energizing circuit which held the guard relay GU operated during the dialing operation is broken at normal contact 55 of SR and the relay GU restores its contact 79. If the called trunk line is idle an energizing circuit for the secret service relay SS is closed. This circuit may be traced from battery through the winding of SS, resistance 89, conductor 81, normal contact 79, wiper 13, contact 17, conductor 110, normal contact 111 of busying relay BU, normal contact 112 of LR^2, and the winding of cut off relay CO^2. Relay CO^2 also energizes over this circuit and closes its contacts 113 and 114 to close the talking conductors which are heavily marked in Fig. 3 and to disconnect the line relay LR^2 from the line at the said contacts 113 and 114. The closure of contact 115 establishes an energizing circuit for the connecting relay CR which is energized by current flowing from battery through the winding of CR, alternate contact 115 of CO^2, conductor 116, contact 18, wiper 14, conductor 117, to ground at alternate contact 56 of relay SR. Relay CR energizes and closes its alternate contacts 118 and 119 which complete the circuit of the talking conductors and connects bridging coil BC across the line to operate the ringing trip relay RT of CS which closes its contact 100 which causes the energization of ringing cut off relay RCO which closes its alternate contacts 94 and 95 to operate the supervisory relay SR′ through the coil BC and to extend the subscriber A to the trunk jack TJ at the main exchange. The closing of alternate contact 113 of CO^2 places the bridging coil BC′ across the conductors c^2 and c^3 leading to the main exchange and causes the operation of line relay LR^3 at the main exchange. The closing of contact 120 of CR causes the lighting of the hold lamp HL which informs the attendant that the trunk is being held for a connection and is busy. Relay LR^3 is energized by current flowing from battery through the upper winding of LR^3, normal contact 121 of CO^3, conductor c^2, alternate contact 113 of CO^2, conductor 122, bridging coil BC′, conductor c^3, normal contact 123, to ground through the lower winding of LR^3. Relay LR^3 closes its alternate contact 124 to cause the illumination of line lamp LL^3 which informs the operator at the main exchange that a line desires attention. The main exchange operator will insert a plug of a cord circuit into the trunk jack TJ which will cause the energization of cut off relay CO^3 by current flowing from the main exchange to ground through the relay CO^3, which opens normal contacts 121 and 123 to cause the deenergization of LR^3 and the subsequent effacement of the line lamp LL^3. The operator at the main exchange will complete the call in the usual and well known manner.

Upon the termination of conversation the main exchange subscriber replaces the receiver upon the switchhook which gives a disconnect signal to the main exchange operator but does not affect any of the apparatus at the private automatic exchange which is entirely under the control of the local subscriber A. The restoration of the receiver at A interrupts the energizing circuit of supervisory relay SR of FS which opens its alternate contact 55 which causes the deenergization of busying relay BR. The opening of contact 58 of BR breaks the holding circuit of relay BG which restores its contacts to normal to open the circuit for cut off relay CO of the line circuit L which restores its contacts 24 and 25 to again place the line relay in circuit with the line conductors 1 and 2. The closing of normal contact 39 of BG establishes an energizing circuit for the release magnet RE which may be traced from battery through the magnet RE, alternate contact 37 of SL, conductor 38, normal contact 39 of BG to ground. The release magnet restores the wipers 3, 4, 5 and 6 and the off normal springs ON to normal. The opening of contact 56 of SR opens the circuit of connecting relay CR which restores its contacts 118 and 119 to open the talking conductors and interrupt the circuit of SR′ through the coil BC which restores its contact 84. The restoration of contact 54 of ON breaks the holding circuit of SL which also restores and opens its contact 37 to deenergize the release magnet RE and closes its normal contact 34 to again connect the finder switch FS to the common starting conductor *cc*. The opening of contact 65 of BR causes the deenergization of relay *b* of GBA and the closing of normal contact 74 of BR establishes an energizing circuit for the release magnet RE′ of CS which may be traced from battery, through magnet RE′, normal contact 84 of SR′ which has restored, conductor 85, normal contact 74 of BR, conductor 73 to ground at alternate contact 72 of RCO. The release magnet RE′ operates and restores the wipers 13, 14, 15 and 16 and the contacts 75 and 87 of ON′ o normal. The locking circuit of RCO is opened at 75 and RCO restores its contacts 94 and 95 to open the talking conductors and its contact 72 to deenergize the release magnet RE′. The circuit of SS is opened by the restoration of wiper 13 and it restores to normal. All the apparatus at FS and CS is now at normal. The restoration of wiper 13 also interrupted the circuit of CO^2 which restored its contacts to again connect the line relay LR^2 across the line. The opening of alternate ccntact 113 of CO^2 disconnects the bridging

