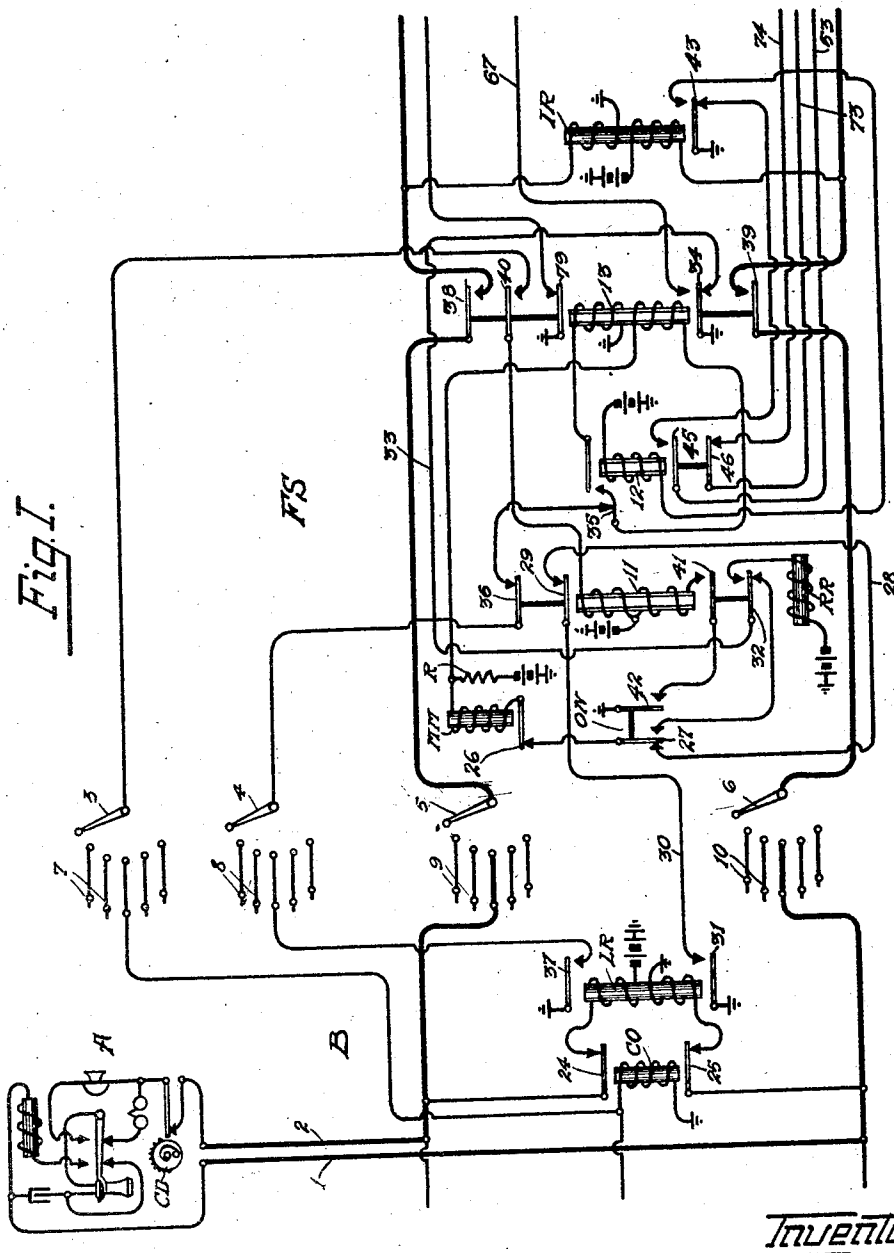
July 13, 1926. 1,592,084

H. D. CURRIER ET AL

TELEPHONE SYSTEM

Filed July 1, 1922 2 Sheets-Sheet 1

Fig. 1.



