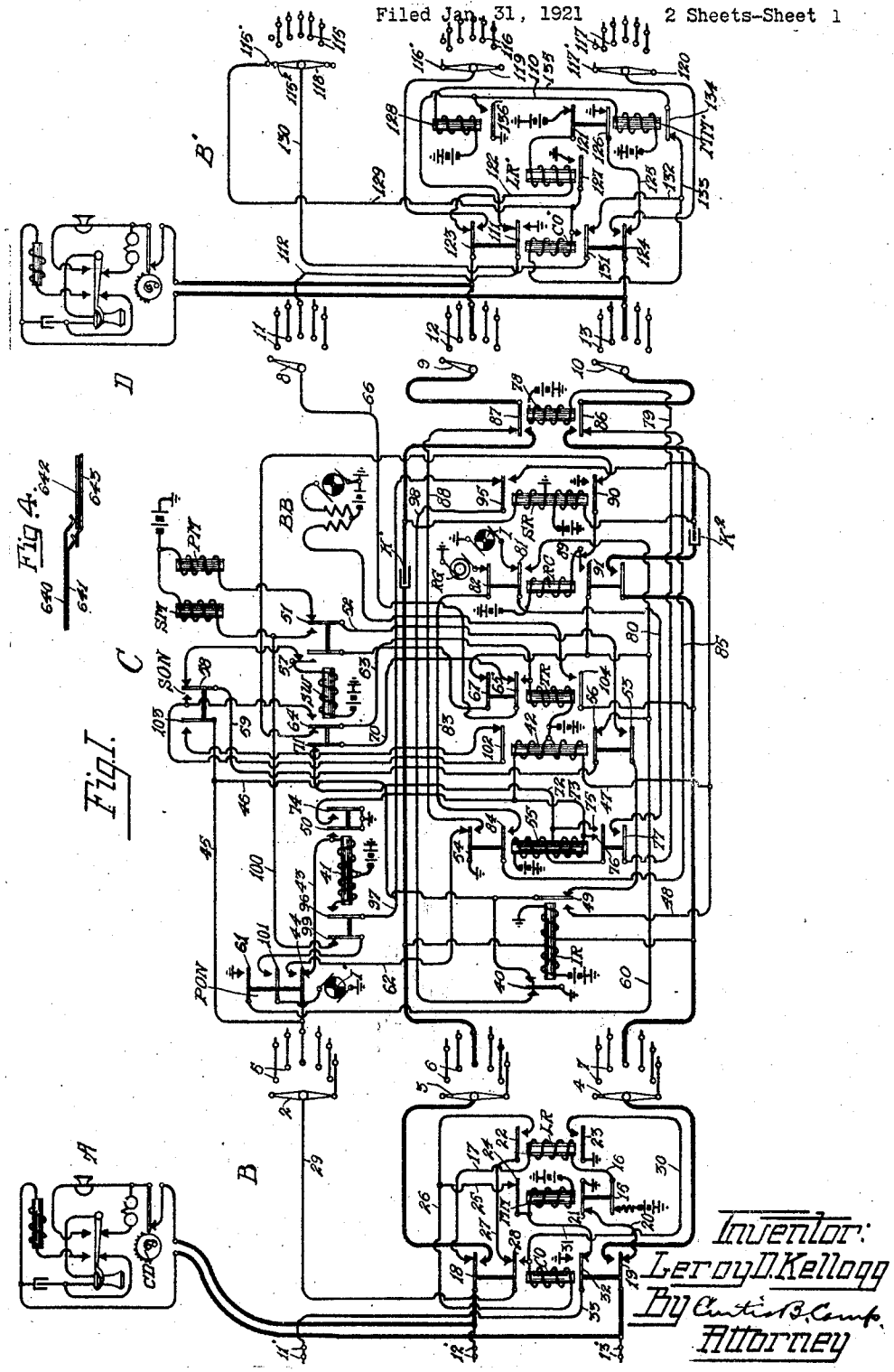
March 24, 1925. 1,530,601

L. D. KELLOGG

TELEPHONE SYSTEM

Filed Jan. 31, 1921 2 Sheets-Sheet 1



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Filed Jan. 31, 1921 2 Sheets-Sheet 2

Fig. 2.

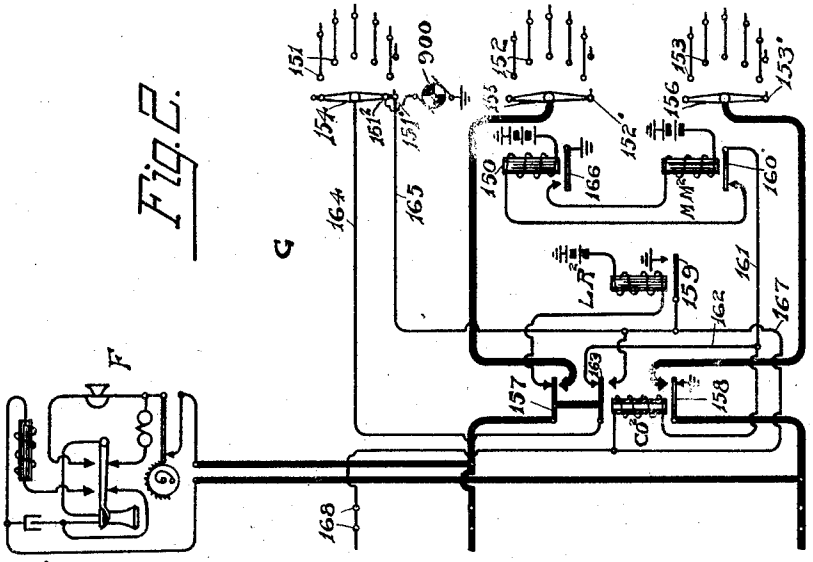
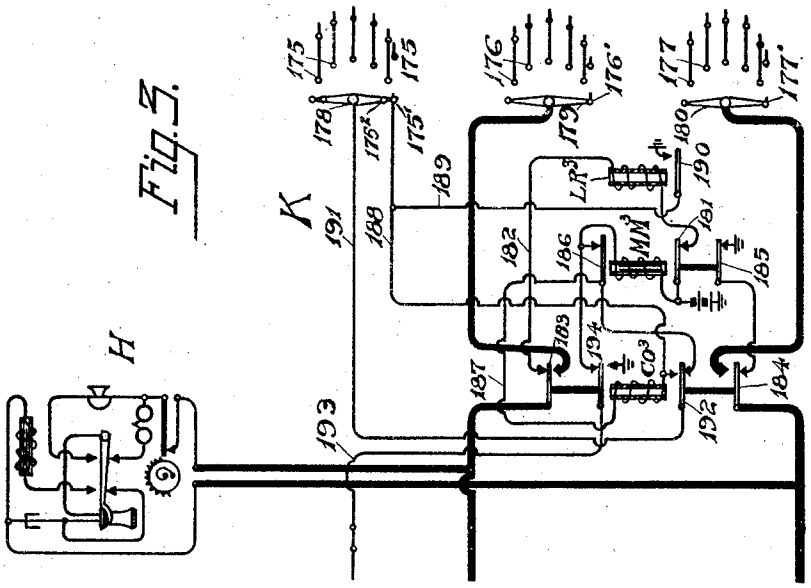


Fig. 3.



