F. SCHOENWOLF.

TELEPHONE SYSTEM.

APPLICATION FILED DEC. 10, 1915.

1,336,098.

Patented Apr. 6, 1920.

4 SHEETS—SHEET 1.

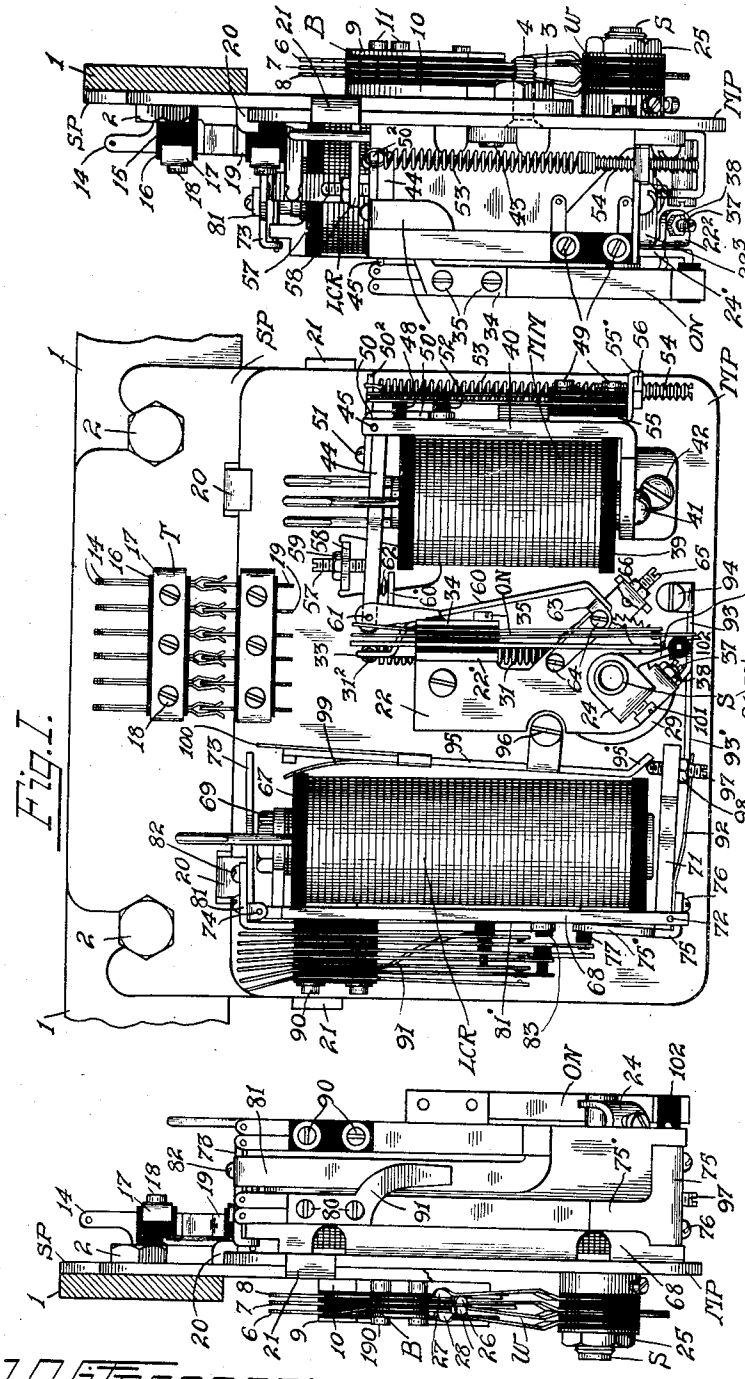

Fig. 1.

Fig. 2.

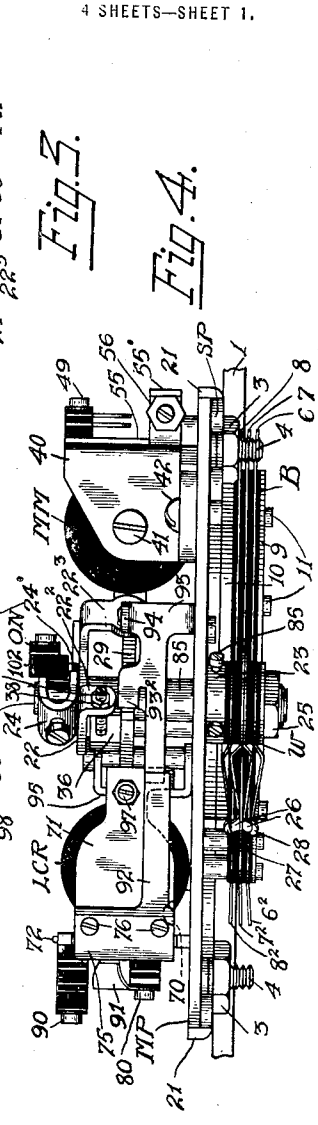

Fig. 3.

Fig. 4.

Witnesses:

G. A. Janochowski.

Wm. Berghalpu

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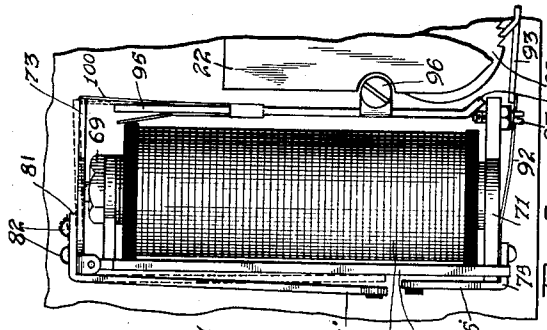

Fig. 8.

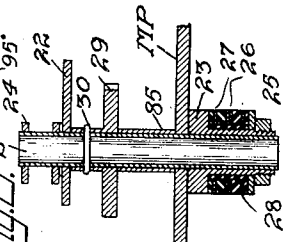

Fig. 9.

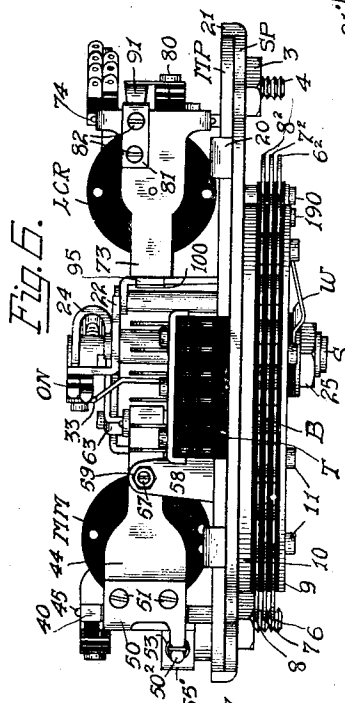

Fig. 6.

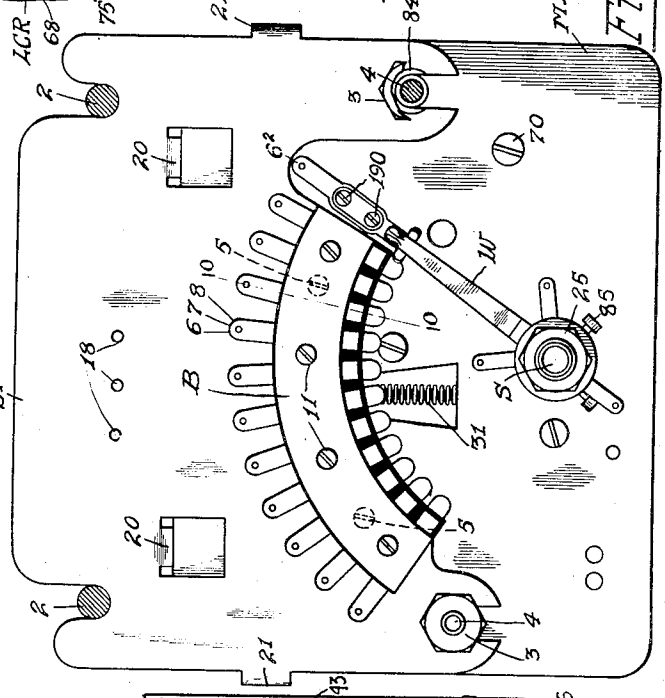

Fig. 5.

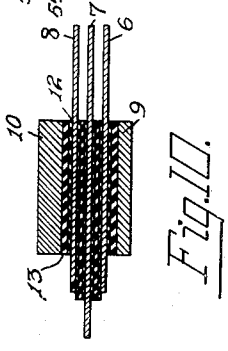

Fig. 10.

