Sept. 1, 1925. 1,551,749

L. D. KELLOGG

TELEPHONE SYSTEM

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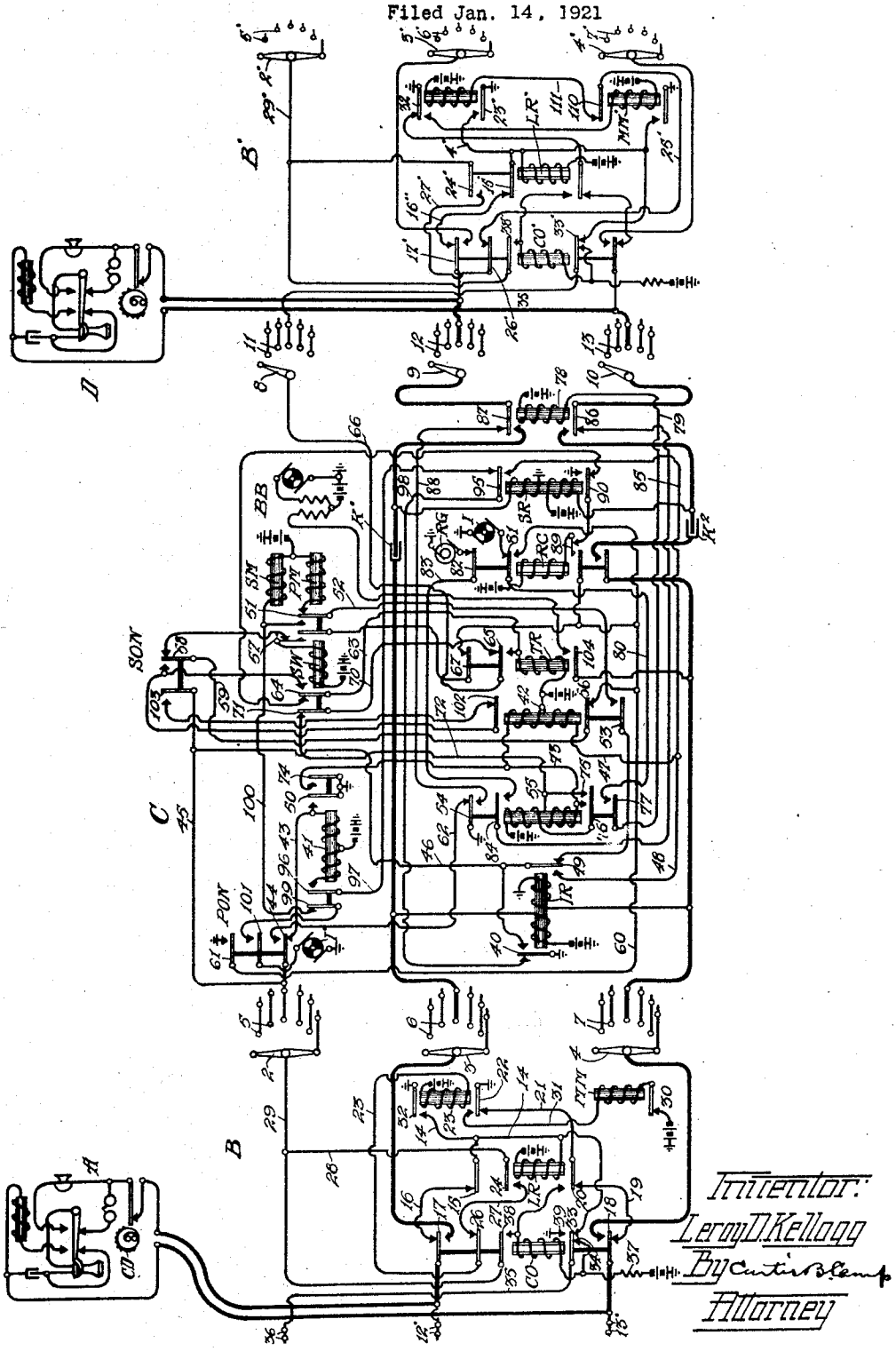

Patented Sept. 1, 1925. 1,551,749

UNITED STATES PATENT OFFICE.

LEROY D. KELLOGG, OF DEERFIELD, ILLINOIS, ASSIGNOR TO KELLOGG SWITCHBOARD AND SUPPLY COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF ILLINOIS.

TELEPHONE SYSTEM.

Application filed January 14, 1921. Serial No. 437,211.

To all whom it may concern:

Be it known that I, LEROY D. KELLOGG, a citizen of the United States of America, and resident of Deerfield, county of Lake, and State of Illinois, have invented certain new and useful Improvements in Telephone Systems, of which the following is a specification.

