

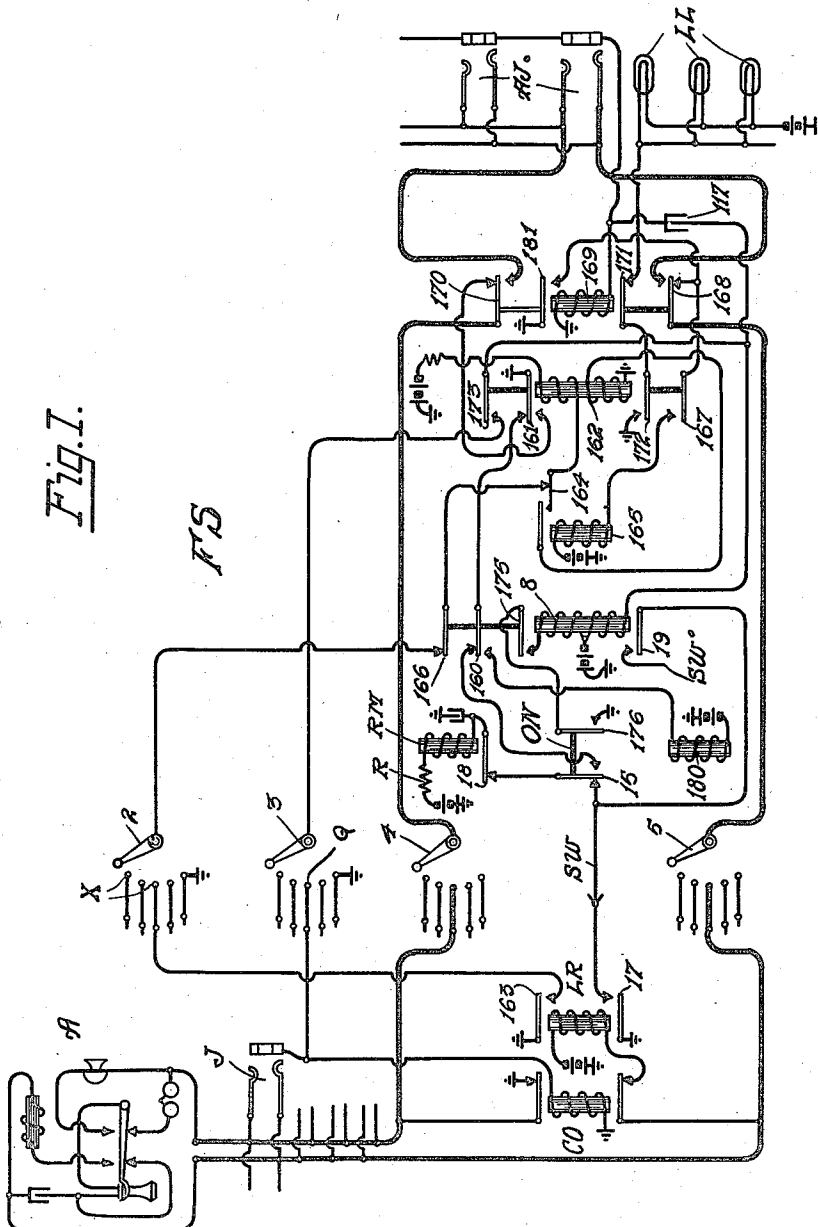
July 29, 1924.

1,503,096

H. D. CURRIER ET AL

CALL DISTRIBUTING SYSTEM

Original Filed June 23, 1919 3 Sheets-Sheet 1



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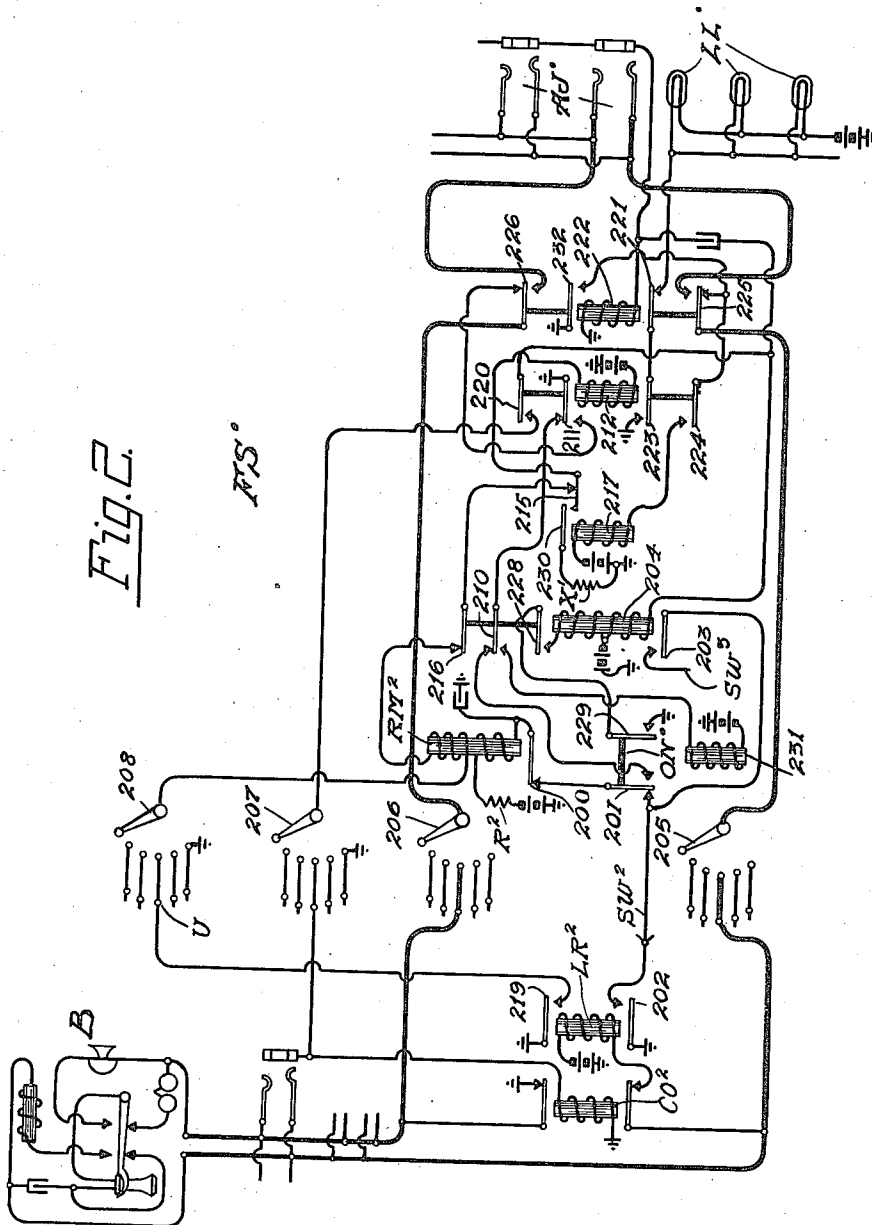
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CALL DISTRIBUTING SYSTEM