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Filed July 1, 1922 2 Sheets-Sheet 2

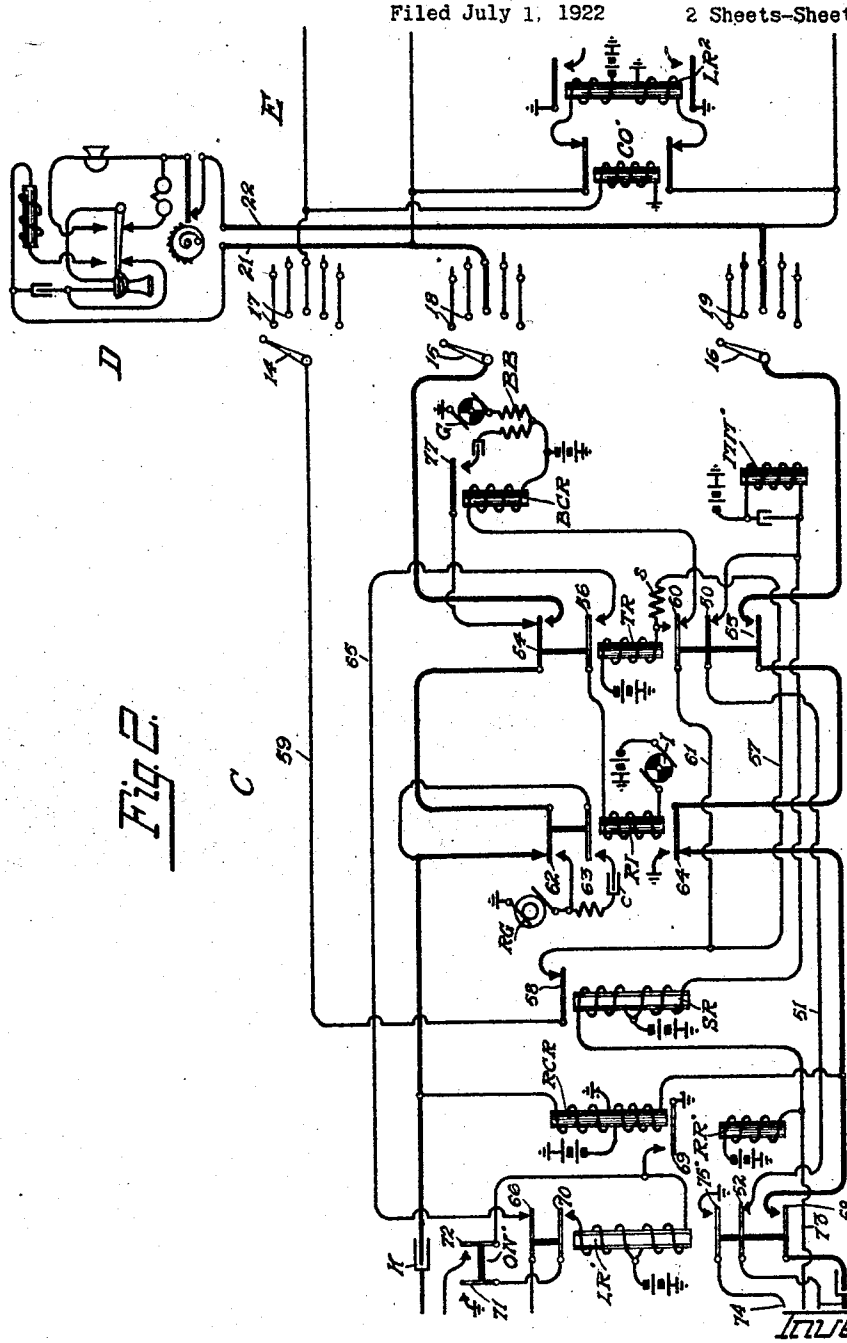

Fig. 2.

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Patented July 13, 1926. 1,592,084

UNITED STATES PATENT OFFICE.

HIRAM D. CURRIER, OF CHICAGO, AND GEORGE R. EATON, OF OAK PARK, ILLINOIS, ASSIGNORS TO KELLOGG SWITCHBOARD AND SUPPLY COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF ILLINOIS.

TELEPHONE SYSTEM.

Application filed July 1, 1922. Serial No. 572,221.

Our invention relates to telephone systems and has to do more particularly with automatic systems in which switches are used for interconnecting subscribers of a local exchange or private branch exchange in conversational circuit, and an object of our invention is the provision of an improved circuit arrangement which embodies desirable features and advantages all in an efficient, simple and economical manner, and in which the switch of our invention is most positive in its operation.

A feature of our invention is the provision of a line finder switch of the rotary type, that is, one in which the contact wipers are moved in a rotary direction only and the provision of a connector switch, also of the rotary type and which is operatively associated with said line finder switch for interconnecting a calling and a called subscriber. We have arranged the circuits of our line finder switches and connector switches so that said finder switches and connector switches are under the sole control of the calling subscriber both in their initial and restoring operations.

