C. S. WINSTON.

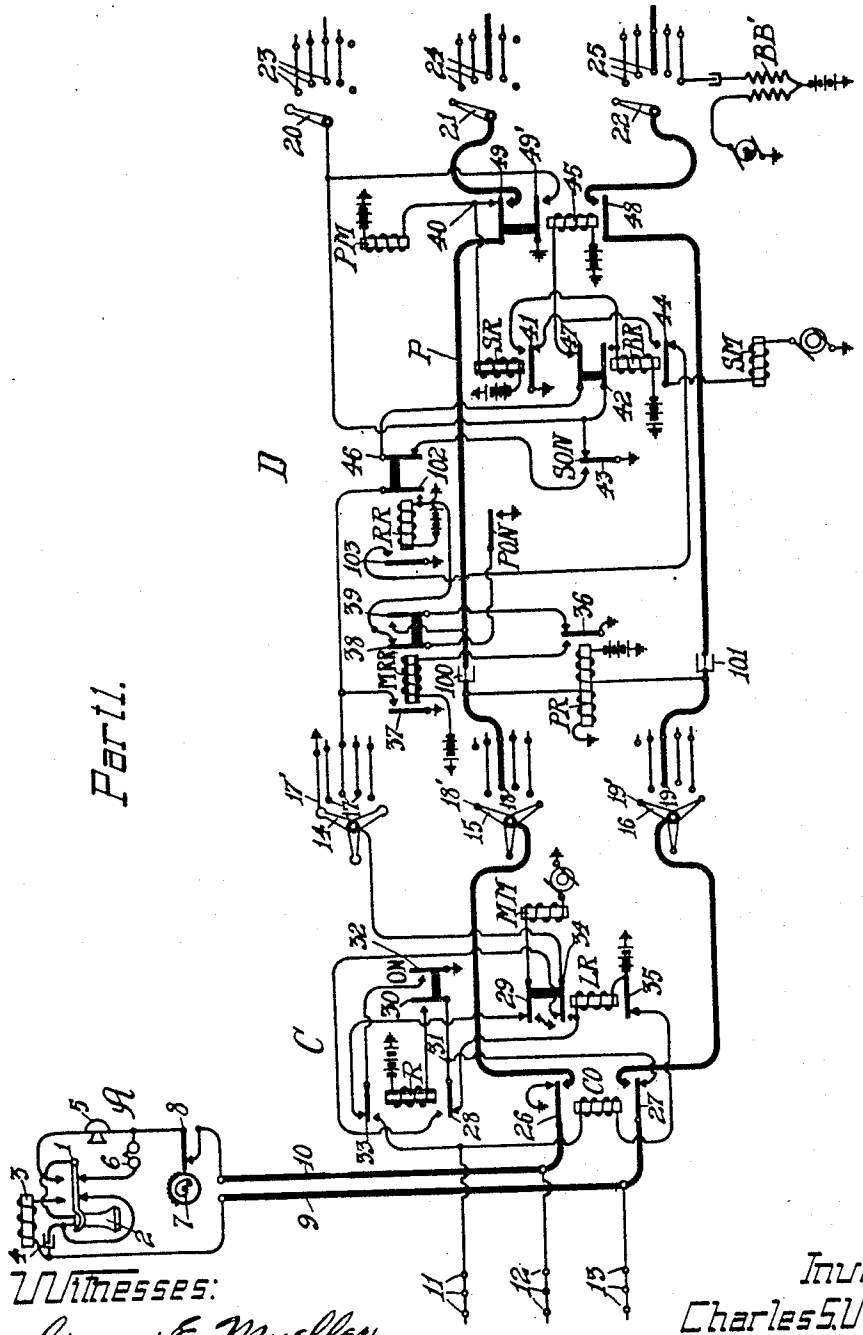
AUTOMATIC TELEPHONE SYSTEM.

APPLICATION FILED FEB. 24, 1911.

1,176,260.

Patented Mar. 21, 1916.

3 SHEETS—SHEET 1.



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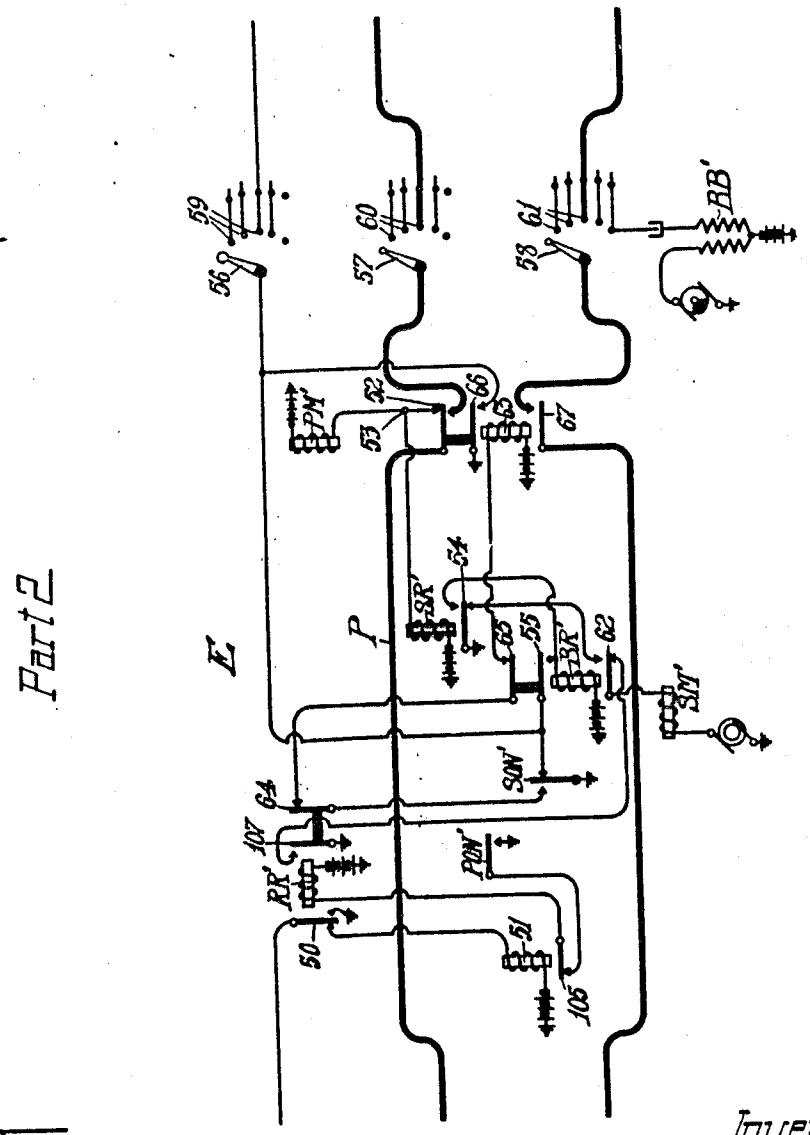

