A. H. BLESSING.

AUTOMATIC TELEPHONE SWITCHING APPARATUS.

APPLICATION FILED MAR. 29, 1912.

1,175,119.

Patented Mar. 14, 1916.

3 SHEETS—SHEET 1.

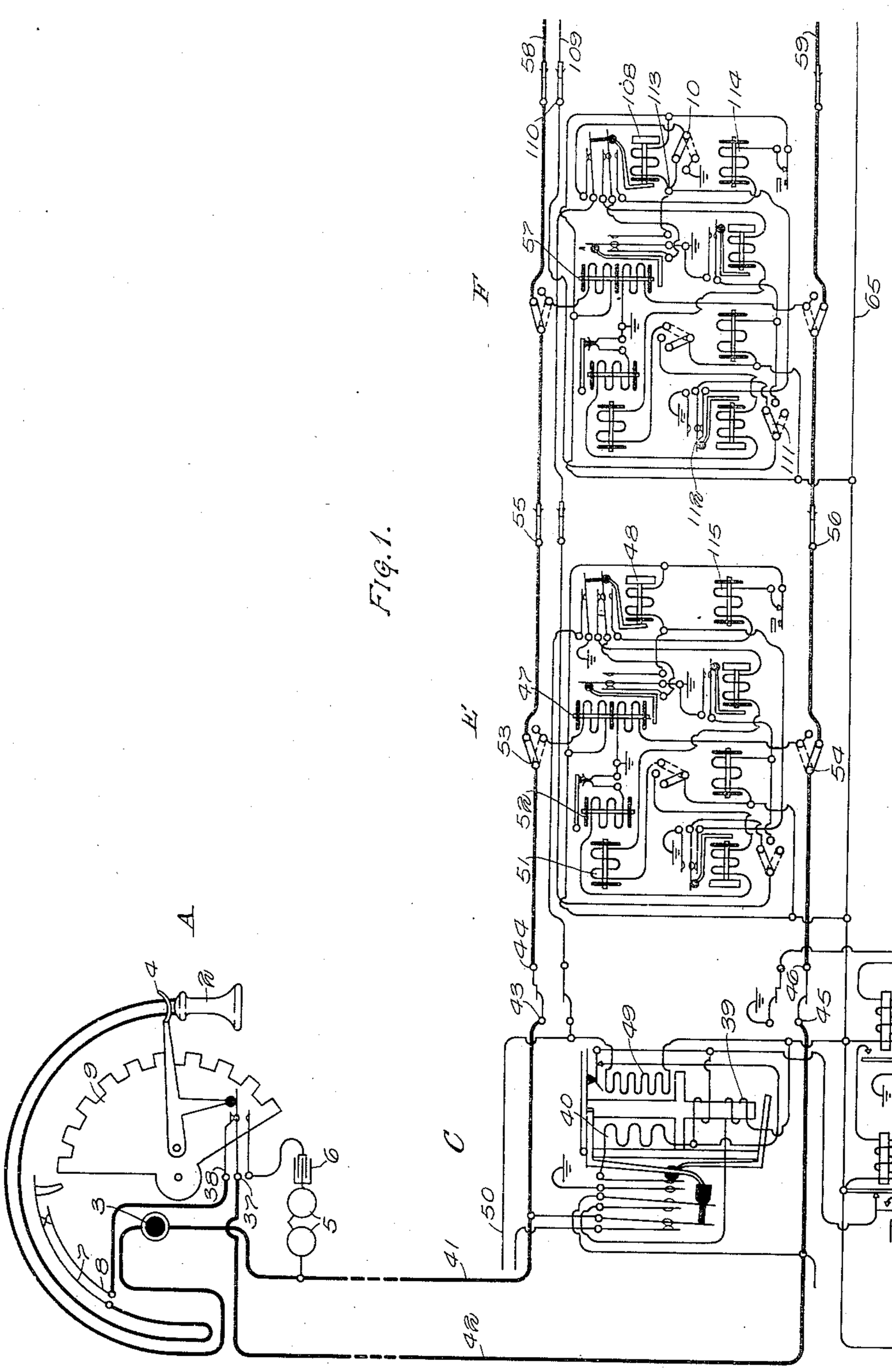

FIG. 1.

WITNESSES

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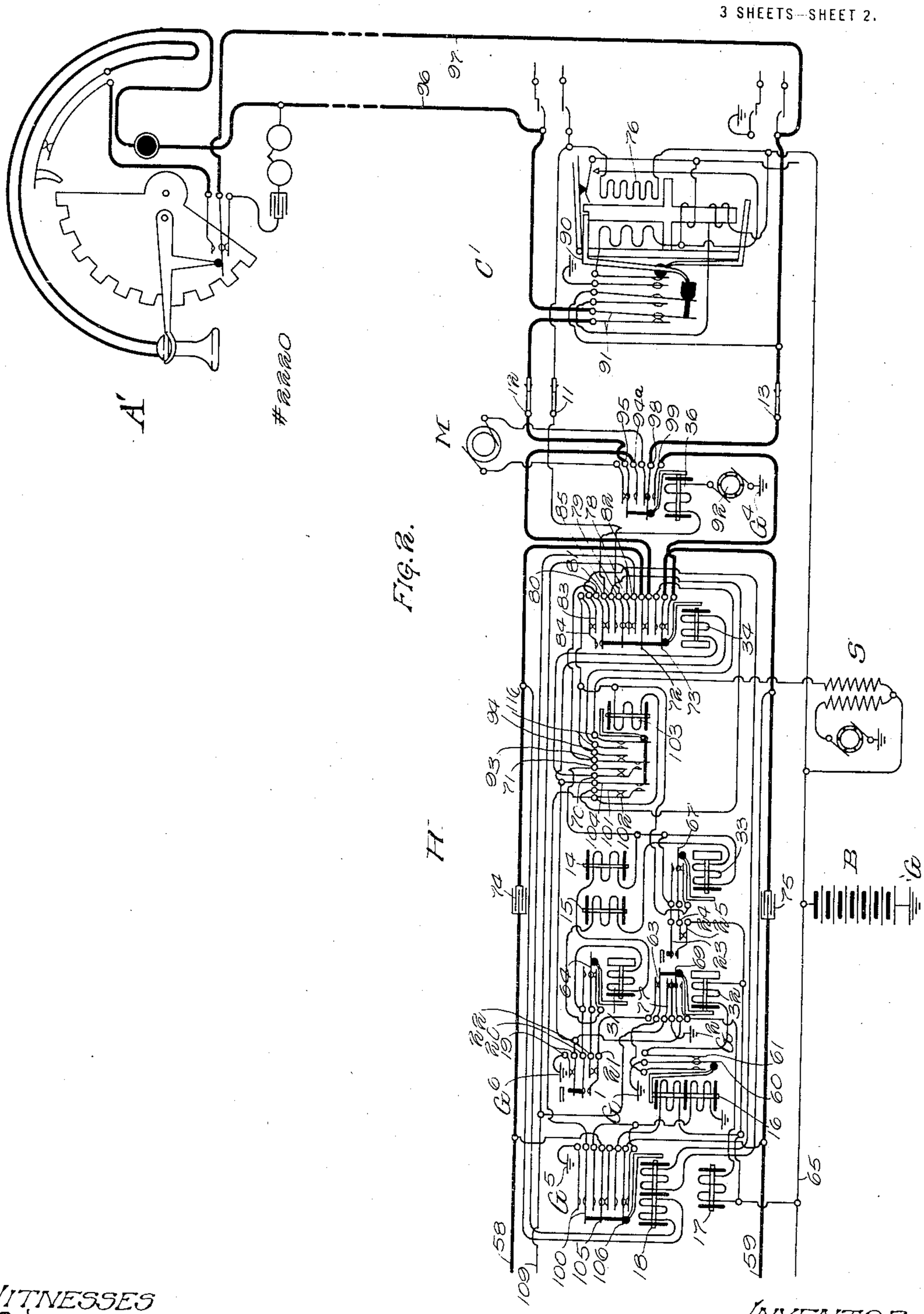

