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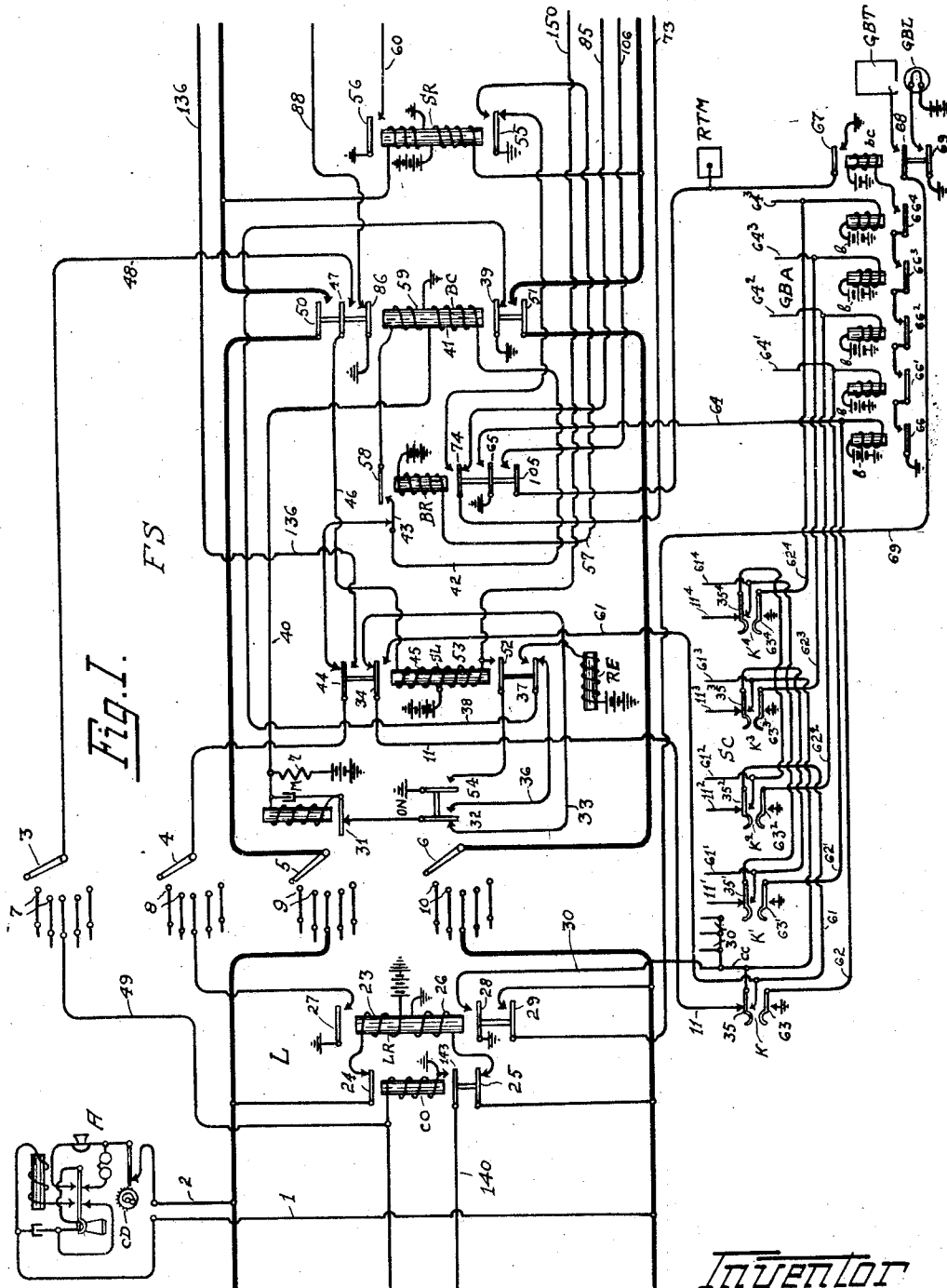
M. B. STAZAK