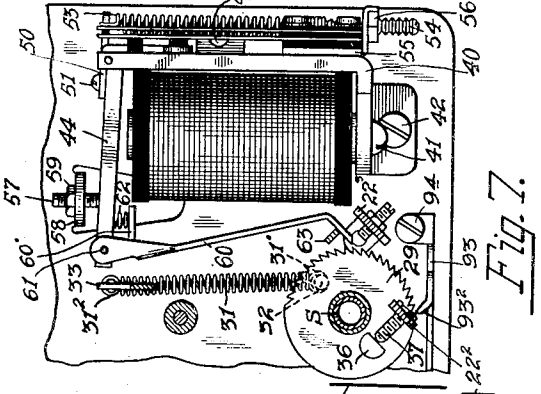

Fig. 7.

Witnesses:

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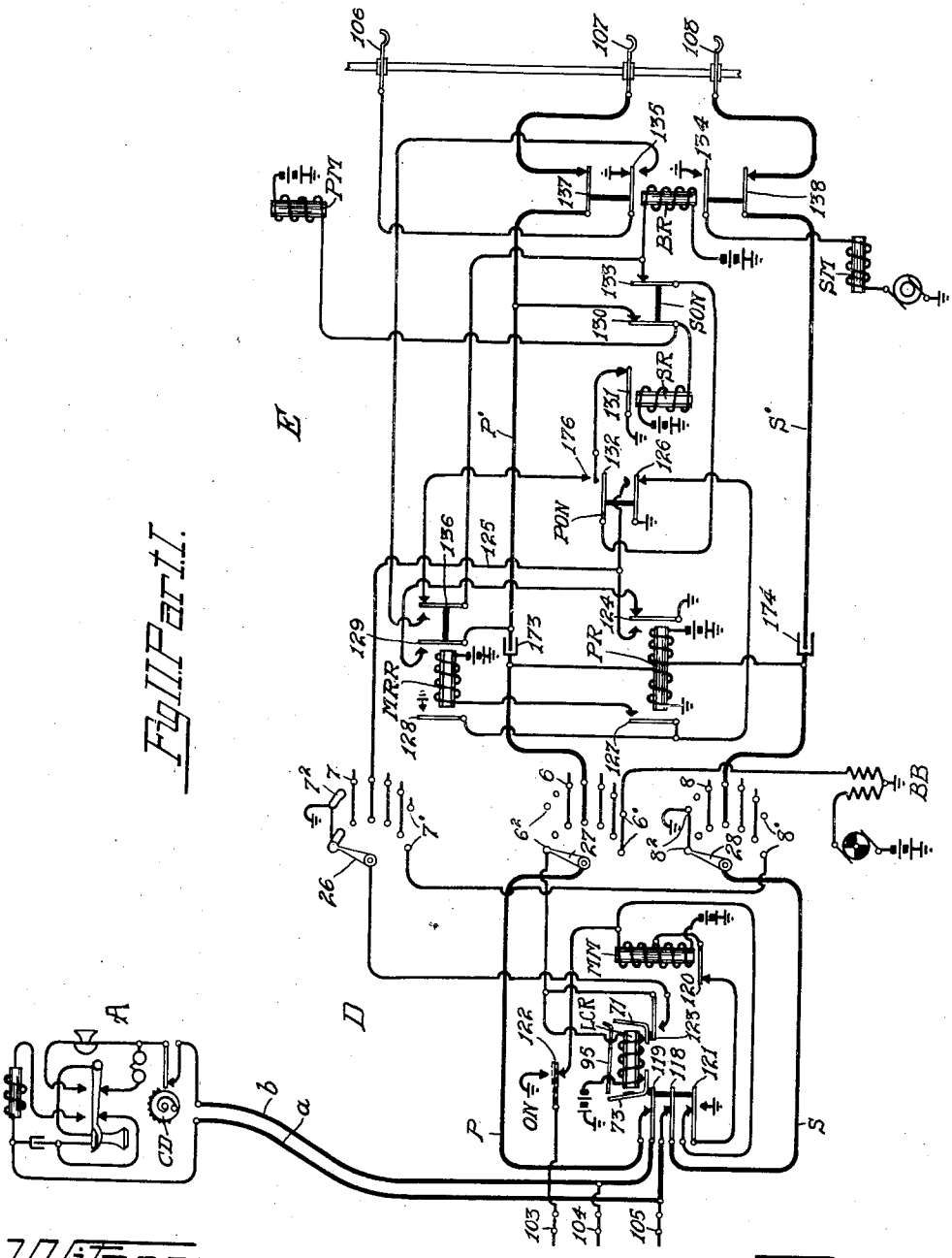
4 SHEETS—SHEET 3.



Witnesses:

G. A. Janochowski.

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4 SHEETS—SHEET 4.

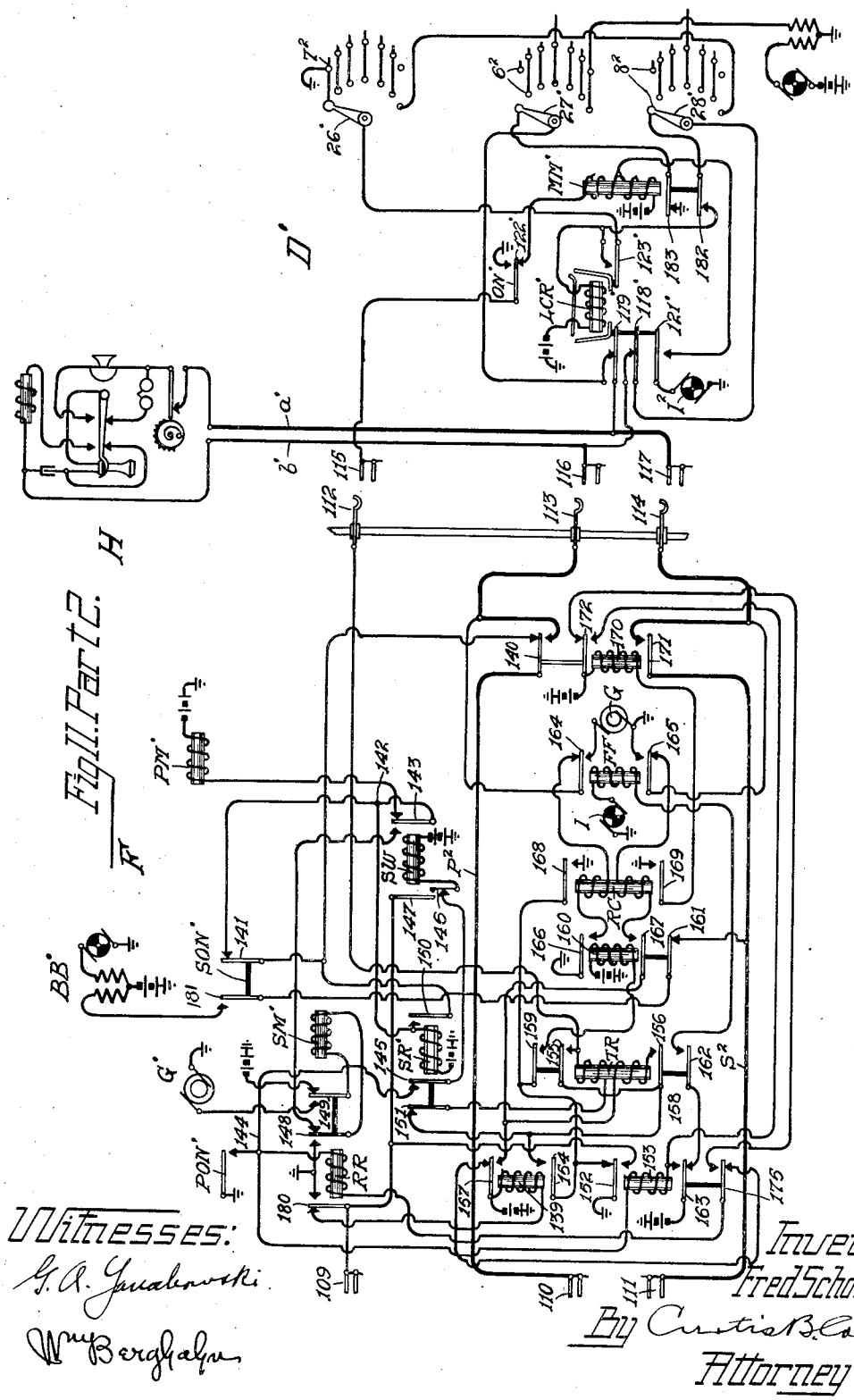

Fig. II. Part 2.