Part 2

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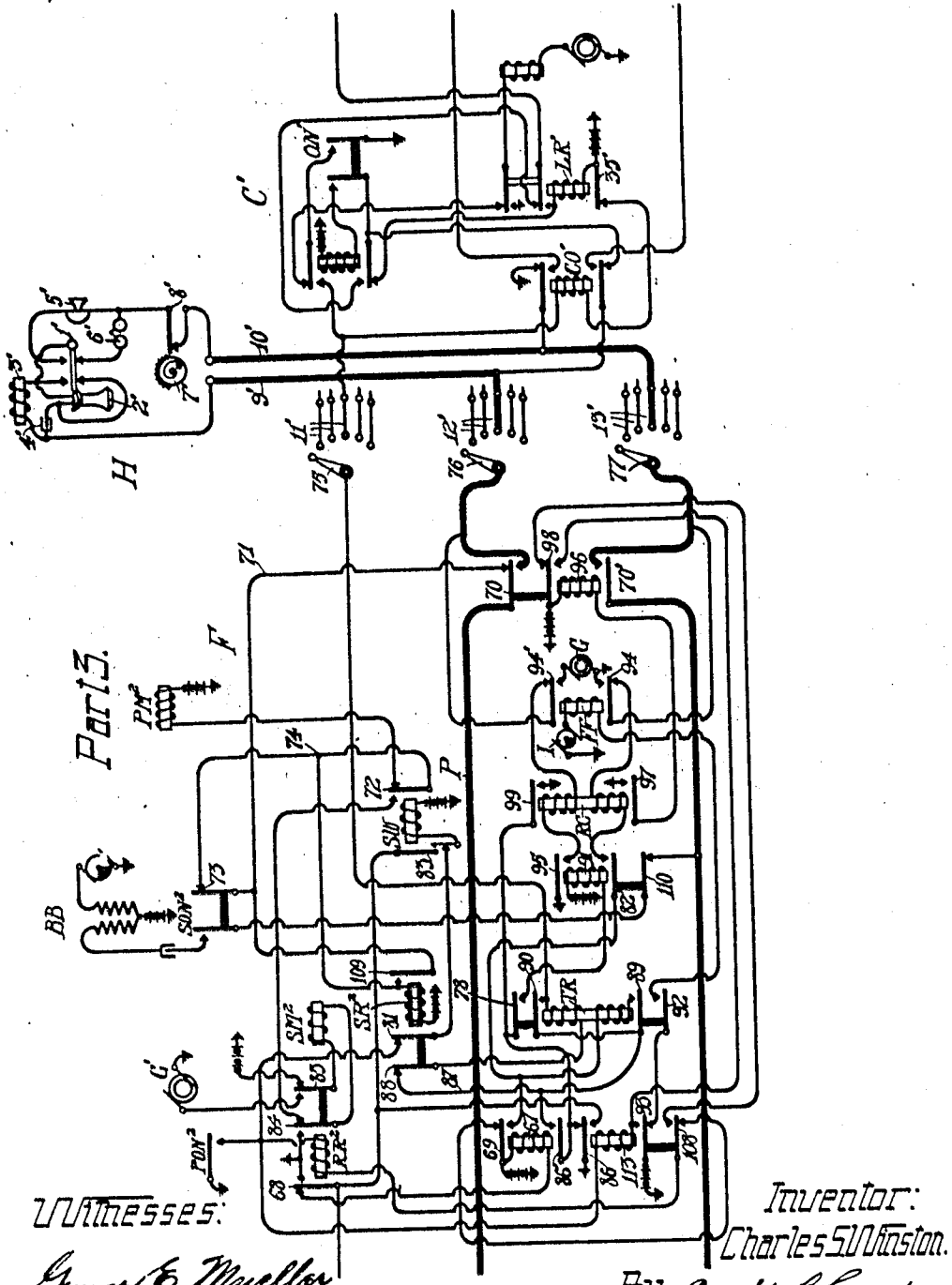

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UNITED STATES PATENT OFFICE.

CHARLES S. WINSTON, OF CHICAGO, ILLINOIS, ASSIGNOR TO KELLOGG SWITCHBOARD AND SUPPLY COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF ILLINOIS.

AUTOMATIC TELEPHONE SYSTEM.

1,176,260. Specification of Letters Patent. Patented Mar. 21, 1916.

Application filed February 24, 1911. Serial No. 610,652.

To all whom it may concern:

Be it known that I, CHARLES S. WINSTON, a citizen of the United States, 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 automatic telephone systems of the type known as two-wire or metallic line systems in which directively controlled switches at the exchange are operated responsive to interruptions of the line circuit by means of a calling device or other suitable means.

My invention is particularly applicable to systems using automatic switches in which the wipers are adjusted in a primary direction to select a group or row of contacts and are then adjusted in a secondary direction to select a contact of a group or row, and in which to release the switches, the wipers are advanced in the secondary direction until they have passed beyond the last contact of the row when they are automatically restored by means of spring tension or gravity.

In an application of William Kaisling for switch for automatic telephone systems, Serial No. 600,664 a switch of the type above referred to is illustrated, and my invention is adapted to be used in connection with a switch of the type therein illustrated. My system is adapted for use with other switches of the type referred to and I do not desire to be limited to the structure disclosed in the said Kaisling application.

My invention is illustrated in the accompanying drawings, comprising Parts 1, 2 and 3, which to be readily followed out are to be placed with Part 2 in the middle, Part 1 to the left of Part 2, and Part 3 to the right of Part 2. Part 1 illustrates a line switch and first selector; Part 2 a second selector, and Part 3, a connector switch and called sub-station with its line switch.

The system as illustrated is adapted for use as a ten-thousand line exchange system, and there would be a line switch C for each line of the exchange. Then on a basis of ten per cent. trunking there would be one thousand first selectors D, one thousand second selectors E, and one thousand connectors F, divided into one-thousand groups and one-hundred sub-groups in a well known manner.

In extending a connection from calling sub-station A to called sub-station H, the switch hook at sub-station A is operated, thereby causing its line switch C to automatically connect with an idle first selector D. A subscriber at sub-station A, by the operation of his calling device, operates the connector first selector D to connect with an idle second selector E. By a further operation of the calling device the calling subscriber operates a connected second selector E to extend the connection to an idle connector switch E, having access to the line of the called sub-station. By a further operation of the calling device the calling subscriber now actuates the selected connector switch F to connect with the line of the called sub-station H. If the called line is busy, a characteristic busy signal will be automatically transmitted to the calling sub-station and the calling subscriber may release all of the switches which were used in establishing the connection by replacing his receiver upon its switch hook. Should the called line be idle, the call bell of the desired sub-station is automatically operated by applying ringing current to the terminals of the called line, and upon a response from the called sub-station the ringing current is automatically disconnected. The subscribers being connected for conversation, when desired may release the switches which were used in establishing the connection. The release of the line switch C, first selector D and second selector E is controlled at the calling sub-station A and the release of the connector switch F is controlled at the called sub-station H.