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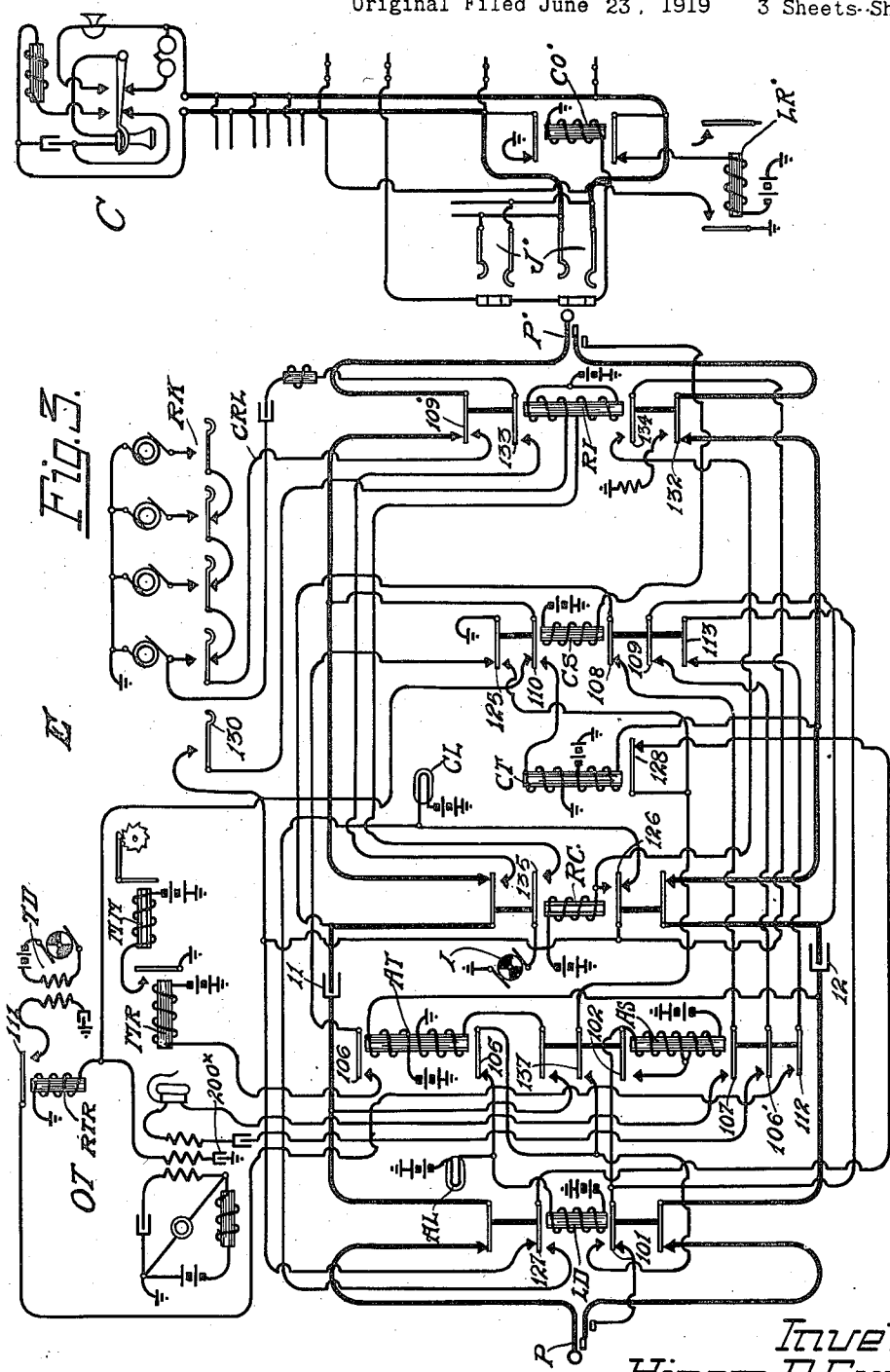
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CALL DISTRIBUTING SYSTEM

Original Filed June 23, 1919 3 Sheets-Sheet 3



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UNITED STATES PATENT OFFICE.

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CALL-DISTRIBUTING SYSTEM.

Application filed June 23, 1919, Serial No. 306,042. Renewed July 18, 1923.

To all whom it may concern:

Be it known that we, HIRAM D. CURRIER and GEORGE R. EATON, citizens of the United States of America, residing in Chicago, county of Cook, and Oak Park, county of Cook, respectively, in the State of Illinois, have invented certain new and useful Improvements in Call-Distributing Systems, of which the following is a specification.

Our invention relates to telephone systems in which link circuits are employed for interconnecting telephone lines, and has to do more particularly with that type of telephone system employing both manual switchboards and automatic apparatus. Our invention is in the nature of an improvement upon the system disclosed in our copending application, Serial Number 278,745, filed February 24, 1919.

One of the objects of our invention is to provide an improved finder switch and switch circuit which has a step-by-step motor magnet.

A feature of our invention resides in the provision of novel test means permitting an increased speed of operation of the finder switch stepping magnet, and in the positive, efficient and simplified arrangement of the relay mechanism and circuits of the finder switch.

These and other features will be more particularly pointed out in the ensuing specification and in the appended claims. Reference may be had to our said copending application for a more complete understanding of the utility and various advantages of a system of the type shown in this application.

We preferably divide the subscribers' lines into groups of fifty and associate with each group of subscribers' lines six finder switches, any one of which may be started when a call is initiated to select back and connect to the calling subscriber's line. The finder switches terminate in multiple answering jacks and lamps upon a manual switchboard so as to distribute the calls and permit any idle operator to answer the call to the exclusion of the other operators. The subscribers' lines also terminate in multiple calling jacks before the operators at the switchboard for calling purposes. So-called "feature" cord circuits are used in our system, which are provided with instantaneous

disconnect, for freeing the finder switch when the calling subscriber signals for disconnection, and with other well-known Kellogg automatic features.

Referring to the accompanying drawings, Figure 1 shows a calling substation A connected by means of its line limbs to relay mechanism at the central exchange, and a finder switch FS, adapted to connect with the calling line A, which terminates in a plurality of multiple jacks AJ and lamps LL at a manual board.

Figure 2 illustrates a similar calling substation B, together with its associated switch mechanism FS', which is adapted to select the calling substation B and also terminates in multiple jacks AJ' at a manual switchboard, and

Figure 3 diagrammatically illustrates a cord circuit E for extending a connection from either the calling substation A or B to a called substation C, shown in Figure 3.

Referring now in general to our invention as illustrated in Figures 1 and 3 which when placed end on end, Figure 3 to the right of Figure 1, illustrates mechanism and the apparatus necessary to connect the calling substation A to the called substation C. These drawings show a calling substation A of the well-known Kellogg common battery type connected by line limbs to central office relay mechanism, which includes a line relay LR and a cut-off relay CO, together with multiple jacks J and multiple bank contacts, each subscriber's line appearing in the banks of six different finder switches. We have found under ordinary trunking conditions that six finder switches are sufficient to handle the traffic or calls from a group of fifty lines. Of course, we can increase the capacity of our finder switches to one hundred or any other desired number of sets of bank contacts, and provide as many finder switches for a group of lines as we find necessary and desirable to handle the traffic.