coil BC′ from the trunk conductors c^2 and c^3 and prevents the energization of LR^3 to falsely indicate a call.

If another subscriber dials the trunk line the wipers 13, 14, 15 and 16 of the second connector switch will engage multiple contacts 17, 18, 19 and 20 of the trunk line. The secret service relay SS of the second connector will not operate because of the high resistance winding 89 which is in the circuit. The busy tone relay BTR of the second connector will operate to transmit the busy tone signal to the second subscriber who will replace the receiver and restore the apparatus of the associated switches as before described. If a second operator at the main exchange attempts to insert a plug of a cord circuit into a multiple jack of the jack TJ she will receive the usual busy "click" because of the battery potential on the sleeve of the jack supplied from the first cord connected thereto. Thus the trunk line is rendered busy as soon as it is connected to at either end.

A call originating at the main exchange will be completed in the following manner. The insertion of the plug of a cord circuit into the jack TJ will cause the relay CO^3 to operate to cut off the line relay LR^3 from the line contacts 121 and 123 as before described. Ringing current is transmitted from the main exchange through jack TJ, conductor c^2, normal contact 113 of CO^2, conductor 125, line relay LR^2, normal contact 114 of CO^2, condenser 126, conductor c^3 and jack TJ back to the main exchange. The line relay LR^2 operates each time ringing current is sent over the line and restores as soon as the current is stopped. However, the contact 127 of LR^2 assumes its alternate position and remains locked in that position to furnish ground to the line lamp LL and to the busy relay BU both of which operate. The lamp LL glowing informs the attendant that an incoming call, that is one from the main exchange, has been placed. The relay BU closes its contact 129 which extends the conductor 110 to resistance r^3 and ground. This connection "busys" the contact 17 to prevent the connection of a connector switch CS with the trunk line. If a wiper 13 engages the contact 17 associated with the trunk line while the same is busy the relay SS will be included in an electrical circuit traced from battery through the relay SS, resistance 89, conductor 81, normal contact 79 of GU, wiper 13, contact 17, conductor 110, make before break contact 111, alternate contact 129 of BU, resistance r^3 to ground. The presence of resistances 89 and r^3 in the circuit prevent the operation of the relay SS but the busy tone relay BTR operates over this circuit to transmit a busy tone to the calling subscriber.

The attendant noticing the glowing of LL operates the listening key LK which closes its alternate contact 132 to establish an energizing circuit for the relay CO^2 which may be traced from battery through resistance r^2, conductor 133, alternate contact 132 of LK, normal contact 131 of DK, conductor 130, normal contact 112, the winding of CO^2 to ground. Relay CO^2 operates and the contacts 113 and 114 assume their alternate positions thus closing the talking conductors and disconnecting the line relay LR^2 from the line. Armature 138 is also attracted and restores the contact 127 of LR^2 to normal thus breaking the energizing circuits of LL and BU.

The restoration of BU again closes contact 111 to extend conductor 110 o the cut off relay CO^2 but a subscriber at the private automatic exchange cannot seize the trunk line as the secret service relay SS in the connector switch will not operate due to the resistances 89 and r^2 in the circuit. Thus it will be seen that a connector switch cannot be connected to a trunk line which is seized from the main exchange.