Another feature of our invention is the provision of means for preventing any interference with other established talking connections when the wipers of a connector switch are stepping over contacts to engage contacts of a called subscriber's line, and also when said wipers are restoring to normal.

The novel features of the invention, through the provision of which the above-mentioned and other advantageous results are obtained, will be described in connection with the accompanying drawings, in which—

Fig. 1 illustrates a subscriber's substation, a line circuit and the line finder switch of our invention;

Fig. 2 illustrates the connector switch of our invention, together with a line circuit and a subscriber's substation.

Referring now more in detail to our invention as illustrated in the accompanying drawings, and referring particularly to Fig. 1, to the left thereof we illustrate a calling substation A, which includes the usual talking and signaling equipment, with the addition of the calling device CD. The calling substation A terminates at the private branch exchange in a line switch B which comprises a line relay LR and cut-off relay CO.

The line finder switch FS of our invention comprises a motor magnet MM which automatically operates when a call is initiated by the subscriber A to step the contact wipers 3, 4, 5 and 6 over the bank contacts 7, 8, 9 and 10 to connect the finder switch to the calling subscriber's line. An impulse relay IR, release relay RR and off-normal contacts ON are provided for the finder switch for purposes to be described. We also provide the finder switch with slow-acting relays 11, 12 and 13 for purposes to be hereinafter described.

The connector C of our invention comprises a motor magnet MM′ which operates, when the impulse relay IR de-energizes and energizes due to impulses sent from the calling substation A, to step the contact wipers 14, 15 and 16 over contacts 17, 18 and 19 to engage contacts of the called line. A test relay TR is provided which tests the called line as to its idle or busy condition and, if busy, will not energize, which permits a suitable busy-back apparatus BB to be connected to the calling line through the medium of a busy-back connecting relay BCR to notify the calling subscriber as to the busy condition of the called line. A ringing interrupter relay RI and interrupter I are provided for intermittently connecting the ringing generator RG in circuit to intermittently apply ringing current to the called subscriber's line. A ringing control relay RCR is provided which operates when the called subscriber responds to cause the operation of the locking relay LR′ which relay LR′ energizing prevents the further application of ringing current to the called line. A release relay RR′ is provided which is controlled by the calling subscriber for releasing the connector C to permit the same to restore to normal. We also provide a slow-acting relay SR, the purpose of which will be described in the ensuing specification. Off-normal contacts ON′ are

also provided which assume their alternate position upon the first step of the motor magnet MM' off normal.

To the right of connector C we show a called substation D terminating in a line circuit E, which line circuit E comprises a cut-off relay CO' and line relay LR².

Our connector switch is of the rotary fifty-point type, and we leave the tens contacts of the bank contacts blank, that is, the tenth set of contacts, twentieth set of contacts, thirtieth set of contacts and fortieth set of contacts are not connected to a subscriber's line but are left blank or in open circuit. Assuming that the calling subscriber is calling a subscriber whose line appears in the twelfth set of contacts, the subscriber will operate his impulse sender or calling device CD to send ten impulses which will operate the connector switch to cause the wipers to engage the tenth set of contacts in the bank and then the subscriber will operate his dial CD to send two impulses to cause the wipers to step over two more contacts to engage the twelfth set of contacts. Now, if the tenth set of contacts had a subscriber's line connected thereto and should said line be connected in conversational circuit, there would be an interference with said connection due to the engagement of the wipers of said connector switch with said tenth set of contacts before the calling device is operated to send the second set of impulses to step the wipers into engagement with the twelfth set of contacts. By leaving the tenth sets of contacts blank and when the impulse sending device is operated to send ten impulses, the wipers will always engage blank contacts instead of engaging contacts leading to a subscriber's line, thereby preventing interference with established connections.

In a fifty-point switch it will be understood that forty-six subscribers' lines may be taken care of since four of the contacts of the switch will be blank and will have no lines connected to them. A number of our line finder switches will be provided which will be common to the subscribers' lines and one of which when idle will operate to connect to any one of the lines when a subscriber thereat initiates a call. A number of our connector switches equal to the number of line finder switches will be provided and associated with said line finders, said connector switches also being common to said subscriber's line. In practice we find that from five to eight line finder switches and connector switches will be sufficient to handle the ordinary calls, but it is evident that a greater number of switches may be used when necessary to handle the calls.

Having described in general the apparatus as illustrated in the accompanying drawings, we will now describe in detail the operation of the individual switches of our invention in establishing a connection between two subscribers' lines.