Witnesses:

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Wm. Berghalyn

Inventor:

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By Curtis B. Camp.

Attorney

UNITED STATES PATENT OFFICE.

FRED SCHOENWOLF, OF CHICAGO, ILLINOIS, ASSIGNOR TO KELLOGG SWITCHBOARD AND SUPPLY COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF ILLINOIS.

TELEPHONE SYSTEM.

1,336,098. Specification of Letters Patent. Patented Apr. 6, 1920.

Application filed December 10, 1915. Serial No. 66,032.

To all whom it may concern:

Be it known that I, FRED SCHOENWOLF, a citizen of the United States of America, residing in Chicago, county of Cook, 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 line switches such as are adapted for use in connecting a calling line with an idle trunk circuit or first selector switch upon the initiation of a call.

Systems to which my invention is particularly directed employ an individual switch for each telephone line. It will be readily apparent that in exchanges of any size, the installation of these switches is quite an item and therefore it is of great advantage to provide a line switch which is compact in form, simple as to construction and positive in its operation.

An object of my invention is to provide such a switch, one that is compact, but yet simple and positive in operation. A feature of my invention is to arrange a switch whose operative functions are controlled by only two relays, namely a motor magnet and a combined line, cut-off and release relay. Another feature of my invention is the construction of the combined line, cut-off and release relay so that this single relay will perform the different functions in a positive and reliable manner. 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 drawing in which like reference characters indicate like parts and in which—

Figure 1 is a plan view of the line switch of my invention;

Fig. 2 is a left side view of Fig. 1;

Fig. 3 is a right side view of Fig. 1;

Fig. 4 is a bottom view of Fig. 1;

Fig. 5 is a rear elevation of Fig. 1;

Fig. 6 is a top view of Fig. 5;

Fig. 7 is a view with parts broken away to show the pawl and ratchet arrangement for advancing the switch wipers;

Fig. 8 is a view of the combined line and cut-off relay showing it in its two actuated positions;

Fig. 9 is a sectional view of the main shaft showing the construction of the same;

Fig. 10 is a sectional view along the line 10, 10, of Fig. 5; and

Fig. 11 comprising parts 1 and 2, illustrates diagrammatically an automatic telephone system including the line switch of my invention.

Referring now more particularly to the structure illustrated in Figs. 1 to 10 inclusive, the line switch comprises two principal units, first a main supporting plate SP, which is adapted to be secured to a mounting frame of some kind, preferably, as shown, a bar 1, the said plate being secured thereto by means of the bolts 2. The other unit comprises a mounting plate MP to which is secured the magnets and movable parts of the switch. The supporting plate SP carries a bank of contacts B and also a set of terminals T. The plate MP is slidably supported by the plate SP, the plate MP being readily movable from the plate SP by loosening nuts 3 which have screw threaded engagement with bolts 4 which are securely staked to the plate MP. The plate MP also supports a hollow shaft S which carries a set of wipers W which coöperate with the contacts of the bank B. A motor magnet MM and a combined line and cut-off release relay LCR are also supported by the plate MP as is also certain other apparatus which will be hereinafter described.

Having described in general the main parts of the switch illustrated in Figs. 1 to 10 inclusive, a detailed description thereof will be given.

Attached to the mounting plate SP is a bank of contacts, comprising eleven sets of contacts, each including three contacts 6, 7, 8, each set of contacts being clamped between the plates 9 and 10 by means of the screws 11, the said bank as a whole being securely fastened to the plate SP by means of screws 5. There is a thin strip of oiled silk 12 between the rows of contacts 6, 7, 8 and the strips of insulating material 13, the said oiled silk and material 13 securely insulating each row from the other. A set of connecting jacks T is rigidly secured to the plate SP, each one of said terminals comprising two similar parts 14 having their contacting ends flared outward to receive a

spring jack 19 mounted on plate MP. The connecting jacks T are set in slots in a block of insulating material 15. For clamping the said terminals in place, an insulating strip 16 and a clamping plate 17 are provided which are adapted to be clamped to the plate SP by means of clamping screws 18. A set of terminals or spring jacks 19, are provided for coöperation with the terminals 14, the terminals 19 being securely held by means of a slotted insulation block and are clamped to the plate in a manner similar to that shown in connection with the terminals 14. These terminals 19, as before mentioned, coöperate with the terminals 14 whereby each of the terminals 19 is inserted between a pair of springs 14 to form a connection. Connecting wires which lead into the line switch are connected to the terminals 14 and the connecting wires that connect to the operating mechanism of the switch are connected to the terminals 19, thereby permitting the operating mechanism to be readily removed without the necessity of unsoldering any of the connecting wires. It will thus be seen that if it is desired to make any adjustment or repairs on the movable parts of the switch, the frame MP may be removed without disturbing any of the soldered connections, as all the incoming and outgoing wires to the parts carried by the frame MP are carried through the connector terminals 14, 19. For detachably securing from MP to the frame SP, screws or bolts 4 (as hereinbefore described) are staked to the plate MP as shown by dotted lines, Fig. 3, and are adapted to receive nuts 3 which have screw-threaded engagement with the said bolts 4. A counterbore opening 84 adapted to receive the nut 3, is sunk in each ear of plate SP, as shown in the right hand view of Fig. 5. The screws 4 extend through a slot which is cut to the center of the counterbore 84, so that when the nuts 3 are unscrewed clear of their respective counterbores 84, in the plate SP, the plate MP may be moved out of supporting engagement with the frame SP. It will be seen that with this arrangement should any of the magnets or moving parts of the switch need adjustment or repair, the plate MP may be quickly removed and another one inserted in place thereof. Stops 20, preferably integral with the plate SP, and guides 21 also integral with the plate SP, are provided; the stops 20 acting as stops when a new plate MP with its mechanism is inserted, and the guides 21 are used to guide the plate MP when inserted in position and to prevent side movement of the said plate MP.

A main shaft S is provided, which is journaled at one end in a plate 22 and at its intermediate portion in the plate MP. This shaft S is rotatably mounted and secured against endwise motion by means of a wiper carrying hub 23 secured to one end thereof below the plate MP and by a U-shaped member 24 adjustably secured to its other end, the said members 23 and 24 being so adjusted upon the shaft S that any lateral motion thereof is prevented. A collar 85 fits over the shaft S between the ratchet wheel 29 and plate MP which also aids against lateral movement of the shaft S. The wiper hub 23 is adjustably secured to the shaft S by means of the set screws 85 which hold the said hub securely in its adjusted position. The hub 23 carries a set of wipers W which are insulatingly mounted thereon and firmly clamped in position by a nut 25 which has screw-threaded engagement with the end of the hub 23. The middle wiper 26 which coöperates with the bank contacts 7 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 27 and 28 known as the line wipers, are included in the talking circuit and their contacting ends so formed that when moved over the bank contacts 6 and 8, they break connection with one contact before making connection with the succeeding contact. The wipers 26, 27 and 28 when at normal engage contacts 6^2, 7^2 and 8^2, the said contacts being suitably fastened to the mounting plate MP by means of the screws 190 which are suitably insulated from the said contacts 6^2, 7^2 and 8^2 and which have screw-threaded engagement with the plate MP. When the switch is in need of repairs and the plate MP removed from the plate SP, the wipers remain in engagement with the said contacts so that when the plate MP is again fastened to the plate SP the wipers are in proper alinement with the contacts mounted in the bank B.

A ratchet wheel 29 is positioned on the shaft S between the plate 22 and plate MP, the said ratchet 29 being fastened to the shaft S in any suitable manner as by means of the pin 30. A restoring spring 31 in the form of a coil spring is provided to hold the wipers W in their normal position, the end 31^1 of the said spring being fastened to a pin 32 which is staked to the under side of the ratchet wheel 29 as shown dotted in Fig. 7. The end 31^2 of the spring 31 is fastened to an arm 33 which is an extension of the plate 34 which is held in place upon the angular portion 22^1 of the plate 22 by means of screws 35. To hold the wipers W in their normal position against the tension of the spring 31, I provide a stop 36 which is staked upon the face of ratchet wheel 29. For coöperating with the

stop 36, I provide an adjustable screw 37 which has screw-threaded engagement with a lug 22^2, formed integrally with the plate 22. When the wipers W are at normal the screw 37 engages the stop 36 against the tension of spring 31. To maintain the proper adjustment of ratchet 29 a lock nut 38 is provided for the adjustable screw 37 which has screw threaded engagement therewith.