The finder switch FS terminates at its one end in multiple jacks AJ and in multiple line lamps LL, a jack AJ and a lamp LL appearing in certain panels of the switchboard, that is, the jacks and lamps associated with each finder switch appear in as many different positions in the switchboard as it is found desirable to multiple

the lamps and jacks to secure adequate traffic distribution. The finder switch itself may be of any desired or suitable construction, and is provided with a spring-restored switch shaft having wipers 2, 3, 4 and 5, and with four sets of bank contacts of fifty contacts each to which the fifty subscribers' lines are connected. A rotary step-by-step magnet RM is provided for rotating the switch shaft and wipers by means of ratchet and pawl mechanism. A retaining pawl is also provided and adapted to be operated by the release magnet 180 for permitting the switch shaft and wipers to be restored to normal position by spring tension. The starting conductor SW is a common starting wire and is connected to a contact of each of the line relays LR of the group of subscribers which is associated with the finder switch FS. The relay 169 is a sleeve cut-off relay used for connecting the finder switch wipers through to the multiple jacks AJ. The relay 8 extends the starting conductor SW through to the next finder switch FS (not shown) when the switch FS is taken for use. The finder switch FS also includes a double-wound test relay 162 and a line relay 165.

The cord circuit E comprises an answering plug P and a calling plug P', the condensers 11 and 12 being interposed between the heavily marked conductors connecting the plugs P and P'. Associated with the answering end of the cord circuit is an answering sleeve relay AS and an answering supervisory relay AT for controlling the circuit of answering supervisory lamp AL. Relay AS also acts as a test relay for controlling the connection of the operator's telephone set OT to the strands of the cord circuit. We also provide a link disconnect relay LD to make possible instantaneous disconnection and recall. Associated with the calling end of the cord circuit E we provide a calling supervisory relay CT and a calling sleeve relay CS for controlling the circuit of the calling lamp CL. The calling sleeve relay CS also controls the disconnection of the operator's set OT from the strands of the cord circuit. A party line ring key RK is provided for connecting one of a plurality of generators to the common ringing conductor CRL and for controlling the ringing control relay RC. The ringing control relay RC controls the ringing interrupter relay RI, which through the medium of the interrupter I applies ringing current from the common conductor CRL to the line of the called subscriber. Associated with the cord circuit is a service register device comprising a meter magnet MM and a meter control relay MR. Associated with the operator's set OT is a revertive tone relay RTR.

At the right of Figure 3 we show a called

substation C similar to the calling substation A and terminating in line equipment including a line relay LR', a cut-off relay CO', multiple jacks J', and multiple finder switch bank contacts.

Referring now to Figure 2 of the drawings which shows a modified circuit arrangement similar to that of Figure 1, it comprises a calling substation B of the well-known Kellogg type connected by line conductors to a line relay LR², cut-off relay CO², finder switch bank contacts and a finder switch FS' adapted to connect the calling substation B through to the multiple answering jacks AJ' and multiple answering lamps LL', which are distributed before the different operators as mentioned in connection with answering jacks AJ and lamps LL. The cord circuit E shown in Figure 3 may be used for extending a connection from answering jacks AJ' to the called subscriber's line C.

The finder switch FS', which terminates in multiple jacks AJ' and lamps LL' is provided with a spring-restored switch shaft and with switch wipers 205, 206, 207 and 208. The switch wipers and shaft are adapted to be advanced by a double-wound differential rotary magnet RM², which is provided with a stepping pawl for engagement with a ratchet attached to the switch shaft. A release magnet 231 is provided for removing a holding pawl from engagement with the switch ratchet, thereby permitting a spring to restore the switch shaft and wipers to normal. Off-normal contacts ON' are also provided as well as the necessary test, line and sleeve relays.

Having described in general the apparatus diagrammatically illustrated on the accompanying sheets of drawings, we will now describe in detail the manner in which a call may be extended from a calling substation A (Fig. 1) to the called substation C (Fig. 3). Subsequently a detailed description will be given of the manner in which a call may be extended from the calling substation B (Fig. 2) to the called substation C (Fig. 3).

Assuming that the subscriber at the substation A wishes to initiate a call, upon the removal of the receiver thereat a circuit is closed through the line relay LR, including the two sides of the subscriber's line circuit in series, and the subscriber's instrument. The relay LR upon energizing places a ground upon the starting wire SW and a ground upon the multiple test contacts X, corresponding to the calling subscriber's line in the banks of the finder switches having access to the calling subscriber's line. The placing of ground upon the conductor SW closes an energizing circuit for the rotary magnet of the first finder switch FS of the series of finder switches associated with the calling subscriber's line, over a circuit ex-

tending from battery through the resistance R, magnet RM of the finder switch FS, off-normal contacts 15 of the finder switch FS and through contacts 17 of the line relay LR to ground. Had the finder switch FS been in use at the time that the subscriber's line relay LR was energized, off-normal contact 15 would have been in its alternate position, and the starting wire circuit would have been extended through alternate contact 19 of relay 8 and over starting conductor SW' to the rotary magnet of the next idle finder. The starting conductor SW is adapted to be extended through each busy switch in the series of switches to the first idle switch of the series. The rotary magnet RM upon energizing steps the switch shaft and wipers 2, 3, 4 and 5 onto the first set of bank contacts of the finder switch and moves the off-normal contacts ON to their alternate position. The movement of off-normal contact 15 to its alternate position closes a local substitute circuit for magnet RM over a circuit extending from battery, through the resistance R of said magnet RM, its interrupter contact 18, alternate off-normal contact 15, contact 160 of relay 8, and normal contact 161 of relay 162 to ground, thereby making the movement of the switch shaft and wipers independent of the starting circuit so that no matter if the calling subscriber should immediately replace his receiver, the finder switch will operate to move the switch shaft and wipers step by step over the bank contacts to the last contact thereof, unless a grounded contact is engaged.

The finder switch wiper 2 upon engaging a grounded contact corresponding to the calling subscriber's line, which contact is grounded through alternate contact 163 of relay LR, the holding magnet 162 is energized over a circuit extending from battery, through the upper winding of said relay 162, make-before-break contact 164 of relay 165, normal contact 166 of relay 8, wiper 2 and its engaged bank contact X and alternate contacts 163 of relay LR to ground. Relay 162 upon energizing opens the operating circuit of the rotary magnet RM at its normal contact 161 and connects the line relay 165 of the finder switch FS across the calling subscriber's line over a circuit extending from battery, through the winding of relay 165, alternate contact 167 of relay 162 and normal contact 168 of relay 169, wiper 5 and its bank contact out through the calling substation and back through the wiper 4, normal contact 170 of relay 169 and alternate contact 161 of relay 162 to ground. A further result, due to the energization of relay 162 is the closing of a circuit for multiple line lamps LL over a path extending from battery, through the line lamps LL, normal contact 171 of relay 169, and contact 172 of relay 162 to ground, thereby displaying a

signal for each of the operators that have access to multiple answering jacks AJ. A still further result due to the energization of relay 162 is the closing of a circuit through the finder switch relay 8, and cut-off relay CO of the subscriber's line equipment in series over a path extending from battery, through the lower winding of relay 8, alternate contact 173 of relay 162, wiper 3 and the cut-off relay CO to ground.

Reverting now to the energization of relay 165, this relay upon energizing closes a substitute locking circuit for relay 162, independent of its original energizing circuit, over a path extending from battery, through the upper winding of said relay 162, alternate make-before-break contact 164 of relay 165, and the lower winding of relay 162 to ground, thereby making the energization of relay 162 dependent upon relay 165.

