W. KAISLING.

AUTOMATIC TELEPHONE SYSTEM.

APPLICATION FILED JUNE 5, 1911. RENEWED APR. 4, 1913.

1,210,386.

Patented Dec. 26, 1916.

4 SHEETS—SHEET 1.

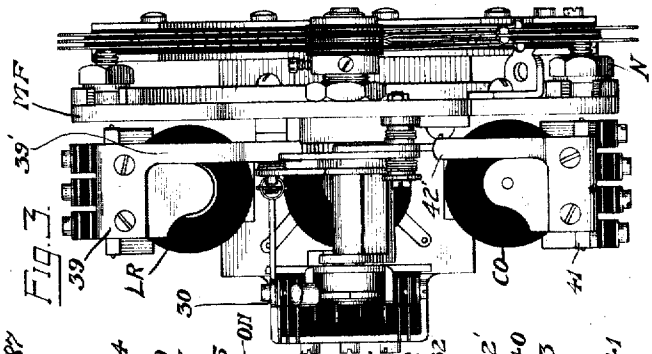


Fig. 3.

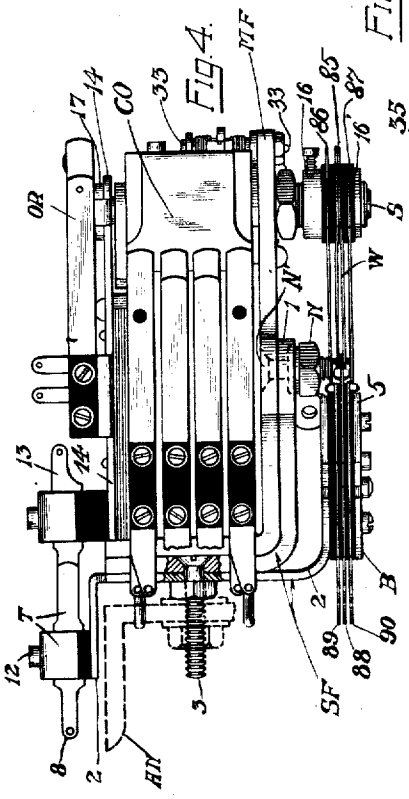


Fig. 4.

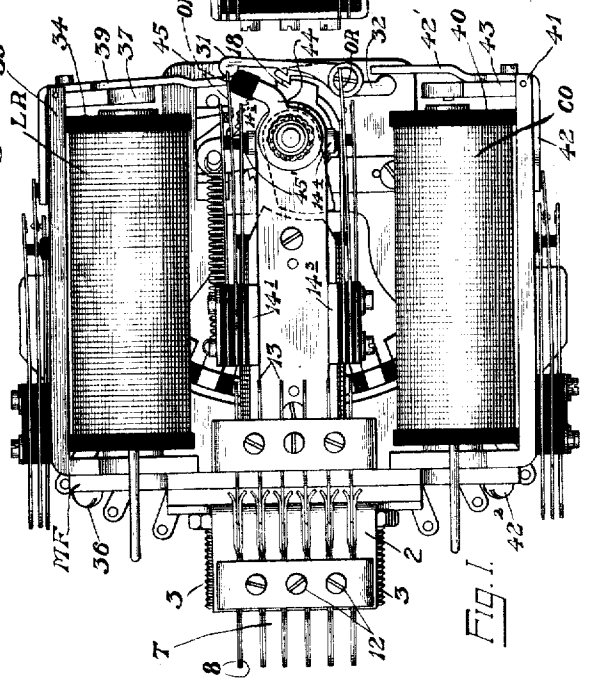


Fig. 1.

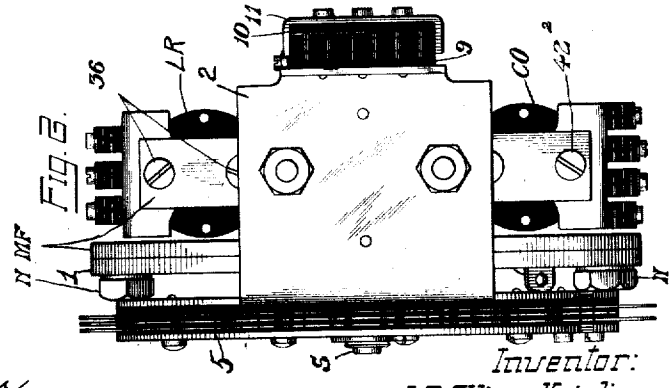


Fig. 2.

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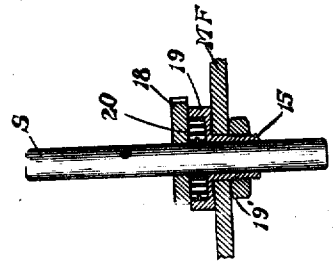

Fig. 6.

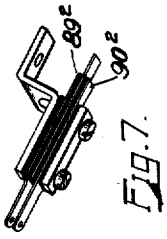

Fig. 7.

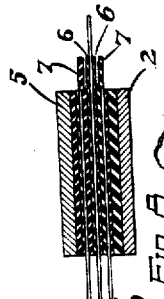

Fig. 8.

Fig. 9.

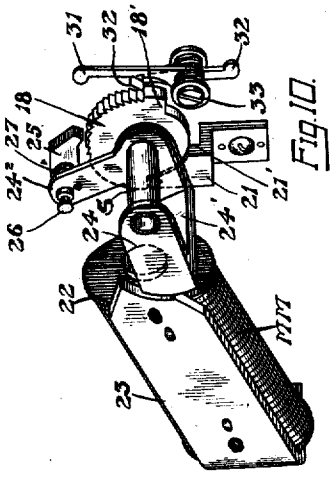

Fig. 10.

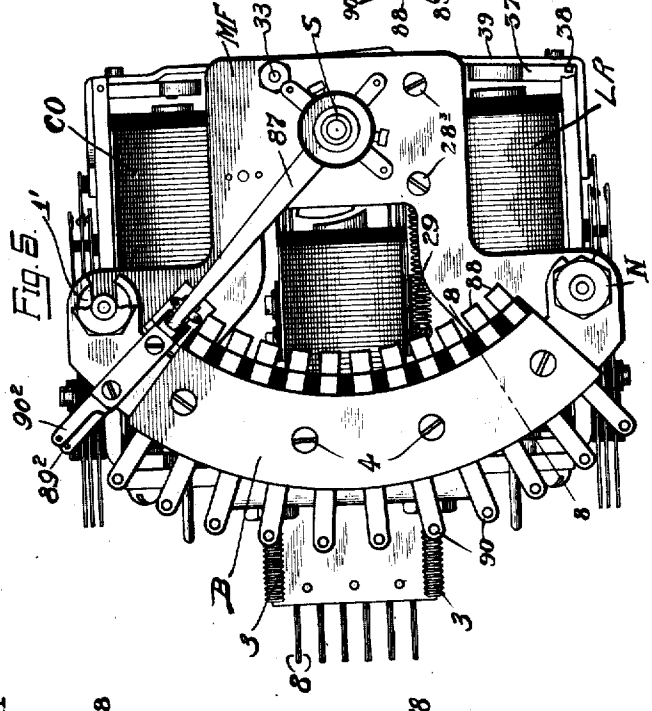

Fig. 5.

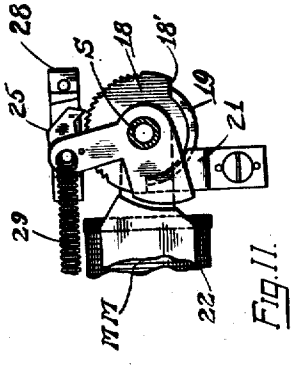

Fig. 11.

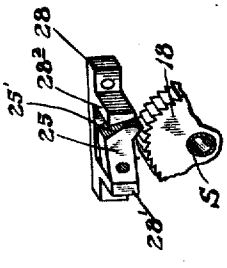

Fig. 12.

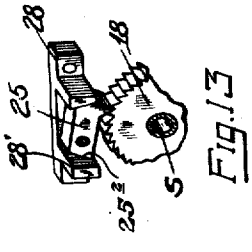

Fig. 13.