Assuming that the subscriber at the substation A desires to talk with the subscriber at the substation D, and whose number is 14, the subscriber at substation A will remove his receiver from its switchhook, whereupon the line relay LR will energize over a circuit traced from battery, upper winding of relay LR, normal contact 24 of cut-off relay CO, line conductor 2, through the substation A, line conductor 1, normal contact 25 of cut-off relay CO, lower winding of relay LR to ground. Relay LR upon energizing closes an energizing circuit for the motor magnet MM of the line finder switch FS, traced from battery, winding of said magnet MM, normal contact 26 of magnet MM, normal contact 27 of off-normal contacts ON, conductor 28, normal contact 29 of slow-acting relay 11, conductor 30 to ground through alternate contact 31 of relay LR. Motor magnet MM energizing over this circuit operates to step the contact wipers 3, 4, 5 and 6 one step to engage the first set of bank contacts 7, 8, 9 and 10. Upon the first step of the finder switch FS off-normal, off-normal contacts ON assumes their alternate position, which opens the initial energizing circuit of the motor magnet MM to cause the same to de-energize, and should the contact 8 engage by the test wiper 4 be free from ground, a substitute circuit will be provided for the motor magnet MM, from battery, winding of motor magnet MM, normal contact 26 of said relay, alternate contact 27 of off-normal contacts ON, normal contact 32 of relay 11, conductor 33, normal contact 34 of relay 13 to ground. Motor magnet MM will energize over this circuit and open its normal contact 26 to cause its de-energization and at the same time step the wipers into engagement with the next set of contacts, and if the next contact 8 engaged by the test wiper 4 is free from ground motor magnet MM will again energize to step the wipers over the bank contacts until the test wiper 4 engages a grounded contact 8, whereupon relay 13 will energize. The energizing circuit for relay 13 may be traced from battery, through resistance R, lower winding of relay 13, make-before-break contact 35, normal contact 36 of relay 11, test wiper 4, contact 8, alternate contact 37 of line relay LR to ground. Relay 13 and motor magnet MM are now in multiple circuit, but motor magnet MM will not operate since sufficient current will not flow through said motor magnet to operate it due to its high resistance due to the shunting effect of the energizing circuit of relay 13, but relay 13 operates and opens the energizing circuit of motor magnet MM at normal contact 34 and closes normally open

contacts 38 and 39 in the talking conductors, thus completing an energizing circuit for the impulse relay IR, traced from battery, lower winding of relay IR, alternate contact 39 of relay 13, wiper 6, contact 10, line limb 1, through the now closed switchhook contacts of the substation A, line limb 2, contact 9, wiper 5, alternate contact 38 of relay 13, upper winding of relay IR to ground. A further result due to the energization of relay 13 is the closing of a circuit for relay 11 traced from battery, upper winding of relay 11, alternate contact 40 of relay 13, wiper 3, contact 7, winding of cut-off relay CO to ground. Relay 11 energizing opens its normal contacts 29, 32, 36 and closes its normally open contact 41, whereupon relay 11 locks up over a circuit traced from battery through the lower winding of relay 11, closed contact 41, alternate contact 42 of off-normal contacts ON to ground. The opening of normal contact 32 of relay 11 prevents the further operation of the motor magnet MM, whereupon the wipers remain in engagement with the contacts of the calling line. The operation of cut-off relay CO opens its normal contacts 24 and 25 to permit the restoration of the line relay LR to normal. Relay IR energizing closes an energizing circuit for relay 12 traced from battery, winding of relay 12, alternate contact 43 of the impulse relay IR to ground, and relay 12 upon energizing closes its make-before-break contact 35 to close a circuit through the upper winding of relay 13, traced from battery through resistance R, lower winding of relay 13, now closed make-before-break contact 35 of relay 12, to ground through the upper winding of relay 13, thus providing an energizing circuit for said relay 13 independently of said test wiper 4.

The line finder switch has now fully operated to connect to the calling subscriber's line and this operation of said switch occurs immediately upon the removal of the receiver from its switchhook by the calling subscriber at substation A and before the calling subscriber operates his calling device CD. The line finder switch FS having connected to the calling line, the subscriber A now operates the calling device CD to cause the connector switch C to connect to the called subscriber's line.