Returning now to the energization of relay 8, this relay upon energizing closes a locking circuit for itself from battery, through its upper winding, its make contact 175 and off-normal contact 176 to ground. The relay 8 upon energizing also extends the starting wire SW through to the next finder switch. A further result, due to the energization of relay 8, is the opening of the rotary magnet circuit at its contact 160 and the opening of the test circuit which extends to wiper 2. The energization of cut-off relay CO of the subscriber's line will disconnect the subscriber's line relay LR, thereby removing ground from the starting conductor SW and from bank contact X. The ground is removed from starting conductor SW before relay 8 has connected the starting conductor through to the next finder switch. Had a second subscriber removed his receiver about the same time that the first subscriber removed his and before the finder switch FS connected with the calling subscriber's line, the instant the relay 8 energized a starting circuit would be extended through to the next finder switch, and it would start the finder switch in operation to seek the other calling subscriber's line.

Assuming that the started finder switch does not find a grounded bank contact, due to the fact that the calling subscriber has replaced his receiver and removed the ground from the bank contact of the finder switch before the finder switch has advanced to the grounded bank contact, the finder switch will be advanced step by step to its fully operated position in which position a circuit will be closed, through the upper winding of relay 162, over a path extending from battery, through the upper winding of said relay 162, contact 164 of relay 165, contact 166 of relay 8, wiper 2 and the last contact of the bank to ground. The relay 162 operating causes the energization

of relays 8 and 165, as before described, the only difference being that in this instance the relay 8 energizes over a path extending through the last contact on the bank of contacts over which the wiper 3 passes. This contact is permanently connected to ground. The relay 8 locks up, as before described, but the relay 165 does not remain energized, as before, due to the fact that its substitute circuit is opened at the subscriber's switch hook. The relay 165 de-energizing opens the locking circuit for relay 162, owing to the fact that contact 166 of relay 8 has been opened, permitting the same to de-energize. Relay 162 de-energizing closes a circuit for release magnet 180 over a path extending from battery, through winding of said release magnet, contact 160 of relay 8 and normal contact 161 of relay 162 to ground. The release magnet upon energization removes the retaining pawl from engagement with the switch shaft ratchet, thereby permitting the switch shaft and wipers to return to normal. The release magnet is held energized as long as relay 8 is held in an energized position, and relay 8 is held energized until the off-normal contact 176 is returned to its normal position. The return of the off-normal contacts to normal when the switch shaft returns to normal places the apparatus in condition to be used for other calls.

Returning now to the point where the finder switch was operated to select the calling substation A and to light multiple line lamps LL at the different operators' positions, an idle operator noting the glowing of the line lamp LL before her inserts a plug P of the cord circuit E into one of the multiple jacks AJ. The insertion of the cord circuit plug into the multiple jack closes an energizing circuit for relay AS of the cord circuit and for relay 169 of the finder switch, extending from battery, through the windings of relay AS in series, normal contact 101 of relay LD, sleeve contacts of the plug P and jack AJ, and through the winding of relay 169 to ground. The relay AS energizing closes, providing that the cord circuit E is the first cord circuit to be connected to the jacks AJ, a shunt about its upper high resistance winding at its contact 102, thereby placing its lower winding in series with relay 169 of the finder switch. This low resistance path prevents a relay AS of another cord circuit from operatively energizing and connecting its associated operator's telephone set in circuit with the calling subscriber's line. The relay 169 upon energizing connects the talking strands of the finder switch through to the tip and ring contacts of the jacks AJ at alternate contacts 168 and 170 of said relay 169, opens the circuit for multiple lamps LL at contact 171, and closes a substitute circuit

for line relay 165 through its alternate contact 171, independent of the original energizing circuit for relay 165, which included the calling substation.

Returning now to the cord circuit E, a further result due to the energization of combined test and supervisory relay AS is the bridging of answering tip supervisory relay AT across the subscriber's talking circuit. The relay AT is immediately energized over the subscriber's line to prevent a premature operation of the supervisory lamp AL and disconnect relay LD by opening its normal contact 105, and closes its contact 106 to operate the meter relay MR and meter magnet MM. A still further result due to the energization of relay AS is the bridging of the operator's telephone set OT across the strands of the cord circuit by closing its alternate contacts 106' and 107. The operator's set is now connected across the strands of the cord circuit through alternate contacts 106' and 107 of relay AS and normal contacts 108 and 109 of relay CS. The operator now being in connection with the calling subscriber inquires the wants of the calling subscriber.

Assuming that it is a subscriber at the substation C that is wanted, the operator tests the line of the called subscriber and if it is idle, she then inserts the calling plug P' into a jack J' connected to the line circuit of the called subscriber. If the line of the called subscriber is busy, the touching of the tip of the plug P' to the sleeve of a jack J' will close a circuit from the busy or battery potential upon the jack J', through the tip of the plug, through contact 109' of relay RI, through contact 110 of relay CS and through the tertiary winding of the operator's induction coil to condenser 200* and to ground, thus giving the operator a busy click in her receiver, notifying her of the busy condition of the called line. The operator thereupon notifies the calling subscriber that the called subscriber's line is busy.

Assuming that the called subscriber is a subscriber whose substation is connected to the line of the calling subscriber, the touching of a multiple jack of the calling subscriber's line by the plug P' closes a circuit from the battery or busy potential found upon the sleeve of multiple jack J, through the tip of plug P', through contact 109' of relay RI, through contact 110 of relay CS and through reverte tone relay RTR to ground. Relay RTR upon energizing closes a circuit from the tone device TD through alternate contact 111 of relay RTR, through contact 112 of relay AS, through normal contact 113 of relay CS, through normal contact 101 of relay LD to the sleeve of a multiple jack AJ, from the sleeve of multiple jack AJ, through the condenser 117, through

alternate contact 173 of relay 162, wiper 3 and engaged contact Q to a multiple jack J, thence through the jack J which is being engaged by the tip of plug P', through the tip of said plug and contact 109' of relay RI, through contact 110 of relay CS, through the tertiary winding of the operator's induction coil, and through the condenser 200* to ground, thereby giving the operator a revertive tone test. The operator then plugs into the jack of the subscriber's line and completes the connection in a manner to be hereinafter described.

Assuming that the called subscriber's line is idle, the insertion of the calling plug P' into the jack J' of the called subscriber's line closes an energizing circuit for the calling sleeve supervisory relay CS and the cut-off relay CO' over a path extending from battery through the winding of said relay CS, the sleeve contacts of the plug P' and jack J', and the winding of relay CO' to ground. Relay CO' upon energizing disconnects the line relay LR' from the line circuit of the called subscriber. The calling sleeve relay CS upon energizing disconnects the operator's set OT from the strands of the cord circuit at its contacts 108 and 109, opens the circuit of revertive test relay RTR at its contact 110, and closes a circuit through the calling supervisory lamp CL at its alternate contact 125. The circuit for the lamp CL may be traced from battery through the said lamp, normal contact 126 of relay RC, normal contact 127 of relay LD, normal contact 128 of relay CT and alternate contact 125 to ground. A further result due to the energization of relay CS is the opening of the circuit for meter relay MR at normal contact 125 of relay CS. The relay MR de-energizing opens the circuit of meter magnet MM, thereby permitting the same to de-energize.