1,829,070

TELEPHONE SYSTEM

Filed Oct. 29, 1929

3 Sheets-Sheet 1



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

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M. B. STAZAK

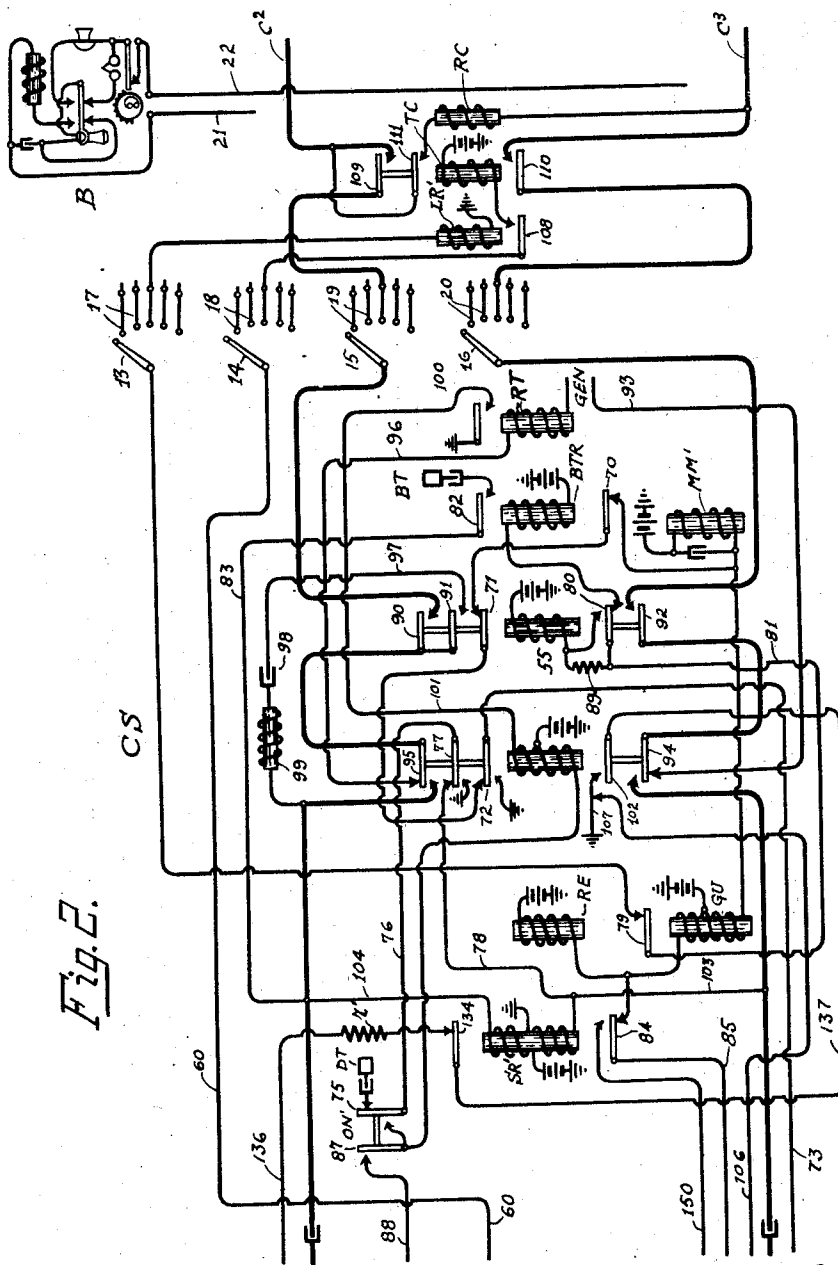
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Fig. 2.