Each sub-station A comprises a well known form of sub-station telephone, having a switch hook 1, receiver 2, impedance coil 3 and condenser 4, and also includes the transmitter 5 and call bell 6, which are adapted to be connected in and out of circuit by means of the switch hook 1. Each sub-station A also includes a calling device, comprising a spring return dial 7, and impulse springs 8. The calling device is so arranged that when the dial 7 is rotated in a clockwise direction, the insulated projections on its periphery do not open the impulse springs 8 but upon the return of the dial 7 after it is released by the operator, each insulated projection opens the contact springs 8 a single time. In other words, if in ad-

vancing the dial 7, five projections pass the springs 8, upon the return of the dial the connection between the said springs 8 is interrupted five times. Each sub-station is connection with an exchange by means of line limbs 9 and 10 which terminate at a line switch C, and are also multiply connected to terminals 11, 12 and 13 of connector switches having access to the line of the said sub-station.

Each line switch C includes a line relay LR which is adapted to be energized upon initiation of a call from the connected sub-station, a cutoff relay CO which is adapted to remove the sub-station control of relay LR, a motor magnet MM which is adapted to advance the wipers of the switch, a release relay R which controls the restoration of the wipers to normal and off normal contacts ON which are adapted to move to their alternate position upon the first step of switch C off normal.

The wipers 14, 15 and 16 are mounted on a single shaft having a suitable ratchet wheel secured thereto and connected to a suitable driving pawl of motor magnet MM. The bank contacts 17, 18 and 19 are arranged in three rows, each row being adapted to coöperate with the said wipers 14, 15 and 16 respectively. Each row of contacts, contain ten such contact sets, while each row also has a normal contact 17', 18' or 19'. It will be noted that each wiper has three projecting arms each carrying a wiper end and the bank contacts are so positioned that when the wipers are advanced, upon one wiper arm leaving the last bank contact, the preceding wiper arm is in a position resting upon its normal bank contact 17', 18', or 19'. The wiper ends 14 are so shaped that when advanced from one contact to the next, they make connection with one contact before breaking connection with the preceding contact. The line wipers 15 and 16 are so arranged that in advancing they break connection with one contact before making connection with the succeeding contact in the row. The motor magnet MM and mechanism is so arranged that for each energization and deënergization of magnet MM, one step of wipers 14, 15 and 16 is effected, each such step advancing the wipers from one set of contacts to the next. In the operation of line switch C, the wipers are moved to connect with one of the bank contact sets and thereafter to restore the switch, the wipers are again advanced until the engaged arms advance one step beyond the last contact in the bank, when as previously stated the preceding arms connect with the normal contacts in the bank and the switch remains thus. The off-normal switch ON is so connected with the wiper shaft that upon the first movement of the said shaft off normal, the said switch assumes an alternate position, retaining this position until the wipers are again advanced to a normal position, when the said off normal switch is thereby restored to its normal position.

In the system of my invention I divide the telephone lines in to groups of one hundred in a well known manner and I provide ten first selectors D for each one hundred lines. Therefore, each such first selector D would be multiply connected to the bank contacts of one hundred line switches C, although in the illustration I have shown but two such multiple connections, and of course there being ten contact sets 17, 18, 19, each switch C has access to ten first selectors D. Each first selector D includes a primary relay PR, which is in bridge of the talking conductors and when connected with a calling line is controlled at the sub-station thereof, to transmit the primary or directive impulses for controlling the switches in extending a connection to a called line. Each switch D also includes a main release relay MRR which is controlled at a connected calling sub-station through the medium of a relay PR. Release relay RR when operated, controls the release of its switch. Primary magnet PM is adapted when operated to adjust the wipers 20, 21 and 22 of the switch in a primary direction to select a group or row of contacts, determined by the number of impulses transmitted, while the secondary magnet SM when operated advances the wipers in a secondary direction to connect with a set of contacts 23, 24, 25 in the selected row, leading to an idle second selector switch E. Secondary relay SR, is a slow relay, or one in which the armature is momentarily held attracted after its energizing circuit is interrupted, the said relay SR being adapted to control the starting of the said secondary movement of the wipers. Busy relay BR is adapted to control the operation of magnet SM in selecting an idle set of bank contacts. Each first selector D has a private or busy wiper 20 and a pair of line wipers 21 and 22. The contact bank of switch D includes one hundred sets of contacts 23, 24 and 25, being arranged in ten groups or rows of ten contact sets each. The primary off normal switch PON is adapted upon the first primary movement of wipers 20, 21 and 22, to move to an alternate position, while the secondary off normal switch SON is adapted upon the first secondary step of said wipers to move to an alternate position. Each first selector D having one hundred sets of bank contacts 23, 24, 25, would of course have access to one hundred second selectors E. Each such second selector E would be multiply connected to the bank contacts of ten first selectors D although I have illustrated but two such multiple connections. The second selector E includes a contact bank and coöperating

wipers, similarly arranged to the contact banks and wipers of the first selectors D. The operating relays and magnets of second selector E which have functions corresponding to similar relays and magnets of first selector D, have corresponding reference characters but include the suffix "′". This is also true of the off normal switches.

Each connector switch F includes relays, magnets, and off normal switches having functions corresponding to the relays, etc., of the first and second selectors, and in the said switch F these parts have corresponding reference characters but with the suffix "2". The bank contacts and coöperating wipers of connector switch F are arranged similar to the bank contacts and wipers of the other switches. Connector switch F has in addition to the magnets, relays, etc., referred to, several other relays, including a switching relay SW which is adapted to disconnect the primary magnet PM^2 and connect the secondary magnet SM^2 to the upper heavily marked conductor, so that they may be operated in their proper sequence by the current impulses. The test relay TR is adapted to be operated by a secondary impulse to test a called line for its idle or busy condition, and thereafter if the line be busy it controls the application of busy signals from busy back BB, or if the line be idle the so called flipflop, or interrupter relay FF, is operated to alternately connect ringing current and the ringing control relay RC to the terminals of the called line. The operation of the other relays of switch F will be more particularly pointed out in the description of the operation of the system. To each group of one hundred lines there are ten such connector switches F, the hundred lines of each group being multiply connected to bank terminals of the ten associated connector switches, although in the illustration but two such multiple connections are shown.

The called sub-station H includes apparatus similar to that of calling sub-station A, but the reference characters of the sub-station H having the suffix "′". The line switch C′ is similar to line switch C, the corresponding parts of switch C′ having reference characters corresponding to those of line switch C but having the suffix "′".

While I have indicated a plurality of batteries, it is to be understood that they may be one and the same, this also being true of the magnet operating alternating current generators.

It is to be understood that although I have shown some of the apparatus connected to ground, in practice this apparatus would be connected to the grounded pole of the battery.