Fig. 2.

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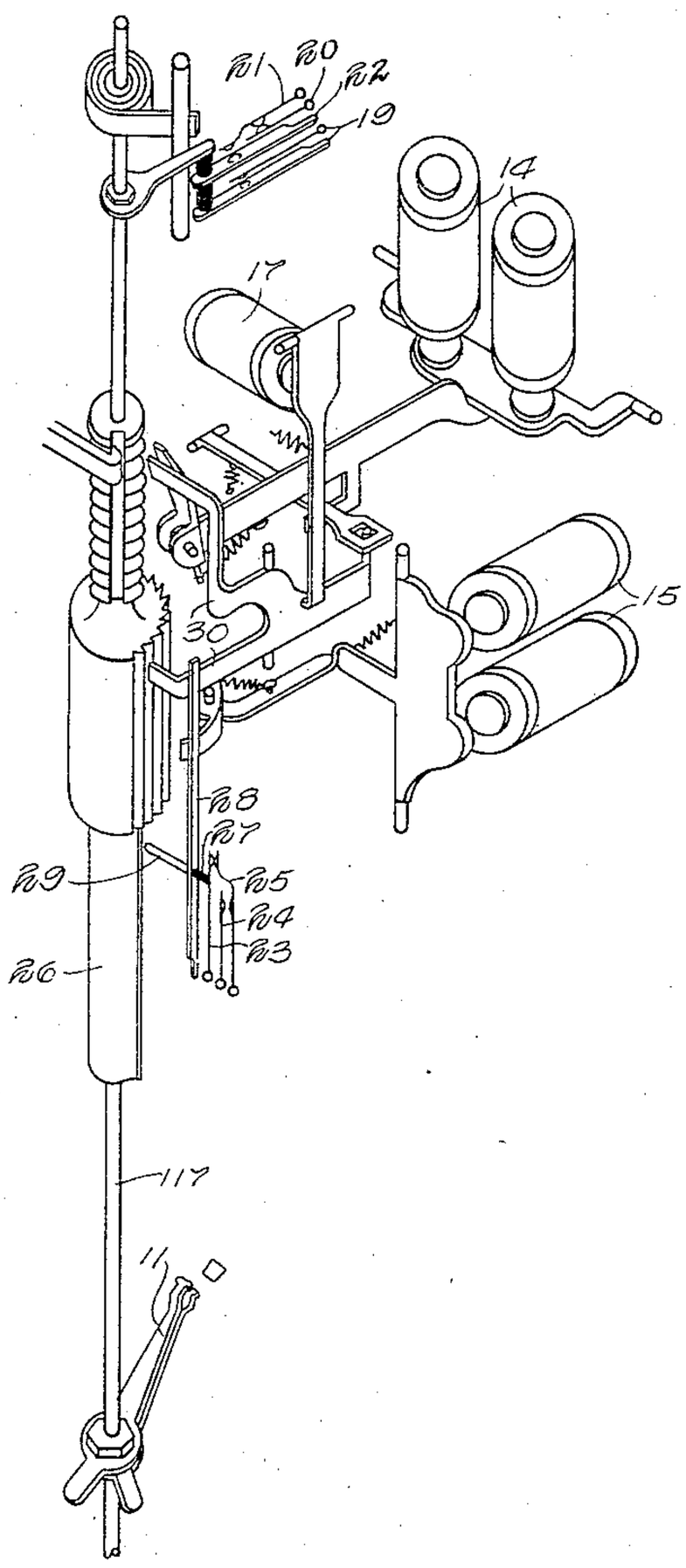
3 SHEETS—SHEET 3.

FIG. 3.



WITNESSES
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AUTOMATIC TELEPHONE SWITCHING APPARATUS.

1,175,119. Specification of Letters Patent. Patented Mar. 14, 1916.

Application filed March 29, 1912. Serial No. 687,042.

To all whom it may concern:

Be it known that I, ALBERT H. BLESSING, a citizen of the United States of America, and resident of Chicago, Cook county, Illinois, have invented certain new and useful Improvements in Automatic Telephone Switching Apparatus, of which the following is a specification.