My invention relates to telephone systems and has to do more particularly with automatic or semi-automatic systems in which switches are used for connecting a calling line to an idle trunk, and an object of my invention is the provision of an improved arrangement which embodies desirable features and advantages, all in an efficient, simple and economical manner, and in which the switch of my invention is most positive in its operation.

Line switches or individual switches of the present type are provided with off-normal contacts which are moved to their alternate positions during a period of the selecting operation of the switch to bring about the proper function of the same, and a feature of my invention is the provision of an individual switch in which I eliminate the off-normal contacts and in which the circuit changes and proper functioning of the switch are brought about entirely by simple relays, no interlocking or partial actuation relays being used.

Another feature of my invention is the provision of a switch of the non-restoring type, that is, one which remains in contact with the trunk last used when disconnection is effected, and which will again seize the trunk last used when a call is initiated, provided the trunk in the meantime has not been seized by another switch and is in use at the time the call is made.

Another feature of my invention is the provision of means in the switch of my invention whereby, when a line is seized as a called line, its associated switch is operated to step its wipers into engagement with the next idle set of contacts, should its wipers be engaging contacts of the trunk last used by the switch in establishing a connection for the line as a calling line, in the event that the said contacts were seized by another switch between the lapse of time that the line was a calling and a called line. In the event that these idle sets of contacts as now engaged by the switch wipers be appropriated by another switch during the time that the line is connected in circuit as a called line, the said contacts will be busied and the switch will operate immediately to step the wipers in search of the next set of idle contacts leading to an idle trunk so that when the called line wishes to recall immediately upon disconnection the wipers will be engaging an idle set of contacts leading to an idle trunk, thus materially reducing the time in extending the connection of the recalling line to an idle trunk.

Another feature of my invention is the provision of a switch with a positive drive circuit that does not permit the wipers of the switch to stop on busy contacts nor to pass over idle contacts. The above features of my invention, as well as others, will be more fully hereinafter described.

The non-restoring switch of my invention is of the general type illustrated and described in a patent to Harry H. Ide, issued Oct. 21, 1924, No. 1,512,101, and for a more complete description of the switch reference may be had to the accompanying application.

The novel features of the invention, through the provision of which the above-mentioned and other advantageous results are attained, will be described by reference to the accompanying drawing, in which I illustrate diagrammatically an automatic telephone system including the line switch of my invention.

Referring now more in detail to my invention as illustrated in the accompanying drawing, to the left thereof I illustrate a calling substation A, which includes the usual talking equipment, with the addition of the calling device CD. The calling substation A connects at the exchange with a line switch B of my invention, comprising a rotary shaft which carries the test or private wiper 2 and a pair of line wipers 3 and 4. A line relay LR is provided which is energized over the subscriber's line conductors, and a cut-off relay CO is also provided which is energized when an idle trunk is seized to extend the connection from the calling substation to the seized trunk. A motor magnet MM is provided for stepping the

wipers 2, 3 and 4 of the switch B step by step over the bank contacts 5, 6 and 7 of the switch.

The connector C comprises an impulse relay IR, which relay IR is energized over the line when an idle connector as C is seized and is de-energized and energized by impulses from the calling substation A to bring about the primary movement of the wipers 8, 9 and 10 through the agency of the primary magnet PM. A switching relay SW is provided which, when energized, connects the secondary magnet SM to be acted upon by impulses to step the wipers 8, 9 and 10 in a secondary direction over contacts 11, 12 and 13 to engage the contacts of the called line. A test relay TR is provided with tests the called line as to its idle or busy condition, and, when busy, connects a suitable busy tone from the busy-back apparatus BB to notify the calling subscriber as to the busy condition of the called line. A ringing control relay RC is provided, which connects the ringing generator RG and interrupter I in circuit to intermittently apply ringing current to the called idle line. A supervisory relay SR is also provided which is energized when the subscriber at the called substation answers. Primary off-normal contacts PON are provided, which assume their alternate position upon the first step of the wipers 8, 9 and 10 in a primary direction, and secondary off-normal contacts SON are also provided, which assume their alternate position upon the first step of the wipers 8, 9 and 10 in a secondary direction.

To the right of the drawing I illustrate a called substation D similar to the calling substation A, which connects at the exchange into a line circuit B′ similar to that of B.

Having described in general the apparatus as illustrated in the accompanying drawing, I will now describe in detail the operation of the system including the individual switch of my invention.