The closing of alternate contacts 113 and 114 of CO^2 connect the attendant and the main exchange subscriber in a talking circuit which may be traced from the operator's set OS, alternate contacts 134 and 135 of LK, normal contacts 136 and 137 of DK, alternate contacts 113 and 114 of CO^2 and conductors c^2 and c^3 to the main exchange. If one of the local subscribers is wanted the attendant will operate the holding key HK which closes a circuit for the hold lamp HL at alternate contact 139 which lights to inform the attendant that the trunk is being held. The closing of alternate contact 140 of HK forms another circuit for the relay CO^2 which remains energized. After receiving the necessary information the attendant operates the dialing key DK which disconnects the operator's set OS from the trunk conductors c^2 and c^3 at contacts 136 and 137 and connects the set OS to conductors c^4 and c^5 which lead to a line circuit similar to L in Fig. 1. The connection of the set OS across the conductors c^4 and c^5 will set a finder switch in motion to seize the calling line. The attendant will operate the dialing mechanism CD′ to step the wipers of the associated connector switch to the contacts of the called line. As soon as the called subscriber answers the attendant operates the connecting key CK which closes its contacts 141 and 142 to close the talking circuit for the local subscriber and main exchange subscriber. The attendant also releases the listening key LK, the dialing key DK and holding key HK which effaces the lamp HL. The supervisory relay SR of FS is held up through the bridging coil BC while the supervisory relay SR′ of CS is held up over the called subscriber's line. The relay CO^2 is maintained energized by current flowing through alternate contact 143 of key CK. The coil BC′ is bridged across the conductors c^2 and c^3 to maintain a super-

visory relay in the cord circuit at the main exchange.

Upon the termination of conversation the subscribers replace their receivers. The attendant restores the connecting key CK which opens its alternate contact 143 which deenergizes the relay CO^2 which restores its contacts 113 and 114 to again connect the line relay LR^2 across the line and to disconnect the bridging coil BC' from the line to give a disconnect signal at the manual main exchange. The opening of contacts 141 and 142 of CK breaks the holding circuit of relay SR of FS which restores to normal to cause the operation of relay magnets RE and RE' to restore to normal the switches FS and CS as before described provided the called subscriber has replaced his receiver.

A subscriber at a private automatic exchange may call the attendant by dialing the number given the information line. A finder switch FS will seize the calling line and connect it to a connector switch CS which will locate the contacts of the information line in the usual manner. When the wipers 13, 14, 15 and 16 engage the contacts 17, 18, 19 and 20 of the information line a circuit is established for the information lamp IL which may be traced from battery, through the lamp IL, normal contact 144 of information key IK, conductor 145 to ground at alternate contact 146 of cut off relay CO' of the line circuit of the information line. Relay CO' is only equipped with the contact 146 in the line circuit of the information line and contact 18 is left blank it being used only in trunk connections. The relay SS operates by battery flowing to ground at CO' but the ringing current thereby connected to contacts 19 and 20 has no effect. The attendant notices the lamp IL glowing and throws the information key IK which connects the operator's set OS to the contacts 19 and 20 through alternate contacts 149 and 151 and conductors 147 and 148. A circuit for the ringing trip relay RT is thus established through the operator's set OS and the said relay RT operates and closes contact 100 which operates RCO which closes the talking conductors at its contacts 94 and 95 to establish an energizing circuit for the supervisory relay SR' through the operator's set OS. The attendant and the calling subscriber are thus connected in a talking circuit.

The restoral of the apparatus used in such a connection is as follows. The replacement of the calling subscriber's receiver opens the circuit of supervisory relay SR and restores it. The restoration of IK opens the circuit of supervisory relay SR' and causes the connector switch CS and finder switch FS to restore.