My invention relates to telephone systems in general, but more particularly to an improved form of connector switch for use in such systems. This connector switch is of the type which has motion in one plane to select a certain group of lines, and then motion in a plane at right-angles thereto to find a given line in the selected group. This switch is also adapted for use in systems in which the control of the switch is accomplished over two sides of the line circuit in series, which systems are ordinarily known as two-wire systems. Heretofore, in such systems and in connection with switches having the two motions above noted, it has been necessary to employ in the connector switch the usual and well-known side switch. The purpose of this side switch was to control the connection between the switch and the line wipers, and, likewise, to control the connection to the operating magnets, whereby these operating magnets were successively brought into operative condition in order to accomplish the proper operation of the switch.

Among the objects of my invention are the provision of a connector switch having motion in two intersecting planes, and in which the control is accomplished by means of relays and off-normal contacts without the necessity of employing the usual side switch.

A further object of my invention is the improved manner of operating the rotary off-normal contacts. These springs have heretofore been controlled by means of a bushing which rests directly on a cam carried by the switch shaft. When the shaft was released, the cam would come into engagement with the bushing as soon as the switch shaft reached its normal position, and the bushing would rub on the cam during downward motion of the shaft and thus have a tendency to make the shaft stick. By my invention I have obviated this objectionable feature.

These and other objects of my invention will be more readily understood by reference to the accompanying drawings, in which—

Figures 1 and 2 taken together show a complete circuit connection between a calling substation A and a called substation A′ in a system embodying the principles of my invention. Fig. 3 is a detail view of a portion of the central office apparatus.

The automatic telephone system represented herein is of the well-known type of system employing subscribers' individual or line switches, selectors and connectors, the connection shown being established through the medium of a line switch C, a first selector E, a second selector F and a connector H. As shown herein, the substation A comprises the usual receiver 2, transmitter 3, switch hook 4, ringer 5 and condenser 6. Being an automatic substation it is also provided with an automatic calling device. This calling device may be of the type shown in British patent to S. G. S. Dicker, No. 29,654 of 1910. In the drawings, however, the calling device is represented diagrammatically by a pair of impulse springs 7 and 8 and a toothed impulse wheel 9, which latter may be controlled by the subscriber through the medium of a dial (not shown) provided with finger holes. The mechanism is so arranged that as the dial and impulse wheel are rotated forward by the subscriber, the impulse springs are not separated, but as the dial and impulse wheel return to normal position, the springs are separated momentarily a number of times, corresponding to the digit called.

The line switch C and the master switch D are of the general type of line and master switches disclosed in British patent to R. W. James, No. 26,301 of 1906, but are of the particular form shown in British patent to T. G. Martin, No. 1,419 of 1910.

The selector E is of the general type of selector switch shown in United States Letters Patent No. 815,321, granted March 13, 1906, to Keith, Erickson and Erickson, the circuits being modified, however, as shown in British Patent No. 1,419 of 1910, referred to above, in order to operate in a system in which the central office apparatus is controlled by the calling subscriber over the two sides of the line in series. The second selector F is similar to the first selector E, with the addition of the side switch wiper 10.

As the construction and operation of the line and master switches and the selectors are in general well known, and are fully described in the publications hereinabove referred to, it is not thought necessary to describe the same in detail herein.

The connector H (Fig. 2) is of the general type of connector switch disclosed in United States Letters Patent No. 815,176, granted March 13, 1906, to Keith, Erickson and Erickson, with the exception that it has no side switch, the circuits, however, being modified to operate in a two-wire system. As shown herein, the connector is assumed to be provided with a bank of contacts arranged in horizontal rows or levels, which contacts are adapted to be engaged by a set of wipers 11, 12 and 13 carried upon a vertically and rotatably movable shaft 117 (Fig. 3) which is controlled by the vertical and rotary operating magnets 14 and 15. The operations of the switch are controlled by the calling subscriber through the medium of the double-wound line relay 16, which relay is connected with the line circuit through the springs of the so-called back-bridge relay 18. The usual means for releasing the switch shaft to permit it to be restored to normal position are provided in the release magnet 17. The springs 19, 20, 21 and 22 are controlled by the switch shaft in such a manner that when the shaft is in its lowest normal position the springs 19 are separated and the spring 20 is in engagement with the spring 21 and the spring 21 is separated from the spring 22. As soon as the switch shaft 117 is raised the first step from its normal position, the springs 19 are permitted to close, and the spring 20 breaks contact with the spring 21 and contact is closed between the springs 21 and 22. The springs 23, 24 and 25 are controlled by the rotary motion of the switch shaft in such manner that as long as the shaft is in its normal rotary position, the spring 23 is in engagement with the spring 25 and the spring 25 is disengaged from the spring 24. As soon as the switch shaft is rotated, however, the contact between the springs 23 and 25 is opened and contact between the springs 24 and 25 is closed. The usual manner of controlling springs, such as the springs 23, 24 and 25, by the rotary motion of the switch shaft is to arrange said springs along side the shaft and provide an insulating bushing upon the end of the spring 23, which bushing is directly engaged by a cam 26 (Fig. 3) on the shaft, whereby the springs are held in their normal positions until the switch shaft is rotated to permit the cam to disengage the bushing on the spring 23. I find, however, that a much more satisfactory means for operating the springs 23, 24 and 25 is that shown in Fig. 3. In this figure the bushing 27 does not engage the cam 26 directly, but engages a lever 28 which is pivoted at its lower end and which is provided with a projection 29 which engages the cam 26 as long as the switch shaft is in its normal rotary position and thereby holds the springs in the position shown in Fig. 3. When the switch shaft is rotated, the cam 26 disengages the projection 29, thereby permitting the springs to assume their operated positions. The lever 28 extends upward behind the holding pawl 30, so that when this pawl is withdrawn from the shaft to permit the shaft to be restored to normal position, the lever 28 is held back by the pawl 30, so that there is no pressure between the projection 29 and the cam 26 to retard the movement of the shaft during the downward movement of the same. The relays 31, 32, 33 and 34, and other relays similarly represented throughout the drawings, are slow acting relays—that is, they are slow to deënergize after their energizing circuits have been broken. The proper operation of these relays may be obtained by securing a ring of copper around one end of the core. The relay 36 is the ringing relay, its function being to connect the ringing current generator M with the called line so as to signal the called subscriber. At S there is shown a busy signaling device for supplying the usual busy signaling current. At B there is shown a battery, having one terminal grounded at G, for supplying current for operating the central office apparatus and for talking purposes.