Assuming now that the subscriber at the calling substation A initiates a call, the removal of the receiver thereat closes an energizing circuit for the line relay LR of individual line switch B, traced from battery through the winding of relay LR, conductor 14, normal contact 15 of the line relay LR, conductor 16, normal contact 17 of cut-off relay CO, through the substation A, back through normal contact 18 of relay CO, conductor 19, normal contact 20 of relay LR, conductor 21 to ground at normal contact 22 of relay 23. Wipers 2, 3 and 4 rest upon the set of contacts 5, 6 and 7, last used by the line as a calling line or in engagement with a set of contacts which were engaged by the wipers when stepped into engagement therewith when the line of subscriber A was seized as a called line, as will be more fully hereinafter described. Assuming that the contacts 5, 6 and 7 upon which the wipers 2, 3 and 4 now rest are busy due to another subscriber's line circuit having selected that connector, the engaged private contact 5 will be grounded. Energized line relay LR now closes its alternate contact 24, establishing an energizing circuit for the relay 23, traced from battery through the winding of relay 23, conductor 25, normal contact 26 of relay CO, conductor 27, alternate contact 24 of relay LR, conductors 28 and 29, wiper 2 and to the grounded busy contact 5. The relay 23 upon energization closes its alternate contact 22, establishing an energizing circuit for the motor magnet MM, traced from battery, normal contact 30 of motor magnet MM, through the winding of motor magnet MM, conductor 31 to ground at alternate contact 22 of relay 23. The motor magnet MM upon energization steps the wipers 2, 3 and 4 into engagement with the next set of contacts 5, 6 and 7, and should the contacts now engaged by the wipers be busy the relay 23 will continue energized and the motor magnet MM will set up a vibratory circuit for itself due to the opening and closing of its normal contact 30, and the magnet MM thus steps the wipers 2, 3 and 4 from one set of contacts 5, 6 and 7 to the next as long as busy, i. e., grounded contacts are encountered, since as long as grounded contacts 5 are encountered by the wiper 2, relay 23 will remain energized and thus keep the vibratory circuit of motor magnet MM closed. The line relay LR has its initial energizing circuit opened at its own contacts 15 and 20 and at normal contact 22 upon the energization of relay 23, but the line relay LR being slow to release is held up momentarily until a substitute circuit is established for it, traced from ground at alternate contact 32 of relay 23, conductor 14 to battery and ground through the winding of relay LR. The ground at alternate contact 32 of relay 23 also extends over conductor 14, normal contact 33 of relay CO, conductor 35, and to the calling line's private normal contacts 36 at the connectors having access to it to render such contacts busy against selection.

When an idle private contact 5 is encountered by the wiper 2, the relay 23 will restore as the contact 5 now engaged will be free from ground, and the opening of its alternate contact 22 prevents further actuation of motor magnet MM. The opening of alternate contact 32 opens the energizing circuit of line relay LR, but the relay being slow to release is held energized momentarily closing an energizing circuit for the cut-off relay CO, traced from battery through resistance 37 and winding of cut-off relay CO, alternate contact 20 of relay LR, conductor 21 to ground at normal contact 22 of relay 23. The line relay LR upon restora-

tion opens the initial energizing circuit for the cut-off relay CO at its alternate contact 20, but the cut-off relay CO being slow to release, is held up momentarily until a substitute circuit is established for the said relay CO, as will presently be described. The relay 23 upon de-energization and relay CO upon its energization remove the busy ground from contacts 36, but the closing of alternate contact 39 of relay CO connects ground to the contacts 36, keeping them busy until the termination of the conversation.

The relay CO having been energized, its contacts 17 and 18 assume their alternate positions and the wipers 2, 3 and 4 of the individual switch B now connect to the contacts 5, 6 and 7 of the idle connector C, thus extending the calling line to the seized idle connector C. A circuit is established for the impulse relay IR of the connector C, traced from battery through the left-hand winding of relay IR, contact 6, wiper 3, alternate contact 17 of cut-off relay CO, through the substation A, back through alternate contact 18 of relay CO, wiper 4, contact 7, to ground through the right-hand winding of the impulse relay IR. The closing of alternate contact 40 of the impulse relay IR establishes energizing circuits for the relays 41 and 42 of the connector C, the circuit of relay 41 extending from battery through the right-hand winding of relay 41, conductor 43, normal contact 44 of primary off-normal contacts PON, conductors 45 and 46 to ground at alternate contact 40 of the impulse relay IR. The circuit of relay 42 extends from battery through the lower winding of relay 42, conductors 47 and 48, alternate contact 49 of relay IR, to ground at alternate contact 40 of impulse relay IR. The relay 41 upon energization closes a locking circuit for itself, traced from battery through the right-hand winding of relay 41 to ground at alternate contact 50 of said relay 41. The closing of alternate contact 40 of impulse relay IR establishes a substitute energizing circuit for cut-off relay CO of the individual line switch B, before it has time to deenergize, which may be traced from battery through the resistance 37 and winding of the cut-off relay CO, its alternate contact 38, conductor 29, wiper 2, contact 5, conductors 45 and 46 to ground at alternate contact 40 of the impulse relay IR, the said relay CO remaining energized until the termination of the conversation.