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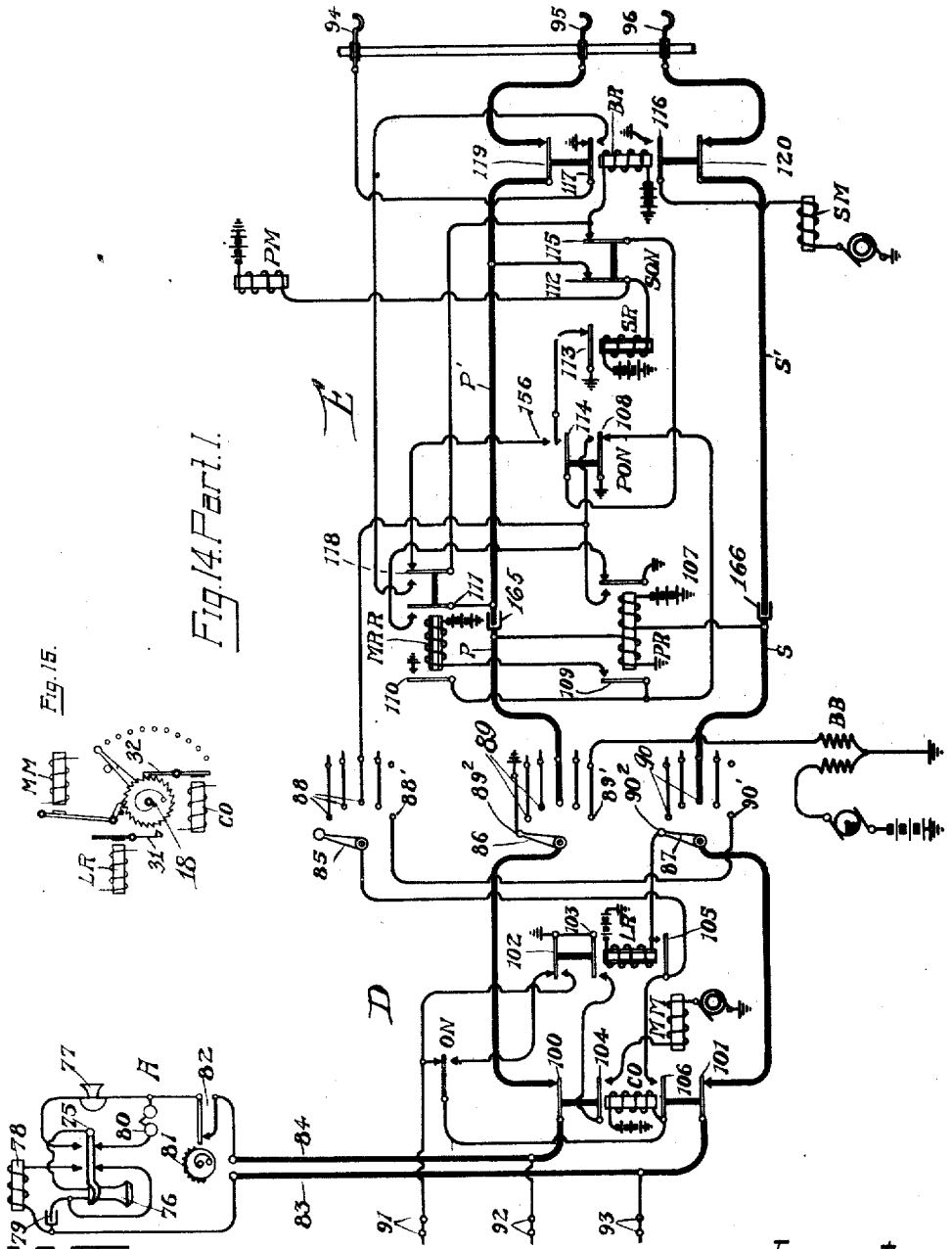
3 SHEETS—SHEET 3.

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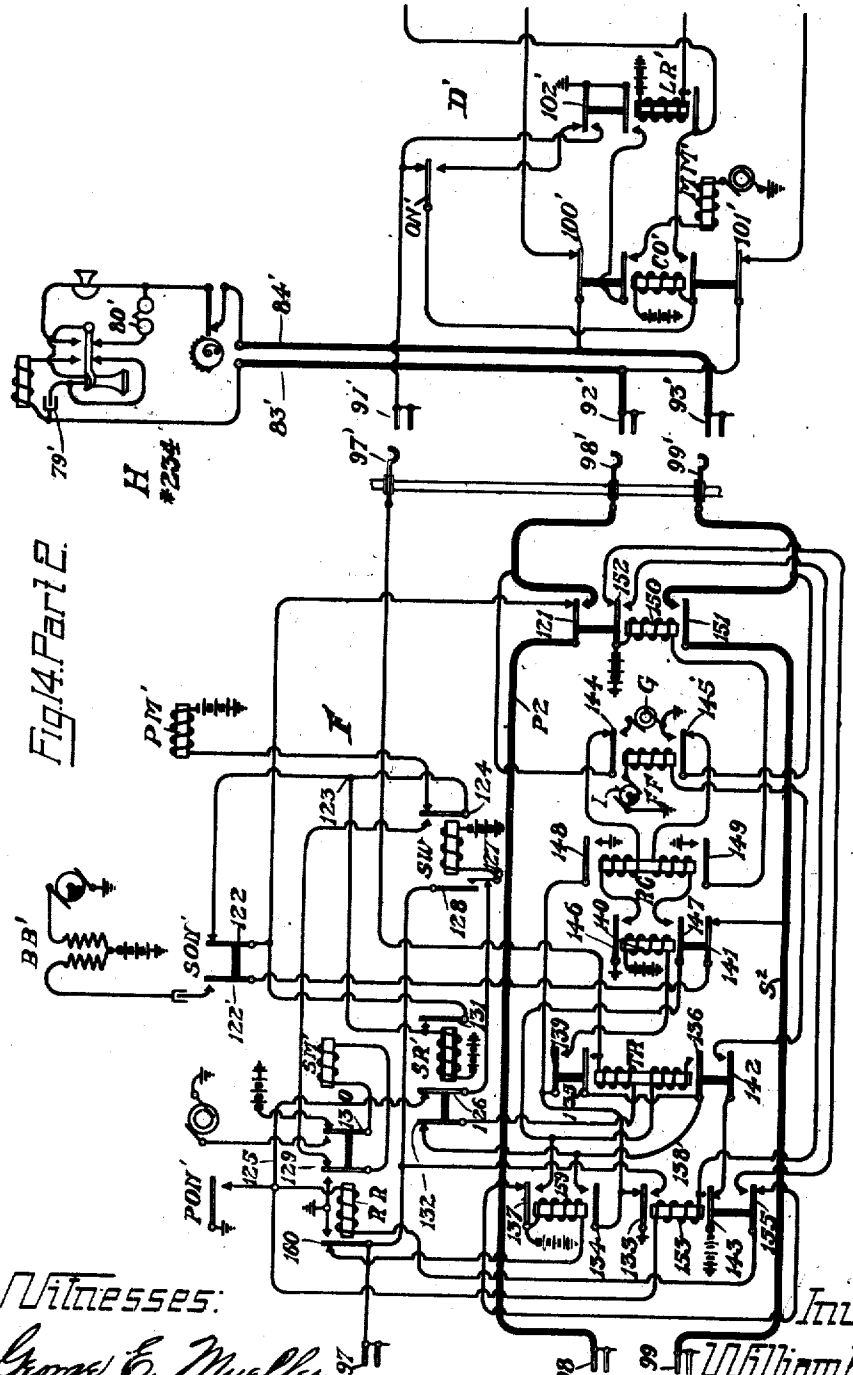


Fig. 4. Part 2.

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# UNITED STATES PATENT OFFICE.

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## AUTOMATIC TELEPHONE SYSTEM.

1,210,386. Specification of Letters Patent. Patented Dec. 26, 1916.

Application filed June 5, 1911, Serial No. 631,480. Renewed April 4, 1913. Serial No. 758,964.

*To all whom it may concern:*

Be it known that I, WILLIAM KAISLING, a citizen of the United States of America, residing in Chicago, county of Cook, State of Illinois, have invented certain new and useful Improvements in Automatic Telephone Systems, of which the following is a specification.

My invention relates to telephone systems and has to do more particularly with line switches such as are adaptable for use in connecting a calling line with an idle trunk circuit or first selector switch upon initiation of a call. In telephone systems wherein line switches are employed individual to the telephone lines, it will be readily seen that in exchanges of any size, the installation of these switches is quite an item, and therefore it is of great advantage to have such a switch which is of comparatively simple circuit arrangement, compact, and at the same time simple of construction and positive in operation.

In working out my invention an object was to provide a line switch which is of very compact arrangement and at the same time simple, and positive in operation.

There are many other features of my invention which will be more particularly pointed out in the accompanying specification and appended claims.

For a better understanding of my invention reference is to be had to the accompanying drawings in which like reference characters indicate like parts.

Figure 1 is a side elevation of the mechanical structure of the line switch of my invention. Fig. 2 is a left end view of the structure illustrated in Fig. 1. Fig. 3 is a right end view of Fig. 1. Fig. 4 is a bottom view of Fig. 1. Fig. 5 is a rear elevation of Fig. 1. Fig. 6 shows the main shaft with the ratchet wheel, spring barrel and a portion of the frame in section. Fig. 7 is a perspective view of the contacts normally engaged by the wipers. Fig. 8 is a section through the bank along the line 8—8 of Fig. 5. Fig. 9 is a perspective view of a portion of an insulating plate inserted between the bank contacts, showing the pressed out portions which come between the bank contacts so as to present an almost smooth surface for the wipers to run over. Fig. 10 is a perspective view of the motor magnet with the cooperating ratchet wheel and pawl for driving the wipers. Fig. 11 is a side view illustrating a portion of the motor magnet together with the armature and driving mechanism. Fig. 12 is a perspective view showing particularly the driving pawl in normal engagement with its back stop. Fig. 13 shows the driving pawl moved forward to the limit of its stroke and in engagement with the front stop. Fig. 14, comprising Parts 1 and 2, illustrates diagrammatically an automatic telephone system including the line switch of my invention. Fig. 15 is a diagrammatic illustration of the line switch showing the mechanical coöperation between the three magnets and the ratchet wheel and wipers.

Although my invention resides particularly in the line switch, I have shown it in connection with a complete automatic telephone system although it is to be understood that my invention is adaptable for other uses.