A general description of the apparatus having been given, it will now be explained how the connection is extended from the calling to the called substation. When the receiver at the substation A is removed from the switch hook preparatory to making a call, the engagement of the hook switch springs 37 and 38 completes a bridge across the line through the receiver and transmitter at the substation. The closure of this bridge across the line establishes an energizing circuit for the line winding 39 of the line switch C. The winding 39, upon energizing, operates to close the circuit of the operating winding 40, which in turn, upon energizing, causes the switch C to operate to extend the line conductors 41 and 42 through the line switch bank springs 43 and 44 and 45 and 46 to the selector E and to disconnect the line winding 39 from the line. When the connection is extended to the selector E its line relay 47, which is normally bridged across the line circuit of the switch in series with the battery, becomes energized and operates to close the circuit of the relay 48. The relay 48, upon energizing, operates to close the circuit of the holding winding 49 of the line switch C and to extend a guarding ground potential over the conductor 50 to

the connector private bank contacts of the calling line. When the substation calling device is operated for the first digit of the called number, which will be assumed to be 2220, the substation impulse springs 7 and 8 are separated twice momentarily, thereby causing the selector line relay to be twice momentarily deënergized. Each time the relay 47 deënergizes it closes a circuit through the vertical magnet 51. Since the digit called is 2, the vertical magnet 51 operates twice to raise the switch shaft and its wipers two steps, after which the side switch passes to second position and causes the rotary magnet 52 to operate in the usual manner to rotate the shaft wipers onto the contacts of an idle trunk line leading to a second selector F. The side switch thereupon passes to third position and through the medium of its wipers 53 and 54 disconnects the line relay 47 from the line circuit and extends the line connection through the shaft wipers 55 and 56 and the contacts upon which they have been rotated to the second selector F. The line relay 57 of the second selector thereupon becomes energized in the same manner in which the line relay of the first selector was energized when connection was first extended to it.

When the substation calling device is operated for the second digit 2 of the called number, the selector F operates in the same manner as explained for the selector E in connection with the previous digit to extend the connection over the trunk conductors 58 and 59 to an idle connector H which has access to the group of lines to which that of the substation A′ belongs. When the connection is thus extended to the connector H its line relay 16, which is normally bridged across the conductors 58 and 59 in series with the battery, becomes energized. The relay 16, upon energizing, completes a circuit extending from ground G′ through the springs 60 and 61 and the relay 32 to the battery lead 65, and thence through battery B to ground G. When the calling subscriber operates his calling device for the third digit 2 of the called number, the circuit of the relay 16 is broken twice momentarily. Since the relay 32 is a slow acting relay it does not deënergize during the momentary interruptions of its circuit by the relay 16, and therefore the first time the relay 16 is deënergized a circuit is closed from ground G′ through the spring 60 and its back contact, springs 63, springs 21 and 20, relay 31, vertical magnet 14 and through springs 23 and 25, to the battery lead 65. The relay 31 and the vertical magnet 14 are both energized over this circuit. The relay 31 operates to carry the spring 64 into engagement with its front contact, and the magnet 14 operates to raise the switch shaft one step, whereby the springs 19 are closed and the spring 21 is shifted out of engagement with the spring 20 and into engagement with the spring 22. The relay 31 being a slow acting relay does not deënergize during the momentary interval between impulses through it. Therefore, each time the relay 16 deënergizes after the first energization, an impulse is transmitted through the relay 31 and the magnet 14 over the circuit extending from ground G′ through the springs 60 and 63 as before, thence through the springs 21 and 22 and the spring 64 and its front contact.

After the last impulse for the third digit is delivered to the line relay it remains in its operated position and thereby maintains the circuit to the relay 31 open longer than the time which elapses between impulses and said relay therefore deënergizes. Since the digit called is 2, the vertical magnet has operated to raise the wipers 11, 12 and 13 two steps. When the substation calling device is operated for the fourth digit 0, the line relay 16 is deënergized ten times. Since the springs 20, 21 and 22 are now in their operated positions and the relay 31 is deënergized, the first engagement of the spring 60 of the line relay with its back contact completes a circuit extending from ground G′ through the spring 60 and its back contact, springs 63, springs 21 and 22, spring 64 and its back contact, rotary magnet 15, relay 33 and the springs 23 and 25 to the battery lead 65. The magnet 15 and the relay 33 are energized by the closure of this circuit. The relay 33 operates to force the spring 67 into engagement with its front contact, and the rotary magnet 15 operates to rotate the switch shaft one step, whereby the spring 25 is shifted out of engagement with the spring 23 and into engagement with the spring 24. The relay 33 being slow acting does not deënergize between the impulses, and therefore, during the following deënergizations of the line relay 60, impulses are transmitted over a circuit extending from ground G′ through the magnet 15 and the relay 33 as before, and thence through the spring 67 and its front contact and the springs 24 and 25 to the battery lead 65. Since the digit called is 0, the rotary magnet 15 receives ten impulses altogether and operates to rotate the shaft wiper ten steps onto the contacts of the desired line. When the relay 32 is energized when the connection is first extended to the connector, a circuit is closed extending from ground G^2 through the spring 69, relay 34, springs 70 and 71 and 23 and 25 to the battery lead 65. The relay 34 is energized by the closure of this circuit and is maintained energized during the entire time the switch is being operated to find the called line, the circuit being maintained, however, during the rotary operation of the switch shaft, through the spring 67 and its front contact

instead of through the springs 23 and 25. Thus it will be seen that while the connector is being operated its wipers 12 and 13 are disconnected from the remainder of the talking circuit by the separation of the springs 72 and 73 from their back contacts. When the relay 33 deënergizes after the last impulse for the last digit is delivered to the rotary magnet 15, the relay 34 deënergizes and completes the connection between the calling and the called subscribers, the entire talking circuit being outlined in the drawings by heavy conductors, said circuit being separated into two inductively connected sections by the condensers 74 and 75 in the connector. The relay 34, upon deenergizing, also completes an energizing circuit for the cut-off winding 76 of the line switch C′, said circuit extending from ground G^2 at the relay 32 through the spring 77, springs 78 and 79 of the relay 34, private wiper 11, connector private bank contacts and the winding 76 to the battery lead 65. The winding 76, upon energizing, attracts the armature 90, which operates to disconnect the switch C′ from the called line and to close the contact 91 in the talking circuit. The closure of the circuit just traced also provides a guarding ground potential for the connector private bank contacts of the called line. A further result of the deënergization of the relay 34 is to close the circuit of the ringing relay 36, said circuit extending from the ground G^4 through the interrupter 92, relay 36, springs 81 and 80, 93 and 94, spring 67 and its back contact and the springs 24 and 25 to the battery lead 65. The ringing relay, upon energizing, operates to disconnect the calling line from the called line and to connect the ringing current generator M with the called line to signal the called subscriber. The interrupter 92 periodically breaks the circuit of the ringing relay.