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Patented Mar. 24, 1925. 1,530,601

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 31, 1921. Serial No. 441,108.

To all whom it may concern:

Be it known that I, LEROY D. KELLOGG, a citizen of the United States of America, and a resident of Deerfield, in the 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.

A feature of my invention is the provision of a switch of the non-restoring type, that is, one in which the wipers remain in contact with the trunk last used when disconnection is effected, and which will again seize the trunk last used when a call is again 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.

A feature of my invention is the provision of a switch of the non-restoring type, which is provided with only three magnets and which has no interlocking mechanism between the magnets. The circuit of this switch is arranged with the so-called positive drive circuit.

Another feature of my invention is the provision of switches of the non-restoring type that operate as preselector switches. I also arrange these switches so that they operate as preselector switches under certain conditions and operate as semi-preselectors under certain other conditions.

A still further feature of my invention is the provision of normal or home contacts for switches of the non-restoring type, which normal or home contacts may be connected in such a manner that the non-restoring switches may or may not rest upon such normal or home contacts.

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

Fig. 1 illustrates diagrammatically an automatic telephone system including a pair of line switches of my invention;

Fig. 2 is another form of line switch embodying features of my invention; and

Fig. 3 is still another form of line switch embodying features of my invention.

Figure 4 shows the construction of the normal or home contacts of some of the switches.

Referring now more in detail to my invention as illustrated in the accompanying drawings and referring particularly to Fig. 1, 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 the line switch B of my invention, which comprises a rotary shaft that 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 line 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 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 from the calling substation A to step the wipers 8, 9 and 10 in a secondary direction over contacts 11, 12 and 13 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, 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 in circuit to intermittently apply ringing current to the called subscriber's 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 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 terminates in the exchange in a line switch B′, which is also provided with a line relay LR′, a cut-off relay CO′ and a motor magnet MM′ in association with an auxiliary relay 128 for providing a positive drive circuit for the switch, as will be more fully hereinafter described.

Referring now to Fig. 2, I illustrate another form of line switch G which comprises a line relay LR^2 and a cut-off relay CO^2, and a motor magnet MM^2 and a relay 150 in association with the motor magnet MM^2 for providing a positive drive circuit for the switch. The switch is of the preselector type, in which the wipers of the switch are in engagement with an idle set of contacts under certain conditions.

Referring to Fig. 3, I illustrate another form of line switch K of my invention, comprising a line relay LR^3, a cut-off relay CO^3 and a motor magnet MM^3 for advancing the wipers.

Referring particularly to the switch B of Fig. 1, it will be noted that this switch is of the non-restoring type and is provided with only three magnets—a line relay, a motor magnet and a cut-off relay. It is to be further noted that this switch is not provided with interlocking mechanism between the different magnets, but that the magnets are simple magnets, and control individual contacts.

Referring next to switch B′ of Fig. 1 and switches G and K of Figs. 2 and 3: These switches I provide with normal or home contacts so that the switches may be operated on the preselector principle. It is well known that individual switches are generally arranged in groups of 50 or 100, or some such number, and that all these switches have access to trunks that are multiply connected to the bank contacts of the switches. It is a further well-known fact that certain switches of a group are likely to be used more frequently than other switches. This, of course, is perfectly obvious because some subscribers do a great deal more calling than do other subscribers.

I have arranged switches B′, G and K so that when their wipers are in connection with an idle trunk and the trunk is seized by another switch, the wipers of all the switches standing upon the trunk seized by the said other switch will be moved from engagement with the trunk that has just been seized and be moved into engagement with an idle trunk. However, I have found that it is not desirable and not necessary to arrange all the switches in a group so that the wipers of the same always remain in engagement with an idle trunk (thus operating on the preselector principle), so I have provided normal or home contacts for each individual switch. The normal or home contacts are not multipled.

Now, if one of these switches is taken for use, it is operated to connect to an idle trunk. When the connection is released the wipers of the switch remain in engagement with the last trunk used. Now, if this trunk is seized, the wipers of the switch will step to the next idle trunk, and so on until the wipers of the switch engage its normal or home contacts, in which position the wipers of the switch will remain until the switch is again used for calling purposes. But, as before stated, it is desirable, in a case where the switch is used a great deal, to arrange it so that it will not remain in engagement with its normal or home contacts, but will always operate as a preselector, so that the instant that the subscriber whose line is associated with this switch removes his switch, the switch immediately connects to the trunk to which the wipers are connected.

The construction of the normal or home contacts of switches B′, G and K is as is shown in Fig. 4. The private wipers of these switches have their end portions formed into two separate contacting portions 640 and 641. The home or normal contacts of the switches are likewise formed into two separate portions 642 and 643. When these wipers are passing over the ordinary private bank contacts, both portions of the wipers may engage the private bank contacts, but when they pass over the normal or home contacts the portion 640 of the wiper engages contact 642 at the same time that the portion 641 engages contact 643. Of course, portions 640 and

641 of the wiper are electrically connected to each other. From the above it will be seen that when the private wiper of switch B′, G or K engages its normal or home contacts, the wiper electrically connects the portion 642 of the contact to portion 643 thereof.

The switch B′ of Fig. 1 is provided with a normal or home contact and, as illustrated, is of the semi-preselector type, in which the inner or home contact is free from ground so that when the wipers of the switch engage its normal or home contact the wipers will remain in engagement with the said home contacts until the switch is again put into use for calling purposes.