*Line switch construction.*—Referring now particularly to the structure illustrated in Figs. 1 to 13, the line switch there shown comprises two principal units. First a main supporting frame SF which is adapted to be secured to a bracket of some kind, preferably shown in the form of an angle iron AN as illustrated by dotted lines in Fig. 4, and the other unit comprises the mechanism mounting frame MF to which is secured the magnets and moving parts of the switch. The supporting frame SF carries the bank of contacts B and also a set of terminals T, said frame SF being adapted to be secured to the angle iron AN by means of a screw and nut arrangement 3 as shown. The frame MF is supported by the frame SF, frame MF being readily removable from SF by loosening the nuts N. Supported by frame MF is a hollow main shaft S carrying a set of wipers W which are adapted to be rotated by means of the ratchet and pawl arrangement shown in Fig. 10, the pawl being actuated by a motor magnet MM, the said magnet being secured to frame MF. A pair of coöperating pawls for the ratchet wheel are provided, the pawl 31 normally out of engagement being controlled by the line magnet LR while the pawl 32 normally in engagement with the ratchet is controlled by the magnet CO, both of the said magnets LR and CO being secured to the frame MF.

Having described in general the main

parts of the switch illustrated in Figs. 1 to 13 inclusive a detailed description thereof will now be given. The supporting frame SF comprises an angular bent plate 1 and a second plate 2, the said plates being securely fastened together by means of a pair of screws 3, the said screws passing through both of the plates 1 and 2 and having a nut threaded thereon as shown more clearly in Fig. 4. A bank of contacts B is securely fastened to the plate 2 by means of screws 4, the said bank comprising eleven sets of contacts, each set including three contacts 88, 89 and 90. These sets of contacts are clamped between the plate 2 and a clamping plate 5, the said contacts having strips of insulating material between them. The middle row of contacts 88 has a thin strip of oiled paper 6 on each side thereof and between this oiled strip of paper and the outer rows of contacts 89 and 90 is a strip of insulating material 7 having portions thereof pressed outward as shown in Fig. 9, these portions fitting in between the contacts, thereby providing a flat surface for the wipers to ride over. A set of terminals T are also rigidly secured to the plate 2, each one of said terminals comprising two similar parts 8 having their contacting ends flared outward as illustrated more clearly in Fig. 1. These terminals T are set into slots of an insulation block 9, and for clamping the said terminals therein, an insulating strip 10 and clamping plate 11 are provided, which are adapted to be clamped by means of the screws 12. A set of terminals 13 are provided for coöperation with the terminals 8, the terminals 13 being securely fastened to a plate 14 by means of slotted insulation blocks and clamps similar to those used for clamping the terminals 8. These terminals 13 it will be noted coöperate with terminals 8, whereby each of the terminals 13 is inserted between a pair of terminals 8 and form a connection. The wiring which is led into a line switch, is connected to the terminals 8, and wiring also extends from the terminals 13 to the various connectors or terminals of the parts carried on frame MF. It will thus be seen that if it is desired to make any adjustments or repairs on the movable parts of the switch, the frame MF may be removed and without disturbing any of the soldered connections, as all the incoming and outgoing wires to the parts carried by frame MF will be through these connector terminals 8—13.

For detachably securing frame MF to frame SF, a screw N′ is threaded into frame MF as shown by dotted lines in Fig. 4, a nut N being threaded onto the screw N′ and adapted to be moved into locking engagement with frame 1, a counterbored opening 1′ adapted to receive nut N being sunk into each ear of plate 1 as shown in the upper ear of Fig. 5. The screw N′ extends through a slot which is cut to the center of the counterbore 1′ so that when the nuts N are unscrewed clear of their respective counterbore 1′ in the plate 1, it will be seen that the frame MF may be moved out of supporting engagement with the frame SF. It will be seen that with this arrangement, that should any of the magnets or moving parts of a switch need adjustment or repair that frame MF may be very quickly removed and another one inserted in place thereof. A main shaft S is provided, being journaled at one end in the plate 14 and at an intermediate portion in a bearing 15. This shaft S is rotatable, but is secured against lateral motion by means of a wiper carrying hub 16 secured to one end thereof below the bearing 15 and a collar 17 adjustably secured to its other end, the said members 16 and 17 being so adjusted upon the shaft S that any lateral motion thereof is prevented, while it is free to be rotated. The hub 16 which is adjustably secured to shaft S, carries a set of wipers W insulatingly mounted thereon and being firmly clamped in position by a washer 16′ which is slipped over the outer end of hub 16 and staked thereon. The middle wiper 85 which coöperates with the bank contacts 88 is what is usually termed the test or private wiper, its contacting end being so formed that when stepped along the row of bank contacts it makes connection with one contact before breaking connection with the preceding one. The other wipers 86 and 87 known as the line wipers, since they are the wipers which are included in the talking circuit, have their contacting ends so formed that when moved over the bank contacts they break connection with one contact before making connection with the succeeding contact. A spring barrel 19 which is integral with the bearing 15 is securely fastened to frame MF by means of the nut 19′ threaded thereon, and clamping the said spring barrel 19 against frame MF. A restoring spring 20 is provided, having one end secured to the spring barrel 19 and its other end fastened to shaft S, the said spring being so coiled as to tend to hold the wipers against forward rotation. To hold the wipers in their normal position, a stop is provided preferably in the form of a block 21 which engages the ratchet wheel 18 as shown by the dotted lines in Figs. 10 and 11, this stop block 21 also serving to prevent forward rotation of the wipers beyond the last contact in the bank, the block 21 being so formed and positioned that its surface 21′ is engaged by the surface 18′ of ratchet wheel 18 when the wipers are rotated into engagement with the last contact in the bank. The said stop 21 is securely fastened and doweled to the frame MF.

The motor magnet MM which furnishes

the power for rotating the wiper shaft, comprises an electromagnet 22 and an extension pole piece 23 which is suitably fastened to the core of electromagnet 22, the forward end of pole piece and the core of electromagnet 22 being formed to register with armature 24. This armature 24, is formed in the shape of a U, being supported by shaft S and rotatable thereon. The connecting bar 24′ of armature 24 is rounded to conform to the rounded surfaces of pole piece 23 and core of magnet 22, and when magnet 22 is energized the armature is attracted and moves into the position indicated by the dotted lines in Fig. 11. An arm $24^2$ carried by armature 24, has pivoted thereto a driving pawl 25, the said pawl being pivoted upon a stud 26 which is driven and staked into the arm $24^2$. A spring 27 is coiled around shaft 26, one end passing through the small hole in arm $24^2$ below stud 26 and the other end of spring 27 acting upon pawl 25, tending to press the pawl inward toward the ratchet wheel 18. Front and back stops for the pawl 25 are provided in the form of a bifurcated block 28, of which the extension 28′ acts as a back stop, while extension $28^2$ acts as a forward or front stop for pawl 25, the said block 28 being fastened to frame MF by means of screws $28^3$. When the armature is in its normal position, pawl 25 is resting against the stop 28′ and is therefore held out of engagement with the teeth of ratchet wheel 18, but as soon as armature 24 is attracted and pawl 25 moves away from stop 28′, the spring 27 forces the tooth of pawl 25 downward into engagement with ratchet wheel 18 and the forward movement of pawl 25 is continued until its beveled surface 25′ engages the beveled surface of front stop $28^2$ as shown in Fig. 13, thereby preventing further forward movement of pawl 25. Due to the construction of these beveled surfaces, it will be seen that when the pawl 25 is advanced to the forward limit of its stroke, it is locked in engagement with a tooth of ratchet wheel 18, thereby preventing any over run of ratchet 18 and shaft S due to any momentum attained thereby and caused by the rapid forward stepping movement of the switch. It will be seen that without such a locking stop as provided by front stop $28^2$ that there would be a tendency of the shaft S and wipers to move more than a single step upon each operation of the magnet. Now upon deënergization of the magnet 22, its armature 24 is retracted by a spring 29 which is hooked over the annular recess in pin 26, the other end of said spring 29 being hooked over a projecting end of a clamping plate 30 as shown in Figs. 1 and 3. Upon retraction of armature 24 pawl 25 moves back toward its back stop 28′ and as the lower end of its surface $25^2$ engages the inner surface of stop 28′, and as the retraction of the armature continues, it will be seen that the toothed end of pawl 25 is lifted out of engagement with the ratchet wheel 18 until this surface $25^2$ is again engaging stop 28′ as shown in Fig. 12.

Two retaining or check pawls 31 and 32 are provided for coöperation with the ratchet wheel 18 each pawl 31 and 32 being staked to a sleeve which acts as a bearing for its pawl, a screw stud 33 extending through these sleeves and bolted to plate 1. These sleeves are loose upon the screw stud 33 so that the pawls are free to be rotated when acted upon by their respective electromagnet armatures. A pair of springs are coiled around the sleeves and acting upon their respective pawls, tending to move the tooth inward toward the ratchet wheel 18.