When the receiver at the called substation is removed from the switch hook in response to the call, or as soon thereafter as the ringing relay 36 deënergizes, if it happens to be energized at the time, said substation is provided with talking current over a circuit extending from ground G^2 at the relay 32 through the spring 77, springs 78 and 82, left-hand winding of the back-bridge relay 18, springs 72 and 73, springs 94^a and 95, wiper 12, contact 91, line 96, thence through the transmitter and receiver of the substation A′ and back over the line 97, wiper 13, springs 98 and 99, back contact of the spring 73, right-hand winding of the back bridge relay 18, springs 83 and 84, back contact of the spring 67 and springs 24 and 25 to the battery lead 65. The relay 18 is energized by this current and operates to complete a circuit extending from ground G^5 through the springs 100, relay 103 and the springs 67, 24 and 25 to the battery lead 65. The relay 103, upon energizing, opens the circuit of the ringing relay 36 by the separation of the springs 93 and 94 and by the engagement of the springs 104 and 102, forms a locking circuit for itself independent of the springs of the relay 18, so that the circuit of the ringing relay will not be again closed when the called subscriber hangs up his receiver, and allows the relay 18 to deenergize again. The shifting of the springs 105 and 106 by the energization of the relay 18 transposes the connection between the windings of the line relay 16 and the conductors 58 and 59, whereby the direction of the current flowing in the calling line is reversed. This reversal of the current in the calling line is without function in the system shown, but may be employed for the purpose of operating call registers or operators' signals.

Upon the termination of conversation the entire connection is automatically released by the hanging up of the receiver at the calling substation. During the time the connection is being maintained the release relays 108 and 48 of the selectors F and E are maintained energized over a circuit extending from ground G^2 at the connector through the spring 77, conductor 109, private wiper 110 of the selector F, side switch wiper 111 and the spring 112 to the point 113, whence one branch of the circuit passes through the relay 108 to the battery, while another branch passes through the side switch wiper 10 and thence to the selector E, and through the relay 48 to the battery lead 65. When the receiver at the substation A is hung up, the line relay 16 of the connector deënergizes and breaks the circuit of the relay 32. The relay 32, upon deënergizing, destroys the holding circuits of the relays 108 and 48 of the selectors, whereupon said relays deenergize and close the circuits of the respective release magnets 114 and 115, which in turn energize and release their respective switches. The relay 48 of the selector E, upon deënergizing, also destroys the holding circuit of the winding 49 of the switch C and allows it to release. The relay 32, upon deenergizing, also closes the circuit of the release magnet 17, said circuit extending from ground G^6 through the springs 19, spring 69 and its back contact and the magnet 17 to the battery lead 65. The magnet 17, upon energizing, allows the switch shaft to restore to normal position and said shaft, upon reaching its lowest position, separates the springs 19 and allows the release magnet to deenergize and all the apparatus employed in the connection is left in its normal position.

In the foregoing description it has been

assumed that the substation A′ is idle when called by the substation A. In case a line is busy when connection is attempted to be established therewith through a connector H, the connection cannot be completed and the calling subscriber is given a busy signal in the following manner: As has been explained, whenever a line is busy there is a guarding ground potential upon its connector private bank contacts. Therefore, when the relay 33 deënergizes after the wipers have been rotated onto the contacts of a called line which is in use, a circuit is closed from the guarded private bank contact of said line through the wiper 11, springs 79 and 85 of the relay 34 (which is in operated position at the time), springs 101 and 102, relay 103 and the springs 67, 24 and 25 to the battery lead 65. The relay 103, upon energizing, completes a circuit extending from ground G^6 through the springs 19, relay 34, springs 70 and 93, 80 and 84, 67, 24 and 25 to battery, thereby locking the relay 34 in its energized position so as to prevent the closing of the contacts 72 and 73 in the talking circuit. The relays 103 and 34 being energized, the busy signaling machine S is connected with the calling line through the springs 116 of the relay 103, back contact of the spring 73 of the relay 34, condenser 75 and thence over the heavy conductors back through the switches F, E and C. The return circuit for the busy signaling current extends back over the other side of the line and through the upper winding of the connector line relay 16 to the battery lead 65, thence back to the machine S. Upon hearing the busy signal the calling subscriber hangs up his receiver, whereupon the switches are released in the same manner as if an idle line had been called. It will be seen that when the relay 103 energizes, when a busy line is called, its energizing ground at the private wiper 11 is disconnected from the circuit by the springs 101 and 102 and the ground G^6 at the springs 19 is substituted therefor through the engagement of the springs 104 and 102, thereby preventing the relay 103 from deënergizing and allowing the connection to be completed with the called line in case it becomes idle, and the guarding potential is removed from its private bank contacts after the calling subscriber A has begun to receive the busy signal.

It will thus be seen that I provide a very efficient and simple connector switch for use in connection with a two-wire system—that is, notwithstanding the fact that this connector switch has motion in two intersecting planes, the entire operation of the switch is controlled without the necessity of employing the side switch, this entire operation being controlled by the off-normal contacts and relays which control local circuits. Furthermore, it will be seen that in the release of this switch there is no friction between the shaft and the bushing which controls the operation of the rotary off-normal springs, thus rendering the release of the switch more positive in its operation.

While I have illustrated and described one embodiment of my invention, and have illustrated this invention in connection with a full automatic system of a particular type, it is to be understood that my improved connector switch is equally as well adapted for use in connection with other automatic systems, or in connection with semi-automatic systems. Likewise, various other modifications may be made without departing from the spirit and intent of my invention.