The motor magnet MM which furnishes the driving power for rotating the wiper shaft S comprises an electromagnet spool 39 and a heel piece 40 which is suitably fastened to the core of the electromagnet by means of the screws 41, the said heel piece and magnet being supported by the plate MP by means of the screws 42 and 43. An armature 44 is provided for the magnet MM which is pivotally supported in suitable manner by means of the pivot pin 45. A pair of interrupter spring contacts are insulatingly mounted upon the pole piece 40 by means of screws 49, the stationary or inactive spring of the interrupter set resting upon the buffer 48. An angularly shaped member 50 is fastened to the armature 44 by means of the screws 51 and is provided with an extension 50^1 which is provided with a rubber buffer 52 which passes through the stationary spring of the interrupter contact and engages the active spring of the interrupter contact set. When the armature 44 is attracted, the extension 50^1 is moved out from the pole piece causing the rubber buffer 52 to force the active spring out of engagement with the stationary spring to open the circuit of the magnet MM as will be more fully described in the following specification.

To keep the armature 44 under proper tension I provide a coiled spring 53 which has its one end fastened to the extension 50^2 of the angular member 50 and its other end fastened to an adjustable screw 54. A member 55 is provided, and suitably fastened to the pole piece 40 by means of the screws 49 and is provided with an extension 55^1 through which the adjustable screw 54 passes, a nut 56 being provided, which has screw-threaded engagement with the screw 54, to hold the screw in place. This screw is used to tension the spring 53 to provide proper tension for the armature 44. An adjustable stop 57 is provided in the form of a screw which has screw-threaded engagement with a lug 58 which is preferably integral with the mounting plate MP said stop being used to obtain the proper air gap between the armature and core of the magnet when the said armature 44 is in its normal position. A lock nut 59 is provided which locks the adjustable screw 57 in its adjusted position.

A pawl 60 is pivotally supported at the end of the armature 44 by means of the pivot pin 61. An extension 60^1 of the pawl extends parallel to the armature 44 and a coiled spring 62 is inserted between the said armature 44 and extension 60^1 so that when in its normal position the spring 62 tends to hold the pawl 60 against a stop 63 which is secured to the plate 22 by means of the screws 64. This stop 63 also tends to hold the pawl out of engagement with the teeth of the ratchet wheel 29 against the tension of the spring 62 so that when the wipers W are released from an advanced position the pawl 60 will not interfere with the return movement of the wipers. When the armature 44 is attracted the pawl moves with it and the coiled spring 62 forces the nose of the pawl into engagement with the teeth of the ratchet wheel 29 to step the wipers one step forward. An adjustable stop comprising a screw 65 and a lock nut 66, is positioned upon an angular extension 22^3 in the path of the nose of the pawl 60. It will be seen that when the pawl 60 is actuated to the forward limit of its stroke, it engages a tooth of the ratchet wheel 29, and at the same time engages the stop 65 thereby limiting the forward stroke of the pawl 60 and the operation of the shaft S.

A combined line cut-off and release relay LCR is also secured to the plate MP, and is provided with an electromagnet spool 67 and an iron core having a copper sleeve thereon for retarding the return movement of its armatures after its energizing circuit is broken. A heel iron or extension pole piece 68 is provided for the relay LCR which is suitably fastened to the core of the electromagnet 67 by means of the nut 69 which has screw-threaded engagement with the said core. The pole piece 68 and electromagnet 67 are secured to the plate MP by means of the screws 70. A pair of armatures are provided for the magnet LCR, the armature 71 being pivotally supported on the pole piece 68 by means of the pivot pin 72 and the armature 73 being also pivotally supported by the pole piece by means of the pivot pin 74. An angularly shaped member 75 is fastened to the armature 71 by means of the screws 76 and is provided with an extension 75^1 which carries a rubber buffer 77 fastened to it, in any suitable manner for engaging the active spring of the set of spring contacts controlled by the armature 71. The said springs are insulatingly mounted upon the heel piece 68 by means of the screws 80. An angularly shaped member 81 is fastened to the armature 73 by means of the screws 82 and its extension 81^1 carries a rubber buffer 83 attached in any suitable manner which engages one of the active springs of the group of springs which are controlled by the armature 73. The set of spring contacts controlled by armature 73 are insulatingly

mounted upon the pole piece 68 by means of the screws 90. A leaf spring 91 held in place by means of the screws 80 rests against the extension 81^1 to keep the armature 73 in its normal position. The armature 71 also carries a leaf spring 92 which is held in place by means of the screws 76. The leaf spring 92, upon the attraction of the armature 71, engages the end of a retaining pawl 93 forcing it into engagement with one of the teeth of the ratchet wheel 29. The retaining pawl 93 is mounted upon the plate MP by means of the pivot screw 94 and an extension 93^1 of the said pawl is engaged by the leaf spring 92.

Upon the attraction of the armature 71, the nose 93^2 of the pawl 93 is forced into engagement with one of the teeth of the ratchet wheel 29 and as the ratchet wheel 29 is stepped around by the pawl 60, due to the energization and deënergization of magnet MM, the said retaining pawl 93 engages successive teeth of the ratchet 29 to keep the said wipers W in their actuated advanced position against the tension of the restoring spring 31. Upon the deënergization of the magnet LCR, the pawl 93 is moved away from engagement with the ratchet 29, allowing the said restoring spring 31 to restore the wipers W to normal. An arm 95 is provided pivotally supported upon the mounting plate MP by means of the pivot screw 96, for coöperating with the two armatures 71 and 73 of the electromagnet LCR. The armature 71 is provided with an adjustable stop for coöperating with the arm 95 and the stop 97 may be locked in its adjustable position by means of the lock nut 98 which has screw-threaded engagement with the said adjustable stop 97. A leaf spring 99 suitably fastened to the arm 95 holds the said arm in its normal position as illustrated in Fig. 1, so that the angular portion 95^1 of the arm 95 engages the adjustable stop 97. A member 100 preferably integral with the spring 99 is mounted upon the outer face of the arm 95 and coöperates with the armature 73 in a manner hereinafter to be described.

Upon the energization of the magnet LCR the two armatures 71 and 73 are simultaneously attracted and the stop 97 engages the angular extension 95^1 of the arm 95, forcing the said arm 95 into the position as shown in Fig. 8 in full lines. When the circuit of relay LCR is opened armature 73 releases before armature 71 does, due to the fact that a copper member is fastened to the inner face of said armature 73 preventing the armature 73 from coming into close contact with the core of electromagnet LCR while the armature 71 is free to move into close contact with the core of the magnet LCR. Now if the magnet LCR is again energized before the armature 71 has had a chance to fall back when the armature 73 is again attracted the member 100 will have assumed the position shown in dotted lines in Fig. 8, preventing the full attraction of the armature 73, thus preventing the operation of the contact springs controlled by armature 73.

A set of off-normal springs ON are insulatingly mounted upon the angular portion 22^1 of the plate 22 by means of the screws 35, and the U-shaped member 24 is adjustably mounted upon the forward end of the shaft S by means of the screw 101. An extension of the member 24 in the form of an arm 24^1 carries a rubber buffer 102 which engages the active or middle contact spring of the off-normal set. Upon the second step of the shaft S off normal, the active contact spring of the off-normal springs ON moves out of engagement with its normal contact and engages its alternate contact and upon restoration of the shaft S the off normal springs ON are again restored by the action of the rubber buffer 102.

For use with the selector and connector circuits of the system of Fig. 11, a switch as shown in Pat. No. 1,131,140 for automatic switch for telephone systems, issued March 9th, 1915 to William Kaisling, may be used.

The switch referred to in the previous paragraph in general comprises a bank of contacts made up of one hundred 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 cooperate with the bank contacts, the primary magnet being adapted to adjust the wipers in a primary direction to select a group of contacts, and a secondary magnet is provided to step the wipers in a secondary direction 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 the 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 are 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 have reached a point directly above the starting point when they are moved down to a plane parallel to the

secondary, but in a direction opposite to the secondary movement until they reach their normal starting position. It is to be understood that for a more complete understanding of this switch reference is to be had to the above identified patent.

The system illustrated in Fig. 11 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 in a ten per cent. trunking system. 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 of a well-known type is shown connected to its line switch D and a called substation H is shown connected with its line switch D^1. In the operation of the system, the calling subscriber at A removes his receiver from its switch-hook 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 hundredths 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, the 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 switch-hook and release the switches which are operated in making the connection.