The line switch G of Fig. 2, as illustrated, is of the full preselector type and is provided with a normal or home contact, but has connected to its inner contact of the home contact set an interrupter that operates a predetermined period to ground the inner contacts of the normal or home contacts of certain switches of the group of switches, to cause the switches to move their wipers from engagement with their normal or home contacts.

The line switch K of Fig. 3, as illustrated, is of the full preselector type and is provided with a normal or home contact and has connected to its inner contact of the home contact set a ground to cause the switches to move their wipers from engagement with their normal or home contacts.

From the above, it is seen that I have by very simple means made non-restoring switches preselector switches, and from the above outline it may be seen that the line switch B′ is provided with a normal or home contact set, which switch operates as a preselector switch when its wipers are in engagement with multiple trunk contacts, but which move to their normal or home contacts and remain there until they are used for calling purposes. It is obvious that the switch B′ may be changed to a switch of the full preselector type by grounding the inner contact of its normal or home contact set. Switches G and K are arranged so as to be full preselector, but it is also obvious that they may be changed to a switch of the semi-preselector type by removing the interrupted ground from the inner contact of the home contact set of the switch G of Fig. 2 and the ground from the inner contact of the home contact set of the switch K of Fig. 3.

From the foregoing it is thought to be obvious that it might not be desirable to have all of the switches of one group operate on a strictly preselector basis, for the reason that if practically all the trunks of the group of trunks to which the group of switches have access become busy, it would mean that all of the remaining idle switches of the group of switches would be moved quite frequently as the last few trunks of the remaining trunks were taken for use.

Having described in general the apparatus as illustrated in the accompanying drawings, I will now describe in detail the operation of the individual switches of my invention.

Referring now more particularly to Fig. 1 and assuming that the subscriber at the substation A initiates a call, the removal of the receiver at the calling substation thereat closes an energizing circuit for the line relay LR of the individual line switch B, traced from battery at normal contact 15 of motor magnet MM, over conductor 16, through the winding of line relay LR, conductor 17, normal contact 18 of cut-off relay CO, switchhook contacts of the calling substation A and returning through normal contact 19 of cut-off relay CO, conductor 20 to ground at normal contact 21 of motor magnet MM. Wipers 2, 3 and 4 always rest upon a set of contacts 5, 6 and 7 last used, and assuming that the contacts upon which the wipers now rest are busy due to another subscriber's line circuit having selected the connector last used by the subscriber A, the private contact 5 will be grounded. Energized line relay LR closes its alternate contacts 22 and 23, and the closing of alternate contact 22 establishes an energizing circuit for the motor magnet MM, traced from battery through the winding of motor magnet MM, normal contact 24 of magnet MM, conductors 25 and 26, alternate contact 22 of relay LR, conductor 27, normal contact 28 of cut-off relay CO, conductor 29 and wiper 2 to the engaged busy contact 5. The cut-off relay CO is shunted while the wiper 2 is engaging busy contacts 5 which are grounded. The shunt may be traced from the busy grounded contact 5, wiper 2, conductor 29, normal contact 28, conductor 27, alternate contact 22, conductor 26 to one terminal of the winding of cut-off relay CO, and from the other terminal of the cut-off relay CO, over conductor 30 to ground at alternate contact 23 of line relay LR. A circuit also extends through magnet MM and cut-off relay CO from battery through the winding of magnet MM, normal contact 24, conductors 25 and 26, through the winding of relay CO, conductor 30 to ground at alternate contact 23 of relay LR. This circuit just traced has no energizing effect on the cut-off relay CO at this time due to the shunt about the said relay CO as above traced, but when an idle contact 5 is engaged by the wiper 2 the relay CO will energize over the circuit above traced.

The motor magnet MM upon operating steps the wipers 2, 3 and 4 into engagement with the next set of contacts 5, 6 and 7. The motor magnet MM upon energization opens its normal contact 24, which inter-

rupts its circuit, permitting the de-energization of the said magnet MM. Should the contacts 5, 6 and 7 now engaged by the wipers 2, 3 and 4 be busy, the motor magnet MM will again be energized over the previously described path, due to the closure of its interrupter contact 24 and the motor magnet MM will again be energized and de-energized to step the wipers 2, 3 and 4 from one set of contacts 5, 6 and 7 to the next, as long as busy, i. e., as long as grounded contacts are encountered by the private wiper 5. Magnet MM alternately opens and closes its contact 24, and thus a vibratory circuit is closed through the winding of cut-off relay CO, as before described, but due to the shunt about cut-off relay CO as before described, the cut-off relay at this time remains inert. The ground from the busy private contacts 5 encountered by the private wiper 2 extends through the normal contact 24 of motor magnet MM, conductor 31, normal contact 32 of relay CO, conductor 33 to the calling line's private normal contacts 11′ at the connectors having access to the said calling line to render such contacts 11′ busy against selection. This ground will be of a vibratory character, and in view of the construction of test relay TR of the connector, the calling line will test busy while the line switch travels, as will be understood from the general operation of the connector C. The motor magnet MM alternately opens and closes its normal contacts 15 and 21 during the selecting operation of the individual line switch B, and the interruption of the contacts 15 and 21 interrupts the energizing circuit of the line relay LR, but due to the slow to release construction of the line relay LR, the said relay is not affected by the rapid interruptions of the motor magnet MM and remains energized.

When an idle private contact 5 is encountered by the private wiper 2, the motor magnet MM will remain unoperated because the private contact 5 now engaged by the private wiper 2 is free from ground. The shunt about the cut-off relay CO, as before described during the selecting operation of the switch, is now removed and the circuit of the cut-off relay CO is closed over a path which may be traced from ground at alternate contact 23 of line relay LR, over conductor 30, through the winding of cut-off relay CO, conductors 26 and 25, normally closed contact 24 of motor magnet MM to battery and ground through the winding of motor magnet MM, but the said motor magnet MM does not energize over this circuit on account of the resistance of the cut-off relay CO, and it therefore remains inert. The opening of normal contacts 18 and 19 of the cut-off relay CO, upon its energization, opens the energizing circuit of the line relay LR, but the line relay LR being of the slow-to-release construction is held momentarily energized to hold the initial energizing circuit of the cut-off relay closed until a substitute circuit is established for it, as will presently be described. The closing of alternate contact 32 of cut-off relay CO upon its energization connects ground over conductor 33 to the private normals 11′ to keep the contacts 11′, 12′ and 13′ busy against selection until upon the termination of conversation.