The calling lamp CL is the customary calling supervisory lamp for indicating to the operator whether or not the called subscriber at C has his receiver upon the switch hook. The operator next depresses one of the ringing key plungers to connect one of the ringing generators to the common ringing conductor CRL and to initiate the operation of the automatic ringing equipment. The operation of end spring 130 of the ringing key closes a circuit for interrupter relay RI extending from battery through the upper winding of said relay, closed contact 130 of the end springs, normal contact 127 of relay LD, normal contact 128 of relay CT and alternate contact 125 of relay CS to ground. Relay RI upon energizing disconnects the strands of the cord circuit from the ring and tip conductors of plug P' and connects the selected generator through alternate contact 109' of said relay RI to the called subscriber's

line, through the call bell at the called substation and back through alternate contact 132 to ground, thus insuring a preliminary ring of the call bell at the called substation the instant that ring key RK is operated. A further result due to the energization of relay RI is the connection of an audible ringing tone to the calling subscriber's line through alternate contact 133 of said relay RI to indicate to the calling subscriber that the call bell at the called substation is being operated. A still further result due to the energization of relay RI is the closure of an energizing circuit for ring control relay RC extending from battery, through the winding of said relay RC, alternate contact 134 of relay RI, normal contact 127 of relay LD, normal contact 128 of relay CT and alternate contact 125 of relay CS to ground. The relay RC upon energizing closes a locking circuit for itself extending from battery through its winding, its alternate contact 126, normal contact 127 of relay LD, normal contact 128 of relay CT and alternate contact 125 of relay CS to ground. A still further result due to the energization of relay RC is the opening of the circuit of calling supervisory lamp CL at normal contact 126 and the closing of a circuit for interrupter relay RI, extending from battery, through the lower winding of relay RI and through alternate contact 135 of relay RC to interrupter I. The ringing relay RI is thus intermittently energized to connect ringing current to the called subscriber's line to operate the call bell thereat.

Upon the response of the called subscriber, a circuit is closed through the calling tip supervisory relay CT, extending from battery through the lower winding of said relay, through contact 132 of relay RI, through the ring contacts of the plug P' and jack J' out over the called line, back through the tip contacts of the jack J' and the plug P', through contact 109' of relay RI, through alternate contact 110 of relay CS and through the upper winding of relay CT to ground. Relay CT upon energizing opens the locking circuit of relay RC at its contact 128, thereby preventing further application of ringing current to the called subscriber's line. The relay RC de-energizing closes the link strands through to the called subscriber and disconnects the interrupter I from the interrupter relay RI. The subscribers may now carry on conversation over the heavily marked conductors.

Assuming now that conversation is finished, the subscriber at substation A upon replacing his receiver upon the switch hook opens the energizing circuit of answering tip relay AT. Relay AT upon de-energizing closes an energizing circuit for the link

disconnect relay LD at its contact 105. The circuit for link disconnect relay LD extends from battery, through its winding, through said contact 105 of relay AT, through alternate contact 137 of relay AS and through alternate contacts 125 of relay CS to ground. Relay LD upon energizing opens the series energizing circuit for relay AS of the cord circuit and relay 169 of the finder switch at its normal contact 101 and closes a substitute circuit for relay AS extending from battery through the lower winding of said relay AS, alternate contact 102 of said relay AS, alternate contact 101 of relay LD, alternate contact 137 of relay AS and alternate contact 125 of relay CS to ground. A further result due to the energization of relay LD is the disconnection of the tip and ring conductors of the cord circuit E from the tip and ring conductors of jacks AJ, thereby operatively disassociating the calling subscriber's line and the finder switch FS from the link circuit E.

The relay 169 of the finder switch FS de-energizing opens the energizing circuit of relay 165 at its contact 181, which relay upon de-energizing opens the energizing circuit for relay 162, permitting the same to de-energize. The relay 162 de-energizing closes a circuit for release magnet 180 over a path extending from battery winding of said release magnet 180, alternate contact 160 of relay 8, and normal contact 161 of relay 162 to ground. Release magnet 180 energizing moves the holding pawl from engagement with the switch shaft ratchet, thereby permitting the switch shaft and wipers to restore to normal. The called subscriber C upon replacing his receiver upon the receiver hook opens the circuit of the calling tip supervisory relay CT at the substation switch hook contacts. The relay CT upon de-energizing closes a circuit for the calling supervisory lamp CL. This circuit may be traced from battery through the filament of said lamp CL, through alternate contact 127 of relay LD, normal contact 128 of relay CT and through alternate contact 125 of relay CS to ground. The operator upon noting the glowing of the answering supervisory lamp AL and the calling supervisory lamp CL removes the answering plug P from the jack AJ and the calling plug P' from the jack J'. The removal of the calling plug P' from the jack J' allows the cut-off relay CO' and calling sleeve relay CS to de-energize. The relay CS upon de-energizing opens the locking circuit for the link disconnect relay LD, answering sleeve relay AS and for the supervisory lamps CL and AL. Relay LD and the relay AS upon de-energizing restore the cord circuit apparatus to normal rendering

it available for connecting another subscribers' lines.

Should the calling subscriber desire to recall before plug P is removed from the jack AJ, he may do so. The subscriber upon removing his receiver for a recall again energizes line relay LR, thereby grounding the common start wire SW and starting another finder switch FS or the same finder switch in search of the calling subscriber's line. As soon as the finder switch finds the calling subscriber's line, the connection is completed the same as heretofore described. If the same finder switch is started that was used in the previous connection, the finder switch upon finding the calling subscriber's line will again cause the lamps LL to glow and either the same operator or another operator may seize the recall.

Having described the operation of the apparatus when a connection is established between the calling substation A and the called substation C, using finder switch FS, the functioning and operation of the apparatus shown in Figs. 2 and 3 of the drawings when a connection is established between the calling substation B and called substation C, will now be given.

Assuming that the subscriber at substation B wishes to initiate a call, upon the removal of the receiver thereat a circuit is closed through the line relay LR², including the two sides of the subscriber's line in series. Relay LR² upon energizing places a ground upon starting wire SW² and a ground upon multiple test contacts U, corresponding to the calling subscriber's line in the banks of the finder switches. The placing of ground upon starting wire SW² closes an energizing circuit through one winding of the rotary magnet RM² over a path extending from battery through resistance R², lower winding of magnet RM², interrupter contact 200 of magnet RM², off-normal contact 201 and contact 202 of relay LR² to ground. Had finder switch FS' been in use at the time that the subscriber's line relay LR² was energized, off-normal contact 201 would have been in its alternate position and the starting circuit would have been extended through alternate contact 203 of relay 204 to starting conductor SW³ and to the rotary magnet of the next finder switch in the series. The rotary magnet RM² upon energizing interrupts its own circuit at its contact 200 and steps the wipers 205, 206, 207 and 208 onto the first set of bank contacts of the finder switch, and moves the off-normal contacts ON' to their alternate position. The movement of off-normal contact 201 to its alternate position closes a local substitute circuit for magnet RM² over a circuit extending from battery, through the lower winding of magnet RM², its interrupter con-

tact 200, off-normal contact 201, normal contact 210 of relay 204 and normal contact 211 of relay 212 to ground, thereby making the movement of the switch shaft and wipers independent of the starting circuit so that no matter if the calling subscriber should immediately replace his receiver, the finder switch will operate to move the switch shaft and wipers step by step over the back contacts to the last contact of the bank, unless a grounded contact corresponding to the calling subscriber's line is engaged.