The line switch D which is the switch of Figs. 1 and 10, and previously described as to mechanical construction, comprises a set of wipers 26, 27 and 28 which are adapted to coöperate with the bank contacts 6, 7 and 8 respectively. The motor magnet MM is provided for advancing the wipers 26, 27 and 28 step-by-step along the bank of contacts including contacts 6, 7 and 8. A combined line cut-off and release relay LCR is adapted to be energized upon the initiation of a call and remains energized until an idle selector has been seized, but due to its slow to release action, its armature 71 remains attracted until a substitute circuit is established for it from the selected idle selector. The armature 73 is released upon the deenergization of relay LCR as previously described and is prevented from being again attracted upon the second energization of relay LCR due to the member 100 as already has been described in full, so that the contacts controlled by the armature 73 remained in their normal position to extend the line conductors to the selected idle selector. When the subscriber replaces his receiver, the relay LCR deënergizes, releasing the wipers and allowing them to restore to normal. Should all the selectors associated with the line switch D 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 connect with the bank contacts 6^1, 7^1, 8^1, the wipers remaining in connection with these contacts permitting a busy signal to be transmitted to the calling subscriber at A from the busy back BB. The calling subscriber receiving the busy signal from the busy back BB replaces his receiver upon the switch hook and brings about the release of 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 103, 104 and 105, the said contacts being the bank contacts of the connector switches, such as F, which have access to the line of substation A. The line switch D^1 is connected to the called substation H by means of the line conductors a^1 and b^1. The said line switch is similar to the line switch described at length, the corresponding parts having corresponding reference characters, but with the suffix prime.

The line switch D^1 as to mechanical construction, is substantially the same as that of D, the circuit for the switch D^1 being different, and I will hereinafter give a description of the same. Now when the called line associated with D^1 answers, the motor magnet MM^1 is energized from ground at the connector F, but its armature is only partially attracted to open its contacts, but not enough to step the wipers into engagement with the next set of contacts as is the case in the line switch D. The operation of line circuit D^1 is in general as follows: upon the removal of the receiver at the substation, a circuit for the relay LCR^1 from battery through said relay, normal contact 182 of magnet MM^1, contact 8^2, wiper 28^1 normal contact 118^1 of LCR^1, through the closed contacts of the switch-hook normal contact 119^1, wiper 27^1 and contact 6^2 to ground at normal contact 183 of MM^1. The initial circuit for LCR^1 is opened at contact 118^1 and 119^1 when LCR^1 energizes, but a locking circuit for LCR^1 is established from ground at contact 7^2 through wiper 26^1, alternate contact 123^1 of LCR^1, through the winding of LCR^1 to battery. The closure

of alternate contact 121^1 of LCR^1 closes a circuit for MM^1 from battery through the lower winding of MM^1, alternate contact 121^1 and through the interrupter I^2 to ground. The magnet MM^1 thereupon steps the wiper 26^1, 27^1 and 28^1 to seek an idle selector and the operation from this point on is the same as previously described in connection with line circuit D.

Each first selector E includes a set of wipers 106 107, and 108, and a bank including one hundred sets of contacts 109, 110 and 111, the said bank of contacts being divided into ten groups of ten sets each, and each set of course has three contacts 109, 110 and 111. The switch E is adapted to first adjust the wipers 106, 107 and 108 in a primary direction to select a group of contacts 109, 110, and 111 and thereafter the said wipers are given a secondary adjustment to select the set of contacts 109, 110 and 111 in the selected group. To operate these wipers a primary magnet PM is provided which is directively controlled by the subscriber to adjust the wipers in primary direction, and for giving the wipers a secondary adjustment a secondary magnet SM is provided. The switch is also provided with a primary relay PR which is connected in bridge of the talking strands and operated responsive to the interruption of the metallic line circuit. Relay PR is adapted for transmitting the so-called primary impulses while the secondary relay SR which is a sluggish or slow releasing relay, is provided for transmitting the secondary impulses for controlling the starting of the secondary adjustment of the wipers. A main release relay MRR is also included in each switch E, the said relay also being of sluggish or slow release construction. The relay MRR is energized upon the selection of the switch E and remains energized until the calling subscriber restores his receiver, whereupon this relay MRR deënergizes and controls the 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 109, 110, and 111. The 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 106, 107 and 108, the secondary magnet SM is again actuated thereby advancing the wipers 106, 107 and 108, 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.

The connector switch F includes a set of wipers 112, 113, and 114, and a bank of one hundred contact sets 115, 116, 117, the said contact being divided into groups similar to the contacts of the first selector switch E, and the wipers 112, 113 and 114 are actuated in a corresponding manner by a primary magnet PM^1 and a secondary magnet SM^1. Each connector switch F is also provided with a secondary relay SR^1 which is also of slow releasing construction. A release relay RR is also provided as is also a switch relay SW which is adapted to cut off primary magnet PM^1 from connection with the heavily marked conductor and connect therewith a secondary magnet SM^1. 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 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 the 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^1. The primary off-normal springs PON^1 and secondary off-normal springs SON^1 are adapted to operate upon the first primary and secondary steps respectively.

Having described in general the system of Fig. 11, parts 1 and 2, the operation thereof in completing a connection from a calling to a called subscriber will now be given. Assuming the subscriber at the substation A desires to connect with subscriber at substation H, whose number we will assume is 234, the subscriber at A removes his receiver from the switch-hook, thereby closing the upper switch-hook contacts and establishing a circuit for the relay LCR, traced from ground at contact 8^2 through the wiper 28, normal contact 118, line conductor *a*, the now closed contacts of the switch-hook, returning over the line conductor *b*, normal contact 119 of LCR, the wiper 27, contact 6^2 and through the winding of relay LCR to battery. Relay LCR is thereupon energized closing a circuit for the motor magnet MM traced from battery through the lower winding of the magnet MM and normal contact 120 of the said magnet MM to ground at alternate contact 121 of relay LCR, whose contacts have now assumed their alternate position due to the attraction of the armatures 71 and 73. The motor magnet MM, upon energization, steps the wipers 26, 27 and 28 one step into engagement with the first set of contacts 6, 7 and 8. The first two contacts which the wiper 26 engages are grounded, while the second set of contacts 6 and 8 engaged by

the line wipers 27 and 28 are on open circuit. The energization of the magnet MM brings about the opening of its normal contact 120 interrupting its own circuit. The magnet MM thereupon deënergizes but is immediately energized again due to the relay LCR remaining energized from the grounded contact engaged by the private wiper. I provide this preliminary set of contacts so that when a call comes to the substation A from a connector as F, magnet MM is energized from ground at the connector through the normal contact 122 of off-normal contacts ON, through normal contact 121 of relay LCR, normal contact 120 of magnet MM and through the lower winding of the said magnet to battery. The magnet MM steps the wipers 26, 27 and 28 one step into engagement with the second set of contacts 6, 7 and 8 which are on open circuit. The off-normal contacts ON do not assume their alternate position on the first step of the wipers, but assume the position shown in dotted lines in Fig. 11, Part 1, so as to keep the magnet MM energized as long as the receivers of the calling and called subscribers are removed from their respective switch hooks.

Referring again to the operation of the relay LCR and stepping magnet MM, the said magnet MM, upon energizing the second time moves the wipers 26, 27 and 28 onto the third set of contacts and effectively operates the off-normal springs ON. The energizing circuit of relay LCR is opened at the private wiper 26 if the third contact engaged by it is ungrounded, but should the third contact engaged by the wiper 26 lead to a busy first selector as E, a circuit is established for the said relay LCR including the grounded contact traced from the grounded contact 7 through the wiper 26, alternate contact 123 of relay LCR and through the winding of said relay LCR, to battery. The circuit of magnet MM is thus maintained closed and due to its interrupter contact 120, the wipers 26, 27, and 28 are advanced step by step until a contact 7 leading to an idle selector as E is encountered. The armature 71 being attracted by the energization of the relay LCR, the pawl 93 controlled by said armature, as previously described, engages the teeth of the ratchet wheel 29, thus preventing the wipers from restoring while the magnet MM is operating. Upon the first step of the wipers off normal, the off-normal contacts ON assume the position shown in dotted lines and upon the second step they assume their alternate position as before described, to cause the alternate contact 122 to place ground upon the multiple private contacts 103 to prevent any connector as F from connecting to the line A. An idle selector having been seized by the individual switch D, the energizing circuit for relay LCR is opened and its armature 73 releases allowing contacts 118, 119 and 121 to resume their normal position. The opening of alternate contact 121 opens the circuit of motor magnet MM preventing further advance of the wipers while the closing of normal contacts 118, 119 connects the subscriber's line to the line wipers 27 and 28 thereby establishing a circuit for the primary relay PR of the first selector E, traced from battery through the right hand winding of relay PR, bank contact 8, wiper 28, normal contact 118 of LCR, the line conductor *a*, through the substation, line conductor *b*, normal contact 119, wiper 27 and bank contact 6 to ground through the left hand winding of the primary relay PR. Upon the closure of alternate contact 124, of relay PR, another circuit for relay LCR is established traced from ground through alternate contact 124, conductor 125, engaged bank contact 7, wiper 26, alternate contact 123 of relay LCR, (armature 71 of relay LCR having remained in its operated position due to its sluggish release,) and through the winding of said relay LCR to battery. Upon the reënergization of relay LCR, armature 71 is held in its energized position and armature 73 is prevented from making its full stroke due to the member 100 blocking its movement as previously explained whereby contacts 118, 119 and 121 remain in their normal position. The ground from alternate contact 124 of relay PR to contact 7 and its multiples also makes switch E busy against selection by any other calling line.