The relay CO having energized, its contacts 18 and 19 assuming their alternate positions, the wipers 2, 3 and 4 of the individual switch B are now connected 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 left-hand winding of relay IR, contact 6, wiper 3, alternate contact 18 of relay CO, through substation A, back through alternate contact 19 of relay CO, wiper 4, contact 7, to ground through the right-hand winding of relay IR. The closing of alternate contact 40 of the impulse relay IR establishes an energizing circuit for the relays 41 and 42, 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 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 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 its alternate contact 50 of relay 41. The closing of alternate contact 40 of relay IR establishes a substitute energizing circuit for the relay CO of the line switch B before it has time to de-energize, which may be traced from battery through the winding of magnet MM, its normal contact 24, conductors 25 and 26, through the winding of relay CO, its alternate contact 28, conductor 29, wiper 2, contact 5, conductors 45 and 46 to ground at alternate contact 40 of the impulse relay IR. Magnet MM does not operate over this circuit for reasons as before described, and the said cut-off relay CO remains energized until upon the termination of conversation.

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 of the connector 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 contact 44 of the primary off-normal contacts PON has moved to its alternate position 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 42 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 IR opened the circuit through the lower winding of relay 42. 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 CD 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, conductor 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 opened the circuit of the switching relay SW. The relay SW de-energizing, 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 motor magnet MM′ of line switch B′, conductor 110, normal contact 111 of cut-off relay CO′, conductor 112, 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 contacts 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 motor magnet MM′ 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 substation 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 left-hand 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 and 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 motor magnet MM′ 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 primary 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.

If the private contact 5 engaged by the wiper 2 is idle when the subscriber at the calling substation A initiates a call by removing his receiver, the line relay LR will energize over a path as before described and operates to close its alternate contacts 22 and 23. There being no ground on the private contact 5 engaged by the wiper 2, no shunt will be closed about the cut-off relay as before described, and the motor magnet MM will also remain inert due to the groundless private contact 5, and the wipers 2, 3 and 4 will remain in engagement with the contacts 5, 6 and 7 that were last used by the individual switch B in establishing a previous connection. The cut-off relay CO is therefore immediately energized from battery through the motor magnet MM and cut-off relay CO to ground at alternate contact 23 of slow-to-release relay LR and the operation of the circuit from this point on is the same as previously described. Thus, it may be seen that the individual switch B only travels when its wipers 2, 3 and 4 are in engagement with a busy trunk when a call is initiated.

Should the substation A be seized as a called line by a connector engaging contacts 11′, 12′ and 13′, ground will be extended to the private contact 11′ from the connector, and this ground extends from the engaged contact 11′ over conductor 33, through normal contact 32 of cut-off relay CO, conductor 31 to battery and ground through the winding of the motor magnet MM. The motor magnet MM upon energization opens its normal contacts 15 and 21 so that when the subscriber at the substation A removes his receiver as a called subscriber from its switchhook, no energizing circuit is established for the line relay LR due to the opening of normal contacts 15 and 21 of motor magnet MM, and this energization of the said motor magnet MM removes the substation control of the line switch B when the substation A is a called line.

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 closing 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.

Operation of switch B'.

The substation D terminates at the exchange in a line switch B', which is of the non-restoring type. The line switch B' is provided with wipers 118, 119 and 120 for engagement with its bank contacts 115, 116 and 117. The switch B' is provided with a normal or home set of bank contacts 115' 115^2, 116', and 117'. If it is desired that the line switch B' be used as a semi-preselector, then the home bank contact 115^2 is not connected to ground, but if it is desired that the line switch B' always operate as a preselector, then the bank contact 115^2 is connected directly to ground or through an interrupter to ground as shown in Fig. 2. When the line switch B' operates as a semi-preselector its wipers, whenever left in engagement with a multiple bank contact, will be moved from engagement with this contact as soon as the trunk is seized by another switch. This operation will continue to happen until the wipers of the switch are stepped to the normal or home set of the bank contacts 115', 115^2, 116' and 117'. The motor magnet of the switch B' is used not only to advance the switch wipers, but is also used as a cut-off relay when the substation D is a called substation.

Assuming now that the subscriber at the substation D initiates a call and that the wipers 118, 119 and 120 are in engagement with the normal home contacts 115', 115^2, 116', and 117' (the switch B' operating as a semi-preselector), the removal of the receiver at the substation D closes an energizing circuit for the line relay LR', traced from battery through the normally closed contact 121 of the motor magnet MM', through the winding of the line relay LR', conductor 122, normal contact 123 of cut-off relay CO', through the now closed contacts of the substation switchhook, and back through normal contact 124 of the relay CO', conductor 125 to ground at normal contact 126 of the magnet MM'. The line relay LR' energizes over this circuit, and having assumed that the wipers 118, 119 and 120 are engaging its set of normal home non-multiple contacts 115', 115^2, 116' and 117' in the bank of contacts of the line switch B', the closure of alternate contact 127 of the line relay LR' establishes an energizing circuit for the relay 128, traced from battery, through the winding of the relay 128, conductor 135, normal contact 134 of the motor magnet MM', conductors 133 and 132, normal contact 131 of the relay CO', conductor 130, wiper 118, normal home contact 115', conductor 129, to ground at alternate contact 127 of the line relay LR'. The relay 128 upon energizing closes its alternate contact 136, establishing an energizing circuit for the motor magnet MM', traced from battery through the winding of the motor magnet MM', conductor 110, to ground at alternate contact 136 of the relay 128. The motor magnet MM' upon operating steps the wipers 118, 119 and 120 from the normal home contact 115', 115^2, 116' and 117' into engagement with the next set of contacts. The motor magnet MM' upon energization opens its normal contact 134, which opens the energizing circuit of the relay 128 and the relay 128 upon de-energization opens its alternate contact 136, which opens the energizing circuit of the magnet MM'. Should the set of contacts now engaged by the wipers be busy, the relay 128 will energize from ground at the busy contact 115, over conductor 130, normal contact 131 of the relay CO', to battery and ground through the winding of the relay 128 over the previous described path, and relay 128 upon energization closes its alternate contact 136, closing an energizing circuit for the motor magnet MM', and the relay 128 and the motor magnet MM' are thus alternately energized and de-energized to cause the motor magnet MM' to step the wipers 118, 119 and 120 from one set of contacts 115, 116 and 117 to the next as long

as busy, i. e., grounded, contacts are encountered. The line relay LR′ has its initial energizing circuit opened at the contacts 121 and 126 of the motor magnet MM′, but the relay LR′ being slow to release remains energized during the rapid interruptions of the contacts 121 and 126. The grounded alternate contact 136 of the relay 128 also extends over conductor 110, normal contact 111 to the private normal contacts 11 of the connectors which have access to the line D to render said contacts busy against selection.