The finder switch wiper 208 upon engagement with a grounded contact corresponding to the calling subscriber's line will close a circuit through the upper winding of the magnet RM^2 over a path extending from battery, through the winding of relay 212, make-before-break contact 215 of relay 217, contact 216 of relay 204, upper winding of magnet RM^2 , wiper 208, its engaged bank contact U and alternate contact 219 of line relay LR^2 to ground. The windings of the magnet RM^2 being wound differentially, the closing of a circuit through the upper winding neutralizes the effect of the circuit of the lower winding, thereby preventing further operations of the stepping magnet RM^2 . Relay 212 upon energizing closes a series energizing circuit for relay 204 of the finder switch FS' and cut-off relay CO^2 of the subscriber's line circuit, bridges the relay 217 across the calling subscriber's line, and closes a circuit through multiple line lamps LL' . The circuit for relays 204 and CO^2 extends from battery, through the lower winding of relay 204, alternate contact 220 of relay 212, wiper 207 and its engaged bank contact and the winding of relay CO^2 to ground. The circuit for the line lamps LL' extends from battery, through the lamps in multiple, contact 221 of relay 222 and contact 223 of relay 212 to ground. The circuit for line relay 217 extends from battery through the winding of said relay, contact 224 of relay 212, contact 225 of relay 222, switch wiper 205 out over the calling subscriber's line, back through the switch wiper 206, contact 226 of relay 222 and contact 211 of relay 212 to ground.

Reverting now to the energization of relay 204, this relay upon energizing closes a locking circuit for itself extending from battery, through its upper winding, its alternate contact 228 and off-normal contact 229 to ground. A further result due to the energization of relay 204 is the opening up of the circuits of the upper and lower windings of the magnet RM^2 at its contacts 210 and 216, and a still further result due to the energization of relay 204 is the extending of the starting circuit through its alternate contact 203 to the next idle finder switch FS' . Relay 217 upon energizing closes a locking circuit for relay 212 inde-

pendent of the original energizing circuit of relay 212. This locking circuit for relay 212 extends from battery, through its winding, contacts 215 and 230 of relay 217, and resistance X' to ground.

Assuming that the started finder switch FS' does not find a grounded bank contact, due to the fact that the calling subscriber has replaced his receiver and removed the ground from the bank contact of the finder switch, the finder switch shaft and wipers will be advanced step by step to its fully operated position, in which position a circuit will be closed through the upper winding of the stepping magnet RM^2 over the hereinbefore traced circuit, thereby neutralizing the effect of the lower winding of the magnet RM^2 , preventing further operations of the same. The wiper 207 upon engagement with the last contact of the bank closes a circuit for relay 204, extending from battery, through the lower winding of said relay, alternate contact 220 of relay 212 (relay 212 having been energized in series with the upper winding of the magnet RM^2), wiper 207 and the last contact in the bank, which contact is connected to ground. Relay 204 upon energizing closes a locking circuit for itself through its upper winding and off-normal contact 229 to ground. The energization of relay 204 also causes the de-energization of relay 212, owing to the fact that when relay 212 connected relay 217 across the subscriber's line there was no circuit for relay 217 (the subscriber having replaced his receiver), consequently, relay 217 de-energizes and does not close a locking circuit for relay 212. Relay 212 de-energizing closes a circuit for release magnet 231 over a path extending from battery, through the winding of said magnet 231, alternate contact 210 of relay 204, and normal contact 211 of relay 212 to ground. Release magnet 231 upon energizing removes the retaining pawl from engagement with the switch shaft ratchet, thereby permitting the switch shaft and wipers to return to normal. The switch shaft returning to normal returns the off-normal springs ON' to their normal position, thereby opening the locking circuit of relay 204. Relay 204 de-energizing opens the circuit of release magnet 231, permitting the same to de-energize. The release of relay 204, of course, opens its contact 203 thereby returning the starting circuit to its rotary magnet RM^2 .

Returning now to the point where the finder switch was operated to select the calling substation B and the multiple line lamps LL' lighted at the different operators' positions, an idle operator noting the glowing of the line lamp at her position inserts the plug P of the cord circuit E into one of the multiple jacks AJ' . The insertion of the cord circuit plug into the jack closes an

energizing circuit for relay AS of the cord circuit in series with relay 222 of the finder switch FS', extending from battery, through both windings of relay AS of the cord circuit, contact 101 of relay LD, sleeve contact of the plug P and of the jack AJ', and through the winding of relay 222 to ground. The relay AS energizing, closes (providing that the cord circuit E is the first cord circuit to connect to a jack AJ') a shunt about its upper high resistance winding at its contact 102, thereby placing its lower winding in series with relay 222 of the finder switch. This low resistance path from battery prevents relay AS of another cord circuit from operatively energizing and connecting its associated operator's telephone set in circuit with the calling subscriber's line. Relay 222 upon energizing connects the talking strands of the finder switch through to the tip and ring contacts of the jacks AJ', extinguishes the multiple line lamps LL', and closes a substitute locking circuit for relay 217, extending from battery through the winding of said relay, alternate contact 224 of relay 212 and alternate contact 232 of relay 222 to ground. From here on the operation of the cord circuit E is the same as hereinbefore described when it was used for establishing a connection between the calling substation A and called substation C.

Assuming now that the conversation is finished, the subscriber at the substation B, upon replacing his receiver, opens the energizing circuit of relay AT. The relay AT de-energizing closes an energizing circuit for the link disconnect relay LD, as hereinbefore described, with the aforementioned results including the opening of the holding circuit of relay 222. Relay 222 de-energizing opens the holding circuit of relay 217 and relay 217 de-energizing opens the holding circuit of relay 212. Relay 212 upon de-energizing closes the energizing circuit of release magnet 231, and magnet 231 thereupon energizes and releases the finder switch FS' in the hereinbefore described manner. The operator noting the glowing of the answering and calling supervisory lamps removes the plugs P and P' from their associated terminals and engaged jacks, which places the apparatus in readiness to be used for further connections.

The circuit is similar to the circuit of switch FS in that it is so arranged that the calling subscriber may recall before the plug P is removed from the jacks AJ'.

In working out our invention we have employed preferred circuit arrangements all of which tend to make an efficient operating system, but it is to be understood that various changes and modifications may readily be made without departing from the spirit and scope of our invention. There-

fore, we do not desire to be limited to the exact arrangement shown and described, but aim to cover all such changes and modifications as come within the spirit and scope of the appended claims.

What we claim as new and desire to secure by United States Letters Patent is:

1. An automatic switch provided with a double-wound motor magnet, means for closing a circuit through one of the windings of said motor magnet to cause the operation of the same, means for closing a circuit through the other of said windings to neutralize the effect of the first winding, thereby preventing further operation of the same and means for releasing and restoring said switch independently of said motor magnet.

2. A telephone system including an automatic switch for selecting calling lines, a double-wound motor magnet for said switch, means for closing a circuit through one of the windings of said motor magnet to cause the same to energize and advance the wipers of the switch, and means for closing a circuit through the other of said windings thereby neutralizing the effect of the first of said windings and preventing further actuations of said motor magnet.

3. A telephone system including an automatic switch for selecting calling lines, a double-wound motor magnet for said switch, means for closing a circuit through one of the windings of said motor magnet to cause the same to energize and advance the wipers of the switch, means for closing a circuit through the other of said windings thereby neutralizing the effect of the first of said windings and preventing further actuations of said motor magnet, and a relay for simultaneously opening the circuit of both of said windings.

4. A telephone system including an automatic switch for selecting calling lines, a double-wound motor magnet for said switch, means for closing a circuit through one of the windings of said motor magnet to cause the same to energize and advance the wipers of the switch, means for closing a circuit through the other of said windings thereby neutralizing the effect of the first of said windings and preventing further actuations of said motor magnet, a test relay adapted to be energized in series with the second winding of said motor magnet, and means controlled by said test relay for opening the circuit of both windings of said motor magnet.