If the private contact 5 engaged by the wiper 2 is idle when the subscriber at the substation A initiates a call, the line relay LR is energized, as before described, and operates to close its alternate contact 24, but as there is no ground on the private contact 5, no energizing circuit is established for the relay 23 and the relay 23 remaining inert its alternate contact 22 remains open, preventing an energizing circuit being established for motor magnet MM, and the wipers 2, 3 and 4, therefore, remain in engagement with the contacts 5, 6 and 7 that were last used by the switch B in establishing a connection, or in connection with a set of contacts 5, 6 and 7 to which the said wipers 2, 3 and 4 were advanced, in the event that the substation A was a called line, as will be more fully hereinafter described. The cut-off relay CO is, therefore, immediately energized from battery through the cut-off relay CO to ground at normal contact 22 of relay 23, as before described, and the operation of the circuit from this point on is the same as above described, it being noted that contact 24 is arranged to close enough ahead of 20 so that relay 23 will operate before relay CO has a chance to operate, if the contact 5 is busy. Thus the switch only travels when its wipers 2, 3 and 4 are in engagement with a busy trunk when a call is initiated.

Assuming now that the substation A is selected as a called line by a connector which has engaged contacts 36, 12′ and 13′ and this ground extends from the connector which seized the contacts of the substation A as a called line to the contact 36, conductor 35, normal contact 33 of cut-off relay CO, conductor 14 and through the winding of line relay LR to battery. The line relay LR upon energization closes its alternate contact 24, and should the private wiper 2 of the line switch B be engaging a busy contact 5 at the time the substation is seized as a called line, an energizing circuit is established for the relay 23, traced from battery through the winding of relay 23, conductor 25, normal contact 26 of cut-off relay CO, conductor 27, alternate contact 24 of line relay LR, conductors 28 and 29, wiper 2 and busy contacts 5, i. e., a grounded contact. The relay 23 upon energization closes its alternate contact 22 to establish an energizing circuit for the motor magnet MM, traced from battery at normal contact 30 of motor magnet MM, through the winding of magnet MM, conductor 31 to ground at alternate contact 22 of relay 23. The motor magnet MM is thus energized and, through the medium of the usual ratchet and pawl mechanism, steps the wipers 2, 3 and 4 into engagement with the next set of contacts 5, 6 and 7. The magnet MM upon energization opens its normal contact 30 and as long as the private wiper 2 engages successive busy contacts 5, the relay 23 will remain energized and the motor magnet MM will establish a vibratory circuit for itself through its normal contact 30 to step the wipers 2, 3 and 4 from one set of contacts 5, 6 and 7 to the next, until the wiper 2 engages a non-busy or non-grounded contact 5.

When an idle contact 5 is engaged the re-

lay 23 restores and the opening of alternate contact 22 of said relay 23 prevents further energization of the motor magnet MM.

When the substation A is seized as a called line, the line relay LR of its associated individual line switch B is energized, as before described, and if the wipers 2, 3 and 4 of the switch B are resting on an idle set of contacts, no energizing circuit is established for the relay 23 of the switch B. The cut-off relay CO does not energize at this time due to the short circuit around it, which extends from a direct ground at contact 36 of the connector, over conductor 35 and through normal contacts 33 and 34 to one terminal of the winding of the relay CO, so that the circuit traced from ground at normal contact 22 of relay 23, conductor 21, alternate contact 20 and to the other terminal of the winding of cut-off relay CO to battery, does not avail to energize it.