A local subscriber may have the attendant complete a call to a subscriber at the main manual exchange. To do this the local subscriber dials the information line as just described and informs the attendant that a subscriber at the manual main exchange is desired. The attendant instructs the calling subscriber to replace the receiver and releases the information key IK which causes the restoration of the finder switch FS and connector switch CS as before described. The attendant operates the listening key LK which closes its alternate contact 132 to energize the cut off relay CO^2 to cut off the line relay LR^2 from the line. The closure of alternate contact 113 connects the bridging coil BC' across the line conductors and causes the operation of line relay LR^3 at the main exchange and the subsequent lighting of the line lamp LL^3. The subscriber at the main exchange is obtained in the usual and well known manner and the attendant operates the holding key HK which lights the hold lamp HL and the dialing key DK which disconnects the operator's set OS from the main exchange at make before break contacts 137 and connects it to the conductors c^4 and c^5 which lead to a line circuit similar to L of Fig. 1. This starts the operation of a finder switch FS which seizes the calling line and connects it to a connector switch CS which by means of the calling device CD' is stepped into engagement with the contacts of the local subscriber's line. When the local subscriber answers the attendant operates the connecting key CK which closes its contacts 141 and 142 to connect the local subscriber in a conversational circuit with the subscriber at the manual main exchange. The attendant releases the keys DK, LK and HK. The relay CO^2 is held energized by current flowing through contact 143 of CK during the connection. The bridging coil BC holds the supervisory relay SR of the switch FS in its energized position during the connection and the supervisory relay SR' of CS is held energized over the local subscriber's line.

Upon the termination of the conversation the subscribers replace their receivers, the operator at the main exchange will receive a disconnect signal but will not take down the connection at this time. The circuit for the relay SR' is broken at the substation of the local subscriber but CS will not restore because SR of FS is still energized. The attendant operates the listening key LK to ascertain if the subscribers are still using the connection and finding that they are not using it the attendant releases the key CK which opens its contacts 141 and 142 to break the circuit of SR which causes the restoration of FS and CS as heretofore explained. The relay CO^2 restores due to the opening of 143 and opens contact 113 which disconnects the bridging coil BC' from the line and causes the operation of a disconnect signal at the main exchange. The main exchange operator notices the disconnect signal and removes

the plug of the cord circuit from the jack TJ thus restoring all the apparatus used in the connection.

Fig. 4 discloses a trunk circuit extending to an automatic main exchange which is designed to handle both incoming and outgoing calls. A subscriber at the private automatic exchange may complete a call to a main exchange subscriber or he may receive a call from the main exchange with the assistance of the attendant or he may have the attendant complete a call to a main exchange subscriber. The description of the operation of the apparatus in completing the different calls will be taken in order.

To complete a call to a main exchange subscriber without the intervention of the attendant a local or private automatic exchange subscriber will remove his receiver from the switchhook. This will cause the operation of a finder switch to seize the calling line and connect it to a connector switch. Upon this connection the subscriber will receive the usual dialing tone whereupon he will operate his calling device CD to cause the wipers 13, 14, 15 and 16 of the connector switch CS to step over the bank contacts 17, 18, 19 and 20 until they reach the contacts 17, 18, 19 and 20 of the trunk line dialed.

Upon the restoration to normal of contact 79 of the guard relay GU of the connector switch an energizing circuit for the secret service relay SS and the cut off relay CO^4 is established. This circuit may be traced from battery, through SS, resistance 89, conductor 81, normal contact 79 of GU, wiper 13, contact 17, conductor 152, normal contact 153 of BU', conductor 154, relay CO^4 to ground. The relay SS closes its alternate contact 80 and forms a shunt for resistance 89 which prevents the operation of relay SS in a second connector switch should another subscriber attempt to seize the same trunk. Relay CO^4 operates to cut off the line relay LR^4 at alternate contacts 155 and 156 and this prevents the placing of an incoming call upon the trunk at the main exchange. A circuit for the hold lamp HL' is established at alternate contact 157 of CO^4. Current flowing from battery through HL', conductor 158, and alternate contact 157 of CO^4 to ground, lights the lamp HL' which remains lit during the connection and informs the attendant that the trunk is busy. The connecting relay CR' is operated by current flowing from battery, through CR', conductor 159, alternate contact 160 of CO^4, conductor 161, contact 18, wiper 14, conductor 117, alternate contact 56 of SR to ground. The closing of alternate contacts 162, 163 and 164 of CR' provides a passage for the ringing current which may be traced from the generator, over conductor 93, normal contact 94 of RCO, alternate contact 92 of SS, wiper 16, contact 20, alternate contact 164 of CR', through the polarized relay PR, alternate contact 163 of CR', contact 19, wiper 15, alternate contact 90 of SS, normal contact 95 of RCO, conductor 96, relay RT to generator. The relay PR attracts its armature 165 to furnish additional ground to the lamp HL'. The ringing trip relay RT is also energized by current flowing over this circuit and closes its alternate contact 100 to energize the ringing cut off relay RCO which disconnects the ringing current from the line and closes the talking conductors at contacts 94 and 95 causing the energization of SR'. Relay RCO closes a locking circuit for itself which may be traced from battery through the lower winding of RCO, alternate contact 75 of ON', to ground at alternate contact 77 of RCO.