Operation.—Having described in general the apparatus used in the different types of switches and sub-stations, the operation of the system in establishing a connection between a calling and called sub-station will now be described.

Assuming that sub-station A is a calling sub-station and a subscriber thereat desires connection with a subscriber at sub-station H, whose number we will assume is "2343", the subscriber at A removes receiver 2 from its switch hook 1, thereby closing the upper contacts of the switch hook and establishing a circuit for line relay LR, traced from ground at normal contact 26, line conductor 10, sub-station A, line conductor 9, normal contact 27, normal contact 28 of relay R, through the winding of line relay LR to battery, energizing the said relay. Responsive to this energization of relay LR, a circuit for motor magnet MM is established, from ground through alternate contact 29, and the winding of magnet MM, to the alternating current generator, the said magnet MM being thereby energized and stepping wipers 14, 15 and 16 into engagement with the first set of contacts 17, 18 and 19. Upon the first step of the said wipers, off normal switch ON assumes its alternate position and a circuit for relay R is closed through alternate contact 30, traced from ground at normal contact 26, over the previously described path, including sub-station A, returning to point 31, then through alternate contact 30 and the winding of relay R to battery. Relay R is thereupon energized, placing a direct ground upon the private contacts 11, traced from ground at alternate contact 32 of switch ON, alternate contact 33, to said multiple contact 11, thus placing a busy condition upon said contacts 11 and preventing any connector switch from connecting with the sub-station A.

Returning now to relay LR it will be remembered that magnet MM has stepped wipers 14, 15 and 16 into engagement with the first set of bank contacts, and assuming that the first set lead to a busy first selector D, there will be a ground upon private contact 17, and a locking circuit for relay LR will be established from said ground through alternate contact 34. Motor magnet MM thereupon advances the wipers another step into engagement with the next set of contacts which are connected to selector switch D, and assuming the switch is in an idle condition as illustrated, there will be no ground connection to its private contact 17 and the circuit of relay LR being interrupted, said relay LR deënergizes, interrupting the circuit through motor magnet MM and preventing any further advance of wipers 14, 15 and 16. Upon deënergization of relay LR a circuit for cutoff relay CO is established from ground through alternate contact 32 of switch ON, alternate contact 33, the winding of relay CO to battery at nor-

mal contact 35. Relay CO is thereupon energized, interrupting the initial energizing circuit for relay R, but the said relay being a slow acting relay does not retract its armature, as a locking circuit is established from relay MRR of switch D as will now be described. Upon the said energization of relay CO primary relay PR of first selector D is energized, due to the closing of alternate contacts 26 and 27 of relay CO, the energizing circuit for the said relay PR being traced from ground through the left-hand winding of relay PR, along the upper heavily marked conductor, over the line limbs and sub-station A, returning over the lower heavily marked conductor and through the right-hand winding of relay PR to battery. Relay PR is thereupon energized closing a circuit through main release relay MRR, from ground through alternate contact 36, thus energizing relay MRR and establishing a locking circuit for relay R as previously stated, traced from ground through alternate contact 37, bank contact 17, wiper 14, normal contact 34, alternate contact 28, alternate contact 30 and the winding of relay R to battery. It will be noted that the main release relay MRR, being a slow acting relay, does not retract its armature when primary relay PR is rapidly operated to transmit impulses, and that the said relay MRR retains its armature in an attracted position until the circuit for relay PR is interrupted for a comparatively long period, which is preferably accomplished by the replacing of receiver 2 upon its switch hook. The line of sub-station A having now been extended to first selector D, the calling subscriber operates dial 7 to cause by means of contact springs 8, two interruptions of the energizing circuit of relay PR. Responsive to the said two interruptions, relay PR retracts its armature two times, thereby transmitting two impulses from ground through normal contact 36, alternate contact 39 of relay MRR, which retains its armature attracted, conductor P, normal contact 49 to point 40 where the said impulses divide, part of the current passing through primary magnet PM, and part through secondary relay SR. Responsive to these impulses, secondary relay SR is energized, closing a circuit through relay BR from ground through alternate contact 41, energizing relay BR which locks itself up through alternate contact 42 and normal contact 43 to ground, said relay SR remaining energized during the sending of the impulses. Also responsive to these impulses primary magnet PM is energized and deënergized two times, thereby stepping wipers 20, 21 and 22 to select the second group or row of contacts of the bank, the said group of contacts being connected with second selectors in the thousand group with which the called line is associated.

Returning now to secondary relay SR, the said relay being slow, as previously described, retains its armature in an attracted position until after the last impulse has been transmitted, when said armature is retracted and a circuit for secondary magnet SM is established from ground through normal contact 41, alternate contact 44, and the winding of magnet SM to alternating current generator. The said magnet is thereupon energized, stepping wipers 20, 21 and 22 into engagement with the first set of contacts 23, 24 and 25. Assuming these contacts lead to a busy second selector E there will be a ground upon private contact 23 and a locking circuit for relay BR will be established from the said ground through wiper 20, alternate contact 42 and the winding of said relay BR to battery, as the off normal switch SON has moved to its alternate position upon the first secondary step of the said wipers interrupting the locking circuit from contact 43. The said busy relay BR remaining energized, magnet SM advances wipers 20, 21 and 22 to the second set of contacts, and assuming these contacts lead to a busy second selector E, relay BR remains energized and magnet SM steps the said wipers into engagement with the next set of bank contacts 23, 24 and 25, which we will assume are the contacts leading to an idle second selector E. There being no ground upon private contact 23 in this instance, relay BR is deënergized, interrupting the circuit for secondary magnet SM, thus preventing any further advance of wipers 20, 21 and 22. Upon deënergization of relay BR the relay 45 is energized over the circuit traced from ground through alternate contact 43 of switch SON, normal contact 46, normal contact 47, winding of said relay 45 to battery. Responsive to the energization of relay 45 alternate contacts 48 and 49 are closed, thus extending the connection to second selector E. Also, upon energization of relay 45 alternate contact 49′ is closed, thereby placing a busy or ground condition upon the multiple contacts 23, thus preventing any other switch from connecting with second selector E. This ground connection also extends through contact 50 and relay 51 to battery, energizing the said relay 51. The subscriber at sub-station A now operates the dial 7 to interrupt, by means of contact springs 8, the circuit of primary relay PR three times, the said relay PR transmitting three impulses from ground through normal contact, 36, alternate contact 39, conductor P, alternate contact 49, wiper 21, contact 24, normal contact 52, to common point 53, dividing and flowing through primary magnet PM′ and secondary relay SR′. Re-