Should another subscriber remove his receiver before the wipers of the line finder switch have passed the contacts leading to said other subscriber's line and before the wipers have engaged the contacts leading to the first calling subscriber's line, relay 13 and motor magnet MM will be placed in multiple circuit as before described, causing the wipers to remain in engagement with the first set of contacts engaged leading to a calling line, but there being more than one finder switch, another finder switch will operate before the calling subscriber has time to operate his calling device, to connect to the calling subscriber's line, since all of the line finder switches are common to all of the subscribers' lines.

The calling subscriber A having removed his receiver from the switchhook and an idle line finder switch FS having operated to connect to said subscriber's line, and having assumed that the called subscriber's number is 14, the subscriber at A now operates the calling device CD to send fourteen impulses of current. The subscriber at A first sends ten impulses to open and close the circuit of the impulse relay IR ten times, thus causing the impulse relay IR to de-energize and energize ten times. Upon each de-energization of impulse relay IR a circuit is closed for the motor magnet MM′ of the connector switch C, which will operate ten times, since relay IR de-energizes ten times, to step the wipers 14, 15 and 16 into engagement with the tenth set of contacts 17, 18 and 19 which are blank as mentioned before. The energizing circuit for motor magnet MM′ may be traced from battery, winding of motor magnet MM′, normal contact 50 of test relay TR, conductor 51, normal contact 52 of relay LR′, conductor 53, alternate contact 45 of relay 12, to ground at normal contact 43 of relay IR. The calling subscriber A now operates the calling device CD to open and close the circuit of impulse relay IR four times to cause relay IR to de-energize and energize four times, thus causing motor magnet MM′ to operate four times over the circuit just traced to step the wipers 14, 15 and 16 into engagement with the fourteenth set of contacts 17, 18 and 19 which lead to the called substation D. During the sending of impulses, slow-acting relay SR will energize upon the first de-energization of impulse relay IR, to open its normal contact 58 to prevent the test relay TR from energizing when the wipers are moving over contacts of other subscribers' lines to the contacts of the called subscriber's line and to further prevent any interference with other established connections, this circuit for relay SR being traced from battery, lower winding of relay SR, normal contact 50 of test relay TR, conductor 51, normal contact 52 of relay LR′, conductor 53, alternate contact 45 of relay 12 to ground at normal contact 43 of impulse relay IR. Relay SR being slow-acting remains energized during the sending of impulses, but de-energizes after impulses have been sent, to again close its normal contact 58 to close the circuit of test relay TR, whereupon relay TR energizes if the contacts leading to the called subscriber's line are found to be idle. Slow-acting relay 12 does not de-energize during the operation of im-

pulse relay IR due to its construction and since relay IR operates with such rapidity that the circuit of relay 12 is not opened sufficiently long to cause said relay 12 to de-energize.

Assuming that the contacts leading to the called substation D are found idle, test relay TR being a quicker acting relay than relay BCR, will energize before relay BCR has time to energize and will open the circuit of relay BCR at normal contact 60 and also close contacts 54 and 55 in the talking conductors and also open normal contact 50 in the energizing circuit of motor magnet MM' and close an energizing circuit for the interrupter ringing relay RIR at contact 56. The circuit for the test relay TR may be traced from battery, winding of relay TR, resistance *s*, conductor 57, normal contact 58 of relay SR, conductor 59, wiper 14, contact 17, winding of cut-off relay CO' to ground. Relay TR energizing closes a locking circuit for itself through its alternate contact 60, conductor 61, and over the previously traced circuit. Cut-off relay CO' energizing attracts its armatures to remove the line relay LR² from the control of the called substation D. Ringing interrupter relay RI now intermittently energizes due to the constantly rotating interrupter I to connect the ringing generator RG in circuit with the called line to intermittently ring the call bell of the substation D. Relay RI also connects a revertive tone means in circuit with the calling substation A to apprise the calling subscriber that the called party is being signaled. The circuit for the ringing interrupter relay RI may be traced from battery, through the constantly rotating interrupter I, winding of relay RI, alternate contact 56 of relay TR, conductor 65, normal contact 66 of relay LR', conductor 67, alternate contact 34 of relay 13 to ground. The circuit for the ringing current may be traced from the ungrounded pole of generator RG, alternate contact 62 of relay RI, alternate contact 54 of relay TR, wiper 15, contact 18, line limb 21, through the call bell of the substation B, line limb 22, contact 19, wiper 16, alternate contact 55, alternate contact 64 of ringing interrupter relay RI to ground. The circuit for the revertive tone is as follows: from ringing generator RG, condenser C, alternate contact 63 of relay RI, alternate contact 38 of relay 13, wiper 5 and contact 9, through the receiver at the substation A, contact 10, wiper 6, alternate contact 39 of relay 13, lower winding of impulse relay IR to battery.