Assuming that the substation A has been seized as a called line and the motor magnet MM has actuated to step the wipers into engagement with an idle set of contacts and that during the time that the substation A is in conversational circuit as a called line the set of contacts 5, 6 and 7 now engaged by the wipers 2, 3 and 4, as before described, are appropriated by another calling line switch, ground will be placed upon the private contact 5 of the contacts just seized, as previously described, and this ground will extend through wiper 2 over conductors 29 and 28, alternate contact 24 of line relay LR, conductor 27, normal contact 26 of relay CO, conductor 25 to battery through the winding of relay 23. The relay 23 upon energization closes its alternate contact 22, establishing an energizing circuit for the motor magnet MM, which now steps the wipers 2, 3 and 4 over successive sets of contacts 5, 6 and 7 until an idle set is seized, as previously described. It will thus be seen that when a substation line has been busy as a called line, it will at the end of conversation have its line switch resting in engagement with an idle trunk line, and the line switch of the calling line will, of course, also be upon an idle trunk. The cut-off relay CO also remains at normal during the stepping of the wipers 2, 3 and 4 over contacts 5, 6 and 7 when the substation A is seized as a called line as during the movement of the wipers 2, 3 and 4 in their act of rotation in seeking an idle set of contacts, the relay 23 is energized and the circuit of cut-off relay CO is opened at the normal contact 22 of the energized relay 23, and no actuation of relay CO takes places.

The energization of relay IR having brought about the energization of relays 41 and 42, as already described, assuming that the called subscriber's number at substation D is 45, the subscriber A now operates his calling device CD to send four impulses of current over the line. These four impulses bring about four de-energizations and energizations of the relay IR, causing the primary magnet PM to energize and de-energize four times to step the wipers 8, 9 and 10 in a primary direction to the fourth group of contacts, that group containing the contacts of the called line. The circuit of the primary magnet PM may be traced from battery through the winding of the said magnet PM, normal contact 51 of switching relay SW, conductor 52, alternate contact 53 of relay 42, normal contact 49 of relay IR, conductor 46, conductor 45, and normal contact 44 of the primary off-normal contacts PON to ground at alternate contact 50 of relay 41.

After the primary off-normal contact 44 has moved on the first step of the switch shaft, the ground fed from normal contact 54 of relay 55 is substituted for the ground fed through contact 50 of relay 41. After the last impulse of the series has been sent, the steady flow of current through both windings of relay 42 causes the said relay 42, due to its differential action, to neutralize and restore its contacts to normal. Relay 42 does not restore during the sending of impulses due to its adjustment, construction and the rapidity of the interruptions of contact 49. It will be noted that the relay when first energized had its upper winding immediately energized by contact 50 of relay 41 and was in a neutral condition with its armature retracted when relay IR sent the first impulses, but immediately energized when relay LR opened the circuit of relay 42's lower winding. The closing of normal contact 56 of relay 42 brings about the energization of the switching relay SW by current traced from battery through the winding of said relay SW, its make-before-break contact 57, normal contact 58 of secondary off-normal springs SON, conductor 59, normal contact 56 of relay 42, and conductor 60 to ground at alternate contact 61 of primary off-normal contacts PON, the said primary off-normal contacts PON having been moved to their alternate position on the first step of the wipers 8, 9 and 10 of the connector switch off normal. The closing of alternate contact 51 of the switching relay SW now renders the secondary magnet SM operative so that when the calling subscriber at the substation A actuates his calling device again to send the last set of impulses, which we have assumed are five in number, the said magnet SM will be energized and de-energized by the impulse relay IR five times over a circuit traced from battery through the winding of the said magnet SM, alternate contact 51 of relay SW, conductor 52, alternate contact 53 of relay 42, normal contact 49 of relay IR, con-

ductor 46, conductor 45, and alternate contact 44 of the primary off-normal contacts PON and conductor 62 to ground at normal contact 54 of relay 55. The secondary magnet SM now steps the wipers 8, 9 and 10 in a secondary direction to engage contacts 11, 12 and 13 of the called line. Upon the first impulse of the last set, the relay 42 again energizes to permit the secondary magnet SM to be operated, and after the last impulse the relay 42 is again de-energized, as previously described. The restoration of the relay 42 closes a circuit for the test relay TR, traced from battery through the winding of the said relay, conductor 63, the alternate contact 64 of relay SW, alternate contact 58 of the secondary off-normal contacts SON (said contacts having been moved to their alternate position upon the first step of the wipers in their secondary direction), conductor 59, normal contact 56 of relay 42, conductor 60 to ground at alternate contact 61 of the primary off-normal contacts PON. The closing of alternate contact 65 of relay TR connects the said relay over conductor 66 to the test wiper 8, and should the called line be busy the private contact 11 of the called line would be grounded, thus closing a locking circuit for the said relay TR through the private wiper.

Called line idle.