sponsive to these three current impulses, relay SR′ is energized closing a circuit through relay BR′ from ground at alternate contact 54, energizing the said relay BR′, which establishes a locking circuit for itself through alternate contact 55 and normal contact of switch SON′ to ground. Relay SR′ being a slow relay retains its armature in an attracted position until after the last of the three said impulses. These three impulses also energize and deënergize primary magnet PM′, which steps wipers 56, 57 and 58 to select the third row or group of contacts of the switch, the said third row of contacts being connected with connector switches F having access to the one hundred group in which the line of called sub-station H terminates. After the last of the three said impulses has been transmitted as described, secondary relay SR′ retracts its armature and a circuit for secondary magnet SM′ is closed from ground through normal contact 54, alternate contact 62 through the winding of said magnet SM′ to alternating current generator. The said magnet SM′ is thereupon energized, stepping wipers 56, 57 and 58 into engagement with the first set of contacts 59, 60 and 61 of the selected row. If the first set of contacts lead to a busy connector switch F there will be a ground upon private contact 59 and a locking circuit will be established for busy relay BR′ from the said ground, the initial locking circuit for the said relay BR′ having been interrupted when switch SON′ moves to its alternate position upon the first secondary movement of wipers 56, 57 and 58. The said relay BR′ remaining energized, the secondary magnet SM′ steps the wipers into engagement with the second set of bank contacts and assuming these also lead to a busy connector the secondary magnet will advance the wipers into engagement with the next set of bank contacts which we will assume are the contacts 59, 60 and 61 leading to the idle connector switch F illustrated. The said connector F being idle there will be no ground upon the private contact 59 and relay BR′ having its locking circuit interrupted, is deënergized, thereby opening the circuit through secondary magnet SM′, thus preventing any further advance of wipers 56, 57 and 58. Upon the said deënergization of relay BR′ a circuit for relay 63 is established from ground through the alternate contact of switch SON′, normal contact 64, normal contact 65, the winding of said relay 63 to battery, energizing the said relay and closing contact 66, thereby connecting ground to wiper 56, and the multiple contacts 59 with which it is connected, thus preventing any other switch from connecting with the selected connector switch F. Also, upon the energization of relay 63 alternate contacts 52 and 67 are closed, thereby extending the talking conductors of the calling sub-station to the connector switch F. The ground connection from contact 66 to wiper 56 also establishes an energizing circuit for relay 67 of connector F being traced through normal contact 68 of relay RR^2. Said relay 67 is energized closing alternate contact 69, but this has no effect upon the circuit at this time. The subscriber at A now operates dial 7 to interrupt, by means of contact springs 8, the circuit of primary relay PR four times, thereby transmitting four current impulses from ground at normal contact 36 over the previously described path, along the upper heavily marked conductor P, through wipers 21 and 57, normal contact 70, conductor 71, normal contact 73, tie 74, normal contact 72 and the winding of primary magnet PM^2 to battery. The said current impulses divide at tie 74, also passing through the winding of secondary relay SR^2 to battery. These said impulses energize relay SR^2 and the said relay being slow acting, maintains its armature in an attracted position until after the last of the four impulses have been transmitted. The said four impulses serve to operate primary magnet PM^2, energizing and deënergizing the said magnet four times, thereby stepping wipers 75, 76 and 77 to select the fourth row of bank contacts, the said row including the terminals 11′, 12′, 13′ of the line of the called sub-station H. After the last impulse has been transmitted secondary relay SR^2 is deënergized releasing its armature, and a circuit for switching relay SW is established from ground, through the alternate contact of switch PON^2, which has moved to its alternate position upon the first primary step of the wipers, normal contact 81, the winding of said relay SW, to battery, energizing the said relay SW which establishes a locking circuit for itself from ground through contact 59 of selector E, alternate contact 83. Upon the said energization of relay SW, contact 72 is moved to its alternate position, thereby disconnecting the primary magnet PM^2 and connecting secondary magnet SM^2 to the upper heavily marked conductor P. The calling subscriber now operates dial 7 to interrupt by means of contact springs 8, the circuit of primary relay PR three times, thereby transmitting three impulses of current from ground at normal contact 36 along the upper heavily marked conductor to normal contact 70, the first one of the three impulses passing over normal contact 73, tie 74, dividing at this point and part of the current passing through alternate contact 72, normal contact 84, the winding of secondary magnet SM^2 and normal contact 85 to battery and part of the current

passing through secondary relay SR^2 to battery. Responsive to the first one of the three impulses, magnet SM^2 steps the wipers 75, 76 and 77 into engagement with the first set of contacts 11', 12' and 13', thereby causing the switch to move secondary off normal contacts SON^2 to their alternate position and interrupting the normal contact 73. The remaining impulses then flow from normal contact 70 through alternate contact 109 and the winding of relay SR^2 to battery, and dividing at alternate contact 109, part of the current of the impulses flows to tie 74, alternate contact 72 and then over the previously described path through magnet SM^2 to battery, operating the said magnet two more times thereby advancing wipers 75, 76 and 77 into engagement with contacts 11', 12' and 13', which are the line terminals of the line of substation H. From the foregoing it will be seen that the first impulse of the last series flows through normal contact 73, while the rest of the impulses flow through alternate contact 109 and then through relay SR^2 and magnet SM^2. After the last impulse, relay SR^2 is deënergized and a circuit for relay TR is closed from ground at normal contact 86, alternate contact 86', conductor 87, normal contact 88, the upper winding of relay TR to private wiper 75. Up to this period, the operation of the system is the same whether connecting to an idle or a busy line, but from this point on the operation differs, depending upon whether the called line is in an idle or busy condition.

Called line idle.—We will assume now that the line of the called sub-station H is in an idle condition and therefore it would be in a condition as illustrated in Part 3. It will be remembered that upon the last deenergization of relay SR^2 that a circuit was traced from ground at contact 86, through the upper winding of relay TR to wiper 75. The line of sub-station H being idle this circuit would be continued through the said wiper 75, contact 11', and the winding of cutoff relay CO' to battery at contact 35'. Responsive to the closing of this circuit the relays TR and CO' are energized, relay CO' thereby removing the sub-station control of line switch C'. Upon energization of relay TR a locking circuit therefor is established from the said ground at contact 86, alternate contact 86', alternate contact 89 and the lower winding of relay TR to battery at alternate contact 69. The closing of alternate contact 90 of relay TR places a direct ground connection from the said contact 86, upon wiper 75 and the multiple contacts 11', thus maintaining relay CO' energized and also preventing any other connector switch from establishing connection with the line of sub-station H. It will be noted that the closing of this contact 90 places a shunt around the upper winding of relay TR and therefore the said relay is maintained energized by current through its lower winding over the previously described path. Also, upon the closing of alternate contact 78 of relay TR, a circuit is established from battery through the winding of relay 91 to the ground at normal contact 86, thus energizing said relay 91. Also, upon energization of relay TR a circuit for relay FF is established from ground through interrupter I, winding of said relay FF, alternate contact 92, normal contact 93, to battery. Due to the interruptions of the energizing circuit of relay FF by the interrupter I, the said relay attracts and retracts its armature, thereby operating springs 94' and 94, and alternately connecting ringing generator G and the windings of ringing control relay RC to the terminals 12' and 13' of the called sub-station H. Thus, upon each energization of relay FF, ringing current from generator G is applied to the called line, being traced from the ungrounded pole of generator G, alternate contact 94', wiper 76, terminal 12', line conductor 9', through the call bell 6' of sub-station H, returning over line conductor 10', terminals 13', wiper 77, alternate contact 94 to the grounded pole of generator G, thereby operating the said call bell 6'. Upon retraction of the armature of relay FF normal contacts 94 and 94' are closed, thereby connecting the windings of ringing control relay RC to the terminals of the called line. The circuit through the upper winding of relay RC is traced from ground through alternate contact 95, the said upper winding, normal contact 94', to the wiper 76 and terminal 12' while the lower winding of the said relay RC is included in a circuit traced from battery at alternate contact 69 of relay 67, alternate contact 82, the said lower winding of relay RC, normal contact 94 to the wiper 77 and terminal 13'. Thus it will be seen that the windings of relay RC are included in a circuit which is interrupted by the condenser 4', and therefore while receiver 2' is on its switch-hook, relay RC does not energize and thus relay FF continues to alternately connect generator G and said relay RC in bridge of the terminals 12' and 13' of the called line. In response to the operation of call bell 6', the called subscriber removes receiver 2' from its switch-hook, thereby interrupting the circuit through the said call bell and establishing a circuit for direct current through impedance coil 3' and the upper contacts of switch-hook 1'. Therefore, it will be seen that upon response of the called subscriber, a circuit for direct current is established through the alternate switch-hook contacts of substation H and ringing control relay RC is energized by current over the previously described path.