For controlling the pawl 31, a magnet LR is provided, this magnet serving as a line relay and also as a release relay in the operation of the switch. The said magnet comprises an electromagnet spool 34, its core having a copper sleeve thereon, thus causing a slow retraction of its armature after deenergization. The extension pole piece 35, is secured to the core of magnet 34, the said pole piece and magnet being supported by the frame MF by means of screws 36. An armature 37 is provided for magnet LR, the said armature having a transverse slot therein through which a pivot pin 38 extends, the said pin also passing through holes in the pole piece 35. The angular shaped piece 39 is secured to armature 37, firmly holding pin 38 clamped in the transverse slot of the armature as shown more clearly in Fig. 5, in which a portion of heel iron 35 is broken away. Three sets of contact springs are insulatingly mounted upon pole piece 35, the active contact spring of each set resting upon a rubber buffer supported by the horizontal extension of the piece 39, so that when armature 37 is attracted by the electromagnet 34, the contact springs mounted thereon will be operated. The downwardly extending portion 39′ of piece 39 as shown in Figs. 1 and 3, is in engagement with the pawl 31, and holds said pawl 31 normally out of engagement with the ratchet wheel 18. Upon attraction of armature 37 it will be seen that this extension 39′ moves inward, thereby allowing pawl 31 to be moved into engagement with a tooth of ratchet wheel 18, and upon deënergization of relay LR, the tension upon its armature 37 by its contact springs, retracts armature 37 and causes extension 39′ to again engage pawl 31, moving it out of engagement with ratchet wheel 18.

For controlling check pawl 32 an electromagnet CO is provided, this electromagnet acting as a combined cut-off relay and busy or trunk-selection-controlling relay when the switch is used as a line switch. The

electromagnet CO comprises the magnet spool 40, which is suitably secured to an extension pole piece 41, the said pole piece 41 being fastened to frame MF by means of screws $42^2$. Four sets of contact springs are insulatingly mounted upon pole piece 41, the active contact springs of these sets resting upon rubber buffers supported by the piece 42 which is clamped to armature 43 of magnet CO. The said armature 43 is pivotally supported by pole piece 41 similar to the supporting means of magnet LR. The piece 42 has an extending portion 42′ which coöperates with pawl 32 in such a manner that when armature 43 is attracted check pawl 32 is moved out of engagement with ratchet wheel 18, while upon deënergization of magnet CO armature 43 moves the extension 42′ outward allowing check pawl 32 to again be moved by its spring, into engagement with ratchet wheel 18. It will be seen that when the wipers have been moved off normal it is necessary in releasing the switch to have both of the pawls 31 and 32 out of engagement with ratchet wheel 18, this meaning that magnet CO must be energized and have its armature attracted while magnet LR must be deënergized with its armature retracted, thus holding both check pawls 31, 32 away from ratchet wheel 18 and allowing restoration of the wipers. A set of off normal springs ON are insulatingly mounted upon a forwardly extending ear 14′ of plate 14, the active or middle contact spring of the off normal set, normally resting upon a rubber buffer 45 which is secured or carried by an arm 44, said arm 44 being staked to the collar 17 which is adjustably secured to an end of shaft S. A separating stud 45′ rests upon a forwardly projecting ear $14^2$ of the plate 14 and supports two of the off normal springs. Upon the first step of the shaft off normal, the active contact spring of the off normal set ON moves out of engagement with its normal contact and into engagement with its alternate contact and upon restoration of the shaft the off normal springs are again restored by the action of the rubber buffer 45. A set of over run springs OR are insulatingly mounted on a forwardly projecting ear $14^3$ of the plate 14, while another forwardly extending ear $14^4$ carries an insulation separating stud, which supports over run contact springs OR. The active contact spring of the set OR is so adjusted, that it is moved into engagement with its alternate contact by reason of engagement with the rubber buffer 45 as the wipers are moved into engagement with the last contact in the bank, the said springs OR being restored to normal when the wipers are released for restoration. These over run contact springs OR, like the off normal contact springs ON are suitable for use in different ways well known in the art. The over-run springs OR are adapted for use in lighting an off-normal lamp or it is apparent, due to the fact that these springs operate after the wipers have passed beyond the last trunk contacts on the switch, that by changing the spring combination they may be used to connect the busy back BB and maintain line relay LR energized as is now done by means of the wipers. Of course, these uses are merely for illustration and these contacts OR are by no means limited to such uses as described.

For use with the selector and connector circuits of the system of Fig. 14 a switch such as is shown in my application for automatic switch for telephone systems, Serial No. 600,664, filed January 3, 1911, may be used.

The switch referred to in the previous paragraph in general comprises a bank of contacts made up of 100 sets of contacts with three contacts to each set, and divided into ten groups of ten contact sets each. A set of wipers are provided, to coöperate with the bank contacts, a primary magnet being adapted to primarily adjust the wipers to select a group of contacts, and a secondary magnet is provided to step the wipers in a secondary direction in a plane at right angles to the primary, to select a contact set of the selected group. The switch construction is such that the wipers are advanced against the tension of a pair of springs, one spring opposing each movement respectively. To release the wipers, that is to restore them to normal, the secondary magnet is again actuated to step the wipers beyond the last contact of the group whereby they are restored to normal by the springs referred to, but over a different path than that taken by the wipers in the advance movement of the switch in selecting a contact. Thus, in the operation of the switch the contacting ends of the wipers travel in a primary direction to select a group of contacts, then in a secondary direction to select a contact in the group, and in the release of the wipers this secondary direction is continued until the contacting ends have passed beyond the last contact in the group, followed by the automatic release of the wipers in which the contacting ends travel in a plane parallel to the primary movement but in an opposite direction until they reach a point directly above the starting point when they are moved through a plane parallel to the secondary but in a direction opposite to the secondary movement until they reach their normal starting point. It is to be understood that for a more complete understanding of this switch, reference is to be had to the above identified application.

*System of Fig. 14.*—The system illustrated in Fig. 14 which comprises Parts 1 and 2 may be readily followed out by placing Part

2 to the right of Part 1. The circuits illustrated are adapted for a thousand line exchange system of which there would be 1000 line switches D, 100 first selectors E and 100 connectors F. The line switches D are individual to each line and divided into groups of 100. For each group of 100 line switches D there are 10 first selectors E and 10 connectors F, they being divided into groups and the groups multiply connected in a well known manner. A calling substation A is shown connected to its line switch D and a called substation H is shown connected with its line switch D'. In the operation of the system the calling subscriber at A removes his receiver from its switchhook whereby the associated line switch D will automatically select an idle first selector E. The subscriber then operates his calling device to operate the first selector E to select an idle connector switch F in the hundreds group with which the called subscriber H is associated. The calling subscriber A then again actuates his calling device to operate the connector switch F to connect with the terminals of the called line H, and if this line is idle its substation call bell will be automatically rung, while if the called line H is busy a characteristic busy signal will be transmitted to the calling subscriber who may then replace his receiver upon its switchhook and release the switches which were operated in making the connection. Each substation comprises a well known form of telephone including a switchhook 75 held in engagement with its normal contacts, due to the receiver 76 being hung thereon, a transmitter 77, impedance coil 78, condenser 79 and call bell 80. The calling device which is shown diagrammatically includes a rotatable dial 81 and coöperating impulse springs 82. To operate impulse springs 82, dial 81 is advanced until the proper number of insulated projections thereon pass impulse springs 82, whereupon the dial being released by the operator, is returned to normal by the spring shown thereon, thereby interrupting the contact between impulse springs 82. It will be noted that when dial 81 is advanced the contact between springs 82 is not interrupted but on the return of dial 81 the contact of springs 82 is interrupted according to the number of projections which were moved beyond it. Substation A is connected to its line switch D at the exchange through the medium of line conductors 83, 84. Line switch D, which is the switch of Figs. 1 to 13, and previously described as to mechanical construction, comprises a set of wipers 85, 86 and 87 which are adapted to coöperate with bank contacts 88, 89 and 90 respectively. The motor magnet MM is provided for advancing wipers 85, 86 and 87 step by step along the bank of contacts including contacts 88, 89 and 90. The combined line and release relay LR is adapted to be energized upon initiation of a call and to remain energized until the receiver of the calling subscriber is again replaced upon its switchhook, whereby it controls the release of the wipers of line switch D. The combined cut off and busy relay CO is adapted upon initiation of a call to disconnect the line conductors 83 and 84 from the wipers 86, 87, while the switch D is operating to select an idle first selector switch E, the said relay CO also serving to control the selection of such an idle switch E.

On a basis of ten per cent. trunking as previously referred to, each group of 100 line switches D would have their bank contacts multiply connected, there being of course ten such sets of multiply connected bank contacts in each group of one hundred line switches, these ten sets being connected to ten first selectors E. Should the ten selectors E of any group be busy at one time, and a line switch D of such a group be started, its wipers would pass over all of the bank contacts until they connected with the bank contacts 88', 89' and 90', the wipers remaining in connection with these contacts and a busy signal is transmitted to the calling subscriber at A from busy back BB, who by replacing his receiver upon the switchhook will release his line switch D. Each line switch D is also provided with off normal switch contacts ON which are adapted to move to an alternate position and remain so until the wipers of the switch are again restored to normal as previously stated. Access to the line of substation A is provided by means of the multiply connected contacts 91, 92 and 93, the said contacts being the bank contacts of the connector switches such as F, which have access to the line of substation A.