During the selecting operation of the switch B′ a shunt is closed about the cut-off relay CO′, the shunt extending from ground at alternate contact 127 of relay LR′ to one terminal of the winding of relay CO′ and the ground encountered by the wiper 118 in engaging busy grounded contacts 115 extends over conductor 130, normal contact 131 and over conductors 132 and 133 to the other terminal of the winding of relay CO′. Upon the de-energization of motor magnet MM′, the circuit is closed for the cut-off relay CO′ from battery through the winding of the relay 128, conductor 135, normal contact 134 of magnet MM′, conductor 133, through the winding of the relay CO′ to ground at the alternate contact 127 of the line relay LR′, but relay CO′ does not energize at this time over this vibratory circuit due to the shunt about its winding, as above described. When an idle contact 115 is encountered by the wiper 118 no energizing circuit is established for the relay 128 as the contact 115 now engaged is free from ground, and the relay 128 restoring its alternate contact 136 is opened, preventing further actuation of the motor magnet MM′ and the shunt is also removed from about the cut-off relay CO′. As contact 115 is free from ground, the closing of normal contact 134 of the magnet MM′ establishes a circuit for the cut-off relay CO′, which may now be traced from battery, through the winding of the relay 128, conductor 135, normal contact 134 of magnet MM′, conductor 133, through the winding of the relay CO′ to ground at alternate contact 127 of line relay LR′. The cut-off relay CO′ energizes over this circuit, but due to the resistance of the relay CO′ relay 128 is not energized over this circuit. The cut-off relay CO′ upon energizing opens its normal contacts 123, 124 and thus interrupts the energizing circuit of the line relay LR′, but the line relay LR′ being slow to release is held momentarily energized, after its circuit is interrupted, to maintain the circuit of the cut-off relay CO′ closed until a substitute circuit is established for it. The relay 128 upon de-energization and the relay CO′ upon energization remove the busy ground from the contacts 11, but the closing of alternate contact 111 of the cut-off relay CO′ connects ground to the contacts 11, keeping them busy until termination of conversation. The relay CO′ having energized, its contacts 123 and 124 assume their alternate positions, and the wipers 118, 119 and 120 of the individual switch B′ are now connected to contacts 115, 116 and 117 of an idle selector or connector, as the case may be, and a substitute circuit for the cut-off relay CO′ is now established over circuit traced from battery through the winding of the relay 128, conductor 135, normal contact 134 of the magnet MM′, conductor 133, through the winding of the relay CO′, alternate contact 131 of relay CO′, conductor 130, wiper 118, contact 115 to ground at the selector or connector, as is readily apparent from the previous description.

If the wiper 118 is in engagement with a contact 115 other than the normal home contact associated with the substation D, when the subscriber at the substation D initiates a call the line relay LR′ is energized as before described and operates to close its alternate contact 127, but as there is no ground on the private contact 115, no energizing circuit is established for relay 128, and the relay 128 remaining inert its alternate contact 136 remains open, preventing an energizing circuit being established from the motor magnet MM′, and the wipers 118, 119 and 120 therefore remain in engagement with the contacts 115, 116 and 117. The cut-off relay CO′ is therefore energized immediately over circuit from battery through relay 128, to the cut-off relay CO′ and to ground at alternate contact 127 of the line relay LR′, and the operation of the circuit from this point on is the same as above described.

Assuming that the substation D is neither a called or a calling line and the wipers 118, 119 and 120 are resting in engagement with an idle set of contacts 115, 116 and 117, and assuming that this set of contacts are appropriated by another line switch during the time that the subscriber at the substation D is neither calling nor being called, the ground placed upon the contacts 115 to render them busy extends through wiper 118, over conductor 130, through normal contact 131, conductors 132 and 133, normal contact 134 of the magnet MM′ and over conductor 135 to battery and ground through the winding of the relay 128. The relay 128 upon energizing closes its alternate contact 136, establishing an energizing circuit for the motor magnet MM′, and the motor magnet MM′ upon energizing steps the wipers 118, 119 and 120 into engagement with the next set of contacts, and continues to do so until an idle set of contacts 115, 116 and 117 are encountered, or until the home set of contacts 115′, 115², 116′ and 117′ are engaged, at which time relay 128 remains

normal to prevent further actuations of motor magnet MM'. From the above description it may be seen that the line switch B', as illustrated and described, is of the non-restoring semi-preselecting type.

Assuming that the switch B' is to operate as a strictly preselector, the home contact 115^2 is connected to ground, either directly or through an interrupter, now when the wiper 118 engages this ground a circuit is immediately closed for relay 128, which relay energizing closes a circuit for magnet MM'. The operation of magnet MM' moves the wipers to the next set of contacts.

From the foregoing it is believed to be apparent that when the home contact 115^2 is connected to ground the wiper 118 always rests in engagement with a non-grounded contact 115 connected to an idle trunk, thereby maintaining the wipers of the switch in engagement with an idle trunk so that as soon as the subscriber removes his receiver his line is immediately connected to an idle trunk.

Operation of switch G.

Referring now to Fig. 2, I show a substation F terminating in the main exchange in a line switch G of the non-restoring type. The switch G, as before mentioned, is provided with a set of wipers 154, 155 and 156 for engagement with bank contacts 151, 152 and 153. The switch G, like the switch B', is provided with a set of normal or home contacts 151', 151^2, 152' and 153', and if it is desired to operate the switch G as a semi-preselector, the normal or home concontact 151^2 is left disconnected from the source of current, while if it is desired to operate the switch G as a strictly preselector the normal or home contact 151^2 is connected either directly to ground or to ground through an interrupter. In Fig. 2 I have shown the bank contact 151^2 connected through an interrupter 900 to ground. If the switch G is operated as a semi-preselector after it is used for extending a call from the substation F, the wipers rest in engagement with the last set of contacts used until this set of contacts is taken for use by another switch of the group of switches to which switch G belongs. As soon as this occurs, the wipers are moved from engagement with this set of bank contacts and they continue to rotate as long as busy contacts 151 are engaged by wiper 154, until the normal or home contact is reached, in which position the switch remains at rest until substation F initiates a further call. If the switch G is operated on a strictly preselector basis, then as soon as the wiper 154 is moved to the home contact 151^2, the motor magnet MM^2 of the switch will be operated to step the wipers to the next set of contacts if the contact 151^2 is connected directly to ground, or the wipers will remain in engagement with the normal or home set of contacts until the interrupter 900 grounds contact 151^2, at which time the wipers will be moved from engagement with the normal or home set of contacts and into engagement with contacts representing an idle trunk. From this it will be seen that the switch G may be operated as a semi-preselector or as a preselector.