Responsive to the energization of relay RC a circuit for relay 96 is established from ground through alternate contact 97 and the winding of relay 96 to battery, energizing relay 96 and establishing a circuit for relay 113 from battery through alternate contact 98, the winding of said relay 113 to ground at alternate contact PON², relay 113 establishing a locking circuit for itself to battery through alternate contact 93. Upon said energization of relay 113, normal contact 86 is opened, but relay RC having previously been energized, a substitute locking circuit for relays TR and 91 is established from ground through alternate contact 99 of relay RC. The circuit through relay FF being interrupted upon the energization of relay 113 the said relay FF remains inert with its armature retracted. The relay 96 having closed alternate contacts 70 and 70′ upon its energization, the calling sub-station A and called sub-station H are connected for conversation, the said connection extending over the heavily marked conductors having the condensers 100 and 101 interposed at first selector D. Talking current for sub-station A is supplied from battery through relay PR and talking current for sub-station H is supplied from battery through the windings of relay RC.

Release of completed connection.—After the subscribers have finished conversation, by replacing their receivers upon their respective switchhooks, they may release all of the switches used in establishing the connection, the calling subscriber controlling the release of line switch C, first selector D and second selector E, and the called subscriber controlling the release of connector switch F. Upon the subscriber at substation A replacing receiver 2 upon its switchhook, the circuit through relay PR is interrupted, deenergizing the said relay and interrupting the circuit through main release relay MRR, at alternate contact 36. Relay MRR thereupon retracts its armature, closing a circuit through release relay RR from ground through switch PON, normal contact 38, the winding of relay RR to battery, energizing the said relay RR and by means of alternate contact 102 maintaining relay R of switch C energized, this circuit being substituted for the connection from contact 37, which is now open. Upon energization of relay RR the circuit through relay 45 is interrupted at contact 46 allowing said relay 45 to deënergize. Also, upon energization of relay RR, a circuit for magnet SM is established from ground through alternate contact 103, normal contact 44, the winding magnet SM to alternating current generator. Responsive to current from said generator, magnet SM advances wipers 20, 21 and 22 until they reach a point beyond the last contact of the row. When the wipers reach this position the primary retaining pawl is automatically withdrawn allowing the said wipers to be restored by spring tension from their primary adjustment. Upon the restoration of the said wipers from the primary adjustment the secondary retaining pawl is automatically withdrawn allowing the said wipers to be restored by spring tension from this secondary adjustment. Upon the restoration of the wipers from this primary adjustment which is accomplished first, switch PON restores to normal interrupting the circuit of relay RR allowing the said relay to deënergize thereby interrupting the circuit through magnet SM at contact 103. It will be seen from this that while the wipers are restoring from their primary movement magnet SM might receive one or more energizations, but due to the construction of the switch this has no effect upon the restoration of the wipers. Upon restoration of the wipers from their secondary adjustment which is the last restoring movement, and upon the said wipers reaching normal, switch SON is restored.

Returning now to relay RR, upon the said deënergization of this relay, the energizing circuit for release relay R of switch C is interrupted upon the opening of contact 102, thus allowing the said relay R to deënergize and restore its contacts, interrupting the circuit through cutoff relay CO at alternate contact 33, allowing said relay CO to deënergize. Also, upon deenergization of relay R a circuit for motor magnet MM is established, traced from ground through alternate contact 32 of switch ON, normal contact 33, normal contact 29, the winding of magnet MM to alternating current generator. Magnet MM is thereupon operated responsive to current from the said generator, stepping wipers 14, 15 and 16 forward until they have advanced one step beyond the last contact in the row, when the off normal switch ON moves back into its normal position thereby interrupting the circuit through magnet MM and preventing any further advance of the wipers. Thus, it will be seen, line switch C and first selector D have been restored to normal and are available for establishing another connection.

Referring now to the release of second selector E and returning once more to first selector D, it will be remembered that relay 45 was deënergized upon the energization of relay RR, thereby interrupting, by means of contact 49′, the circuit of relay 51, selector E. Upon deënergization of relay 51, a circuit for release relay RR′ is established from ground at switch PON′, which is closed, normal contact 105, through the winding of relay RR′ to battery. Relay RR′ is thereupon energized interrupting the circuit through relay 63 by means of contact