Fig. 15 illustrates diagrammatically the construction of the switch shown in Figs. 1 to 13. It will be noted that the retaining pawl controlled by relay CO is normally engaging the ratchet wheel while the retaining pawl controlled by relay LR is normally out of engagement with the ratchet wheel. In the operation of the switch relay LR is first energized thereby moving its pawl into engagement with the ratchet wheel and thereafter relay CO is energized moving its pawl away from the ratchet wheel. Motor magnet MM is then operated to advance the wipers, the pawl of relay LR now acting as a retaining pawl. After the selection of an idle set of contacts by the wipers, relay CO is deënergized while relay LR remains energized, thus maintaining both of the pawls in engagement with the ratchet wheel during conversation. When the switch is released relay CO is energized and relay LR is deënergized thus holding both of the

pawls out of engagement with the ratchet wheel thereby allowing the wipers to restore. Each first selector E includes a set of wipers 94, 95 and 96 and a bank including 100 sets of contacts 97, 98 and 99, the said bank contacts being divided into ten groups of ten sets each, and each set of course having three contacts 97, 98, 99. Switch E is adapted to first adjust wipers 94, 95 and 96 in a primary direction to select a group of contacts 97, 98 and 99 and thereafter the said wipers are given a secondary adjustment to select a set of contacts 97, 98 and 99 in the selected group. To operate these wipers a primary magnet PM is provided which is directively controlled by the subscriber to primarily adjust the wipers, and for giving the wipers a secondary adjustment a secondary magnet SM is provided. Each switch E also includes a primary relay PR which is connected in bridge of the talking strands and operated responsive to interruptions of the metallic line circuit. Relay PR is adapted for transmitting the so-called primary impulses while a secondary relay SR which is a sluggish or slow releasing relay is provided for transmitting a secondary impulse for controlling the starting of the secondary adjustment of the wipers. A main release relay MRR is also included in each switch E, said relay also being of sluggish or slow releasing construction. Relay MRR is energized upon selection of switch E and remains energized until the calling subscriber restores his receiver whereupon this relay MRR deenergizes and controls restoration of certain of the switches depending upon the stage of the call. The busy relay BR is adapted to be energized by the secondary impulse and controls the selection of an idle set of contacts 97, 98 and 99. Primary off normal springs PON are adapted to be moved to an alternate position upon the first primary step of the switch, while secondary off normal springs SON are adapted to be moved to an alternate position upon the first secondary step of the switch. To restore the wipers 94, 95 and 96 secondary magnet SM is again actuated, thereby advancing wipers 94, 95 and 96, this advance continuing until the said wipers have moved beyond the last contact in the group whereby they are restored to normal by spring tension as previously stated.

Connector switch F includes a set of wipers 97′, 98′, and 99′ and a bank of one hundred contact sets 91′, 92′ and 93′, the said contacts being divided into groups similar to the contacts of the first selector switches E and the wipers 97′, 98′ and 99′ are actuated in a corresponding manner by their primary magnet PM′ and secondary magnet SM′. Each connector switch F is also provided with a secondary relay SR′ which is also of slow releasing construction. A release relay RR is also provided as is also a switching relay SW which is adapted to cut off the primary magnet PM′ from connection with the upper heavily marked conductor and connect therewith a secondary magnet SM′. A test relay TR is also included with each connector switch F, being adapted to test the terminals of a called line and if idle a so-called flip-flop or interrupter relay FF is operated to connect ringing current to the terminals of the called line and a ringing control relay RC is thereby intermittently connected through the contacts of relay FF with the terminals of the called line for controlling the cutting off of the ringing current upon response of the called subscriber. If the line of the called substation H is busy, a busy signal is transmitted to the calling subscriber by means of busy back apparatus BB′. Primary off normal springs PON′ and secondary off normal springs SON′ are adapted to operate upon the first primary and secondary step respectively. Line switch D′ is connected to the called substation H by means of line conductors 83′, 84′, the said line switch D′ being similar to line switch D, the corresponding parts having corresponding reference characters, but with the suffix prime. The called station H is equipped similar to that of calling substation A.

*Operation of system of Fig. 14.*—Having described in general the system of Fig. 14, the operation thereof in completing a connection from a calling to a called subscriber will now be given. Assuming a subscriber at substation A desires to connect with substation H whose number we will assume is 234, the subscriber at A removes his receiver 76 from its switchhook 75, thereby closing circuit through the upper contacts and establishing a circuit for line relay LR traced from ground at contact $89^2$, wiper 86, normal contact 100, conductor 84, the upper contacts of switchhook 75, impedance coil 78, returning over conductor 83, normal contact 101, wiper 87, normal contact $90^2$, the winding of relay LR to battery. Relay LR is thereupon energized closing a circuit for relay CO from ground through alternate contact 102, normal contact ON and the winding of relay CO to battery, energizing the said relay CO. The closing of alternate contact 102 also places a ground upon multiple contacts 91, preventing any connector F from connecting to line A, this contact 102 remaining closed until disconnection. Upon energization of relay CO a circuit for motor magnet MM is established, traced from ground through alternate contact 103, alternate contact 104, the winding of magnet MM to alternating current generator. Magnet MM is thereby alternately energized and deënergized and

steps wipers 85, 86 and 87 into engagement with the first set of multiple contacts 88, 89, 90, and assuming these contacts lead to a busy first selector E the test contact 88 is connected to ground, from a switch E as will be more fully explained, and a locking circuit for relays CO and LR is thus established from the grounded contact 88, wiper 85, alternate contact 105 and the winding of relay LR to battery, the said grounded circuit dividing at armature 105 and also extending through alternate contact 106 and the winding of relay CO to battery.

Upon reference to the line switch drawings or to Fig. 15 it will be noted that normally the check pawl of magnet CO is engaging the ratchet wheel 18 while the check pawl of magnet LR is disengaged from ratchet 18 and it will be remembered that upon initiation of the call from substation A both of the magnets LR and CO were energized, thus disengaging the check pawl of magnet CO from ratchet wheel 18 while the check pawl of magnet LR is moved into engagement with ratchet wheel 18, this last condition of the check pawls being maintained while the wipers 85, 86 and 87 are passing over busy contacts 88, 89 and 90 respectively, the check pawl of magnet LR thus preventing back rotation of the wipers while the magnet MM is operating. At the first step of the wipers 85, 86, 87 off of normal, contact ON assumes its alternate position, thus interrupting the initial energizing circuit for relay CO. The said relays CO, LR, remaining energized due to the maintaining circuit from busy test contact 88, magnet MM advances the wipers another step into engagement with the next set of contacts and if these are busy this advance continues until a set of idle contacts are reached of which the test contact 88 is ungrounded. The maintaining circuit for relays CO and LR being interrupted, relay CO which is a quick acting relay, immediately deënergizes interrupting the circuit through magnet MM at contact 104, thereby preventing any further advance of the wipers. It will be remembered that relay LR is a sluggish relay and therefore does not release its armature, but maintains it in an attracted position until another locking circuit therefor is supplied from the first selector E as will now be described.

Upon deënergization of relay CO, a circuit for primary relay PR of first selector E is established over the line conductors of the calling line being traced from ground through the left hand winding of said relay PR, conductor P, contact 89, wiper 86, normal contact 100, conductor 84, substation A, returning over conductor 83, normal contact 101, wiper 87, contact 90, conductor S and the right hand winding of relay PR to battery. Relay PR is thereupon energized closing a locking circuit for relay LR from ground through alternate contact 107, contact 88, wiper 85, alternate contact 105 and the winding of relay LR to battery. This ground connection from alternate contact 107 to contact 89 and its multiples also make switch E busy against selection by any other calling line. An energizing circuit for relay MRR is also established upon energization of relay PR, being traced from normal contact 108 of off normal switch PON, alternate contact 109 and the winding of relay MRR to battery, the said relay thereupon energizing and establishing a locking circuit for itself from ground at alternate contact 110 and through alternate contact 109. The line of substation A it will be noted, has now been extended through to a first selector E, the talking conductors being traced over the heavily marked conductors P and S, having in bridge thereof the primary relay PR, which is controlled at substation A. The number of the called substation being 234, the subscriber at A first operates his dial 81 to cause two interruptions of contact springs 82, thereby interrupting the circuit through primary relay PR two times which in response to these two interruptions of its circuit retracts its armature twice and transmits two primary impulses through the primary magnet PM. Although the relay MRR has its circuit interrupted at contact 109 upon each deënergization of relay PR, said relay MRR being a sluggish relay does not allow its armature to retract, as these interruptions are only of short duration.