Assuming that the substation F initiates a call and that the wipers 154, 155 and 156 are in engagement with the normal home contacts 151', 151^2, 152' and 153' (switch operating as a semi-preselector), the removal of the receiver at the substation closes an energizing circuit for the line relay LR^2, traced from battery through the winding of said relay, normal contact 157 of cut-off relay CO^2, through the substation, and back to ground at normal contact 158 of the cut-off relay CO^2. The line relay LR^2 energizes over this circuit, and having assumed that the wipers are in engagement with the set of normal home contacts 151', 151^2, 152' and 153', the closure of alternate contact 159 of the line relay LR^2 establishes an energizing circuit for the relay 150, traced from battery through the winding of the said relay 150, normal contact 160 of motor magnet MM^2, conductors 161 and 162, normal contact 163 of cut-off relay CO^2, conductor 164, wiper 154, the private home contact 151', conductor 165 to ground at alternate contact 159 of the relay LR^2. The relay 150 upon energizing closes its alternate contact 166, establishing an energizing circuit for the motor magnet MM^2 from ground at alternate contact 166, to battery and ground through the winding of the motor magnet MM^2. The motor magnet MM^2 upon operation steps the wipers 154, 155 and 156 from the normal home contacts upon which the wipers are resting, into engagement with the next set of contacts. The motor magnet MM^2 upon energization opens its normal contact 160, which opens the energizing circuit of the relay 150, and the relay 150 upon de-energization opens its alternate contact 166, which opens the energizing circuit of the motor magnet MM^2. Should the set of contacts now engaged by the wipers be busy, the relay 150 will energize from ground at the busy contact 151 engaged by the wiper 154, over conductor 164, through normal contact 163 of the cut-off relay CO^2, to battery and ground through the winding of relay 150 over the previously described path. The relay 150 upon energization in turn again closes an energizing circuit for the motor magnet MM^2, and the relay 150 and motor magnet MM^2 are thus

alternately energized and de-energized to cause the motor magnet MM² to step the wipers 154, 155 and 156 from one set of contacts 151, 152 and 153 to the next as long as busy, that is, grounded, contacts are encountered. The ground at alternate contact 159 of the line relay LR² extends over conductor 167 to the private normal contacts 168 of the connectors, which have access to the substation F, to thus render the said contacts busy against selection. During the selecting operation of the switch G a shunt is closed about the cut-off relay CO², the shunt extending from ground at alternate contact 159 of the line relay LR², over conductor 167, to one terminal of the winding of the cut-off relay CO², and the ground encountered by the wiper 154 in engaging busy contacts extends over conductor 164 to normal contact 163, to the other terminal of the winding of cut-off relay CO².

Upon each de-energization of the motor magnet MM², a circuit is closed for the cut-off relay CO² from battery through the winding of relay 150, through normal contact 160 of motor magnet MM², through the winding of the cut-off relay CO², and over conductor 167 to ground at alternate contact 159 of line relay LR². The relay CO² does not energize at this time over this vibratory circuit due to the shunt about its winding, as above described. When an idle contact 151 is encountered by the wiper 154, relay 150 will restore and contact 151, now engaged, will be free from ground, and the opening of its alternate contact 166 prevents further actuation of the motor magnet MM² and the shunt is also removed from about the cut-off relay CO². As the contact 151 is free from ground, the closing of normal contact 160 establishes a circuit for the cut-off relay CO², which now may be traced from battery through the winding of the relay 150, normal contact 160 of magnet MM², through the winding of the cut-off relay CO² and over conductor 167, to ground at alternate contact 159 of the line relay LR². The cut-off relay CO² energizes over this circuit, but due to the resistance of the cut-off relay CO² relay 150 is not energized over this circuit. The cut-off relay CO², upon energization, opens its normal contacts 157 and 158, and this interrupts the energizing circuit of the line relay LR², and the line relay LR² de-energizing opens its alternate contact 159, which opens the initial energizing circuit of the cut-off relay CO², but the cut-off relay CO² being slow to release is momentarily held energized after the de-energization of the line relay LR² until a substitute circuit is established for it from ground over the seized trunk, as described in connection with Fig. 1. This holding ground for the cut-off relay CO² extends from the engaged contact 151 of wiper 154, over conductor 164, through alternate contact 163 of cut-off relay CO², conductor 167, through the winding of the cut-off relay CO², normal contact 160 of the motor magnet MM² to battery and ground through the winding of the relay 150, the cut-off relay CO² thus remaining energized until the termination of conversation. The ground for making switch G inaccessible during conversation also extends over conductor 167 to the connector contacts 168, keeping them busy until termination of conversation.

If the wiper 154 is in engagement with a contact other than the normal home contact, when the subscriber at substation F initiates a call the line relay LR² is energized as before described and operates to close its alternate contact 159, but as there is no ground on the private contact 151 no energizing circuit is established for relay 150, and the relay 150 remaining inert its alternate contact 166 remains open, preventing an energizing circuit being established for the motor magnet MM², and the wipers 154, 155 and 156 therefore remain in engagement with the contacts 151, 152 and 153 that were last used by the switch G in establishing a connection. The cut-off relay CO² is therefore energized to ground at alternate contact 159 of the relay LR², and the operation of the circuit from this point on is the same as above described.

Assuming that the substation F is neither a called nor a calling line and the wipers 154, 155 and 156 are resting in engagement with an idle set of contacts 151, 152 and 153, and assuming that this set of contacts are appropriated by another line switch during the time that the subscriber at the substation F is not being called or is not calling, the ground placed upon the contact 151 to render it busy extends through wiper 154, conductor 164, normal contact 163 of the cut-off relay CO², conductors 162 and 161, normal contact 160 of the motor magnet MM² to battery and ground through the winding of the relay 150. The relay 150 upon energizing closes its alternate contact 166, establishing an energizing circuit for the motor magnet MM², and the motor magnet MM² upon energizing steps the wipers 154, 155 and 156 into engagement with the next set of contacts, and continues to do so until an idle set of contacts 151, 152 and 153 are encountered or the home contacts are engaged.