The called subscriber D in response to the ringing of his call bell, removes the receiver from its switchhook, thereby closing an energizing circuit for the ringing control relay RCR, which will energize when the ringing interrupter relay RI is in a de-energized condition, said circuit being traced from battery, lower winding of relay RCR, normal contact 64 of relay RI, alternate contact 55 of relay TR, wiper 16, contact 19, the now closed switchhook contacts of substation D, contact 18, wiper 15, alternate contact 54 of relay TR, normal contact 62 of relay RI, upper winding of relay RCR to ground. Relay RCR will not operate prior to the removal of the receiver from its switchhook due to the combined resistances of the condenser and call bell at the substation D, but when the receiver is removed and the switchhook, which is spring-pressed upward, closes its alternate contacts, said condenser and call bell are shunted out to permit the energization of relay RCR. Relay RCR energizing closes a circuit for locking relay LR', from battery, lower winding of relay LR', alternate contact 69 of relay RCR to ground. Relay LR energizing opens its normal contact 66, which opens the energizing circuit of the ringing interrupter relay RI to prevent the further application of ringing current to the called line, and also closes a locking circuit for itself, traced from battery, upper winding and alternate contact 70 of said relay LR' and to ground through alternate contact 71 of off-normal contacts ON', which off-normal contacts assume their alternate position upon the first step of the connector C off normal. The subscribers A and D are now in conversational circuit, which may be traced over the heavily marked lines having the condensers K and K' interposed.

The subscribers having finished conversation and assuming that the subscriber at the calling substation A is first to replace his receiver upon the switchhook, the opening of the switchhook contacts brings about the de-energization of the impulse relay IR of the line finder switch FS. The restoration of the relay IR brings about the opening of the circuit of the slow-acting relay 12, which relay 12 de-energizing closes an energizing circuit for the release relay RR' of the connector C, traced from battery, winding of relay RR', conductor 73, normal contact 46 of relay 12, conductor 74, alternate contact 75 of the locking relay LR' to ground. A further result due to the de-energization of relay 12 is the closing of a circuit for the slow-acting relay SR, traced from battery, upper winding of relay SR, conductor 73, normal contact 46 of relay 12, conductor 74 to ground through alternate contact 75 of relay LR'. Release relay RR' energizing withdraws the retaining pawls which hold the connector C in its operated position, whereby the connector C automatically restores to normal while relay SR remains energized during the restoration of said connector C to maintain its normal contact 58 open to prevent the energization of

relay TR and to prevent the connector C from connecting to another subscriber's line or interfere with other established connections during the restoration of said connector C to normal. When connector C has restored to normal, off-normal contacts ON' will assume their normal position, thereby opening the locking circuit of relay LR' to permit the same to restore, and said relay LR' upon restoring opens the circuit of relays RR' and SR at its alternate contact 75, thereby causing the de-energization of relays RR' and LR'. The connector switch C is now in its normal position.

A further result due to the de-energization of relay 12 is the opening of the circuit of the slow-acting relay 13 at its make-before-break contact 35, which permits relay 13 to restore to close an energizing circuit for the release relay RR of the finder switch FS traced from battery, winding of release relay RR, alternate contact 32 of relay 11, which remains energized until the switch FS is restored and off-normal contacts ON assume their normal position, conductor 33, normal contact 34 of relay 13 to ground. Release relay RR energizing withdraws the retaining pawls holding the switch FS in its operative position, whereby said switch FS automatically restores to normal and off-normal contacts ON assume their normal position, thereby opening the locking circuit of relay 11 to permit the same to de-energize. The finder switch FS and connector switch C are now at normal and are available for extending another call.

Should the subscriber at substation D be first to replace his receiver upon the switchhook, relay RCR of the connector C will de-energize, but nothing more happens at this time since the impulse relay IR of the finder switch FS is energized and no circuit will be closed for the release relays RR' and RR. Thus, it is evident from the above description that the release of the line finder switch FS and connector switch C is under the sole control of the calling subscriber and that said switches will restore regardless of whether or not the called subscriber has replaced his receiver upon its switchhook.

Called line busy.