Inventor:
Michael B. Stazak
by Charles P. Loper
Attorney

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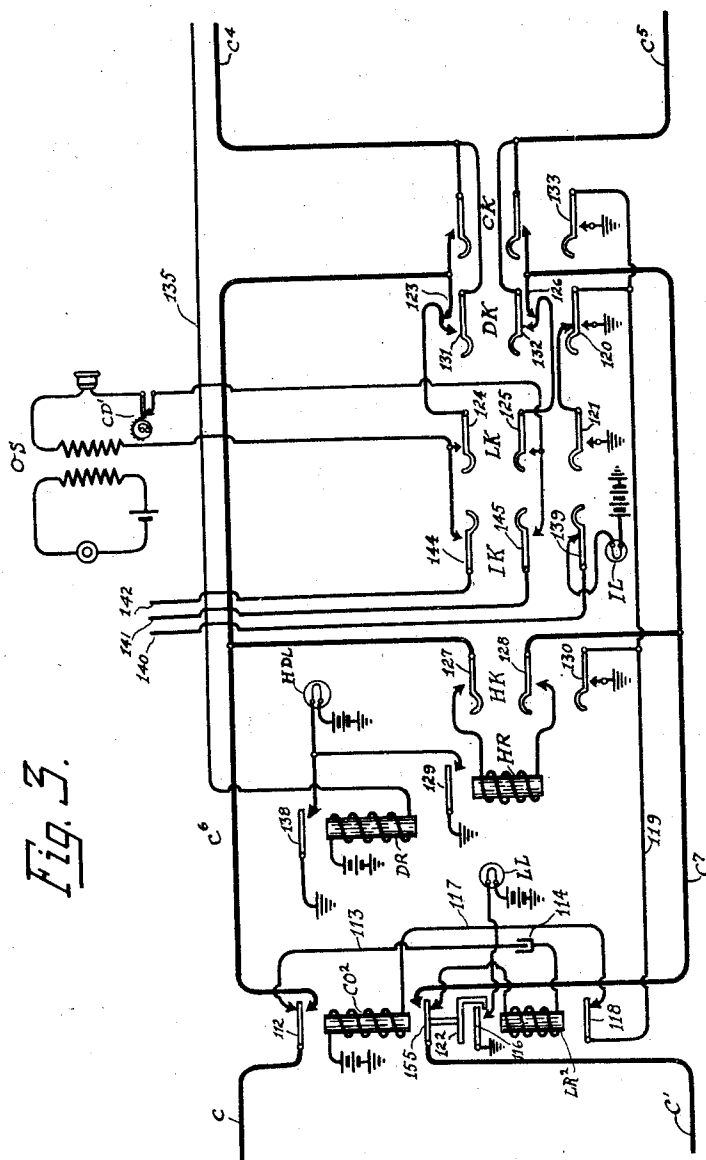


Fig. 3.

Inventor:
Michael B. Stazak
by Charles P. Loper
Attorney

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

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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. 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 seize the line of the calling subscriber 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 main exchange or the attendant at the private automatic exchange.

A feature of my invention is the provision 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 consists of a group busy alarm which informs the calling subscriber of the busy condition of the finder switches of the group with which he is connected.

A further feature of my invention is the provision of a plurality of "tones" supplied to the calling subscriber's line to indicate the condition of the connecting apparatus at the private exchange.

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.

Another feature is the provision in such a system of means whereby the subscriber at the private exchange upon the termination of a conversation with a called main exchange subscriber releases all the apparatus at the private exchange involved in setting up the connection.

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

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

Fig. 1 illustrates diagrammatically a call-

ing subscriber's line, a finder switch, a starting circuit and the group busy alarm;

Fig. 2 illustrates diagrammatically a connector switch and a called subscriber's line and an outgoing trunk circuit to a two wire automatic exchange;

Fig. 3 illustrates diagrammatically the apparatus at the attendant's station for completing an incoming call from 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. A busy- ing 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', k², k³ and k⁴ 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 busy- ing relays b, b', b², b³ and b⁴, 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.

5 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.