An energizing circuit for relay MRR is also established upon the energization of relay PR over a circuit traced from normal contact 126 of primary off-normal switch PON, alternate contact 127 of relay PR 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 128 through alternate contact 127.

The line of substation A, it will be noted, has now been extended 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 calling dial CD to cause two interruptions of its contact springs, 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 127 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 124 of relay PR, alternate contact 129, of MRR, conductor P^1, normal contact 130 and the winding of magnet PM to battery, these two impulses causing magnet PM to step wipers 106, 108 and 107 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 130, 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 131 of relay SR, alternate contact 132, normal contact 133 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 134 through said magnet SM to an alternating current generator, whereby said magnet SM advances wipers 106, 107 and 108 into engagement with the first set of contacts 109, 110 and 111. Upon the first secondary step of the wipers, switch SON moves to its alternate position, thereby interrupting the initial energizing circuit for relay BR at contact 133 and assuming that the first set of bank contacts 109, 110 and 111 lead to a busy connector switch, there will be a ground upon test contact 109, as will be pointed out, and a locking circuit for relay BR will be established from said ground through wiper 106, alternate contact 135, alternate contact 136 and through the 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 also 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 109 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 107 and 108 are disconnected from the talking conductors by reason of contacts 137, 138 being open.

Upon deënergization of relay BR, ground is connected to test contacts 106 and its multiples, traced from normal contact 135 of relay BR to the said contact thus making connector F busy against selection by any other first selector. This ground connection, it will be noted extends through relay 139 of switch F, to battery energizing said relay 139, 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 the calling device CD 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^1 of connector switch F and its multiply connected secondary relay SR^1, these impulses being traced from ground through normal contact 124 of relay PR, alternate contact 129, conductor P^1, contact 137, wiper 107, contact 110, normal contact 140, normal contact 141 to tie 142 dividing at this point, part of the current passing through and energizing secondary relay SR^1 and part of the current passing through normal contact 143 and magnet PM^1 to battery. Relay SR^1 being a sluggish relay as previously stated, maintains its armature in an attracted position during the sending of these impulses, while magnet PM^1 responsive to these three impulses, advances wipers 112, 113 and 114 to select the third group of bank contacts in which are located the bank contacts 115, 116 and 117, the terminals of the called line. Upon cessation of the primary impulses secondary relay SR^1 releases its armature, thereby closing a circuit through switching relay SW, traced from ground through contact PON^1, which has now moved to its alternate position, conductor 144, normal contact 145, normal contact 146 and the winding of relay SW to battery, energizing the said relay, thereby closing its alternate contact 147, and establishing a locking circuit for itself from the grounded test terminal 109. It will be noted that upon energization of switching relay SW contact 143 moves to its alternate position, thereby disconnecting primary magnet PM^1 and connecting secondary magnet SM^1 to the primary conductor P^2.

The subscriber now operates the dial to cause four interruptions of the primary relay PR, thereby transmitting four primary

impulses from ground through normal contact 124 over the previously described path to normal contact 140, then through normal contact 141 to tie 142, the first one of said impulses dividing at this point, part of the current passing through secondary relay SR^1, energizing the said relay as before and part of the current passing through alternate contact 143, normal contact 148, winding of secondary magnet SM^1 and normal contact 149 to battery.

Responsive to the first said impulse through magnet SM^1, wipers 112 and 113, 114 are advanced one step while the secondary off normal switch SON^1 is moved to its alternate position, thus interrupting at contact 141, the initial path for the impulses, but secondary relay SR^1 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 140 to alternate contact 150 of SR^1, dividing at this point, part of the current of these last three impulses passing through relay SR^1 maintaining it energized and part of the current passing along the conductor leading up from alternate contact 150 to tie 142 then through alternate contact 143 and over the previously described path through secondary magnet SM^1. Thus it will be seen that although switch SON^1 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 150 of relay SR^1.

These last three impulses are of course effective to cause magnet SM^1 to advance wipers 112, 113 and 114 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^1 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 115. Returning now to the test circuit which is established upon deënergization of relay SR^1, this circuit is closed by normal contact 151 of relay SR^1, being traced from the ground at normal contact 152 of relay 153, alternate contact 154, normal contact 151, the upper winding of relay TR to test wiper 112. As stated, the line of substation H being idle it will be in the condition as illustrated at D^1, its test contact 115 being connected to magnet MM^1 and without any direct ground connection to its terminal 115. Therefore upon the closing of this test circuit just described, a series circuit for the upper winding of relay TR and windings of magnet MM^1 is established, the said relay and magnet thereupon energizing, magnet MM^1 opening its contacts 182 183 and removing the substation control of line switch D^1. The magnet MM^1, however, does not energize sufficiently to move its wipers on to the first set of bank contacts, as hereinbefore described.

Upon energization of relay TR, the closing of alternate contact 155 shunts the upper winding of relay TR but a locking circuit for TR is established through its lower winding upon the closing of contact 156, this locking circuit being traced from battery through alternate contact 157, of relay 139, the lower winding of relay TR, alternate contact 156, conductor 158, alternate contact 154, normal contact 152 to ground. The closing of contact 159 of relay TR establishes a circuit for relay 160, traced from ground at normal contact 152, alternate contact 159 and the winding of relay 160 to battery, energizing relay 160 and by means of its contact 161 interrupting the connection from the busy back BB^1 to the secondary conductor S^2. The closing of alternate contact 162 of relay TR establishes a circuit for relay FF, traced from battery at normal contact 163, of relay 153, alternate contact 162, 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 deënergizes and upon its first energization alternate contacts 164, 165 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 165, wiper 114, contact 117, conductor a^1, call bell and condenser of the called substation, returning over conductor b^1, contact 116, wiper 113, alternate contact 164 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 deënergizing, 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 164, 165 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 switch-hook, but due to a condenser at the called substation being connected in circuit, while the receiver is on, no path for direct current exists.

Upon hearing the call bell, the subscriber at substation H removes his receiver from its switch-hook thereby establishing a circuit for relay RC, traced from ground through alternate contact 166, the upper winding of relay RC, normal contact 164, wiper 113, contact 116, conductor b^1, substation H, returning over conductor a^1, contact 117, wiper 114, normal contact 165, the

lower winding of relay RC, alternate contact 167 to battery at alternate contact 157. The closing of this circuit causes the energization of relay RC which closes its contact 168 establishes a locking circuit for relay 160 and test relay TR thus placing these relays under the control of the called subscriber as relay 153 is now energized interrupting normal contact 152, as will now be described. The closing of contact 169 establishes a circuit for relay 170 which is now energized, closing alternate contacts 140, 171, thereby establishing a continuous talking connection between the calling and called substations. The closing of alternate contact 172 of relay 170, establishes a circuit for relay 153 traced from battery through said alternate contact 172, the winding of relay 153 to ground at contact PON[1], energizing relay 153, which establishes a locking circuit for itself through alternate contact 163 to battery. The opening of normal contact 163 of relay 153 interrupts the circuit for relay FF, thus preventing any further operation thereof. Although normal contact 152 is opened upon energization of relay 153, it will be remembered that a substitute circuit was established from ground through alternate contact 168 so that the opening of this normal contact 152 has no effect upon relays TR and 160.