Assuming that the commutator 900 is connected to home contact 151², should the wipers 154, 155 and 156 be stepped into engagement with the normal home contacts, the wipers remain in engagement with the said contacts as long as the brushes of the

commutator are engaging insulated portions of the commutator, but when the live segment of the commutator engages the commutator brushes, ground is connected through the live segments thereof and through the wiper 154, over conductor 164, to battery and ground through the winding of the relay 150. The relay 150 upon energizing closes an energizing circuit for the motor magnet MM^2, and the motor magnet MM^2 steps the wipers from the normal home contacts into engagement with the next set of contacts, and should these contacts be busy the wipers continue to be stepped around by the alternate energization and de-energization of the relay 150 and motor magnet MM^2 until an idle set of contacts are encountered.

When the switch G is used for called purposes and when a connector switch applies ground to the private normal contact 168, the cut-off relay CO^2 is energized over a path extending from battery through the winding of relay 150, contact 160 of motor magnet MM^2 and the winding of relay CO^2 to the private normal contact 168. The relay CO^2 energizes, disconnects ground and battery from the subscriber's line F, thereby removing the substation control of switch G. The relay CO^2 energizes in series with the relay 150, but the relay 150 remains inert when included in this energizing circuit, for the reasons heretofore assigned.

Operation of switch K.

Referring now to Fig. 3, I show a substation H terminating in the main exchange in a line switch K of the non-restoring type. The line switch K is provided with a set of wipers 178, 179 and 180 for engagement with the set of bank contacts 175, 176 and 177. The switch K, like switches B′ and G, is provided with a set of home contacts 175′, 175^2, 176′ and 177′. The home contact 175^2 may either be connected to ground or through an interrupter to ground, or there may be no connection whatever to this contact. The normal or home contacts as mentioned in connection with switches B′ and G are non-multipled, but are individual to the bank of contacts individual to switch K. If home contact 175^2 is connected directly to ground or through an interrupter to ground, the switch will operate on a strictly preselector basis, while if there is no connection to contact 175^2, the switch operates on the semi-preselector basis—that is, the switch will operate as a preselector as long as its wipers are in engagement with bank contacts connected to trunks, but will not operate as a preselector when its switch wipers are in engagement with its normal or home set of contacts. I have shown the contact 175^2 free from ground connection.

Assuming that the subscriber at the substation H initiates a call and that the wipers are in engagement with the normal or home set of contacts 175′, 175^2, 176′ and 177′, and that the switch K is operated as a semi-preselector, the removal of the receiver at the substation closes an energizing circuit for the line relay LR^3, traced from battery at normal contact 181 of the motor magnet MM^3, through the winding of the line relay LR^3, conductor 182, normal contact 183 of the cut-off relay CO^3, through the substation, back through normal contact 184 of the cut-off relay CO^3, to ground at normal contact 185 of the motor magnet MM^3. The energization of relay LR^3 closes a circuit for magnet MM^3 extending from battery through said magnet, normal contact 186, contact 192, wiper 178, home contact 175′ and contact 190 of line relay LR^3 to ground. Magnet MM^3 energizes and de-energizes, moving the switch wipers, and continues to do so as long as wiper 178 engages grounded contacts. When an idle contact is found, an energizing circuit is established for the relay CO^3, traced from battery through the winding of the motor magnet MM^3, its normal contact 186, conductor 187, through the winding of the cut-off relay CO^3, conductors 188 and 189, to ground at alternate contact 190 of the line relay LR^3. The motor magnet MM^3 is not energized over this circuit due to the resistance of cut-off relay CO^3. The cut-off relay CO^3 upon energizing opens its normal contacts 183, 184, opening the energizing circuit for the line relay LR^3. The closing of the said alternate contacts 183 and 184 of the cut-off relay CO^3 of the switch K extends the line conductors to wipers 178, 179 and 180 which engage contacts of the selector or connector seized, as described in connection with Fig. 1. The line relay LR^3 upon de-energization opens the initial energizing circuit for the cut-off relay CO^3, but the cut-off relay CO^3 being slow to release, the relay is held momentarily energized until a substitute energizing circuit is established for it, traced from the ground which is placed upon the private contact 175 from the seized selector-connector switch, extending over conductor 191, through alternate contact 192 of the cut-off relay CO^3, through the winding of the said cut-off relay, conductor 187, normal contact 186 of the motor magnet MM^3, and through the winding of the magnet MM^3 to battery and ground. The cut-off relay remains energized over this circuit until termination of conversation.

Assuming now that the called substation H is a called line, the ground extending from the connector associated with the substation H extends over conductor 193, through normal contact 194, through the

winding of the motor magnet MM³ to battery and ground, and the opening of normal contacts 181 and 185 of the motor magnet MM³ removes the substation control of the line switch K.

Upon termination of conversation motor magnet MM³ of switch K restores to normal, and assuming that the contacts with which the wipers 178, 179 and 180 are engaging have been appropriated by another switch, a circuit will be immediately established for the motor magnet MM³ from the now busy grounded contact 175, through the wiper 178, conductor 191, normal contact 192 of relay CO³, normal contact 186 of the motor magnet MM³, through the winding of the magnet MM³ to battery and ground. The magnet MM³ upon operation steps the wipers into engagement with the next set of contacts. The motor magnet MM³ upon energizing opens its interrupter contact 186, allowing said magnet MM³ to de-energize, and should the next set of contacts encountered now engaged by the wipers be busy, another circuit is established for the motor magnet MM³ to step the wipers into engagement with the next set of contacts. This stepping of the wipers is continued until an idle set of contacts are encountered.

Should the substation H be neither a calling nor a called subscriber, and assuming that the contacts engaged by the wipers have been appropriated by another switch, the contact 175 is grounded, this ground extending over conductor 191, to normal contact 192 of the cut-off relay CO³, the interrupter contact 186 of the motor magnet MM³ to battery. The motor magnet MM³ steps the wipers from one set of contacts to the next until an idle set of contacts are encountered.