What I claim as my invention is:—

1. In a telephone system, a line, an automatic connector switch having motion in two intersecting planes associated with said line, a relay for said switch, an operating magnet for controlling the motion of said switch in one of said planes, a second operating magnet for controlling the motion of said switch in the second of said planes, means for closing a break in the circuit of said second operating magnet upon the initial movement of said switch in said first plane, and means for preventing the operation of the second magnet after the second magnet is substituted for the first magnet to the control of the relay until the relay is operated over the line circuit.

2. In a telephone system, a line, an automatic connector switch having motion in two intersecting planes associated with said line, a relay for said switch, an operating magnet for controlling the motion of said switch in one of said planes, a second operating magnet for controlling the motion of said switch in the second of said planes, means for closing the circuit of said second operating magnet upon the initial movement of said switch in said first plane, means for opening said circuit at a second point during the first movement of said switch, and means for preventing the operation of the second magnet after the second magnet is substituted for the first magnet to the control of the relay until the relay is operated over the line circuit.

3. In a telephone system, a line, an automatic connector switch having motion in two intersecting planes associated with said line, a relay for said switch, an operating magnet for controlling the motion of said switch in one of said planes, a second operating magnet for controlling the motion of said switch in the second of said planes, means for closing the circuit of said second operating magnet upon the initial movement of said switch in said first plane, a

slow acting relay for maintaining said cirsuit open at a second point until said switch has completed its first motion, and means for preventing the operation of the second magnet after the second magnet is substituted for the first magnet to the control of the relay until the relay is operated over the line circuit.

4. In a telephone system, a line, an automatic connector switch having motion in two intersecting planes associated with said line, a relay for said switch, an operating magnet for controlling the motion of said switch in one of said planes, a second operating magnet for controlling the motion of said switch in the second of said planes, means for closing the circuit of said second operating magnet upon the initial movement of said switch in said first plane, a slow acting relay connected in series with said first operating magnet for maintaining said circuit open until the switch has completed its first motion, and means for preventing the operation of the second magnet after the second magnet is substituted for the first magnet to the control of the relay until the relay is operated over the line circuit.

5. In a telephone system, a line, a connector switch having motion in two intersecting planes associated with said line, a relay for said switch, means for transmitting a series of impulses for moving said switch in one of said planes, followed by a second series of impulses for moving said switch in the other plane, an operating magnet responsive to said first series of impulses, a second operating magnet responsive to said second series, the circuit of said second operating magnet adapted to be closed at one point on the initial movement of said switch in said first plane, and means for preventing the operation of the second magnet after the second magnet is substituted for the first magnet to the control of the relay until the relay is operated over the line circuit.

6. In a telephone system, a line, a connector switch having motion in two intersecting planes associated with said line, a relay for said switch, means for transmitting a series of impulses for moving said switch in one of said planes, followed by a second series of impulses for moving said switch in the other plane, an operating magnet responsive to said first series of impulses, a second operating magnet responsive to said second series, the circuit of said second operating magnet adapted to be closed at one point on the initial movement of said switch in said first plane, a slow acting relay connected in series with said first operating magnet for maintaining said circuit open at a second point until after the last impulse of the first series has been received, and means for preventing the operation of the second magnet after the second magnet is substituted for the first magnet to the control of the relay until the relay is operated over the line circuit.

7. In a telephone system, a line, an automatic connector switch having motion in two intersecting planes associated with said line, a relay for said switch, an operating magnet for controlling the motion in the first plane, a second operating magnet for controlling the motion in the second plane, a local circuit for controlling said second operating magnet, contacts in said local circuit opened during the first motion of said switch, means for automatically closing said open contacts upon the cessation of said first motion, and means for preventing the operation of the second magnet after the second magnet is substituted for the first magnet to the control of the relay until the relay is operated over the line circuit.

8. In a telephone system, a line, an automatic connector switch having motion in two intersecting planes associated with said line, a relay for said switch, an operating magnet for controlling the motion in the first plane, a second operating magnet for controlling the motion in the second plane, a local circuit for controlling said second operating magnet, contacts in said local circuit opened during the first motion of said switch, a slow acting relay connected in series with said first operating magnet for closing said contacts upon the cessation of said first motion, and means for preventing the operation of the second magnet after the second magnet is substituted for the first magnet to the control of the relay until the relay is operated over the line circuit.

9. In a telephone system, a line, a connector switch having motion in two intersecting planes associated with said line, a line relay, a pair of operating magnets controlled successively by said line relay, means for shifting said control from one to the other of said magnets, said means including contact springs controlled by the movement of said switch, means for controlling the operation of said switch over a circuit including two sides of a line circuit in series, and means for preventing the operation of the second magnet after the second magnet is substituted for the first magnet to the control of the relay until the relay is operated over the line circuit.

10. In a telephone system, a line, a connector switch having motion in two intersecting planes associated with said line, a line relay, a pair of operating magnets controlled successively by said line relay for controlling the movement of said switch in said intersecting planes, means for shifting the control from one to the other of said

magnets, said means including contact springs controlled by the movement of said switch and a relay connected in series with one of said operating magnets, means for controlling the operation of said switch over a circuit including two sides of a line circuit in series, and means for preventing the operation of the second magnet after the second magnet is substituted for the first magnet to the control of the relay until the relay is operated over the line circuit.

11. In a telephone system, a line, an automatic connector switch having motion in two intersecting planes associated with said line, a relay for said switch, an operating magnet for controlling the motion of said switch in one of said planes, a second operating magnet for controlling the motion of said switch in the second of said planes, means for closing the circuit of said second operating magnet at one point upon the initial movement of said switch in said first plane, means for controlling the operation of said switch over a circuit including two sides of a line circuit in series, and means for preventing the operation of the second magnet after the second magnet is substituted for the first magnet to the control of the relay until the relay is operated over the line circuit.

12. In a telephone system, a line, an automatic connector switch having motion in two intersecting planes associated with said line, a relay for said switch, an operating magnet for controlling the motion of said switch in one of said planes, a second operating magnet for controlling the motion of said switch in the second of said planes, means for closing the circuit of said second operating magnet upon the initial movement of said switch in said first plane, means for opening said circuit at a second point during the first movement of said switch, means for controlling the operation of said switch over a circuit including two sides of a line circuit in series, and means for preventing the operation of the second magnet after the second magnet is substituted for the first magnet to the control of the relay until the relay is operated over the line circuit.