64 and closing an energizing circuit through magnet SM′ traced from ground through alternate contact 107, normal contact 62, the winding of magnet SM′ to alternating current generator. The secondary magnet SM′ thereupon advances wipers 56, 57 and 58 to a point beyond the last set of contacts in the row, whereupon the said wipers are automatically restored by spring tension, in a manner similar to that of first selector D. The off normal switch PON′ is first restored to normal and thereafter upon restoration of the wipers to their normal resting position, the secondary switch SON′ is restored. Upon restoration of switch PON′ the circuit through relay RR′ is interrupted allowing the said relay to deënergize and interrupt the circuit through secondary magnet SM′. The switch E having been restored to normal is available for further use in establishing other connections. During the restoration of second selector E and upon deënergization of its relay 63 the ground connection from the said switch to wiper 56 and multiple contact 59 is interrupted at contact 66 of relay 63, but the contacts 59 are maintained busy from ground at alternate contact 86, of relay 113 of connector switch F, thus preventing any other second selector from connecting with switch F until it has been restored. Upon the subscriber at sub-station H replacing his receiver upon its switch-hook, the circuit through relay RC is interrupted at the upper contacts of the said switch hook and the said relay RC is deënergized opening its contact 99, thereby interrupting the circuit through relays TR, 91 and CO′, allowing the said relays to deënergize, and opening its contact 97 allowing relay 96 to deënergize. Upon deënergization of relay 96, a circuit for release relay RR^2 is established, from battery through normal contact 98, alternate contact 108, the winding of relay RR^2 to ground at off normal switch PON^2. Relay RR^2 is thereupon energized allowing relay 67 to deënergize and closing alternate contacts 84 and 85 thereby establishing a circuit through magnet SM^2 from alternating current generator G′. Magnet SM^2 thereupon advances wipers 75, 76 and 77 to a point beyond the last set of contacts in the row, whereupon the said wipers are automatically restored by spring tension as in the case of the first and second selectors. In the restoration of the wipers, switch PON^2 is first restored to normal and thereafter switch SON^2 is restored to normal. Upon restoration of switch PON^2 the circuit through relays RR^2, and 113 is interrupted allowing the said relays to deënergize, and the deënergization of relay 113 interrupts the circuit through relay SW. Upon restoration of switch SON^2 which occurs after the restoration of switch PON^2, magnet PM^2 is again connected through contact 73, and relay CO′ having been deënergized as previously stated, connector switch F, and the line switch C′ of substation H are available for further use in establishing other connections.

Connection with busy line.—Having described the operation of the system in connecting with an idle line, the operation will now be described in connecting with a busy called line.

As previously stated the operation of the system until the last impulse has been transmitted from the calling substation is similar either in connecting to the terminals of an idle or busy line, but thereafter the operation differs. We will now assume that the called substation H is busy and therefore there will be a ground connection upon multiple terminal 11′ from ground at switch ON′ if substation H be calling or if it be called the said multiple terminals 11′, will be connected to ground from a connector switch as previously described. It will also be remembered that after the last impulse has been transmitted and wipers 75, 76 and 77 connected with terminal contacts 11′, 12′ and 13′, that relays 67 and SW were locked in an energized position. After the last impulse has been transmitted as stated, relay SR^2 deënergizes, closing contacts 88 and connecting ground from normal contact 86 to said contact 88, the upper winding of test relay TR to wipers 75, but as the terminals 11′ are at this time connected with a direct ground due to the busy condition of the line of substation H, relay TR does not energize and therefore relays 91 or FF are not energized. A characteristic busy signal is now transmitted to the calling sub-station being traced from busy back BB through the alternate contact of switch SON^2, normal contact 110, back along the lower heavily marked conductor, over line conductor 9, the receiver of sub-station A, returning over line conductor 10, along the upper heavily marked conductor and through the lefthand winding of relay PR to ground. The calling subscriber hearing this signal knows that the called substation is busy and therefore by replacing his receiver upon its switch hook will release the switches used in establishing the connection. The release of line switch C, first selector D and second selector E is accomplished as previously described when connecting to an idle line, but the release of the connector switch is accomplished in a different manner, that is the relays are operated differently. It will be remembered that when connecting to an idle line, and upon response of the called subscriber, relay RC is energized, followed by the energization of relay 96, which in turn closed an energizing path through 113, but, when connecting to a busy line it will be remembered that none of these three re-

lays are energized. Therefore, relay 113 not having energized, no locking circuit for relay 67 was established and the said relay 67 therefore deënergized when the ground connection from contact 66 relay 63 of second selector E was interrupted, upon release of selector E. Therefore, relay 67 deenergizes and a circuit for relay RR^2 is established from battery through normal contact 69, normal contact 108, relay RR^2 to ground at switch PON^2. Relay RR^2 is thereupon energized, closing a circuit through secondary magnet SM^2 as before traced from ground through alternate contact 84, winding of magnet SM^2, alternate contact 85, to alternating current generator G'. Magnet SM^2 thereupon steps wipers 75, 76 and 77 to a point beyond the last contacts of the row and the switch is automatically restored as previously described. Off normal switches PON^2 and SON^2 are restored to normal as before and the circuit through relay RR^2 is interrupted allowing the said relay to deënergize and interrupt the circuit through magnet SM^2 preventing any further actuation thereof. The connector switch F and its relays are now at normal and said switch F is available for further use in establishing other connections.

The system of my invention is so arranged that any switch operated in an incompleted connection may be restored by the calling subscriber. For instance, should a subscriber at A simply remove the receiver from his switch-hook and thereafter restore it without operating the dial, line switch C would connect with a first selector D energizing relays PR and MRR as usual and the subscriber then replacing his receiver, relay PR would deënergize, interrupting the circuit through relay MRR which in turn would interrupt the locking circuit for release relay R of line switch C, allowing the said switch to restore to normal. Should the subscriber at A operate the calling device a single time, thereby operating first selector D, and then replace his receiver upon its switch hook, relay PR would deenergize as before, interrupting the circuit through relay MRR which in turn would be deënergized, closing a circuit through release relay RR thereby releasing first selector D, and upon the deënergization of relay RR resulting from the opening of off normal switch PON, line switch C would restore as previously described. Should the subscriber at A operate first selector D and a second selector E, and then replace his receiver upon its switch hook, first selector D and line switch C would restore and upon deënergization of relay 45 of selector D, relay 51 of second selector E would deënergize, allowing the relay RR' to energize, thereby causing the restoration of second selector E as previously described. Should a calling subscriber extend connection from his line to the line of an idle called subscriber and then replace his receiver upon its switch hook before the called subscriber has responded, line switch C, first selector D and second selector E will release as before and upon deënergization of relay 63 of second selector E, relay 67 of connector switch F will deënergize, as it will be remembered that the called subscriber not having responded, relay 113 has not been energized, therefore no locking circuit for relay 67 was established. Upon deënergization of relay 67 relay RR^2 is energized, thereby causing restoration of connector switch F as previously described, and it is now available for use in establishing other connections.

Where an automatic switch is used for establishing connection with an idle one of a group of trunks, it is desirable, should all trunks be busy, to transmit a signal to the calling subscriber. Accordingly I preferably connect a busy-back arrangement BB' to a contact beyond the last trunk contact of each group, so that should all trunks be busy, the switch wipers will remain in connection with the contact set connected with the busy-back and the subscriber receiving this signal, replaces his receiver upon its switch-hook, thus restoring the switches operated to normal, in a manner as previously described.

While I have illustrated and described my invention as operating in connection with a preferred form of switch structure, I do not wish to be limited to any particular type of switch, as I have contemplated using my invention with any switch having the necessary characteristics to coöperate therewith. Neither do I wish to be limited to the specific circuit arrangement illustrated, as many changes and modifications of my invention may be made and I desire to cover all such changes and modifications as come within the spirit and scope of the appended claims.