The conductors c^6 and c^7 lead to an automatic main exchange and terminate in a line circuit which may be similar to L of Fig. 1. A finder switch at the main exchange will operate and seize the conductors c^6 and c^7 which comprise the calling line. The calling subscriber will operate the calling device CD to dial the subscriber at the main exchange. The energizing circuit of relay SR will be intermittently interrupted by the opening and closing of the contacts of the calling device CD and the relay SR will accordingly open and close its contacts. The opening and closing of contact 55 of SR has no effect upon the guard relay GU and motor magnet MM' of CS because relay SS has operated to open normally closed contact 71 which is in the energizing circuit of MM' and GU. The opening and closing of contact 56 of SR interrupts the circuit of CR' of Fig. 4 to alternately deenergize and energize the said CR' which accordingly opens and closes its alternate contacts 162, 163 and 164 which causes the operation of apparatus at the main exchange to complete the call to the called subscriber.

The circuit arrangement of my invention is such that the apparatus is under the control of the called party on local connections and under the control of the originating party on trunk connections. Accordingly the replacement of the receiver at the substation of the main exchange subscriber will only release the apparatus at the main exchange. The release magnet RE' cannot operate because the supervisory relay SR' of CS is energized and the contact 74 of BR is in its alternate position. The restoration of the receiver at substation A opens the switchhook contacts which causes the restoration of SR. The restoration of contact 56 of SR opens the circuit of CR' which restores its contacts to normal to restore the main exchange apparatus and to restore SR' which causes the restoration of FS and CS. The restoration to normal of wiper 13 opens the circuit of CO^4 which also restores to

again connect the line relay LR⁴ across the trunk line.

A call initiated by a subscriber at the main exchange desiring to be connected to a private exchange subscriber will be completed as follows. Ringing current transmitted from the main exchange will flow over conductor c^6, normal contact 155 of CO⁴, conductor 166, relay LR⁴, condenser 167, normal contact 156 of CO⁴, conductor c^7 to the main exchange. The line relay LR⁴ operates and contact 168 assumes its alternate position, in which it locks, and furnishes a ground connection for line lamp LL′ and busy relay BU′ both of which operate. The line lamp LL′ informs the attendant that an incoming call has been made and needs attention. The relay BU′ closes its contact 169 which extends the conductor 152 to resistance r^5 and ground. This "busys" the contact 17 to prevent the connection of a connector switch CS with the trunk line. If a wiper 13 of a switch CS engages the contact 17 associated with the trunk line while the same is busy the secret service relay SS will be included in an electrical circuit traced from battery through the relay SS, resistance 89, conductor 81, normal contact 79 of GU, wiper 13, contact 17, conductor 152, make before break contact 153, alternate contact 169, resistance r^5 to ground. The presence of resistances 89 and r^5 in the circuit prevent the relay SS from operating but the busy tone relay BTR will operate over this same circuit to transmit a busy signal to the calling subscriber.