Returning now to the first two primary impulses, these are traced from ground through normal contact 107, of relay PR, alternate contact 111, conductor P', normal contact 112 and the winding of magnet PM to battery, these two impulses causing magnet PM to step wipers 94, 95 and 96 two steps in a primary direction to select the second group of bank contacts, which lead to connector switches F associated with the hundred group which includes the line of substation H. These primary impulses which operate magnet PM divide at the terminal of contact 112, part of the current of these impulses passing through the winding of secondary relay SR energizing the said relay which being a sluggish relay maintains its armature attracted during the sending of these primary impulses. Upon cessation of these primary impulses secondary relay SR restores its armature, and primary off normal switch PON having moved to its alternate position upon the first primary step of the wipers, a circuit for busy relay BR is established from ground

through normal contact 113 of relay SR, alternate contact 114, normal contact 115 and the winding of relay BR to battery. Relay BR is thereupon energized closing a circuit through secondary magnet SM, from ground at alternate contact 116, said magnet SM to alternating current generator, whereby said magnet SM advances wipers 94, 95, 96 into engagement with the first set of contacts 97, 98 and 99. Upon the first secondary step of the wiper, switch SON moves to its alternate position, thereby interrupting the initial energizing circuit for relay BR at contact 115 and assuming that the first set of bank contacts 97, 98 and 99 lead to a busy connector switch, there will be a ground upon test contact 97, as will be pointed out, and a locking circuit for relay BR will be established from said ground through wiper 94, alternate contact 117, alternate contact 118, winding of relay BR to battery. The relay BR thus being maintained energized, magnet SM steps the wipers into engagement with the next set of contacts and if these are busy this advance of the wipers is continued until an idle set of contacts is reached whereby the locking circuit for relay BR is interrupted, as the test contact 97 is not grounded, allowing the said relay to deënergize, interrupting the circuit through secondary magnet SM and preventing any further advance of the wipers. It will be noted that while the wipers are moving over the busy bank contacts relay BR is energized and the line wipers 95 and 96 are disconnected from the talking conductors by reason of contacts 119, 120 being open. Upon deënergization of relay BR, ground is connected to test contacts 97 and its multiples, traced from normal contact 117 of relay BR, thus making connector F busy against selection by any other first selector. This ground connection it will be noted extends through relay 159 of switch F, to battery energizing said relay 159, but at this time nothing else occurs.

The line of substation A has now been extended to a connector switch F which is associated with the two-hundred group of lines which includes the terminals of line 234 and which is the line of called substation H. The next move of the subscriber is to cause the actuation of connector switch F to connect its wipers with the terminals of the line of the called subscriber. The subscriber at A therefore actuates calling device 81 to cause three interruptions of the line circuit, thus interrupting the circuit of primary relay PR which transmits three impulses of current through the primary magnet PM′ of connector switch F and its multiply connected secondary relay SR′, these impulses being traced from ground through normal contact 107, of relay PR, alternate contact 111, conductor P′, wiper 95, contact 98, normal contact 121, normal contact 122 to tie 123 dividing at this point, part of the current passing through and energizing secondary relay SR′ and part of the current passing through normal contact 124 and magnet PM′ to battery. Relay SR′ being a sluggish relay as previously stated, maintains its armature in an attracted position during the sending of these impulses, while magnet PM′ responsive to these three impulses advances wipers 97′, 98′ and 99′ to select the third group of bank contacts in which are located the bank contacts 91′, 92′ and 93′, the terminals of the called line. Upon cessation of the primary impulses secondary relay SR′ releases its armature, thereby closing a circuit through switching relay SW, traced from ground through contact PON′, which has now moved to its alternate position, conductor 125, normal contact 126, normal contact 127 and the winding of relay SW to battery, energizing the said relay, closing alternate contact 128 and establishing a locking circuit for itself from the grounded test terminal 97. It will be noted that upon energization of switching relay SW contact 124 moves to its alternate position, thereby disconnecting primary magnet PM′ and connecting secondary magnet SM′ to the primary conductor P′. The subscriber now operates dial 81 to cause four interruptions of the primary relay PR, thereby transmitting four primary impulses from ground through normal contact 107 over the previously described path to normal contact 121, normal contact 122 to tie 123, the first one of said impulses dividing at this point, part of the current passing through secondary relay SR′, energizing the said relay as before and part of the current passing through alternate contact 124, normal contact 129, winding of secondary magnet SM′, normal contact 130 to battery. Responsive to the first said impulse through magnet SM′, wipers 97′, 98′ and 99′ are advanced one step while the secondary off normal switch SON′ is moved to its alternate position, thus interrupting at contact 122 the initial path for the impulses, but secondary relay SR′ having energized responsive to the first impulse as stated, the impulses following the first impulse, in this instance three, follow the path of the conductor leading from normal contact 121 to alternate contact 131, dividing at this point, part of the current of these last three impulses passing through relay SR′ maintaining it energized and part of the current passing along the conductor leading up from alternate contact 131 to tie 123, then through alternate contact 124 and over the previously described path through secondary magnet SM′. Thus it will be seen that although switch SON′ moves to its alternate position upon the first step of the switch wipers, a

substitute path for any impulses following the first one is provided by the closing of alternate contact 131 of relay SR'. These last three impulses are of course effective to cause magnet SM' to advance wipers 97', 98' and 99' into engagement with the fourth set of contacts of the selected group, which are the terminals of the line of the called substation H. Upon cessation of the impulses relay SR' deënergizes and a circuit for test relay TR is now established for the purpose of testing the terminals of the called line to determine its idle or busy condition. Assuming that the called line is idle, there will be no ground upon its test contact 91'. Returning now to the test circuit which is established upon deënergization of relay SR', this circuit is closed by normal contact 132 of relay SR', being traced from the ground at normal contact 133, of relay 153, alternate contact 134, normal contact 132, the upper winding of relay TR to test wiper 97'. As stated, the line of substation H being idle it will be in the condition as illustrated at D', its test contact 91' being connected to cut off relay CO' and without any direct ground connection to this terminal 91'. Therefore upon the closing of this test circuit just described, a series circuit for the upper winding of relay TR and relay CO' is established, the said relays thereupon energizing, relay CO' opening its contacts 100', 101' and removing the substation control of line switch D'.

Upon energization of relay TR, the closing of alternate contact 135 shunts the upper winding of relay TR but a locking circuit for TR is established through its lower winding upon the closing of contact 136, this locking circuit being traced from battery through alternate contact 137, of relay 159, the lower winding of relay TR, alternate contact 136, conductor 138, alternate contact 134, normal contact 133 to ground. The closing of contact 139 of relay TR establishes a circuit for relay 140, traced from ground at normal contact 133, alternate contact 139 and the winding of relay 140 to battery, energizing relay 140 and by means of its contact 141 interrupting the connection from the busy back BB' to the secondary conductor $S^2$. The closing of alternate contact 142 of relay TR establishes a circuit for relay FF, traced from battery at normal contact 143, of relay 153, alternate contact 142, the winding of relay FF and interrupter I to ground. Due to the interrupter I being included in this circuit, relay FF periodically energizes and deenergizes and upon its first energization alternate contacts 144, 145 are closed, thereby connecting the ringing generator G to the terminals of the called line to ring the bell of the called substation H, this circuit being traced from the grounded pole of generator G, alternate contact 145, wiper 99', contact 93', conductor 84', call bell 80', normal switchhook contacts and condenser 79' returning over conductor 83', contact 92', wiper 98', alternate contact 144 to the ungrounded pole of generator G. The closing of this circuit of course operates the call bell of the substation H, and relay FF deenergizing, due to the interruption of its circuit by interrupter I, the ringing control relay RC is bridged across the terminals of the called line through normal contacts 144, 145 of relay FF. This relay RC is adapted upon response of the called subscriber, to be energized by current flowing over the called line when the receiver is removed from its switchhook, but due to condenser 79' being connected in circuit while the receiver is on, no path for direct current exists.

Upon hearing the call bell 80', the subscriber at substation H removes his receiver from its switchhook thereby establishing a circuit for relay RC, traced from ground through alternate contact 146, the upper winding of relay RC, normal contact 144, wiper 98', contact 92', conductor 83', substation H, returning over conductor 84', contact 93', wiper 99', normal contact 145, the lower winding of relay RC, alternate contact 147 to battery at alternate contact 137. The closing of this circuit causes the energization of relay RC which closing its contact 148 establishes a locking circuit for relay 140 and test relay TR thus placing these relays under the control of the called subscriber as relay 153 is now energized interrupting normal contact 133, as will now be described. The closing of contact 149 establishes a circuit for relay 150 which is now energized, closing alternate contacts 121, 151, thereby establishing a continuous talking connection between the calling and called substations. The closing of alternate contact 152 of relay 150, establishes a circuit for relay 153 traced from battery through said alternate contact 152, the winding of relay 153 to ground at contact PON', energizing relay 153, which establishes a locking circuit for itself through alternate contact 143 to battery. The opening of normal contact 143 of relay 153 interrupts the circuit for relay FF, thus preventing any further operation thereof. Although normal contact 133 is opened upon energization of relay 153, it will be remembered that a substitute circuit was established from ground through alternate contact 148 so that the opening of this normal contact 133 has no effect upon relays TR and 140. The two substations A and H are now connected for conversation, the circuit being traced over the heavily marked conductors, battery for the called substation A being supplied through the windings of relay PR and battery for the called substation H being sup-

plied through the windings of relay RC, the said substations being inductively united through the condensers 165, 166, which are interposed in the talking conductors at first selector E.