13. In a telephone system, a line, an automatic connector switch having motion in two intersecting planes associated with said line, a line relay for said switch, an operating magnet for controlling the motion of said switch in one of said planes, a second operating magnet for controlling the motion of said switch in the second of said planes, means for closing the circuit of said second operating magnet upon the initial movement of said switch in said first plane, a slow acting relay for maintaining said circuit open at a second point until said switch has completed its first motion, means for controlling the operation of said switch over a circuit including two sides of a line circuit in series and means for preventing the operation of the second magnet after the second magnet is substituted for the first magnet to the control of the line relay until the said line relay is operated over the line circuit.

14. In a telephone system, a line, an automatic connector switch having motion in two intersecting planes associated with said line, a line relay for said switch, an operating magnet for controlling the motion of said switch in one of said planes, a second operating magnet for controlling the motion of said switch in the second of said planes, means for closing the circuit of said second operating magnet upon the initial movement of said switch in said first plane, a slow acting relay connected in series with said first operating magnet for maintaining said circuit open until the switch has completed its first motion, means for controlling the operation of said switch over a circuit including two sides of a line circuit in series, and means for preventing the operation of the second magnet after the second magnet is substituted for the first magnet to the control of the line relay until the said line relay is operated over the line circuit.

15. In a telephone system, a line, a connector switch having motion in two intersecting planes associated with said line, a relay for said switch, means for transmitting a series of impulses for moving said switch in one of said planes, followed by a second series of impulses for moving said switch in the other plane, an operating magnet responsive to said first series of impulses, a second operating magnet responsive to said second series, the circuit of said second operating magnet adapted to be closed at one point on the initial movement of said switch in said first plane, means for controlling the operation of said switch over a circuit including two sides of a line circuit in series, and means for preventing the operation of the second magnet after the second magnet is substituted for the first magnet to the control of the relay until the relay is operated over the line circuit.

16. In a telephone system, a line, a connector switch having motion in two intersecting planes associated with said line, a line relay for said switch, means for transmitting a series of impulses for moving said switch in one of said planes, followed by a second series of impulses for moving said switch in the other plane, an operating magnet responsive to said first series of impulses, a second operating magnet responsive to said second series, the circuit of said second operating magnet adapted to be closed on the initial movement of said switch in said first plane, a slow acting relay connected in series with said first operating magnet for maintaining said circuit

open at a second point until after the last impulse of the first series has been received, means for controlling the operation of said switch over a circuit including two sides of a line circuit in series, and means for preventing the operation of the second magnet after the second magnet is substituted for the first magnet to the control of the line relay until the said line relay is operated over the line circuit.

17. In a telephone system, a line, an automatic connector switch having motion in two intersecting planes associated with said line, a relay for said switch, an operating magnet for controlling the motion in the first plane, a second operating magnet for controlling the motion in the second plane, a local circuit for controlling said second operating magnet, contacts in said local circuit opened during the first motion of said switch, means for automatically closing said open contacts upon the cessation of said first motion, means for controlling the operation of said switch over a circuit including two sides of a line circuit in series, and means for preventing the operation of the second magnet after the second magnet is substituted for the first magnet to the control of the relay until the relay is operated over the line circuit.

18. In a telephone system, a line, an automatic connector switch having motion in two intersecting planes associated with said line, a line relay for said switch, an operating magnet for controlling the motion in the first plane, a second operating magnet for controlling the motion in the second plane, a local circuit for controlling said second operating magnet, contacts in said local circuit opened during the first motion of said switch, a slow acting relay connected in series with said first operating magnet for closing said contacts upon the cessation of said first motion, means for controlling the operation of said switch over a circuit including two sides of a line circuit in series, and means for preventing the operation of the second magnet after the second magnet is substituted for the first magnet to the control of the line relay until the said line relay is operated over the line circuit.

19. In a telephone system, an automatic connector switch having vertical and rotary motions, a pair of operating magnets, a ringer relay, and means for successively controlling said magnets and relay, said means including contacts controlled by the vertical motion of said switch and other contacts controlled by the rotary motion of said switch.

20. In a telephone system, a connector switch having vertical and rotary motions, a rotary operating magnet for controlling the rotary motion of said switch, a ringer relay for controlling the application of ringing current to the called line, means for successively controlling said operating magnet and ringer relay, and means for shifting the control from said magnet to said relay, said means including a line relay and contacts which are closed by the initial rotary motion of said switch.

21. In a telephone system, a connector switch having vertical and rotary motions, a rotary operating magnet for controlling the rotary motion of said switch, a ringer relay for controlling the application of ringing current to the called line, means for successively controlling said operating magnet and ringer relay, and means for shifting the control from said magnet to said relay, said means including a line relay and contacts which are closed by the initial rotary motion of said switch and a relay connected in series with said operating magnet.

22. In a telephone system, a connector switch having rotary motion for connecting with a called line, a ringer relay for controlling the application of ringing current to said line, a circuit for said ringer relay having normally open contacts, and means for closing said contacts upon the initial rotary motion of said switch.

23. In a telephone system, a connector switch having rotary motion for connecting with a called line, a ringer relay for controlling the application of ringing current to said line, a circuit for said ringer relay having normally open contacts, means for closing said contacts upon the initial rotary motion of said switch, and means for opening said circuit at a second point during the rotary motion of said switch.

24. In a telephone system, a connector switch having rotary motion for connecting with a called line, a ringer relay for controlling the application of ringing current to said line, a circuit for said ringer relay having normally open contacts, means for closing said contacts upon the initial rotary motion of said switch, and a slow acting relay for maintaining said circuit open at a second point until said switch has completed its rotary motion.

25. In a telephone system, a connector switch having rotary motion for connecting with a called line, a rotary magnet for controlling the rotation of said switch, a ringer relay for controlling the application of ringing current to said line, a circuit for said ringer relay having normally open contacts, means for closing said contacts upon the initial rotary motion of said switch, and a slow acting relay connected in series with said rotary magnet for maintaining said circuit open until the switch has completed its rotary motion.