I claim as my invention:

1. An automatic selector comprising a primary relay, a source of current, a circuit including said relay and source of current to energize said relay, means for effecting changes in said circuit whereby said relay is operated, a slow relay energized responsive to initial energization of the primary relay, and maintaining its armature attracted while said primary relay is operating, adjusting electromagnets operated responsive to the said operation of the primary relay, means for deënergizing said relays, and release mechanism including one of said magnets effective upon said deënergization.

2. A selector for telephone systems comprising a metallic circuit, a primary relay

and source of current for energizing said relay in bridge of said circuit, means for rapidly interrupting said circuit whereby said primary relay rapidly vibrates its armature, a slow relay energized responsive to said primary relay, and maintaining its armature attracted while said armature is vibrating, electromagnets for adjusting said switch responsive to said vibrations, means for opening said circuit whereby said relays are deënergized, and a release relay operated responsive to deënergization of said slow relay whereby one of said electromagnets is again operated to restore said switch.

3. A selector for telephone systems comprising a metallic circuit, a primary relay and source of current for energizing said relay in bridge of said circuit, means for rapidly interrupting said circuit whereby said relay rapidly vibrates its armature, a slow relay energized responsive to said primary relay and maintaining its armature attracted while said armature is vibrating, a primary magnet jointly controlled by said relays for adjusting said switch responsive to said vibrations, a secondary magnet, means for operating said secondary magnet responsive to cessation of said vibration to adjust said switch, means for opening said circuit whereby said relays are deënergized, a release relay operated upon said deënergization, and means controlled by said release relay to again operate said secondary magnet to release said switch.

4. A selector for telephone systems including a wiper, primary and secondary magnets for adjusting said wiper, a metallic circuit, a primary relay and source of current for energizing said relay in bridge of said circuit, means for rapidly interrupting said circuit to vibrate the armature of said relay, a slow relay energized responsive to said primary relay, and maintaining its armature attracted while said armature is vibrating, said primary magnet operating responsive to said vibrations, means for operating said secondary magnet responsive to cessation of said vibrations, means for deenergizing said relays and a release circuit rendered effective upon deënergization of the slow relay whereby said secondary magnet is operated to restore the wiper.

5. A selector for telephone systems, including a metallic circuit, a primary relay and source of current in bridge thereof, means for vibrating the armature of said relay responsive to rapid interruptions of said circuit, a slow relay energized responsive to said primary relay and maintaining its armature attracted during said vibration, primary actuating means jointly controlled by said relays operated responsive to said vibrations, secondary actuating means operated responsive to cessation of said vibration, means for opening said metallic circuit whereby said relays are deënergized, and release mechanism including said secondary actuating means operated responsive to deenergization of said slow relay.

6. A selector for telephone systems, comprising a metallic circuit, a primary relay and source of current for energizing said relay in bridge thereof, a calling device for rapidly interrupting said metallic circuit, whereby said relay vibrates its armature, a slow relay energized responsive to initial energization of said primary relay and maintaining its armature attracted during said vibration, a primary magnet jointly controlled by said relays and actuated responsive to said vibration, a secondary magnet, means effective upon cessation of said vibration to operate said secondary magnet, means for deënergizing said relays, and release mechanism including said secondary magnet operated responsive to said deenergization.

7. In a telephone system the combination with telephone lines, automatic switches for interchangeably connecting calling and called lines, a primary relay in circuit with a calling line, and energized by current over said line, means for effecting changes in said circuit for operating said relay, a slow relay energized responsive to initial energization of said primary relay and maintained energized during said operation, primary and secondary magnets for said switches, operated responsive to said operation of the primary relay to extend the circuit of the calling to a called line, means for deënergizing said relays, and release mechanism for each of said switches including its secondary magnet effective upon said deënergization.

8. In a telephone system the combination with a calling subscriber's telephone line, a connector switch connected with said line, a primary relay in circuit with said line and energized by current over said line, means controlled at the sub-station of said line for operating said relay to transmit current impulses, a second relay energized responsive to said primary relay, means for maintaining the armature of said second relay attracted while said primary relay is operating, primary and secondary magnets for said switch operated responsive to said impulses, means for deënergizing said relays, and a release relay effective upon said deënergization to again operate said secondary magnet whereby said switch is restored.

9. In a telephone system the combination with telephone lines, a connector switch connected by a metallic circuit with a calling one of said lines, a primary relay and source of current for energizing said relay in bridge of said metallic circuit, a calling device at the sub-station of said line for rapidly interrupting said metallic circuit where-

by said relay transmits impulses corresponding to said interruptions, a slow relay energized responsive to initial energization of the primary relay and maintaining its armature attracted during transmission of said impulses, primary and secondary actuating magnets for said switch operated responsive to said impulses, means controlled at said sub-station to deënergize said relays, and means effective upon said deënergization whereby release mechanism of said switch including said secondary magnet is operated.

10. A selector comprising a pair of talking conductors, a quick acting primary relay and source of current in bridge thereof, a slow acting relay and an energizing circuit therefor closed responsive to said primary relay, a pair of wipers for said selector, a primary magnet responsive to operations of the primary relay, a secondary magnet and means for actuating it responsive to cessation of operation of the primary relay, and a release circuit including said secondary magnet effective while said primary and slow acting relays are restored and said wipers are off normal.

11. A telephone system comprising telephone lines, a source of current, a selector switch, means for automatically connecting a calling line with said selector switch, said selector switch comprising a circuit including a primary relay and source of current to energize said relay, means controllable over a calling line for effecting changes in said circuit whereby said relay is operated, a slow relay energized responsive to initial energization of the primary relay and maintaining its armature attracted while said primary relay is operated, adjusting electromagnets operated responsive to the said operation of the primary relay, means controlled over the calling line for deënergizing said relays, and release mechanism including one of said magnets effective upon said deënergization.

12. A telephone system comprising telephone lines, a step by step switch, means for automatically extending a calling line to said switch upon removal of the receiver in initiating a call, operating magnets for said switch controlled over the calling line for extending the circuit thereof, and means controlled over the calling line by the calling subscriber for operating one of said magnets to restore the switch.

13. A telephone system comprising calling lines, line switches for said lines, a step by step switch common thereto, means for operating the line switch upon removal of the receiver in initiating a call over a calling line to extend the circuit thereof to said step by step switch, operating magnets for said switch controlled by the calling subscriber for extending the circuit of the calling line, and means controlled over the calling line for operating one of said magnets to restore the switch.

14. A telephone system comprising calling telephone lines, directive step by step switches common thereto, automatic line switches for automatically extending the circuit of a calling line to an idle one of said step by step switches, and driving magnets for said switch controlled over the two sides of the calling line in series for operating and releasing a selected step by step switch.

15. In a telephone system, subscribers lines, a directive step-by-step switch provided with driving magnets, automatic means for connecting the line circuit of a calling one of said subscribers to said step-by-step switch, and means for controlling said magnets over the two sides of the calling line in series for operating and releasing said connected step-by-step switch.

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

CHARLES S. WINSTON.

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