Assuming that the called line is idle, private contact 11 of the called line will have a battery potential upon it, and the relay TR will not remain energized but will de-energize. The opening of normal contact 67 of relay TR opens the circuit of the switching relay SW. The relay SW de-energizes and opens the circuit for relay TR at its contact 64, leaving the relay TR dependent upon the potential found upon the private contact 11 of the called line for its holding potential, and, as assumed, this contact is free from ground potential; therefore, the relay TR de-energizes and returns to normal. The relay TR de-energizing causes the energization of the relay 55 over a circuit which may be traced from battery through the winding of line relay LR′, conductor 14′, normal contact 33′, conductor 35′, bank contact 11, wiper 8, conductor 66, normal contact 65 of relay TR, conductor 70, normal contact 71 of relay SW, conductor 72, through the lower winding of the relay 55, and conductor 73 to ground at alternate contact 74 of relay 41. The closing of alternate contact 75 of relay 55 short-circuits the lower winding of the said relay, and the closing of alternate contact 76 of relay 55 closes a circuit through the upper winding of the said relay, through the alternate contact 76 and conductor 73 to ground at alternate contact 74 of relay 41. The line relay LR′ of the line switch B′ associated with the called line is energized over this circuit and remains energized until conversation has terminated.

The closing of alternate contact 77 of relay 55 connects the interrupter I to the relay 78 and the circuit for relay 78 may be traced from battery through the winding of the said relay 78, conductor 79, alternate contact 77 of relay 55, conductor 80, normal contact 81 of relay RC and through the interrupter I to ground. The relay 78 is thus intermittently energized and de-energized by the rotating interrupter I, and upon each de-energization of the relay 78 the ringing generator RG is connected to the called line over a circuit extending from the ungrounded pole of the generator RG, through normal contact 82 of ringing control relay RC, conductor 83, alternate contact 84 of relay 55, conductor 85, normal contact 86 of relay 78, wiper 10, bank contact 13, through the condenser and call bell of the called sub-station D, back through bank contact 12, wiper 9, normal contact 87 of relay 78, and conductor 88 to ground at alternate contact 54 of relay 55.

The call bell of the called subscriber at the substation D is thus intermittently rung, due to the energization and de-energization of the relay 78 by the interrupter I. When the called subscriber answers and the relay 78 is in its energized position, a circuit for the relay SR is closed, which may be traced from battery through the lower winding of the relay SR, through alternate contact 86 of relay 78, wiper 10, contact 13, through the now closed contacts of the substation switchhook at the called substation D, back through contact 12, wiper 9, alternate contact 87 of relay 78, and through the upper winding of the relay SR to ground. The relay SR, upon energizing, closes an energizing circuit for the ringing control relay RC, which may be traced from battery through the winding of the said relay RC, its make-before-break contact 89 to ground at alternate contact 90 of relay SR. The closing of alternate contact 91 of relay RC closes a locking circuit for the said relay RC which may be traced from battery through the winding of the said relay, its alternate contact 91 and conductor 60 to ground at alternate contact 61 of the primary off-normal contacts PON. The opening of normal contacts 81 and 82 upon the energization of relay RC disconnects the interrupter I and the ringing generator RG to prevent further application of ringing current. A substitute circuit for the relay 78 is now established which may be traced from battery through the winding of the relay 78, conductor 79, alternate contact 77 of relay 55, conductor 80, alternate contact 81 of relay RC, and conductor 60 to ground at alternate contact 61 to primary off-normal

contacts PON. The subscribers are now in conversational circuit, and the talking circuit may be traced over the heavily marked conductors, said conductors having the condensers K′ and K² 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 connector C. The restoration of the relay IR brings about the opening of the holding circuit of the relay CO of the individual switch B, which relay CO restores and places the individual switch B in condition to be used in establishing another connection.

The subscriber D restoring his receiver upon its switchhook interrupts the circuit of the relay SR at the switchhook contacts, causing the said relay to de-energize. The closing of normal contact 95 of relay SR closes a circuit through the lefthand winding of the relay 41, which may be traced from battery through the left-hand winding of the said relay 41, alternate contact 96 of relay 41, conductor 97, normal contact 95 of relay SR and conductor 98 to ground at normal contact 40 of relay IR. Due to the differential construction of relay 41, the said relay neutralizes and restores to normal. The closing of normal contact 99 of relay 41 closes an energizing circuit for the secondary magnet SM, which may be traced from battery through the winding of said secondary magnet SM, conductor 100, normal contact 99 of relay 41, alternate contact 101 of the primary off-normal contacts PON, through the interrupter I′ to ground. The secondary magnet SM thus steps the wipers 8, 9 and 10 beyond the last set of contacts in the group and the wipers then restore to normal from this position by spring tension. The restoration of the relay 41 brings about the opening of the circuit of the relay 55 at alternate contact 74, and the relay 55 restoring opens the circuit of relay 78 at contact 77 of relay 55, and the primary off-normal contacts PON having restored upon the restoration of the switch, the opening of the alternate contact 61 of PON brings about the de-energization of the relay RC. The relay 41 also brings about the de-energization of the line relay IR′ of the line switch B′ which is associated with the called subscriber D. All the apparatus used in establishing a connection between a calling subscriber at the substation A and the called subscriber at the substation D is now at normal and available for use in establishing other connections.