Assuming now that the called line is busy, the operation of the circuit is the same up to and including the time that the wipers 14, 15 and 16 engage the contacts leading to the called line. The line being busy, there will be a busy battery potential on the bank contact 17 of the called line, said battery also extending to ground through the cut-off relay CO'. When the test wiper 14 engages busy contact 17, test relay TR will not energize due to its high resistance and due to the potential on contact 17, which do not permit sufficient flow of current to operate said test relay, relay TR failing to energize, busy-back connecting relay BCR, being of low resistance, will energize to connect the busy-back signaling device BB in circuit with the calling substation A to notify the subscriber thereat of the busy condition of the called line. The circuit for the relay BCR extends from battery, through winding of said relay BCR, normal contact 60 of test relay TR, normal contact 58 of relay SR, conductor 59, test wiper 14, contact 17, to ground through the winding of cut-off relay CO'. The circuit for the busy signal may be traced from ground, through the generator G, alternate contact 77 of the relay BCR, normal contact 54 of test relay TR, normal contact 62 of relay RI, condenser K, alternate contact 38 of relay 13, wiper 5, contact 9, through the receiver at the substation A, contact 10, wiper 6, alternate contact 39 of relay 13, lower winding of impulse relay IR to battery. The calling subscriber at substation A hearing the busy signal will know that the called line is busy and will replace his receiver upon the switchhook to bring about the restoration of the switch FS and connector C to normal. When the subscriber at substation A replaces his receiver upon the switchhook, the circuit for the impulse relay IR is opened at the switchhook contacts and relay IR will de-energize to open the circuit of relay 12, and relay 12 de-energizing opens its make-before-break contact 35 to open the circuit of relay 13 as before described.

Relay 13 de-energizing closes its normal contact 79 to close a circuit for relay LR' of the connector C, traced from battery, lower winding of relay LR', alternate contact 72 of off-normal contacts ON', normal contact 79 of relay 13 to ground. Relay LR' energizing over this circuit closes its alternate contact 70 and locks up as previously described. Relays IR, 12 and 13 of the finder switch FS having de-energized and relay LR' of the connector C having energized, circuits are now closed for the release relays RR and RR', which operate, and the switches FS and C restore to normal as previously described.

While we have described our switch as a fifty-point switch, it is to be understood that a larger switch may be used if desired, and it is to be further understood that we do not wish to be limited to this exact disclosure of our invention, as changes and modifications may suggest themselves and we, therefore, do not wish to be limited to this exact disclosure, 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. In a telephone system including sub-

scribers' lines, rotary switches comprising a group of line finder switches and a group of connector switches permanently tied to said group of line finder switches for interconnecting said lines in conversational circuit, means for preventing the interference of established connections by said switches, and means including a double-wound slow-acting relay individual to said line finder and connector switches for releasing said switches to permit the same to restore to normal, the double-wound slow-acting relay being controlled by either the calling or called subscriber, said last means controlled solely over the calling line at all times.

2. In a telephone system including telephone lines, rotary switches comprising a group of line finder switches and a group of connector switches permanently tied to said group of line finder switches common to said lines and adapted to interconnect said lines in conversational circuit, releasing means including a release relay individual to said line finder and connector switches for permitting the restoration of said switches to normal, said releasing means controlled solely by the calling subscriber at all times, and a double wound slow acting relay for each pair of said switches and associated with the release relays of said line finder and connector switches, said slow acting relays of said switches having an energizing winding and a locking winding and adapted to control the energizing circuit of its associated release relay.

3. In a telephone system, a calling line and a called line, a line finder switch for automatically connecting to said calling line, a connector switch permanently tied to said line finder switch and controlled over said calling line to operate in a single plane to connect to said called line, releasing means including a release relay and a double-wound slow-acting relay individual to said line finder and connector switches and controlled over said calling line at all times independently of said called line for permitting the restoration of said switches, said double wound slow acting relay individual to each of said line finder and connector switches controlling a circuit of said release relay individual to said line finder and connecting switches, said double wound slow acting relay having an energizing circuit and a locking circuit to maintain said double wound relay energized until a switch associated therewith is restored to normal.

4. In a telephone system including telephone lines, a plurality of rotary line finder switches common to said telephone lines, a plurality of rotary connector switches permanently tied to said line finder switches and common to said telephone lines, automatic means for causing an idle line finder switch to connect to one of said telephone lines when the subscriber thereon initiates a call, means for said connected line finder switch controllable over the calling line for transmitting impulses to one of said connector switches to operate said connector switch to connect to another of said telephone lines, a double wound slow acting relay individual to said connector switch having a circuit for energizing the same during the selection of said other line, and having another circuit for energizing the said double wound slow acting relay during the restoration of said connector switch to prevent the interference of said connector switch with bank contacts of the other of said lines, and means individual to said line finder switch and said connector switch controlled solely over said calling line to permit the restoration of said line finder switch and connector switch.