The two substations A and H are now connected for conversation, the circuit being traced over the heavily marked conductors, battery for the calling substation A being supplied through the windings of relay PR and battery for the called substation H being supplied through the windings of relay RC, the said substations being inductively united through the condensers 173, 174, 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 effective by the restoration of the receivers upon their respective switch-hooks. The subscriber at A replacing his receiver upon its switch-hook interrupts the circuit of relay PR at the switch-hook contacts allowing the relay PR to deënergize and interrupt the circuit of main release relay MRR, due to the opening of alternate contact 127. Relay MRR therefore deënergizes and closes a circuit for relay BR, the said circuit being traced from ground at normal contact 131, alternate contact 176, normal contact 136 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 134. Magnet SM thereupon advances wipers 106, 107 and 108 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 126 is opened, thereby interrupting the locking circuit for relay LCR of line switch D allowing said relay LCR to deënergize and due to the deënergization of relay LCR it withdraws its retaining pawl from engagement with the ratchet wheel 29 allowing the wipers to be restored by the spring 31. Upon restoration of the wipers to normal, switch ON is also restored.

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 switch-hook, 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 169 restoring and interrupting the circuit for relay 170 which also deënergizes restoring its contacts. The opening of contacts 168 of relay RC interrupts the locking circuit for relays 160, TR and MM[1] allowing the said relays to deënergize and restore their contacts. Relays SW, 153 and 139 it will be remembered are all energized, relays 139 and SW being held energized by ground from alternate contact 152, so that upon deënergization of relay 170 a circuit for release relay RR is established from battery at normal contact 172 of relay 170, through alternate contact 175 or 153, the winding of relay RR to ground at alternate contact PON[1]. Relay RR is thereupon energized interrupting the circuit for relay 139, due to the opening of normal contact 180, allowing said relay 139 to deënergize and restore its contacts. Upon energization of relay RR alternate contacts 148 and 149 are closed, thereby establishing a circuit for secondary magnet SM[1] traced from ground through alternate contact 148, the winding of magnet SM[1] to alternating current generator G[1] at alternate contact 149. This last traced circuit energizes and deenergizes magnet SM[1] to step wipers 112, 113 and 114 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[1], the circuit for relays RR and 153 is interrupted, allowing the said relays to restore to normal, and upon restoration of contacts 180 and 152 of said relays RR and 153, the circuit for relay SW is interrupted allowing it to restore. During the advance or restoring movement of wipers 112, 113 and 114, they are free to wipe over the bank

contacts 115, 116, 117 without interfering with any existing connections, wipers 113 and 114 being disconnected due to the de-energization of relays 170 and 160 while the circuit of wiper 112 is interrupted, due to the restoration of relays TR and 139 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 MM[1] 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 switch-hook and thereafter the called subscriber replaced his receiver upon its switch-hook. Should the called subscriber at substation H replace his receiver upon its switch-hook before the calling subscriber, the connector switch F will be restored first and upon the calling subscriber replacing his receiver upon its switch-hook 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[1] after the final set of impulses are transmitted. It will be remembered that after the last set of impulses were transmitted, secondary relay SR[1] deënergized, and at this time relays SW and 139 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 115, either from an alternate contact 122[1] of line switch D[1] if the line be calling, or from a connector switch F, if the line be a called line, so that when secondary relay SR[1] 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 112 to the upper winding of relay TR, the other ground connection being traced from the normal contact 152, alternate contact 154, normal contact 151 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 and 160. Relay 160 failing to attract its armature, a characteristic busy signal is transmitted from busy back BB[1] through alternate contact 181 of springs SON[1] normal contact 161 of relay 160 toward the left over conductor S[2], contact 111, wiper 108, back over the lower heavily marked conductor and line conductor *a*, the receiver of the calling substation A returning over line conductor *b* and the upper heavily marked conductor to the first selector E, then through the left hand winding of the 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 switch-hook 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 136 as before, and upon energization of relay BR the magnet SM steps wipers 106, 107 and 108 forward, all as previously described, thereby causing the restoration of first selector E, followed by the restoration of line switch D, as previously described.

In this instance the restoration of connector switch F is also controlled by the calling subscriber, its restoration being effected as follows: Upon energization of relay BR of first selector E at the time of release, normal contact 135 is opened, thereby interrupting the circuit for relay 139 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 152 was not closed, so that upon interruption of normal contact 152 of relay BR at first selector E, the relay 139 of connector switch F restores. Upon said restoration of relay 139, a circuit for release relay RR is established from ground at contact PON[1], through winding of relay RR, normal contact 175 of relay 153 and normal contact 157 to battery, energizing relay RR and establishing a circuit for secondary magnet SM[1] through alternate contacts 148 and 149 as previously described, thereby causing magnet SM[1] to step wipers 112, 113 and 114, 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[1] 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 last set of contacts which are the contacts 6[1], 7[1] and 8[1]. It will be remembered that relay LCR is maintained energized from the grounded or busy test

contacts 7, so that when the wipers 26, 27 and 28 are stepped into engagement with the last set of contacts 6^1, 7^1 and 8^1, there being no maintaining circuit for relay LCR, but relay LCR being a sluggish relay maintains its armature 71 attracted until an energizing circuit is again supplied as will now be described. The circuit is traced from ground through the right hand winding of busy back BB to contact 6^1, wiper 27, normal contact 119 over the line conductor *b*, and through the calling substation A, returning over conductor *a*, normal contact 118, wiper 28, contact 8^1, contact 7^1, wiper 26, alternate contact 123 and the winding of relay LCR to battery. It will be seen from this that relay LCR is now maintained energized by current flowing over the line and through the calling substation, thus placing relay LCR 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 LCR. The subscriber at A will probably hear this signal immediately and would therefore replace his receiver upon its switch-hook, although should the subscriber fail to immediately receive this signal he might proceed to operate his calling device to attempt to connect to the line of a called substation. This operation of the calling device although interrupting the circuit for relay LCR has no effect thereon, as the impulses or interruptions are of too short duration to allow relay LCR 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 switch-hook the circuit for relay LCR is interrupted allowing the relay to deënergize and retract its armature 71. Relay LCR thus deënergizes withdrawing check pawl 93 out of engagement with ratchet wheel 29 allowing the wipers to be restored to normal by spring tension.

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.

Having described my invention what I claim as new and desire to secure by United States Letters Patent, is:

1. A telephone system including a subscriber's telephone line, a spring restored line switch therefor provided with contacts and coöperating wipers, a motor magnet for said switch for moving said wipers over said contacts, and a line and cut-off relay controllable over the two sides of the line in series for controlling the operations of said motor magnet and the circuits of said wipers.

2. In a telephone system, an automatic switch, a motor magnet for said switch, said motor magnet adapted to operate a plurality of times when said switch is used for calling purposes, and adapted to be energized a single time and held energized when said switch is used for called purposes.

3. A telephone system including a subscriber's telephone line, a line switch individual thereto, a motor magnet for said switch, a line relay under substation control for causing actuation of said motor magnet, and independent means for energizing said motor magnet and retaining it energized to render said line relay unresponsive to substation control.

4. In a telephone system the combination of a substation telephone line, of an automatic switch therefor, trunk lines, a line relay for controlling the operation of said switch to select an idle one of said trunks, a motor magnet, and a circuit for said motor magnet closed when said line is a called line for rendering ineffective the substation control of said line relay, said circuit remaining closed as long as said line is in use.

5. In a telephone system the combination of a substation telephone line, of an automatic line switch therefor provided with active contacts, a relay for said switch adapted upon energization to control the selecting operation thereof and to disconnect the said active contacts from the substation line, a holding pawl for maintaining said active contacts in an advanced position, and means controlled by said relay for operating said pawl to release said switch.

6. A telephone system comprising a subscriber's line, an automatic switch for said line, progressively movable contacts for said switch, and a relay for said switch controlled at the said substation for controlling the selecting operations of said switch and for disconnecting and connecting said movable contacts with the said subscriber's line, said relay being provided with an armature adapted to be attracted when the call is made and released only when disconnection is desired.

7. A telephone system comprising a substation telephone line, a spring restored automatic line switch for said line, a motor

magnet for said switch, means for operating said motor magnet a plurality of times when said line is used as a calling line for extending a connection therefrom, means for operating said magnet a single time when said line is used as a called line for rendering ineffective the substation control of said line, and means for releasing said switch to normal.

8. In a telephone system, a substation telephone line, an automatic line switch therefor, a magnet for said switch provided with a pair of armatures, means for closing a circuit through said magnet whereby both of said armatures are attracted, and means for subsequently closing a circuit through said magnet whereby one of said armatures renders the other of said armatures ineffective.

9. In a telephone system the combination of a substation telephone line, of an automatic spring restored switch therefor, a magnet for said switch provided with a pair of armatures, a single winding for said magnet, means for closing a circuit through said winding whereby both of said armatures are attracted, means for closing a circuit through said winding whereby only one of said armatures is attracted, and means controllable by said last armature for restoring said switch.