5. A telephone system including subscribers' telephone lines, answering jacks, automatic spring-restored switches for interconnecting said subscribers' lines and said jacks, step-by-step motor magnets for said switches for effecting such connections, link circuits for extending connections from said jacks

to called subscribers' lines, and subscriber-controlled means individual to said link circuits adapted to disconnect said link circuits from said jacks and to permit the restoration of the automatic switches without disconnecting the link circuit terminals from the jacks.

6. A telephone system including a calling subscriber's line, multiple jacks, an automatic switch provided with wipers having contact makers, a step-by-step motor magnet for said switch adapted to be operated to move the contact makers to connect said multiple jacks with the calling subscribers' line, a link circuit provided with a terminal adapted to be connected to said jacks to extend a connection therefrom, and subscriber-controlled means for disconnecting said link circuit from said jack.

7. A telephone system including a calling subscriber's line, multiple jacks, an automatic switch provided with wipers having contact makers, a step-by-step motor magnet for said switch adapted to be operated to move the contact makers to connect said multiple jacks with the calling subscriber's line, a link circuit provided with a terminal adapted to be connected to said jacks to extend a connection therefrom, subscriber-controlled means for disconnecting said link circuit from said jack while maintaining said link terminal connected to said jack, and release means for said switch responsive to said subscriber-controlled means.

8. A telephone system including a subscriber's line, a jack, an automatic step-by-step switch for connecting said jack to said line, a motor magnet for said switch, a test relay for said switch, and a circuit for said test relay including a winding of said motor magnet.

9. An automatic switch of the character described provided with bank contacts and contact makers and operable in a single plane, and a differentially-wound motor magnet for said switch for moving said contact makers into engagement with said bank contacts.

10. An automatic switch of the character described provided with bank contacts and contact makers, a differentially-wound motor magnet for said switch for moving said contact makers into engagement with said bank contacts, and a test relay for said switch adapted to be included in series circuit with one of the differential windings of said motor magnet.

11. A telephone system including subscribers' telephone lines, multiple jacks and multiple line lamps appearing at a plurality of operators' positions upon a switchboard, an automatic switch provided with contact makers, a step-by-step motor magnet for said automatic switch for connecting said multi-

ple jacks to a calling one of said subscribers' lines, a link circuit for use in extending a connection from said jacks to a called one of said subscribers' lines, and subscriber-controlled means for disconnecting said link circuit from said multiple jacks.

12. A telephone system including subscribers' telephone lines, multiple jacks and multiple line lamps appearing at a plurality of operators' positions upon a switchboard, an automatic switch provided with contact makers, a step-by-step motor magnet for said automatic switch for connecting said multiple jacks to a calling one of said subscribers' lines, a link circuit for use in extending a connection from said jacks to a called one of said subscribers' lines, and subscriber-controlled means for releasing said automatic switch and for disconnecting said link circuit from said multiple jacks.

13. A telephone system including a subscriber's telephone line, a jack, an automatic switch, and a differentially-wound operating magnet for moving the wipers of said switch to connect said jack to said subscriber's line.

14. A telephone system including a subscriber's telephone line, a jack, an automatic switch provided with contact makers, a differentially-wound operating magnet for said automatic switch for moving said contact makers to connect said subscriber's telephone line and said jack, a link circuit for extending connection from said jack, and subscriber-controlled means for effectively disconnecting said link circuit from said jack and for restoring the contact makers of said switch.

15. A telephone system including subscribers' lines, connecting circuits common to said lines and terminating in multiple jacks and multiple lamps upon a multiple line lamp board, automatic switches provided with contact makers, step-by-step motor magnets for said switches for moving the contact makers to effect connection between said jacks and said subscribers' lines, test relays for said switches adapted to be included in series circuit with the windings of said motor magnets, cord circuits at the operators' positions for extending a call from any one of the multiple jacks towards a called subscriber's line, and automatic means for restoring said contact makers to their normal position.

16. A telephone system including subscribers' telephone lines, multiple lamps and answering terminals appearing at a plurality of positions upon a switchboard, automatic spring-restored switches for said terminals for connecting to said subscribers' lines, step-by-step motor magnets for said switches for effecting such connections, operator-controlled link circuits for extend-

ing connections from said terminals to called subscribers' lines, and subscriber-controlled means individual to the link circuits for disassociating the link circuit connected to one of said terminals without disconnecting the said connected link circuit terminal from the said multiple terminal.

17. A telephone system including subscribers' telephone lines, multiple lamps and answering terminals appearing at a plurality of positions upon a switchboard, automatic spring-restored switches for said terminals for connecting to said subscribers' lines, step-by-step motor magnets for said switches for effecting such connections, operator-controlled link circuits for extending connections from said terminals to called subscribers' lines, link circuit means for preventing effective connection of more than one of said link circuits to a calling one of said subscribers' lines, and subscriber-controlled means individual to the link circuits for disassociating the link circuit connected to one of said terminals without disconnecting said connected link circuit terminal from said multiple terminal.

18. A telephone system including subscribers' telephone lines, multiple lamps and answering terminals appearing at a plurality of positions upon a switchboard, automatic spring-restored switches for said terminals for connecting to said subscribers' lines, step-by-step motor magnets for said switches for effecting such connections, operator-controlled link circuits for extending connections from said terminals to called subscribers' lines, and subscriber-controlled means individual to the link circuits for disassociating the link circuit connected to one of said terminals without disconnecting said connected link circuit terminal from the said multiple terminal. The disassociation of the link circuit from the multiple terminals permitting the restoration of the automatic switch.

19. A telephone system including subscribers' telephone lines, a manual switchboard, multiple answering terminals and multiple lamps appearing in various positions upon said switchboard, an automatic spring-restored switch for effecting connection between the said multiple terminals and a calling one of said lines, a step-by-step motor magnet for said switch for effecting such connection, link circuits for extending connections from said multiple terminals to called subscribers' lines, automatic means in said link circuits for preventing the simultaneous effective connection of more than one link circuit to a calling one of said subscribers' lines, and subscriber-controlled automatic disconnect means for the link circuit that is used to complete the said connection for disassociating the link circuit from the subscribers' line, thereby releasing the said

automatic switch and rendering said automatic switch effective for extending other connections.

20. A telephone system including subscribers' telephone lines, multiple jacks and multiple line lamps appearing at a plurality of operators' positions upon a switchboard, an automatic switch provided with contact makers, a step-by-step motor magnet for said automatic switch for connecting said multiple jacks to a calling one of said subscribers' lines, a link circuit for use in extending a connection from said jacks to a called one of said subscribers' lines, an operator's telephone, automatic means for connecting and disconnecting said operator's telephone and said link circuit, and subscriber-controlled means for disconnecting said link circuit from said multiple jacks.

21. A telephone system including subscribers' telephone lines, multiple jacks and multiple line lamps appearing at a plurality of operators' positions upon a switchboard, an automatic switch provided with contact makers, a step-by-step motor magnet for said automatic switch for connecting said multiple jacks to a calling one of said subscribers' lines, a link circuit for use in extending a connection from said jacks to a called one of said subscribers' lines, an operator's telephone, automatic means for connecting and disconnecting said operator's telephone and said link circuit, automatic ringing means for said link circuit for signaling the said called subscriber, and automatic means for disassociating said link circuit and said jacks to render said switch available for use.