Assuming now that the subscriber at the called substation D was first to replace his receiver upon the switchhook, the opening of the switchhook contacts at the substation D brings about the de-energization of the relay SR. Nothing else happens at this time as the relay IR is still maintained energized over the line of the calling substation A. The calling subscriber at the substation A replacing his receiver interrupts the circuit of the impulse relay IR at the switchhook contacts. The relay IR de-energizing closes a circuit for the left-hand winding of relay 41, causing the said relay to de-energize, as hereinbefore described. The restoration of the individual switch B and connector C is the same as previously described from this point on. Should the called subscriber D fail to replace his receiver upon the switchhook after the conversation is terminated, the replacing of the receiver at the substation A brings about the de-energization of the impulse relay IR of connector C, the same as before, and the opening of alternate contact 40 of impulse relay IR opens the circuit of the relay CO of individual switch B, as before described, and causes the release of switch B.

The subscriber at the called substation failing to replace his receiver, permits the continued energization of the relay SR, thus holding the contact 95 of said relay in its alternate position, preventing the differential wound relay 41 from restoring to normal and closing the energizing circuit for the secondary magnet SM. The relay 42 energizes when the line relay IR drops back but is immediately restored to normal due to the closure of an energizing circuit through the lower winding of the said relay 42, which may be traced from battery through the said lower winding, conductor 47, alternate contact 95, connector 98, to ground at normal contact 40 of the now restored impulse relay IR. Relay 42 being differentially wound, restores to normal, and the closing of normal contact 102 of the said relay 42 places a ground upon the private contact of the connector C over a circuit which may be traced from ground at alternate contact 61 of the primray off-normal contact PON, conductor 60, normal contact 56 of relay 42, conductor 59, alternate contact 58, normal contact 102 of relay 42, alternate contact 103 of the secondary off-normal contacts SON, to the private contact 5. The placing of this busy potential upon the private contact prevents any individual switch B from engaging the contacts of this busy connector.

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 relay TR momentarily energizes. The line being busy, the private contact 11 has a busy ground potential placed upon it, thus clos-

ing a locking circuit for the test relay TR from battery through the winding of the said relay, its alternate contact 65, conductor 66, and the wiper 8 to ground at contact 11. The closing of alternate contact 104 of the test relay TR connects the busy signal BB to the line to transmit a busy signal to said calling subscriber at substation A, thus notifying him of the busy condition of the said called substation D. The relay TR upon locking to ground at the private contact 11, closes a circuit for relay RC, traced from battery through the winding of relay RC, make-before-break contact 89, normal contact 90 of relay SR, normal contact 64 of relay SW, conductor 63, alternate contact 65 of relay TR, and conductor 66 to the grounded private contact 11. The relay RC thus closes a locking circuit for itself, traced through the winding of said relay RC, alternate contact 91, conductor 60 to ground at alternate contact 61 of the off-normal contacts PON. Now, should the line called become idle during the time the busy signal is being transmitted to the calling substation, the falling back of relay TR will not cause the called subscriber to be signaled owing to the fact that relay RC is locked up to ground at contact 61. The calling subscriber now replaces his receiver, bringing about the de-energization of the impulse relay IR. The relay IR restoring, opens the circuit of the relay CO of the individual switch B to place the switch in condition for establishing other connections as previously described. The relay IR de-energizing brings about the restoration of the relay 41, due to the fact that the relay SR has not been energized. The closing of the circuit through the left-hand winding of the circuit 41 brings about the neutralization of said relay 41. The closing of normal contact 99 of the said relay 41 closes a circuit through the secondary magnet SM, which magnet steps the wipers 8, 9 and 10 beyond the last set of contacts. The wipers then restore to normal by spring tension. The primary off-normal contacts PON and secondary off-normal contacts SON are also restored, and the apparatus used in this busy connection is now at normal and available for use in establishing other connections.