The attendant noticing the glowing of LL′ operates the listening key LK′ which closes its alternate contact 171 to establish an energizing circuit for the relay CO⁴ which may be traced from battery, through resistance r^4, conductor 172, alternate contact 171 of LK′, normal contact 173 of DK′, conductor 174, normal contact 175 of LR⁴, relay CO⁴ to ground. Relay CO⁴ operates and the contacts 155 and 156 assume their alternate positions thus closing the talking conductors and disconnecting the line relay LR⁴ from the conductors c^6 and c^7. Contact 157 is closed to operate the hold lamp HL′. Armature 176 is attracted and restores the contact 168 of LR⁴ to normal thus deenergizing the lamp LL′ and relay BU′.

The restoration of BU′ again closes contact 153 to extend conductor 152 to the cut off relay CO⁴ but a subscriber at the private exchange cannot seize the trunk line because the secret service relay SS of the connector switch will not operate due to the battery current flowing through resistance r^4 which is included in the circuit through contacts 173 and 171. Thus it will be seen that a connector switch cannot be connected to a trunk line which is seized from the main exchange.

The closing of alternate contacts 155 and 156 connect the attendant and the subscriber at the main exchange in a talking circuit which may be traced from the main exchange over conductor c^6, alternate contact 155 of CO⁴, normal contact 177 of DK′, alternate contact 179 of LK′, conductor 181, through the operator's set OS′, conductor 182, alternate contact 180 of LK′, normal contact 178 of DK′, alternate contact 156 of CO⁴, conductor c^7 to the main exchange. If one of the local subscribers is wanted the operator will depress the holding key HK′ which bridges the holding relay HR′ across the talking conductors at alternate contacts 183 and 184. The relay HR′ is operated by current flowing from the main exchange over the talking conductors and holds the apparatus at the main exchange until the attendant completes the call. Relay HR′ closes its alternate contact 185 to close another circuit for the hold lamp HL′.

The attendant next operates the dialing key DK′ which opens the contacts 177 and 178 and closes contacts 186 and 187 to disconnect the operator's set OS′ from the trunk conductors c^6 and c^7 and connect the set OS′ across the conductors c^8 and c^9 which lead to a line circuit similar to L of Fig. 1. The connection of the set OS′ across the conductors c^8 and c^9 sets a finder switch FS in operation to seize the calling line. The attendant operates the dialing mechanism associated with the operator's set OS′ to step the wipers of the connector switch associated with the finder switch to select the line of the local subscriber wanted. During the dialing operation the supervisory relay SR is intermittently energized through the operator's set OS′. As soon as the called subscriber answers the attendant operates the connecting key CK′ which closes its contacts 188 and 189 to close the talking circuit for the local and main exchange subscribers. The attendant also releases the holding key HK′ which restores HR′ and effaces the lamp HL′; the dialing key DK′ and the listening key LK′. The relay CO⁴ is maintained energized through a substitute circuit formed by the closing of contact 190 of CK′. The supervisory relay SR of FS is now under the control of the originating party or main exchange subscriber.

Upon the termination of conversation the called subscriber replaces his receiver which deenergizes SR′ of CS; the calling subscriber at the main exchange replaces his receiver which causes the deenergization of SR which operates the release relays RE and RE′ to restore the finder and connector switches respectively. The attendant releases the key CK′ which opens its contact 190 which causes the deenergization of relay CO⁴ which restores its contacts 155 and 156 to again connect the line relay LR⁴ across the trunk con-