26. In a telephone system, a connector switch having motion in two intersecting planes to connect with a called line, means

for transmitting a series of impulses for moving said switch in one of said planes, followed by a series of impulses for moving said switch in the other plane, an operating magnet responsive to said first series of impulses, a second operating magnet responsive to said second series, a ringer relay for controlling the application of ringing current to the called line, the circuit of said ringer relay adapted to be closed on the initial movement of said switch in the second plane, and a slow acting relay connected in series with said second operating magnet for maintaining said circuit open at a second point until after the operation of said switch is completed.

27. In a telephone system, an automatic connector switch having vertical and rotary motions, a pair of operating magnets, a ringer relay, means for successively controlling said magnets and relay, said means including contacts controlled by the vertical motion of said switch and other contacts controlled by the rotary motion of said switch, and means for controlling two sides of a line circuit in series to control the operation of said switch.

28. In a telephone system, a connector switch having vertical and rotary motions, a rotary operating magnet for controlling the rotary motion of said switch, a ringer relay for controlling the application of ringing current to the called line, a line relay for successively controlling said operating magnet and ringer relay, means for shifting the control from said magnet to said relay, said means including contacts which are closed by the initial rotary motion of said switch, and means for controlling two sides of a line circuit in series to control the operation of said switch.

29. In a telephone system, a connector switch having vertical and rotary motions, a rotary operating magnet for controlling the rotary motion of said switch, a ringer relay for controlling the application of ringing current to the called line, a line relay for controlling said operating magnet, means for removing said magnet from the control of the relay and for closing the circuit of the ringing relay, said means including contacts which are closed by the initial rotary motion of said switch and a relay connected in series with said operating magnet, and means for controlling two sides of a line circuit in series to control the operation of said switch.

30. In a telephone system, a connector switch having rotary motion for connecting with a called line, a ringer relay for controlling the application of ringing current to said line, a circuit for said ringer relay having normally open contacts, means for closing said contacts upon the initial rotary motion of said switch, and means for controlling two sides of a line circuit in series to control the operation of said switch.

31. In a telephone system, a connector switch having rotary motion for connecting with a called line, a ringer relay for controlling the application of ringing current to said line, a circuit for said ringer relay having normally open contacts, means for closing said contacts upon the initial rotary motion of said switch, means for opening said circuit at a second point during the rotary motion of said switch, and means for controlling two sides of a line circuit in series to control the operation of said switch.

32. In a telephone system, a connector switch having rotary motion for connecting with a called line, a ringer relay for controlling the application of ringing current to said line, a circuit for said ringer relay having normally open contacts, means for closing said contacts upon the initial rotary motion of said switch, a slow acting relay for maintaining said circuit open at a second point until said switch has completed its rotary motion, and means for controlling two sides of a line circuit in series to control the operation of said switch.

33. In a telephone system, a connector switch having rotary motion for connecting with a called line, a rotary magnet for controlling the rotation of said switch, a ringer relay for controlling the application of ringing current to said line, a circuit for said ringer relay having normally open contacts, means for closing said contacts upon the initial rotary motion of said switch, a slow acting relay connected in series with said rotary magnet for maintaining said circuit open until the switch has completed its rotary motion, and means for controlling two sides of a line circuit in series to control the operation of said switch.

34. In a telephone system, a connector switch having motion in two intersecting planes to connect with a called line, means for transmitting a series of impulses for moving said switch in one of said planes, followed by a series of impulses for moving said switch in the other plane, an operating magnet responsive to said first series of impulses, a second operating magnet responsive to said second series, a ringer relay for controlling the application of ringing current to the called line, the circuit of said ringer relay adapted to be closed on the initial movement of said switch in the second plane, a slow acting relay connected in series with said second operating magnet for maintaining said circuit open at a second point until after the operation of said switch is completed, and means for controlling two sides of a line circuit in series to control the operation of said switch.

35. In a telephone system, a connector

switch having vertical and rotary motions for connecting with a called line, a ringer relay for controlling the application of ringing current to said line, a relay adapted to be energized when said switch is seized and to remain energized during the operation of said switch, a second relay adapted to be energized during the rotary motion of said switch, a pair of contacts adapted to be closed upon the initial rotary motion of said switch, and a circuit for said ringer relay, the closure of said circuit being dependent upon both of said relays being deënergized and said contacts being operated.

36. In a telephone system, an automatic connector switch adapted to connect with a called line, said switch including line wipers, a relay, means for energizing said relay as soon as a connection is extended to said switch to open said connection, and means for deënergizing said relay to again close said connection when said switch is fully operated.

37. In a telephone system, an automatic connector switch having motion in two intersecting planes for connecting with a called line, said switch including line wipers, a relay, means for energizing said relay to break said connection as soon as a connection is extended to said switch, a second relay, means for energizing said second relay during the operation of said switch, means for deënergizing said second relay as soon as the switch has completed its operation, and means controlled by the second relay for deënergizing said first relay for extending connection to said wipers.

38. In a telephone system, an automatic switch having vertical and rotary motions, a pair of rotary off-normal springs, a cam on the switch shaft, a lug adapted to engage said cam and maintain said springs normally separated, means for operating said switch, and means for preventing said lug from contacting with said cam during the release of said switch.

39. In a telephone system, an automatic switch having vertical and rotary motions, a pair of rotary off-normal springs, a cam carried by the switch shaft, a lever carrying a lug adapted to bear against said cam and operating to maintain said springs out of contact, means for operating said switch, and means operating upon the release of said switch for engaging said lever to hold said lug out of engagement with said cam until said switch has reached normal position.

40. In a telephone system, a line, a switch for said line, a plurality of other lines, terminals for said other lines associated with said switch, a progressively movable element for said switch for finding any one of said terminals, an open connection between the line and said element, a slow-acting relay for closing said connection, said terminals divided into groups, means for moving said element to find a group, means for moving the element to find a terminal in the group, and an energizing circuit for said relay under the control of said first means and also under the control of the second means.

Signed by me at Chicago, Cook county, Illinois, this 25th day of March, 1912.

ALBERT H. BLESSING.

Witnesses:

ARTHUR BESSEY SMITH,

ARTHUR J. RAY.