*Release of switches.*—The release of the switches after the subscribers have finished their conversation is effected by the restoration of the receivers upon their respective switchhooks. The subscriber at A replacing his receiver upon its switchhook interrupts the circuit of relay PR at the switchhook contacts allowing the relay PR to deënergize and interrupt the circuit of main release relay MRR, due to the opening of alternate contact 109. Relay MRR therefore deënergizes and closes a circuit for relay BR, the said circuit being traced from ground at normal contact 113, alternate contact 156, normal contact 118 and the winding of relay BR to battery, energizing the relay BR and establishing a circuit for secondary magnet SM from ground through alternate contact 116. Magnet SM thereupon advances wipers 94, 95 and 96 until they have stepped beyond the last contact of the group, whereupon the retaining ratchets are automatically released to allow the restoration of the wipers to normal. Upon restoration of the primary off normal switch PON, alternate contact 108 is opened, thereby interrupting the locking circuit for relay LR of line switch D allowing said relay LR to deënergize, thereby closing a circuit for relay CO traced from ground at normal contact 102, alternate contact ON and the winding of relay CO to battery, energizing said relay CO. Although upon deënergization of relay LR it withdraws its retaining pawl from engagement with the ratchet wheel 18, relay CO also being deënergized its retaining pawl is also in engagement with the ratchet wheel, but upon energization of relay CO its retaining pawl is withdrawn from engagement with the ratchet wheel allowing the wipers to be restored by the spring tension. Upon restoration of the wipers to normal switch ON is restored thereby interrupting the circuit for relay CO which deënergizes. During restoration of the wipers 85, 86 and 87, relay CO is energized as stated, thus maintaining the line wipers 86, 87 disconnected and preventing any interference with existing connections, due to the passing of wipers 86, 87 over busy contacts 89, 90. The line switch D and first selector E having been restored to normal, the line of substation A is now available for use in establishing other connections. The called subscriber at substation H, by replacing his receiver upon its switchhook, interrupts the circuit of relay RC, which it will be remembered was energized by current over the called line, allowing the said relay to deënergize, its contact 149 restoring and interrupting the circuit for relay 150 which also deënergizes restoring its contacts. The opening of contact 148 of relay RC interrupts the locking circuit for relays 140 TR and CO′, allowing the said relays to deënergize and restore their contacts. Relays SW, 153 and 159 it will be remembered are all energized, relays 159 and SW being held energized by ground from alternate contact 133, so that upon deënergization of relay 150 a circuit for release relay RR is established from battery at normal contact 152, of relay 150, alternate contact 155, the winding of relay RR to ground at alternate contact PON′. Relay RR is thereupon energized interrupting the circuit for relay 159, due to the opening of normal contact 160, allowing said relay 159 to deënergize and restore its contacts. Upon energization of relay RR alternate contacts 129 and 130 are closed, thereby establishing a circuit for secondary magnet SM′ traced from ground through alternate contact 129, the winding of magnet SM′ to alternating current generator at alternate contact 130. This last traced circuit energizes and deënergizes magnet SM′ to step wipers 97′, 98′ and 99′ beyond the last contact in the bank, whereupon the release pawls are automatically operated to allow the restoration of the wipers by spring tension. Upon restoration of the primary off normal contact PON′ the circuit for relays RR and 153 is interrupted, allowing the said relays to restore to normal, and upon restoration of contacts 160 and 133 of said relays RR, 153, the circuit for relay SW is interrupted allowing it to restore. During the advance or restoring movement of wipers 97′, 98′ and 99′ they are free to wipe over the bank contacts 91′, 92′, 93′ without interfering with any existing connections, wipers 98′ and 99′ being disconnected due to the deënergization of relays 150 and 140 while the circuit of wiper 97′ is interrupted, due to the restoration of relays TR and 159, and energization of relay 153, during the restoring movement of the switch. The connector switch F having been restored to normal is now available for further use and the relay CO′ having been restored as previously described the line of substation H is available for further use in establishing other connections.

In the restoration of the connection as just described, it was assumed that the calling subscriber first replaced his receiver upon its switchhook and thereafter the called subscriber replaced his receiver upon its switchhook. Should the called subscriber at substation H replace his receiver upon its switchhook, before the calling subscriber, the connector switch F will be restored first and upon the calling subscriber replacing

his receiver upon its switchhook the line switch D and first selector E will be restored as previously described.

*Connection with busy called line.*—In the connection just described it was assumed that the called line was idle. Therefore a connection to a busy called line will now be described. In connecting to a busy line the operation of the system is the same as previously described up to the point of the deënergization of secondary relay SR′ after the final set of primary impulses are transmitted. It will be remembered that after the last set of impulses were transmitted secondary relay SR′ deënergized, and at this time relays SW and 159 of connector F are in an energized condition. Assuming that the line of substation H is busy there will be a ground upon its test contact 91′ either from an alternate contact 102′ of line switch D′ if the line be calling or from a connector switch F if the line be a called line, so that when secondary relay SR′ deënergizes after the last primary impulse, an energizing circuit for test relay TR will not be established as there will be a ground potential upon both terminals of the upper winding of relay TR, the one ground potential being traced from wiper 97′ to the upper winding of relay TR, the other ground connection being traced from the normal contact 133, alternate contact 134, normal contact 132 to the lower terminal of the upper winding of relay TR. Relay TR therefore fails to energize and therefore no circuit is established for relays FF or 140, and relay 140 failing to attract its armature a characteristic busy signal is transmitted from busy back BB′ through alternate contact 122′, normal contact 141 toward the left over conductor $S^2$, contact 99, wiper 96, back over the lower heavily marked conductor and line conductor 83, the condenser and receiver of the calling substation A, returning over line conductor 84 and the upper heavily marked conductor to the first selector E, then over the left hand winding of relay PR to ground. The calling subscriber at A receiving this signal, is aware that the called line is busy and therefore will replace his receiver upon its switchhook interrupting the circuit for relay PR as previously stated. Relay PR therefore deënergizes, interrupting the circuit for relay MRR which in turn causes the energization of relay BR, due to the closing of normal contact 118 as before and upon energization of relay BR the magnet SM steps wipers 94, 95, 96 forward all as previously described, thereby causing the restoration of first selector E, followed by the restoration of line switch E, as previously described. In this instance the restoration of connector switch F is also controlled by the calling subscriber at A, its restoration being effected as follows: Upon energization of relay BR of first selector E at the time of release, normal contact 117 is opened, thereby interrupting the circuit for relay 159 of connector switch F. It will be remembered that relay 153 of F, was not energized upon connecting with a busy line and therefore its alternate contact 133 was not closed, so that upon interruption of normal contact 117 of relay BR at first selector E, the relay 159 of connector switch F restores. Upon said restoration of relay 159 a circuit for release relay RR is established from ground at contact PON′, winding of relay RR, normal contact 155, normal contact 137 to battery, energizing relay RR and establishing a circuit for secondary magnet SM′ through alternate contacts 129 and 130 as previously described, thereby causing magnet SM′ to step wipers 97′, 98′ and 99′ ahead until they have passed beyond the last contact set in the bank, whereby they are automatically restored as previously described. Upon restoration of contact PON′ the circuit for relay RR is interrupted, causing the restoration of said relay, followed by the restoration of relay SW, all as previously described. Connector switch F having been restored to normal, is available for further use in establishing other connections.

Returning now to the line switch D, this switch and circuits are so arranged that should all of the trunks leading therefrom to first selectors E be busy, the wipers will be stepped to the eleventh set of contacts which are the contacts 88′, 89′ and 90′. It will be remembered that both of the relays LR and CO are maintained energized from the grounded or busy test contacts 88, so that when the wipers 85, 86 and 87 are stepped into engagement with the last set of contacts 88′, 89′ and 90′ there being no maintaining circuit for relays CO and LR from contact 88′, relay CO being a quick acting relay immediately drops back, closing the normal contacts 100, 101, while relay LR being a sluggish relay maintains its armature attracted until an energizing circuit is again supplied as will now be described. Upon the closing of the contacts 100 and 101, an energizing circuit for relay LR is again established, traced from ground through the right hand winding of busy-back BB to contact 89′, wiper 86, normal contact 100 over the line conductor 84 and through the calling substation A, returning over conductor 83, normal contact 101, wiper 87, contact 90′, contact 88′, wiper 85, alternate contact 105 and the winding of relay LR to battery. It will be seen from this that relay LR is now maintained energized by current flowing over the line and through the calling substation, thus placing relay LR

under the control of the calling subscriber. A characteristic busy signal is transmitted from busy back BB to the calling substation A, being traced over the path just described, which is the path of the maintaining current for relay LR. The subscriber at A will probably hear t is signal immediately and would therefore replace his receiver upon its switchhook, although should the subscriber fail to immediately receive this signal he might proceed to operate his calling device 81 to attempt to connect to the line of a called substation. This operation of calling device 81 although interrupting the circuit for relay LR has no effect thereon, as the impulses or interruptions are of too short duration to allow relay LR to retract its armature, and therefore after the subscriber at substation A has finished with the operation of his calling device, he would receive this characteristic busy signal just referred to as soon as he placed his receiver to his ear. By then replacing his receiver upon its switchhook the circuit for relay LR is interrupted allowing the relay to deënergize and retract its armature, thus closing a circuit for relay CO from ground at normal contact 102 through alternate contact ON and the winding of relay CO to battery. Relay CO would therefore energize withdrawing check pawl 32 out of engagement with ratchet wheel 18, and as relay LR is already deënergized and its check pawl 31 is out of engagement with ratchet wheel 18, the wipers are restored to normal by spring tension.