ductors c^6 and c^7 and to efface the lamp HL'. A subscriber at a private exchange may call the attendant by dialing the number given the information line. A finder switch FS will seize the calling line and connect it to a connector switch CS which will locate the contacts of the information line in the usual manner. When the wipers 13, 14, 15 and 16 engage the contacts 17, 18, 19 and 20 of the information line a circuit is established for the information lamp IL' which may be traced from battery, through the lamp IL', normal contact 191 of IK', conductor 192, to ground at alternate contact 146 of CO' of the line circuit L' associated with the information line. Relay CO' operated with relay SS upon the restoration of contact 79 of GU. The cut off relay used in the line circuit of the information line is the only one equipped with the contact 146. Contact 18 is of course left blank it being used only in trunk connections. The relay SS is operated by current flowing to ground at CO' but the ringing current thereby connected to contacts 19 and 20 has no effect. The attendant notices the lamp IL' glowing and depresses the information key IK' which connects the operator's set OS' to the contacts 19 and 20 through alternate contacts 193 and 194 of IK' and conductors 195 and 196. A circuit for the ringing trip relay RT is established through the operator's set OS' and the said relay RT operates and closes its contact 100 to operate the ringing cut off relay RCO which disconnects the ringing current and closes the talking conductors at contacts 94 and 95 to establish an energizing circuit for the supervisory relay SR' through the operator's set OS'. The attendant and calling subscriber are thus connected in a talking circuit.

The restoral of the apparatus in such a connection is as follows. The replacement of the calling subscriber's receiver opens the energizing circuit of supervisory relay SR and it restores. The restoration of key IK' opens the circuit of supervisory relay SR' and causes the connector switch CS and finder switch FS to restore.

A local subscriber may have the attendant complete a call to the automatic main exchange. To do this the local subscriber dials the information line as just described and informs the attendant that a subscriber at the automatic main exchange is wanted. The attendant instructs the calling subscriber to replace his receiver and releases the information key IK' which causes the restoration of FS and CS as just described. The attendant operates the listening key LK' which closes its alternate contact 171 to energize relay CO^4 which closes its alternate contacts 155 and 156 to disconnect the line relay LR^4 from the line and to connect the operator's set OS' across the line. The trunk is "busied" to incoming calls as the line relay is removed from the conductors c^6 and c^7 and is "busied" against calls from the local exchange as the relay SS of a connector switch will not operate should the trunk be selected due to the resistances 89 and r^4. The attendant operates the dialing mechanism at OS' to secure the main exchange subscriber in the usual and well known manner.

When the subscriber has answered the attendant operates the holding key HK' which connects holding relay HR' across the conductors c^6 and c^7 to hold the switch at the main exchange. Relay HR' operates and lights hold lamp HL' which shows the condition of the trunk to the attendant. The attendant operates dialing key DK' which disconnects the operator's set OS' from the main exchange at make before break contacts 177 and 178 and connects it through contacts 186 and 187 to conductors c^8 and c^9 which lead to a line circuit similar to L of Fig. 1. This starts the operation of a finder switch FS which seizes the calling line and connects it to a connector switch CS which is operated by means of the calling device associated with set OS' to step its wipers into engagement with the contacts of the local subscriber's line.

When the local subscriber answers the attendant operates the connecting key CK' which closes its contacts 188 and 189 to connect the subscribers in a talking circuit. The attendant releases the holding key HK' which causes the deenergization of HR' and the effacement of HL', and releases the listening key LK' and the dialing key DK'. The relay CO^4 is maintained energized through a substitute circuit formed by the closing of contact 190 of CK'. The supervisory relay SR of FS which was held energized through the set OS' during the establishing of the connection is now held up through the subscriber's station at the main exchange while the supervisory relay SR' is held up through the local subscriber's station.

Upon the termination of conversation the subscribers replace their receivers which break the energizing circuits of SR and SR' which cause the restoration of FS and CS in the usual manner. The attendant restores the connecting key CK' which deenergizes CO^4 which returns to normal to open the talking conductors and again connect the line relay LR^4 across the line.

While I have described a preferred arrangement of my invention I do not wish to be limited to the same as changes and modifications may be apparent to one skilled in the art. I therefore desire to claim everything within the spirit and scope of the appended claims.

Having described my invention, what I claim as new and desire to secure by United States Letters Patent is—

1. In a telephone system a private auto-

matic exchange, an automatic main exchange, telephone lines terminating at said main exchange, telephone lines terminating at said private automatic exchange, a finder switch and a connector switch for interconnecting the telephone lines at said private automatic exchange, and a two way trunk line for interconnecting the telephone lines at said private automatic exchange and said automatic main exchange.