10 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
15 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
20 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
25 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 to send ten impulses which
30 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
35 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
40 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
45 would be interference with the connection when the wipers engaged the tenth and twentieth set of contacts but by leaving the said contacts blank the wipers will not cause interference with an established connection
50 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.

55 In the upper right hand corner of Fig. 2 is illustrated a called subscriber's station B which is connected by conductors 21 and 22 to a line circuit similar in detail to line circuit L as shown in Fig. 1. The apparatus
60 necessary to extend the subscriber's station to an automatic main exchange comprising a line relay LR', a cut off relay CO' and a retardation coil RC is also shown. When Fig. 2 is placed to the right of Fig. 1 the
65 two show the complete circuit arrangement.

Fig. 3 shows the apparatus at the attendant's station of the private automatic exchange necessary to extend an incoming call from a main automatic exchange to a subscriber's station or to complete an outgoing
70 call for a subscriber. The apparatus disclosed consists of a line relay LR² which is actuated by current from the main exchange over conductors *c* and *c'* to operate the line lamp LL. A cut off relay CO² is provided
75 to disconnect the line relay LR² from the conductors *c* and *c'*. A holding key HK is adapted to connect a holding relay HR across the talking conductors to operate a hold and disconnect lamp HDL which may also be
80 operated upon the energization of a disconnect relay DR. An operator's set OS is provided and may be connected to the talking conductors through a listening key LK and a dial key DK or to an information line comprising the conductors 140, 141 and 142 which
85 are connected to a bank of contacts as shown in Fig. 2 by means of the information key IK. A connecting key CK is also provided. 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
90 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,
95 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
100 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
105 *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
110 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.
115
120
125
130

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 ES. 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 from 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 busy 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 35² of key k^2 and thence over conductor 11² 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 61² to the fifth switch through contact 35⁴ of key k^4 and conductor 11⁴. If the fifth switch is in use the connection will be extended over conductor 62⁴ to the second switch and if it is busy the connection will be extended to the fourth switch over conductor 61⁴. 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', e. c. 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 contacts 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 66⁴, 66³, 66², 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 device 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 and 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 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 contact 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 op-

erating 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 7 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 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 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 of the called subscriber's line to operate to cut off the line relay 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 multiple 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 closes contacts 90, 91 and 92 which immediately connect ringing current to the called subscriber's line. The circuit for the ringing current may be traced from a source of interrupted generator current GEN, 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 reverte ring 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 battery through the upper winding of RCO, conductor 101, 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 contact 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 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 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 through the medium of the supervisory 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 places the switch FS in position to seize another calling line and the closing 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 73, to ground at alternate contact 72 of RCO. It will be noted that the release magnet of the conductor 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 the release magnet RE' restores and all the apparatus of the connector switch is at normal. The release of the connector switch CS is entirely under the control of the called party and cannot take place until the called party hangs up. This prevents the operation of another finder switch to locate the calling line should the called party fail to replace his receiver before the calling party does.

Certain sets of the contacts 17, 18, 19 and 20 are connected to trunk lines which interconnect the private automatic exchange and a main automatic exchange. These trunk lines are of the two wire type and may comprise conductors c^2 and c^3 shown in Fig. 2. The process of obtaining a trunk line is exactly the same as obtaining a subscriber's line up to the time the wipers 13, 14, 15 and 16 engage the contacts of the selected trunk line. If the trunk line is busy the secret service relay SS will not operate due to the shunt circuit around the high resistance winding 89 in the connector switch already connected to the selected trunk line, but the busy tone relay BTR will energize over a circuit traced to ground through line relay LR' of the trunk circuit. The operation of BTR opens the energizing circuit for the motor magnet MM' at contact 70 and connects the busy tone signal BT to the calling subscriber's line at contact 82 as before described. Upon the replacement of the receiver at station A the apparatus is restored to normal in the same manner as described in the connection between stations A and B.