When the wipers 178, 179 and 180 are stepped into engagement with the normal home contacts associated with the substation H and the private normal home contact 175² is permanently grounded, to provide full preselection for the switch K, the ground encountered by the wiper 178 extends through the wiper 178, over conductor 191, to normal contact 192 of the cut-off relay CO³, through the interrupter contact 186 and the motor magnet MM³ to battery and ground. The motor magnet MM³ thus steps the wipers from the normal home contacts engaged by the said wipers into engagement with the next set of contacts and the wipers continue to step ahead until an idle set of contacts are encountered.

When the switch is used on the strictly preselector basis the wiper 178 is always maintained in engagement with an idle trunk so that as soon as the subscriber removes his receiver at substation H, his line is immediately connected to the idle trunk. The home contact of switch K, of course, could be connected through an interrupter to ground.

While I have shown a system of 100 capacity, it is to be understood that by inserting first selectors, the system may be increased to a 1000 system, etc.

It is to be understood that I do not wish to be limited to the exact matters as shown, as various other arrangements may readily suggest themselves to one sikIled in the art. Therefore, I desire to cover all such changes and modifications as come within the spirit and scope of the appended claims.

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

1. A telephone system including a non-numerical non-restoring trunking switch having only three operating magnets one of which is a motor magnet, subscriber-controlled means for operating said motor magnet to cause said switch to connect the subscriber's line to a trunk, subscriber-controlled means for operating said motor magnet without effecting operation of the other of said magnets to prevent said first subscriber from exercising a control over said switch and means for maintaining said switch always in engagement with a set of contacts connected to an idle trunk.

2. A telephone system including an automatic single level non-restoring trunking switch having only three operating magnets so arranged that its wipers always remain in contact with an idle trunk unless the wipers of the switch are in one certain position.

3. An automatic non-restoring single level switch of the character described provided with bank contacts connected to circuits, wipers for said switch always in engagement with contacts of said bank of contacts, and means for maintaining said wipers always in engagement with a set of contacts connected to an idle circuit unless the wipers of the switch are in one certain position.

4. A switch of the non-restoring progressively movable single level type provided with means to maintain the wipers of the switch in engagement with idle bank contacts unless the wipers of the switch are in one certain position.

5. A switch of the progressively movable non-restoring type provided with means for maintaining its wipers in engagement with idle contacts unless the wipers of the switch are in one certain position.

6. An automatic progressively movable non-restoring switch provided with bank contacts, wipers for said switch, means for moving said wipers when they are in engagement with one set of said bank contacts even though the switch is not being used for calling purposes, and means for permitting the switch to remain in engagement with an-

other set of bank contacts under all conditions except when the switch is used for calling purposes.

7. A system of the character described including a plurality of non-restoring switches arranged in a group and having access to multiply connected link circuits, circuits so arranged that the switches of the group maintain their wipers in engagement with idle link circuits when the switches are idle, and whereby the switches do not maintain their wipers in engagement with idle circuits when the switches are idle and when the said wipers are in one certain position.

8. An automatic progressively movable non-restoring switch provided with bank contacts connected to connecting circuits, other bank contacts for said switch, circuit connections for maintaining the wipers of said switch when idle and in engagement with any of said first contacts in connection with an idle connecting circuit, and means whereby when the wipers of said switch engage the said other contacts it remains there until the switch is used.

9. An automatic progressively movable non-restoring switch provided with bank contacts connected to connecting circuits, other bank contacts for said switch, circuit connections for maintaining the wipers of said switch when idle and in engagement with any of said first contacts in connection with an idle connecting circuit, and means whereby when the wipers of said switch engage said other contacts and the switch is idle the wipers thereof will be moved from engagement therewith and into engagement with contacts connected to an idle connecting circuit.

10. A system of the character described provided with switches of the non-restoring type, bank contacts for said switches connected to link circuits, other bank contacts for said switches, means for maintaining the wipers of said switches when idle in engagement with contacts connected to an idle link circuit, and means for maintaining the wipers of said switches when idle in engagement with idle link circuits or in engagement with said other contacts.

11. An automatic progressively movable switch of the non-restoring type that operates as a semi-preselector.

12. A system of the character described having switches arranged in groups, bank contacts and wipers for said switches, an auxiliary set of contacts for said banks, said switches being of the non-restoring type, means for maintaining said switch wipers in engagement with idle sets of contacts, thus operating said switches as preselectors until such time as said switch wipers engage said auxiliary set of contacts, means for maintaining said switch wipers in engagement with said auxiliary set of contacts until said switches are used for calling purposes.

13. An automatic progressively movable non-restoring switch provided with bank contacts connected to link circuits, other bank contacts for said switch, means for maintaining the wipers of said switch when idle in engagement with an idle link circuit or in engagement with said other bank contacts, and means operative at certain intervals to move said switch when idle from engagement with said other contacts and into engagement with contacts connected to an idle link circuit.

14. A system of the character described including progressively movable non-restoring switches, multiply connected bank contacts for said switches connected to link circuits, other bank contacts for said switches, means for always maintaining the wipers of said switches when said switches are idle in connection with idle link circuits until said wipers engage said other bank contacts, and means for permitting said switches to maintain their wipers in connection with said other bank contacts until said switches are taken for use.

15. A system of the character described including progressively movable non-restoring switches, multiply connected bank contacts for said switches connected to link circuits, other bank contacts for said switches, means for maintaining the wipers of said switches when said switches are idle in connection with idle link circuits, means whereby said switches maintain their wipers in engagement with said other bank contacts until taken for use, and means whereby said switches may move their wipers to said other bank contacts and their wipers remain there for a predetermined period of time, at which time the wipers are removed from engagement with said bank contacts and into engagement with contacts connected to an idle link circuit.

16. A system of the character described including progressively movable non-restoring switches, multiply connected bank contacts for said switches connected to link circuits, other bank contacts for said switches, means for maintaining the wipers of said switches when said switches are idle in connection with idle link circuits, and means whereby said switches may move their wipers to said other bank contacts and their wipers remain there for a predetermined period of time, at which time the wipers are removed from engagement with said bank contacts and into engagement with contacts connected to an idle link circuit.

17. A system of the character described provided with switches of the non-restoring type, bank contacts for said switches multiply connected to link circuits, a normal or

home set of contacts for said switch, means for maintaining the wipers of said switches when idle in engagement with contacts connected to an idle link circuit until said wipers engage such normal or home set of contacts, and means for maintaining the wipers of said switches in engagement with said normal or home set of contacts until said switch is used for calling purposes.

Signed by me at Chicago, in the county of Cook and State of Illinois, this 27 day of January, 1921.

LEROY D. KELLOGG.