2. In a telephone system, a main exchange of the manual type, a private automatic exchange, telephone lines terminating at said main exchange, telephone lines terminating at said private exchange, a finder switch and a connector switch for interconnecting said lines at said private automatic exchange, a two way trunk line for interconnecting the telephone lines at said private automatic exchange and the said main manual exchange, and a plurality of tones adapted to be connected to said calling line to indicate the condition of the apparatus.

3. A telephone system including an automatic main exchange, telephone lines terminating at said main exchange, a private automatic exchange, telephone lines terminating at said private automatic exchange, a two way trunk line extending between said private automatic exchange and said automatic main exchange, a group of switches for interconnecting said telephone lines at said private automatic exchange and for interconnecting a telephone line terminating at said private exchange and said trunk line, means preventing the connection to said trunk line of more than one of said switches at a time, and a plurality of tones adapted to be connected to said calling line to indicate the condition of the apparatus.

4. A telephone system including a manual main exchange, telephone lines terminating at said manual main exchange, a private automatic exchange, local telephone lines terminating at said private exchange, a trunk line extending between said exchanges, automatic switching means at said private exchange for connecting a local line and said trunk line, relay means in said trunk line for indicating a call instituted at said manual exchange, means operable upon the connection of said local line and said trunk line to render said relay means inoperative, and a plurality of tones adapted to be connected to said calling line to indicate the condition of the apparatus.

5. A telephone system including an automatic main exchange, telephone lines terminating at said automatic main exchange, a private automatic exchange, local telephone lines terminating at said private automatic exchange, a two-way trunk line extending between said exchanges, automatic switching means at said private automatic exchange for connecting a local line to said trunk line, relay means in said trunk line for indicating a call instituted at said main automatic exchange, and means operable upon the connection of a local line and said trunk line to render said relay means inoperative.

6. A telephone system including a manual main exchange, telephone lines terminating at said manual main exchange, a private automatic exchange, local telephone lines terminating at said private exchange, a trunk line extending between said exchanges, automatic switching means at said private exchange for interconnecting a calling local line and said trunk line, relay means in said trunk line operable upon the institution of a call from said manual main exchange to place a call at said trunk line, means in said trunk line for preventing the subsequent connection of a calling local line to said trunk line, and a plurality of tones adapted to be connected to said calling line to indicate the condition of the apparatus.

7. A telephone system including an automatic main exchange, telephone lines terminating at said automatic main exchange, a private automatic exchange, local telephone lines terminating at said private automatic exchange, a two-way trunk line extending between said exchanges, switching means at said private exchange for connecting a calling local line to said trunk line, relay means in said trunk line for indicating a call instituted at said main automatic exchange, and means for preventing the subsequent connection of a calling local line to said trunk line.

8. In a telephone system, a private automatic exchange, local telephone lines terminating at said private exchange, an automatic main exchange, a manual main exchange, a two way trunk line extending from said private automatic exchange to said automatic main exchange, a two way trunk line extending from said private automatic exchange to said manual main exchange and automatic switching means for connecting said local lines to any of said trunk lines.

9. In a telephone system a private automatic exchange, local telephone lines terminating at said private exchange, an automatic main exchange, a manual main exchange, a two way trunk line extending from said private automatic exchange to said main automatic exchange, a two way trunk line extending from said private automatic exchange, to said manual main exchange, automatic switching means for connecting a calling local line to any of said trunk lines and means for preventing the operative connection of another calling line to said connected trunk line.

10. In a telephone system a private automatic exchange, local telephone lines terminating at said private exchange, an automatic main exchange, a manual main exchange,

a two way trunk line extending from said private exchange to said main automatic exchange, a two way trunk line extending from said private exchange to said main manual exchange, automatic switching means for connecting a calling local line to any of said trunk lines, means preventing the operative connection of another calling line to said trunk line and a plurality of tones adapted to be connected to said calling line to indicate the condition of the apparatus.

Signed at Chicago, in the county of Cook and State of Illinois, this 22nd day of October, 1929.

MICHAEL B. STAZAK.