10. In a telephone system the combination with a substation telephone line, of an automatic line switch for said line, a magnet for said switch provided with a pair of armatures, means for closing a circuit through said magnet whereby both of said armatures are operated, means for closing a circuit through said magnet whereby only one of said armatures is operated, and means mechanically associated with said magnet for restoring the said switch.

11. In a telephone system the combination with a substation telephone line, of an automatic line switch for said line, a magnet for said switch provided with a pair of armatures for controlling the operations of said switch, said armatures being mechanically related so that one of said armatures operates to render the other of said armatures ineffective after the selecting operations of said switch have been performed.

12. In a telephone system the combination of a substation telephone line, of an automatic line switch therefor, a single wound magnet for said line switch provided with a pair of armatures, means controlled at the substation for closing a circuit through said magnet whereby both of said armatures are effectively attracted, and means for subsequently closing a circuit through said magnet whereby only one of said armatures is effectively attracted.

13. A line switch for telephone systems comprising contacts and coöperating wipers, spring restoring means for said wipers, a motor magnet for operating said wipers, a line relay for initiating travel of said wipers, a pawl for maintaining said wipers in an advanced position, and means mechanically associated with said line relay for operating said pawl to release said wipers.

14. A line switch for telephone systems comprising contacts and coöperating wipers, spring restoring means for said wipers, a motor magnet for operating said wipers, a line relay for initiating travel of said wipers and for controlling the circuits of said wipers, and a holding pawl controlled by said line relay for controlling the restoration of said wipers.

15. A telephone system comprising a substation telephone line, trunk lines, a line relay for said line provided with a quick-acting armature and a slow-acting armature, an automatic line switch for said line operated responsive to an actuation of the quick-acting armature of said line relay to select an idle one of said trunks, means associated with said trunk for closing a maintaining circuit for said line relay, and mechanical means controlled by the slow-acting armature of said relay for releasing said switch.

16. A telephone system comprising a substation telephone line, an automatic switch individual thereto provided with only three wipers and with only two operating magnets, a motor magnet and a combined line and release relay.

17. A telephone system comprising a substation telephone line, trunk lines, a line relay normally connected to said line, an automatic switch for said line operated responsive to said line relay to select an idle one of said trunks, means associated with said trunk for closing a maintaining circuit for said line relay, and contacts controlled by said relay for disconnecting said telephone line from said trunks while said switch is performing a selecting operation, and a magnet adapted to be energized and remain energized when said line is a called line.

18. In a telephone system the combination with a substation telephone line, of an automatic spring restored line switch therefor, a line relay for said switch, a quick acting armature for controlling the selecting operations of said switch, and a slow-acting armature controlled by said line relay for restoring said switch to normal.

19. In a telephone system the combination with a substation telephone line, of an automatic spring restored line switch therefor, a motor magnet for said switch, a line relay, controlled at said substation for controlling the operations of said motor magnet, and independent means for operating said motor magnet for rendering said line relay unresponsive to substation control.

20. A telephone system comprising a substation telephone line, a progressively movable switch for said line, contacts and cooperating wipers for said switch, a motor magnet for said switch for moving said wipers over said contacts, and a combined line and release relay provided with a quick-acting armature and a slow-acting armature, said quick-acting armature controlling the operations of said motor magnet and said slow-acting armature controlling the release of said switch.

21. In a telephone system the combination with a substation telephone line, of a switch individual to said line, spring means for said switch for restoring it to normal from an actuated position, contacts and coöperating wipers for said switch, a motor magnet for advancing said wipers over said contacts, and a combined line and release relay for controlling the operations of said motor magnet, the connection of said telephone line to said wipers and the release of said wipers from their advanced position.

22. A line switch for telephone systems comprising contacts and coöperating wipers, spring restoring means for said wipers, a motor magnet for advancing said wipers over said contacts, a holding pawl for holding the wipers in an advanced position, and a combined line and release relay for controlling the operation of said motor magnet and the release of said wipers from their advanced position by actuating said holding pawl.

23. A line switch for telephone systems comprising contacts and coöperating wipers, a motor magnet for moving said wipers over said contents, and a relay provided with a pair of armatures for controlling said magnet, one of said armatures maintaining the other of said armatures in its unattracted position during the interval that the said wipers rest upon a selected set of said contacts.

24. In a telephone system the combination with a substation telephone line, of an individual switch for said line provided with active contacts, a relay for said switch, means controlled at the substation of said line for energizing said relay to cause said switch to perform a selecting operation, a maintaining circuit for said relay including a contact controlled by its armature, and other spring contacts controlled by said relay for connecting said telephone line with said active contacts, and a magnet adapted to be held energized for retaining said relay ineffective when said line is a called line.

25. In a telephone system the combination with a substation telephone line, of trunk lines, a spring restored automatic line switch for said line provided with a relay controlled at the substation for operating said switch to select an idle one of said trunks, means associated with a selected trunk for closing a maintaining circuit for said relay, and contacts actuated by said relay controlling the connection of said line to said selected trunk.

26. In a telephone system the combination with a substation telephone line, of trunk lines, an automatic line switch for said line provided with a single wound relay controlled at the substation for operating said switch to select an idle one of said trunks, means associated with a selected trunk for closing a maintaining circuit for said relay, substation controlled means for opening said maintaining circuit, and mechanism for controlling the restoration of said switch, said mechanism being under the exclusive control of said relay.

27. A spring restored line switch for telephone systems comprising contacts and cooperating wipers, a motor magnet for moving said wipers over said contacts, and a line and cut-off relay for controlling the operation of said motor magnet and the circuits of said wipers.

28. A line switch for telephone systems comprising a single wound electromagnet, a pair of armatures for said electromagnet, means for energizing said electromagnet whereby both of said armatures are attracted, means for retaining one of said armatures and releasing the other of said armatures, and means controlled by the retained armature for preventing the released armature from assuming its attracted position.

29. In a telephone system the combination with a substation telephone line, of an individual switch therefor, a magnet for said switch provided with a pair of armatures, energizing means for said magnet for attracting both of said armatures, means for releasing one of said armatures and retaining the other of said armatures in its attracted position, and means for preventing said released armature from again assuming its attracted position.

30. In a telephone system the combination with a substation telephone line, of an automatic line switch for said line, a magnet provided with a pair of armatures for controlling the operations of said switch, means for closing an energizing circuit for said magnet whereby both of said armatures are effectively attracted, means for opening said circuit whereby one of said armatures releases, means for closing a substitute circuit for said magnet, and means controlled by the attracted armature for preventing the released armature from again assuming its attracted position.

31. A spring restored individual line switch for telephone systems provided with only two magnets, a combined line and release magnet, and a motor magnet.

32. A telephone system including an automatic switch provided with a motor magnet, a pair of windings for said magnet, circuits for said motor magnet whereby said magnet is actuated a single time when said windings are included in series circuit and adapted to operate a plurality of times when only one of said windings is included in a circuit.

33. A telephone system including a subscriber's telephone line, trunk lines, an automatic line switch for said telephone line having a relay provided with a quick-acting armature and a slow-acting armature, the quick-acting armature controlling the operations of said switch in selecting an idle one of said trunks, and the slow-acting armature controlling the restoration of said line switch to normal.

34. A telephone system including a substation telephone line, trunk lines, a self-restoring automatic line switch, a relay for said line switch provided with a pair of armatures, means controlled by one of said armatures upon initiation of a call over said line to select an idle one of said trunks, and mechanically controlled means controlled by the other of said armatures for restoring said switch.

35. A line switch for telephone subscribers provided with only two operating magnets, a set of rotatable wipers for said switch advanced by one of said magnets and released from its advanced position by the other of said magnets.

36. In a telephone system, a subscriber's telephone line, an automatic switch therefor provided with only two operating magnets, rotatable contact makers for said switch, means controlled over said telephone line for operating one of said magnets to advance said contact wipers, and means controlled over said telephone line for operating the other of said magnets to restore said wipers to normal.

37. A spring restored individual line switch for selecting lines provided with only three wipers and with only two magnets, a combined line and release magnet, and a motor magnet.

38. A telephone system including an automatic switch provided with only three wipers, a motor magnet for said switch, said motor magnet being adapted to operate a plurality of times when said switch is used for calling purposes and adapted to be operated a single time when said switch is used for called purposes.

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

FRED SCHOENWOLF.

Witnesses:
G. A. YANOCHOWSKI,
B. O'BRIEN.