It will be noted that when line switch D is operated, and the wipers 85, 86, 87 are advanced into engagement with an idle set of contacts 88, 89, 90, or to the last or busy transmitting set of contacts 88′, 89′ and 90′, that relay LR is maintained energized while relay CO retracts its armature. With the said relays in such condition the check pawls 31 and 32 are both engaging ratchet wheel 18 and are maintained so until the subscriber replaces his receiver, whereby relay LR deënergizes, withdrawing check pawl 31. It will be seen from this, that relay LR maintains its check pawl 31 in engagement with ratchet wheel 18 until the time of release, and if some other holding means, such as check pawl 32, were not provided, upon deënergization of relay LR the wipers would immediately restore and wipe over the contacts of any busy existing connection, but by providing the additional holding means for the wipers, preferably in the form of the additional check pawl 32, it will be seen that cut-off relay CO must again be energized before the wipers restore, thus disconnecting the line conductors from wipers 86, 87 before the restoring movement.

While I have described and illustrated my invention in connection with an automatic telephone system, I do not desire to be limited to such use, as my invention is adapted for use in connection with semi-automatic telephone systems, or other telephone systems in which a line switch may be used for automatically selecting an idle trunk circuit.

Many changes and modifications of the line switch of my invention may occur to those familiar with the art, and I do not desire to be limited to my invention as shown and described, but aim to cover all such changes and modifications as come within the scope and spirit 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 line switch, a substation telephone line connected thereto, a pair of relays energized responsive to removal of the receiver upon initiation of a call over said line for controlling the selecting movement of said switch, said relays being mechanically associated with said switch whereby said switch is restored when the receiver of the calling substation is again replaced upon its switchhook.

2. A telephone system including a substation telephone line, a line switch for said line comprising multiply connected contacts, wipers for said switch connected with said line, a pair of electromagnets energized upon initiation of a call over said line, means for advancing said wipers into successive engagement with said contacts, responsive to said electromagnets, and release mechanism for said wipers jointly controlled by said electromagnets.

3. A telephone system including a substation telephone line, a line switch for said line comprising multiply connected contacts, wipers for said switch connected with said line, a pair of electromagnets energized upon initiation of a call over said line, means for advancing said wipers into successive engagement with said contacts, said means being jointly controlled by said electromagnets upon their said energization, and release mechanism for said wipers mechanically associated with said electromagnets and jointly controlled thereby.

4. A telephone system including a substation telephone line, a line switch for said line comprising multiply connected contacts, wipers for said switch connected with said line, a pair of relays energized upon initiation of a call over said line, an electromagnet and associated mechanism for advancing said wipers into successive engagement with said contacts, said electromagnet having its circuit jointly controlled through contacts of the relays upon their said energization, resilient means for restoring said wipers, and mechanism controlling said re-

silient means, mechanically associated with said means and relays and jointly controlled by said relays.

5. A telephone system comprising individual line switches, sets of multiply connected bank terminals therefor, wiper sets for each of said switches, a motor magnet for each of said switches adapted for advancing their wipers to connect with the associated contact sets successively, a pair of relays for each switch energized upon initiation of a call over the associated line, for controlling the selection of an idle one of said contact sets, and resilient release means for each wiper set jointly controlled by the associated pair of relays.

6. A telephone system including a substation telephone line, a line relay and cut off relay for said line energized upon initiation of a call over said line, a line switch for said line comprising bank contacts and associated wipers, means for advancing said wipers into successive engagement with said contacts responsive to said energization of said relays, means controlled by one of said relays for stopping said wiper in engagement with an idle set of said contacts, release means mechanically associated with said relays, and means controlled at the calling substation to operate said relays whereby said release means are effective to restore said switch.

7. A telephone system comprising a telephone line, a pair of relays energized by current over said line when calling, an automatic switch, means controlled through normally open contacts of said relays when energized for operating said switch, and mechanical means for releasing said switch, directly controlled by said relays.

8. A line switch comprising passive contacts and an associated wiper, a motor magnet for advancing said wiper over said contacts, and a pair of electromagnets mechanically associated with said wipers and jointly controlling the release thereof.

9. A line switch comprising passive contacts, a wiper, means for advancing said wiper to successively engage said contacts, resilient means adapted for restoring said wiper, and a pair of holding members and respectively associated electromagnets for controlling restoration of said wipers, one of said elements being normally in holding engagement and the other of said elements being normally out of holding engagement.

10. A line switch comprising sets of passive contacts, each set including line and test contacts, wipers for coöperation with each contact of said sets respectively, means for advancing said wipers to successively engage said sets of contacts, resilient means adapted for restoring said wipers, a pair of check pawls for controlling the restoration of said wipers, and a cut off relay and line relay for controlling said pawls respectively.

11. A line switch comprising sets of passive contacts, each set including line and test contacts, wipers for coöperation with each contact of said sets respectively, means for advancing said wipers to successively engage said sets of contacts, resilient means adapted for restoring said wipers, a pair of check pawls for controlling the restoration of said wipers, one of said pawls being normally in holding engagement and the other of said pawls being normally out of holding engagement, and a pair of electromagnets for controlling said pawls respectively.

12. A line switch comprising passive contacts, a wiper for coöperation therewith, means for advancing said wiper to successively engage said contacts, means adapted for restoring said wiper, a pair of holding members adapted to control the restoration of said wiper, one of said members being normally in holding engagement and the other of said members being normally out of holding engagement, and a pair of electromagnets for controlling said members respectively.

13. A line switch comprising passive contacts, a wiper for coöperation therewith, means for advancing said wiper to engage said contacts, means adapted for restoring said wiper, a pair of check pawls for controlling the restoration of said wiper, one of said pawls being normally in holding engagement and the other of said pawls being normally out of holding engagement, and a pair of electromagnets for controlling said pawls respectively.

14. A line switch comprising passive contacts, a wiper for coöperation therewith, a motor magnet for advancing said wiper to select one of said contacts, means adapted for restoring said wiper, a pair of check pawls for controlling the restoration of said wiper, and a cut off relay and line relay for controlling said pawls respectively.

15. A line switch comprising passive contacts, a wiper for coöperation therewith, means for advancing said wiper to successively engage said contacts, means adapted for restoring said wiper, a check pawl and ratchet device for controlling the restoration of said wiper, an electromagnet adapted for controlling said check pawl, and a second electromagnet and associated holding mechanism also adapted for controlling restoration of said wiper, said holding mechanisms being so arranged that one is normally in holding relation and the other is normally out of holding relation.

16. A telephone system including a line switch, a substation telephone line connected thereto, a pair of relays energized responsive to a removal of the receiver upon initiation of a call over said line, means for causing a selecting movement of said switch jointly controlled by said relays, and mech-

anism effective to cause restoration of said switch jointly controlled by said relays when the receiver is again replaced upon its switch hook.

17. A telephone system including a line switch, a substation telephone line connected thereto, a pair of relays energized responsive to a removal of the receiver upon initiation of a call over said line, means for causing a selecting movement of said switch including a control circuit having normally open contacts on each of said relays whereby said means are effective responsive to said energization of the relays, and means mechanically associated with said relays effective to cause restoration of said switch by said relays when the receiver is again replaced upon its switch hook.

18. A telephone system including a line switch, a substation telephone line connected thereto, a line relay and cut-off relay energized responsive to a removal of the receiver upon initiation of a call over said line for controlling the selecting movement of said switch, means for restoring said cut-off relay to stop the selecting movement of said switch, means for thereafter holding said line relay energized by a circuit controlled over the calling line, whereby said line relay is restored when the receiver is replaced upon its switch hook, means for again energizing said cut-off relay responsive to deenergization of the line relay, and mechanism connecting said relays and said switch effective to cause its restoration when said line relay is deënergized and said cut-off relay deënergized.

19. An automatic switch comprising a mounting frame, a bank of contacts carried thereby, wipers for coöperation with said bank contacts, a shaft for said wipers suitably supported by said frame, a rotary armature pivotally supported by said shaft, a ratchet secured to said shaft and a coöperating pawl therefor carried by said armature, an electromagnet for operating said armature, and a pair of holding pawls for controlling the release of said shaft, one of said holding pawls normally engaging said ratchet.

20. An automatic switch comprising a mounting frame, a bank of contacts carried thereby, wipers for coöperation with said bank contacts, a shaft for said wipers suitably supported by said frame, a rotary armature pivotally supported by said shaft, a ratchet secured to said shaft and a coöperating pawl therefor carried by said armature, an electromagnet for operating said armature to advance the wipers over said contact bank, restoring means for the wipers, a pair of pawls for holding the wipers in advanced position, and electromagnetic means for operating said holding pawls to permit said restoring means to return said wipers to normal.

21. An automatic switch comprising a mounting frame, a contact bank supported thereby, self-restoring wipers for coöperation with said contact bank, a shaft for said wipers suitably supported by said frame, an armature pivotally supported by said shaft, a ratchet secured to the shaft, a coöperating pawl therefor carried by the armature, an electromagnet supported by said frame and adapted for advancing said wipers, a pair of pawls for holding said wipers in an advanced position and for releasing the same from said advanced position, and electromagnetic means for controlling the said holding pawls.

22. An automatic switch comprising a mounting frame, a contact bank supported thereby, wipers for coöperation with said contact bank, a shaft for carrying said wipers, a ratchet attached to said shaft, an electromagnet provided with an armature having a driving pawl for engagement with said ratchet, and a pair of holding pawls controlled by a pair of electromagnets for holding the wipers in an advanced position and for releasing the same from such advanced position.

Signed by me at Chicago, county of Cook and State of Illinois, in the presence of two witnesses.

WILLIAM KAISLING.

Witnesses:
GEORGE E. MUELLER,
M. R. ROCHFORD.