If the trunk line selected is idle the secret service relay SS and line relay LR' will energize. The energizing circuit may be traced from battery, through relay SS, conductor 81, normal contact 79, wiper 13, contact 17 to ground through relay LR'. Relay LR' closes a circuit at its alternate contact 108 for the trunk connecting relay TC which circuit may be traced from battery, relay TC, alternate contact 108, contact 18, wiper 14, conductor 60, alternate contact 56 of SR to ground. Relay TC operates and closes its contacts 109, 110 and 111 to connect the subscriber at A to the trunk conductors c^2 and c^3 which lead to an automatic main exchange (not shown) and terminate in a line circuit similar to L shown in Fig. 1. The closure of contact 111 of TC connects the retard coil RC across the conductors c^2 and c^3 to provide an energizing cir-

cuit for the line relay at the main exchange which operates and starts a finder switch operating to select the calling trunk line. The subscriber A operates the calling device CD which intermittently interrupts the energizing circuit of supervisory relay SR. The opening and closing of contact 55 of SR has no effect as the circuit of the motor magnet MM' is open at contact 71 of relay SS but the flickering of contact 56 of SR breaks the circuit of TC and causes the trunk connecting relay TC to deenergize and energize each time the contact 56 is opened and closed thereby cutting the retard coil RC into and out of the circuit at its contact 111 which interrupts the circuit of apparatus situated at the main exchange to operate mechanism to select the desired party. As soon as the trunk line is selected and the relay TC has operated the retard coil RC closes a circuit for the ringing trip relay RT which closes its contact 100 to cause the operation of ringing cut off relay RCO which disconnects the ringing current from the trunk line by opening normal contacts 94 and 95. The supervisory relay SR' is also operated by current flowing through the retard coil RC and attracts its contact 84 to control the release of the apparatus used.

Upon termination of the conversation the subscriber at A replaces his receiver upon its switchhook which opens the circuit of supervisory relay SR which causes the finder switch FS to restore to normal as before described. The restoration of alternate contact 56 of SR opens the holding circuit of relay TC which restores to normal opening its contacts 109, 110 and 111. The opening of the contacts 109 and 110 of the relay TC causes the deenergization of the relay SR' which restores its contact 84 to cause the operation of the release magnet RE' which restores the connector switch CS to normal in the same manner as described in the connection between the subscribers A and B. Both the finder switch FS and the connector switch CS are under the control of the subscriber at the private automatic exchange when a trunk line is connected in circuit, that is the finder switch FS and the connector switch CS will not restore to normal until the subscriber at the private exchange hangs up in which case they restore even though the main exchange subscriber has not replaced his receiver.

Incoming trunk calls can only be completed through the assistance of the attendant at the private automatic exchange. Assume that a subscriber at a main exchange desires to converse with a subscriber at the private automatic exchange and that the trunk conductors c and c' have been selected as the trunk line to be used. Ringing current is transmitted from the main exchange over conductor c , normal contact 112 of cut off relay CO², conductor 113, condenser 114,