The individual line switch circuit B′ associated with the called line D is similar in operation to that of line switch B associated with the calling line A, the material difference being in what is sometimes called a positive drive circuit. This positive drive circuit is under the control of the motor magnet MM′ and the relay 23′. The line relay LR′ energizes either when the substation D is a calling or a called line. First assuming that line is a called line, the relay LR′ is energized as before described and, assuming that the private wiper 2′ is engaging a busy contact 5′, ground from the grounded contact 5′ will extend through wiper 2′, over conductor 29′, alternate contact 24′ of relay LR′, conductor 27′, normal contact 26′ of cut-off relay CO′, conductor 25′, normal contact 110 of motor magnet MM′, conductor 111 and through the winding of relay 23′ to battery. The relay 23′ upon energization closes its alternate contact 32′, closing an energizing circuit for the motor magnet MM′, which steps the wiper into engagement with the next set of contacts. The magnet MM′ upon energization opens the energizing circuit of relay 23′ at its normal contact 110 and allows relay 23′ to restore, and relay 23′ upon restoration opens the energizing circuit of relay MM′ at its alternate contact 32′. Now, should the wiper 2′ engage another busy contact 5′, relay 23′ will again energize, which in turn will energize magnet MM′ and this see-saw action of relay 23′ and magnet MM′ will continue until a private contact 5′ is seized. From the foregoing it will be seen that relay 23′ only operates when a busy private contact 5′ is engaged, and magnet MM′ is only energized when relay 23′ is energized, and when an idle contact is engaged relay 23′ remains at normal, and thus magnet MM′ will fail to energize, and the wipers will not stop on a busy contact or pass an idle one. The circuit operation of the individual line switch B′ as to the operation of the cut-off relay CO′ and its circuit functions, are the same in general as those of line switch B and it is thought, will be sufficiently apparent without further detailed description.

While I have referred to relay CO as a cut-off relay having generally in mind its function of cutting the line off from the line relay, it will be observed it might well be called a "line cut on" relay because it connects the line on to the wipers. I shall accordingly in the claims refer to it in the latter way when I wish particularly to note its latter function.

I do not intend to limit myself to the particular embodiment of my invention herein shown and described, as it may be readily employed in various modifications.

What I claim as new and desire to secure by Letters Patent, is:

1. In a line circuit for telephone systems, a relay for energization to extend the line limbs when the line is a calling line, multiple terminals for said line as a called line and a link circuit terminal adapted to be applied to one of said multiple terminals, means associated with said link circuit to short-circuit said relay when so applied, and a motor magnet, said relay energizable to

prevent the operation of said motor magnet and de-energizable to permit said motor magnet to operate and to also permit a calling line to be connected to said line circuit at the same time, said motor magnet being operable even though a calling line is connected to said line circuit.

2. In a telephone system, a line switch and associated circuit controlling relay, a connector operable responsive to directive impulses to select said line, said connector having means to short-circuit said relay when the line is idle, a second relay for said switch controlled by said controlling relay, and a motor magnet controlled by said second relay, said second relay and said motor magnet adapted to operate alternately to progressively advance said switch.

3. In a telephone system, a subscriber's line circuit and controlling relay therefor, and an associated automatic selecting switch operated by current over said line, controlling means short-circuiting said relay while said switch travels, and other means controlled over another subscriber's line circuit for short-circuiting said relay.

4. In an automatic telephone system, a telephone line and an automatic switch adapted to travel in response to said line's control, a relay short-circuited while said switch travels, and a selective switch operable by directive impulses over another line having means to short-circuit said relay.

5. A telephone system including a relay adapted for energization over a link circuit, talking circuit contacts controlled by said relay, means for short-circuiting said relay when said talking circuit is busy as a calling circuit, and means for short-circuiting said relay when said talking circuit is busy as a called circuit.

6. In a telephone system, a line relay operated by current over the line when the subscriber initiates a call or answers a call, another relay and means for short-circuiting said relay when the line is connected to as a called line, and a circuit for said second relay controlled by said first relay.

7. An automatic telephone system including a telephone line and an automatic non-restoring switch, a relay for said switch for extending the line limbs of said telephone line when the switch is operated to extend said line as a calling line, a connector switch for connecting to said line as a called line and provided with means to establish a shunt circuit about said relay when the line is connected to as a called line to prevent the extension of said line limbs, but to allow progressive operation of said switch.

8. A telephone system including a telephone line, an automatic non-restoring switch for said line, a motor magnet for operating said switch to extend the line towards a called line, a controlling relay for extending the line limbs of said line through said switch, a connector switch adapted to be connected to said telephone line as a called line and provided with means for establishing a shunt circuit about said relay when said telephone line is connected to as a called line to render said relay inoperable to prevent the extension of said line limbs but to allow progressive movement of said switch without interfering with the connection between the said connector switch and said line.

Signed by me at Chicago, in the county of Cook and State of Illinois, this 12th day of January, 1921.

LEROY D. KELLOGG.