5. In a telpehone system including a calling line and a called line, a rotary type line finder switch for automatically connecting to said calling line when the subscriber thereon initiates a call, a rotary type connector switch permanently tied to said line finder switch and controlled by the calling subscriber to cause the same to connect to said called line, a quick-acting relay and three slow-acting relays for said line finder switch, a double-wound slow-acting relay for said connector switch having an energizing winding and a locking winding, releasing means individual to said switches and operable when two of the slow-acting relays and the quick acting relay of said finder switch are de-energized and the other slow-acting relay of said finder switch and the double-wound relay of said connector switch are energized to permit the restoration of said switches to normal.

6. In a telephone system, a calling line and a called line, a finder switch for automatically connecting to said calling line, a connector switch associated with said finder switch and controlled over said calling line for connecting to said called line, operating circuits for controlling the operation of said switches, four relays for said finder switch for controlling said operating circuits, releasing means for said finder switch and operable when three of said relays are de-energized and the other of said relays is energized to permit the restoration of said finder switch to normal, a relay for said connector switch, releasing means for said connector switch and operable when said three relays of said finder switch are de-energized and said last relay is energized, to permit the restoration of said connector switch to normal.

7. In a telephone system including a calling line and a called line, a rotary switch for automatically connecting to said calling line when the subscriber thereon initiates a

call, a second rotary switch associated with said first switch and operatively controlled over the calling line to connect to said called line, operating circuits for controlling the operation of said switches, a set of four relays for said first switch for controlling said operating circuits, releasing means for said first switch operable upon the de-energization of three of said relays and the energization of the other of said relays to permit said switch to restore, a relay and releasing means for said second switch, said last releasing means operable when said last relay is energized and three of said first relays are de-energized to permit said second switch to restore.

8. In a telephone system including subscribers' telephone lines, a line finder switch common to said telephone lines and operable to connect to one of said lines when the subscriber thereon initiates a call, a restoring connector switch associated with said finder switch and common to said lines and operable to connect to one of said telephone lines as a called line, a high resistance test relay for said connector switch operable to extend the connection from the calling line through to the called line and to close contacts in the talking circuit if said called line is idle, a slow-acting relay operable to prevent the operation of said test relay during the operation of said connector switch in connecting to said called line and to also cause the restoration of said test relay immediately upon the calling subscriber replacing his receiver and prior to the restoration of said connector switch.

9. In a telephone system including subscribers' telephone lines terminating in bank contacts, a finder switch common to said bank contacts and operable to connect to one of said bank contacts when the line terminating therein is a calling line, a restoring connector switch associated with said finder switch and also common to said bank contacts, means for causing said connector to connect to the bank contacts of one of said lines as a called line, a high resistance test relay for said connector switch for controlling contacts in said connector switch, said last contacts including contacts in the talking circuit of said telephone system, a double-wound slow-acting relay controlled by the calling subscriber and operable during the operation of said connector switch in connecting to the bank contacts of the called line to prevent the premature operation of said test relay and to also cause the restoration of said test relay upon the calling subscriber replacing his receiver and prior to the restoration of said connector switch to normal to prevent the interference of said connector switch with the bank contacts of other lines.

10. In a telephone system including subscribers' telephone lines terminating in multiple bank contacts, line finder switches common to said subscribers' lines and operable to connect one of said lines when the subscriber thereon initiates a call, a connector switch associated with said finder switch and common to said lines, contact wipers for said connector switch for engaging the bank contacts of said lines, driving means for stepping said wipers into engagement with the bank contacts of a called line, a circuit for said driving means, a double-wound slow-acting relay for said connector switch controlled by the calling subscriber for preventing said wipers from interfering with other bank contacts in their movement to engage the bank contacts of the called line, and test means for controlling a contact in said circuit and also for closing contacts in the talking circuit of said telephone system to extend a conversational connection between the calling and called lines and to connect ringing means to the called line if said called line is idle.

Signed by us at Chicago, in the county of Cook and State of Illinois, this 29th day of June, 1922.

HIRAM D. CURRIER.
GEORGE R. EATON.