line relay LR², normal contact 115 of CO², conductor c' to the main exchange. The line relay LR² operates and closes its contact 116, which remains in its alternate position after the line relay LR² has deenergized, and closes a circuit for the line lamp LL; said circuit being traced from battery through the lamp LL to ground at alternate contact 116 of LR². The attendant notices the lamp LL glowing and depresses the listening key LK to connect the operator's set OS to the trunk conductors c and c' . An energizing circuit for cut off relay CO² is closed and the relay operates and closes its alternate contacts 112 and 115 which extend the trunk conductors c and c' to the attendant and also cut off the line relay LR² from the trunk conductors c and c' . The attraction of armature 112 restores the contact 116 of LR² to normal to efface the line lamp LL. The relay CO² is energized by current flowing from battery through the winding of CO², conductor 117, normal contact 118 of LR², conductor 119, normal contact 120 of dial key DK, to ground at alternate contact 121 of the depressed listening key LK. The operator inquires the wants of the calling party and ascertains that the subscriber B is wanted. The operator's set OS is connected in a conversational circuit with the main exchange subscriber over trunk conductor c , alternate contact 112 of CO², conductor c' , normal contact 123 of dial key DK, alternate contact 124 of LK, the operator's set OS, alternate contact 125 of LK, normal contact 126 of DK, conductor c' , alternate contact 115 of CO² and conductor c . It is over this circuit that the operator learns the desires of the calling party; battery for the talking circuit being supplied at the main exchange. The operator depresses the holding key HK which establishes an energizing circuit for the holding relay HR which is operated by current flowing from the main exchange, conductor c , alternate contact 112, conductor c' , closed contact 127, relay HR, closed contact 128, conductor c' , alternate contact 115, conductor c' to the main exchange. The contact 129 of HR is closed and connects ground to the hold and disconnect lamp HDL to illuminate the lamp HDL which informs the operator that the trunk line $c-c'$ is being held. The key HK is left in its depressed condition and the trunk line is held through the contacts 127 and 128 and relay HR and contact 130 places an additional ground on conductor 119 to hold relay CO² energized. The conductors c^4 and c^5 are connected to a line circuit similar to L of Fig. 1 and associated with a finder switch FS and connector switch CS. The operator next depresses the dialing key DK which opens its contacts 123 and 126 to disconnect the operator's set OS from the trunk line $c-c'$ and closes its make before break contacts 131 and 132 which connect the op-

erator's set OS to the line circuit at the private exchange over conductors c^4 and c^5 which causes the energization of a line relay LR and the operation of a finder switch FS which finds the contacts 9 and 10 associated with the conductors c^4 and c^5 . The attendant operates the calling device CD' and causes the connector switch CS to find the line of the called subscriber B in the same manner as explained in the connection between A and B. As soon as the subscriber B answers the operator throws the connecting key CK and releases the dialing key DK and listening key LK which disconnect the operator's set OS from the connection. The holding key HK is also released and the opening of contacts 127 and 128 interrupts the circuit of HR which restores to normal and effaces the lamp HDL by opening contact 129. The cut off relay CO² is maintained energized over the circuit before described ground being furnished at alternate contact 133 of CK. The supervisory relay SR of the finder switch FS is maintained energized over apparatus at the main exchange and consequently upon the termination of the conversation and the replacement of the receivers the finder switch FS and connector switch CS will be restored as before described. However, the deenergization of relay SR' and subsequent restoration of CS closes normal contact 134 of SR' which establishes an energizing circuit for the disconnect relay DR of Fig. 3. This circuit may be traced from battery, through relay DR, conductor 135 which is connected to a contact 8 of the line circuit associated with the conductors c^4 and c^5 , wiper 4, alternate contact 44 of SL, conductor 136, resistance r' , normal contact 134, conductor 137 to ground at normal contact 102 of RCO which restored to normal upon the movement of off normal contacts ON'. The relay DR operates and closes its alternate contact 138 which closes a circuit to ground for the hold and disconnect lamp HDL. The attendant noticing the lamp HDL glowing realizes that the conversation has terminated and accordingly restores the connecting key CK which opens the circuit for CO² at contact 133 which deenergizes and disconnects the conductors c and c' from the conductors c^6 and c^7 .

Should a subscriber at the PAX desire to call a subscriber at a main exchange, he may have the attendant complete the call. A subscriber such as A will dial the number given the information line which is the one leading to the attendant's station. When the wipers 13, 14, 15 and 16 engage the contacts associated with the information line a circuit for the information lamp IL is established. This circuit may be traced from battery, through the lamp IL, normal contact 129 of information key IK, conductor 140 which leads to