22. A telephone system including subscribers' telephone lines, answering jacks, automatic spring-restored switches for interconnecting said subscribers' lines and said jacks, step-by-step motor magnets for said switches for effecting such connections, link circuits for extending connections from said jacks to called subscribers' lines, automatic means for preventing the simultaneous connection of more than one of said link circuits to a calling one of said subscribers' lines, and subscriber-controlled means individual to said link circuits adapted to disconnect said link circuits from said jacks and to permit the restoration of the automatic switches without disconnecting the link circuit terminals from the jacks.

23. A telephone system including subscribers' telephone lines, answering jacks, automatic spring-restored switches for interconnecting said subscribers' lines and said jacks, step-by-step motor magnets for said switches for effecting such connections, link circuits for extending connections from said jacks to called subscribers' lines, automatic means for preventing the simultaneous connection of more than one of said link

circuits to a calling one of said subscribers' lines, an operator's set, automatic means for connecting and disconnecting said operator's set and said link circuits, automatic ringing means for said link circuits for signaling said called subscribers, and subscriber-controlled means individual to said link circuits adapted to disconnect said link circuits from said jacks and to permit the restoration of the automatic switches without disconnecting the link circuit terminals from the jacks.

24. A telephone system including a subscriber's telephone line, a plurality of multiple jacks and multiple lamps appearing before a plurality of operators' positions, an automatic single plane step by step switch controlled over said subscriber's telephone line for automatically connecting said subscriber's line with said multiple jacks and lamps, and means for preventing more than one operator from operatively connecting with said subscriber's telephone line at the same time.

25. A telephone system including a subscriber's telephone line, a single level step by step automatic switch, said subscriber's telephone line terminating in bank contacts of said automatic switch, a plurality of multiple lamps and jacks distributed among a plurality of operators' positions, means controlled over said subscriber's line for causing said switch to automatically select said line and to connect the same with said multiple lamps and jacks via said bank contacts.

26. A telephone system including a telephone line, a step by step switch, a plurality of multiple lamps and jacks distributed among a plurality of operators' positions, said switch adapted to operate automatically in a single plane, when the subscriber on said line initiates a call, to select and to connect said telephone line with said multiple lamps and jacks, and to cause said lamps to light to notify the operators before whom said lamps light of such call.

27. A telephone system including a telephone line, multiple lamps and jacks appearing before different operators' positions, an automatic switch operable step by step in a single plane to automatically select said line and to connect said line to said multiple lamps and jacks, when a call is initiated over said line, and to cause said multiple lamps to light to indicate to the operators before whom said lamps appear that a call has been initiated, and automatic means for preventing more than one of said operators from answering the call at the same time.

28. A telephone system including a telephone line, an automatic rotary switch, said telephone line appearing in bank contacts of said switch, multiple lamps and jacks distributed among different operators' positions, said switch operable step by step to

connect said line via said bank contacts with said multiple lamps and jacks when a call is initiated over said line, and means for permitting only one operator to operatively connect to one of said multiple jacks to answer the call.

29. A telephone system including subscribers' telephone lines, multiple lamps and jacks appearing before a number of operators' positions, an automatic switch operable step by step in a single plane to pick out anyone of said subscribers' lines as a calling line and to extend the same to said multiple lamps and jacks, and means for causing said lamps to light to apprise the operators of the extension of said calling line and said call.

30. A telephone system including a calling subscriber's telephone line, a plurality of lamps and jacks appearing before different operators' positions, an automatic rotary step by step switch for selecting said calling subscriber's telephone line and connecting the same to said lamps and jacks when a call is initiated over said line, said lamps lighting to notify the operators before whom they appear of said call, and automatic means for preventing more than one operator from answering said call.

31. A telephone system including subscribers' telephone lines, multiple lamps and jacks distributed among different operators' positions, an automatic switch operable step by step in a single plane to select any one of said subscribers lines as a calling line and to extend the same to said multiple lamps and jacks, and means controlled over said selected calling line for restoring said automatic switch to normal to disassociate said calling line and said multiple lamps and jacks.

32. A telephone system including subscribers' telephone lines, multiple lamps and jacks appearing before a plurality of operators' positions, automatic single level step by step switches for automatically picking out said lines as calling lines and automatically extending the same to said multiple lamps and jacks, link circuits for each of said operators' positions for connecting to said subscribers' lines via said multiple jacks, means individual to said link circuits for preventing more than one of said link circuits from being operatively connected to the same subscriber's line at the same time.

33. A telephone system including subscribers' telephone lines, multiple lamps and jacks appearing before a number of operators' positions, step by step rotary switches for automatically selecting said lines as calling lines and to extend the same to said multiple lamps and jacks, link circuits for each of said operators' positions for answering the calls extended by said switches, means for preventing more than one opera-

tor from answering the same call at the same time, and means for preventing the operator from listening in on a connection established between a calling and a called subscriber's line.

34. A telephone system including a calling subscriber's line, a called subscriber's line, multiple lamps and jacks distributed among different operators' positions, a step by step rotary switch for automatically connecting to said calling line, when a call is initiated, and to extend the same to said multiple lamps and jacks, a link circuit for each of said operators' positions for seizing the call extended by said switch and to connect the calling line to said called line, automatic means for permitting only one operator to seize the call at the same time, and automatic means for preventing any operator from listening in on a connection established between said calling line and said called line.

35. A telephone system, including a calling line and a called line, multiple lamps and jacks distributed among different operators, an automatic switch, having a single driving magnet, for automatically selecting said calling line and to connect the same to said multiple lamps and jacks, a circuit for said magnet including a contact of said magnet, a cord circuit for interconnecting said calling line and said called line via one of said multiple jacks, an operators' set for said cord circuit but normally disconnected therefrom, automatic means for connecting said operators' set to said cord circuit when said cord circuit is connected to one of said jacks, and automatic means for disconnecting said operator's set when said cord circuit is connected to said called line.

36. A telephone system including step by step switches operable in a single plane, subscribers' telephone lines terminating in bank contacts of said switches, multiple lamps and jacks distributed among different operators, means for causing said switches to automatically select said lines as calling

lines and to extend the same to said multiple lamps and jacks, cord circuits for interconnecting said lines via said multiple jacks, an operators' set for said cord circuits but normally disconnected therefrom, automatic means for connecting said operators' set to one of said cord circuits when the said one cord circuit is connected to one of said jacks, and automatic means for disconnecting said operator's set from said one cord circuit when said one cord circuit is connected to a called line.

37. A telephone system including a calling line and a called line, multiple lamps and jacks, a step by step rotary switch for automatically selecting and extending said calling line to said multiple lamps and jacks, a cord circuit for interconnecting said calling line and said called line via one of said multiple jacks, an operator's set for said cord circuit, but normally disconnected therefrom, automatic means for connecting said operator's set in conversational circuit with the calling subscriber, and automatic means for disconnecting said operator's set from conversational circuit with the calling subscriber.

38. A telephone system including a calling line, a called line, multiple lamps and jacks, a step by step rotary switch for automatically selecting and extending said calling line to said multiple lamps and jacks, a cord circuit for interconnecting said calling and called line via one of said multiple jacks, an operator's set for said cord circuit, automatic means for connecting said operator's set to said cord circuit to permit the operator to answer the call, and automatic means for automatically disconnecting said operator's set from said cord circuit when said cord circuit is connected to said called line.

Signed by us at Chicago, in the county of Cook and State of Illinois this 21st day of June, 1919.

HIRAM D. CURRIER.
GEORGE R. EATON.