ground at alternate contact 143 of the cut off relay associated with the line circuit of the information line. The contact 143 of cut off relay CO is used only in the line circuit of the information line and contacts 18 are used only in connection with trunk lines and are not used in connection with subscribers' lines or the information line. The glowing of the information lamp IL apprises the attendant that a subscriber desires attention and the attendant operates the information key IK. The closing of contacts 144 and 145 of IK connect the operator's set OS in a talking circuit with the subscriber A, through the switches FS and CS, contacts 19 and 20 and conductors 141 and 142. The attendant inquires the wants of the calling subscriber and is given the number of the desired party located at the main exchange whereupon the operator instructs the calling subscriber to replace his receiver and the attendant restores the information key IK and the finder switch FS and connector switch CS restore due to the opening of the energizing circuits of supervisory relays SR and SR' as before described. The attendant throws the listening key LK which connects the set OS across the conductors c and c' through the alternate contacts 112 and 115 of CO² which operates upon the closure of contact 121 of LK. The operator next operates the dialing mechanism CD' which affects apparatus at the main exchange to cause the connection to the called subscriber. Upon the answering of the called subscriber the attendant operates the holding key HK to hold the trunk connections and proceeds to call the originating or calling party in the same manner as described in connection with an incoming trunk call. The release of the apparatus also is accomplished in the same manner.

While I have described a preferred embodiment of my invention I do not wish to limit myself to the same as modifications and alterations may readily suggest themselves to one skilled in the art, I therefore 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 an automatic telephone system of the character described, a plurality of telephone lines terminating at a private automatic exchange, a group of finder switches for locating a calling line, a group of connector switches associated with said finder switches, a calling device, said connector switch operable upon the actuation of said calling device to connect said calling line to a called line, a common starting conductor for said finder switches, means for extending said common conductor to the next finder switch of the group, a busy group alarm comprising a plurality of busy relays each associated with a

finder switch, means in said finder switches for operating the associated busy relay in said busy group alarm when said finder switch locates a calling line.

2. In an automatic telephone system a plurality of telephone lines terminating at a private automatic exchange, a group of finder switches for locating a calling line, a group of connector switches associated with said finder switches for extending said calling line to a called line, a common starting conductor for said group of finder switches, means in each of said finder switches operable upon the connection of a finder switch to a calling line for extending said common conductor to the next finder switch of the group and switching means for removing any one of said finder switches from said group.

3. In an automatic telephone system a plurality of telephone lines terminating at a private automatic exchange, a group of finder switches for locating a calling line, a group of connector switches for extending said calling line to a called line, a common starting conductor for said finder switches, a busy group alarm comprising a group of busy relays each associated with a finder switch, means in said finder switches operable upon the location of a calling line by said finder switch for extending said common conductor to the next finder switch and for operating the associated busy relay in the said busy group alarm.

4. In an automatic telephone system a plurality of telephone lines terminating at a private automatic exchange, a group of connector switches for extending a calling line to a called line, a common starting conductor for said finder switches, a busy group alarm comprising a busy relay each associated with one of said finder switches, relay means in each of said finder switches operable upon the connection of said finder switch and said calling line to extend said starting conductor to the next finder switch of the group and to operate the associated busy group alarm, and switching means for removing one of said finder switches from the group and for extending said starting conductor to the next finder switch and for operating the busy relay associated with the finder switch removed from the group.

5. In an automatic telephone system, a plurality of telephone lines terminating at a private automatic exchange, a group of finder switches for seizing lines as calling lines, a group of connector switches for connecting said calling line to a called line, a ringing tone machine supplying a plurality of tones and ringing current to said system, means operable upon the seizure of a calling line by a finder switch to start said ringing tone machine, and relay means for stopping said ringing tone machine.

6. In a telephone system of the character

described, a plurality of telephone lines terminating at a private automatic exchange, a group of finder switches for locating a calling line, a group of connector switches associated with said finder switches, a calling device, said connector switch operable upon the actuation of said calling device to connect said calling line to a called line, a source of dialing tone, and means in said connector switch for joining said source to the calling line when the said connector switch is in circuit with said calling line.

7. In an automatic telephone system a plurality of telephone lines terminating at a private automatic exchange, a group of finder switches for seizing lines as calling lines, a group of connector switches for connecting said calling line to an idle called line, a common starting conductor, a group busy alarm comprising a group of busy relays each associated with a finder switch, relay means in said finder switch operable upon the connection of said finder switch and said calling line to extend said starting conductor to an idle finder switch and to operate the busy relay associated with the said finder switch, a group busy tone device, a busy connecting relay in said group busy alarm operable when all the finder switches are busy to connect said group busy tone device to a calling line.

8. In an automatic telephone system a plurality of telephone lines terminating at a private automatic exchange, a group of finder switches for seizing calling lines, a group of connector switches for selecting idle called lines, a calling device for said calling line, a dial tone device, a busy tone device, a separate group busy tone device and relay means for connecting said tone devices to said calling line.

9. A telephone system comprising telephone lines terminating at an auxiliary exchange, finder switches and connector switches connected in pairs to form a connecting circuit for interconnecting said lines as calling and called lines, an automatic main exchange, trunk lines extending from said auxiliary exchange to said main exchange, a calling device adapted to operate said connector switch to select a trunk line, means in said trunk line responsive to said calling device for operating mechanism at said automatic main exchange to complete a call to a subscriber at said automatic main exchange, a source of dialing tone and means for joining said source to a calling line when one of said connector switches becomes operatively connected thereto.

10. A telephone system comprising local subscriber's lines terminating at an auxiliary exchange, an automatic main exchange, trunk lines extending between said main and auxiliary exchanges, a finder switch adapted to seize a local subscriber's line as a calling line, a calling device in said calling line, a

connector switch responsive to said calling device for connecting said calling line to a local subscriber's line, a trunk line or an information line, an attendant's station, said information line extending to said attendant's station, signaling means at said attendant's station operable upon the connection of said connector switch to said information line, trunk lines extending between said attendant's station and said main exchange and means at said attendant's station for connecting a local calling line to a called subscriber's line at said main exchange.

11. A telephone system comprising local subscriber's lines terminating at an auxiliary exchange, an automatic main exchange, trunk lines extending between said exchanges, a finder switch for seizing a local line as a calling line, a connector switch associated with said finder switch, a calling device in said calling line, said connector switch responsive to said calling device to select a called local line or a called trunk line, said finder switch and said connector switch forming a connecting circuit for interconnecting said lines, means in said trunk line responsive to said calling device adapted to operate mechanism at said main automatic exchange to complete a call to a subscriber at said main exchange, and release means under the control of the said local subscriber for restoring said finder switch and said connector switch, a source of dialing tone and means for joining said source to a calling line when one of said connector switches becomes operatively connected thereto.

12. A telephone system comprising local lines terminating at an auxiliary exchange, an attendant's station, a main automatic exchange, incoming trunk lines extending between said main exchange and said attendant's station, signaling means at said attendant's station for apprising the attendant of an incoming trunk call from said main exchange, a finder switch and a connector switch for interconnecting said attendant's station and a local line, said finder switch and connector switch responsive to means at said attendant's station to select a local called line, means at said attendant's station for extending said incoming call to a local subscriber's line, and a disconnect signal at said attendant's station under the control of the local subscriber for signalling for a disconnection.

13. A telephone system comprising local lines terminating at an auxiliary exchange, an attendant's station, a main automatic exchange, incoming trunk lines extending between said main exchange and said attendant's station, signaling means at said attendant's station for apprising the attendant of an incoming trunk call from said main exchange, a finder switch and a connector switch for interconnecting said attendant's

station and a local line, said finder switch and connector switch responsive to means at said attendant's station to select a local called line, means at said attendant's station for extending said incoming call to a local subscriber's line, and a disconnect signal at said attendant's station under the control of the local subscriber for signalling for a disconnection and means under the control of said local subscriber for restoring said finder and connector switches.

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

MICHAEL B. STAZAK. 80

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