J. G. BLESSING.

AUTOMATIC SELECTING SWITCH.

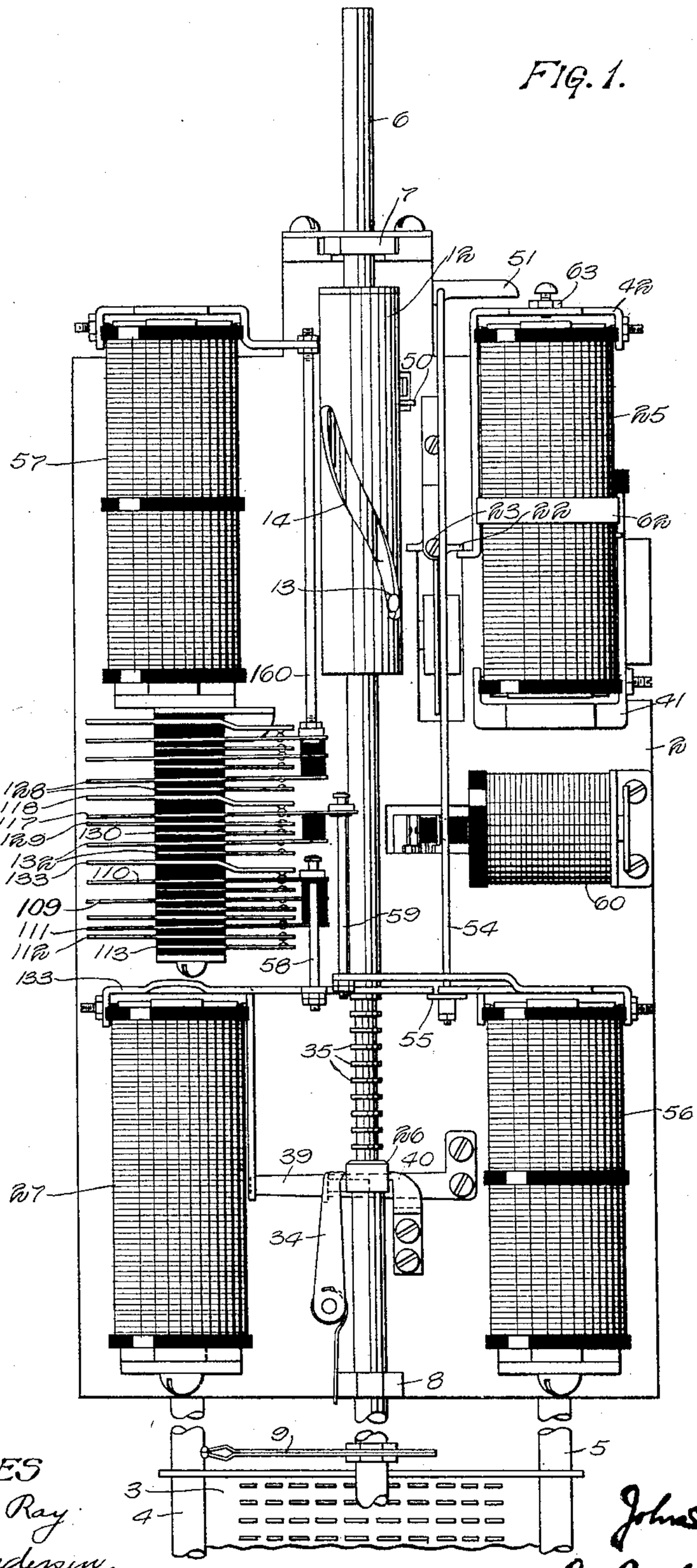
APPLICATION FILED MAR. 29, 1912.

1,218,048.

Patented Mar. 6, 1917.

4 SHEETS—SHEET 1.

FIG. 1.



WITNESSES

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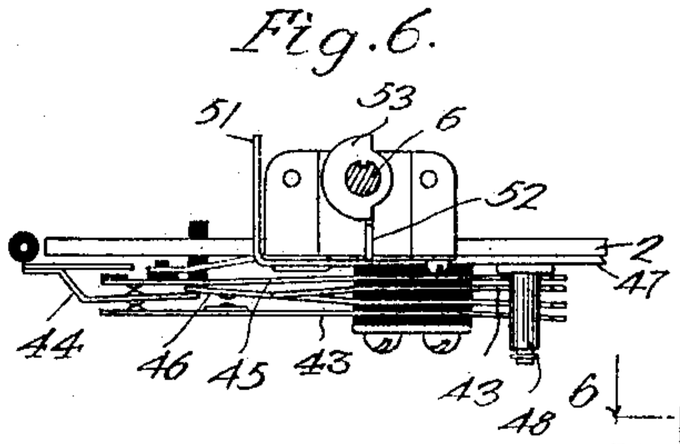
4 SHEETS—SHEET 2.

Fig. 6.



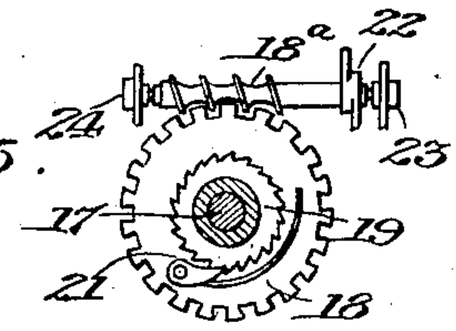


FIG. 5.

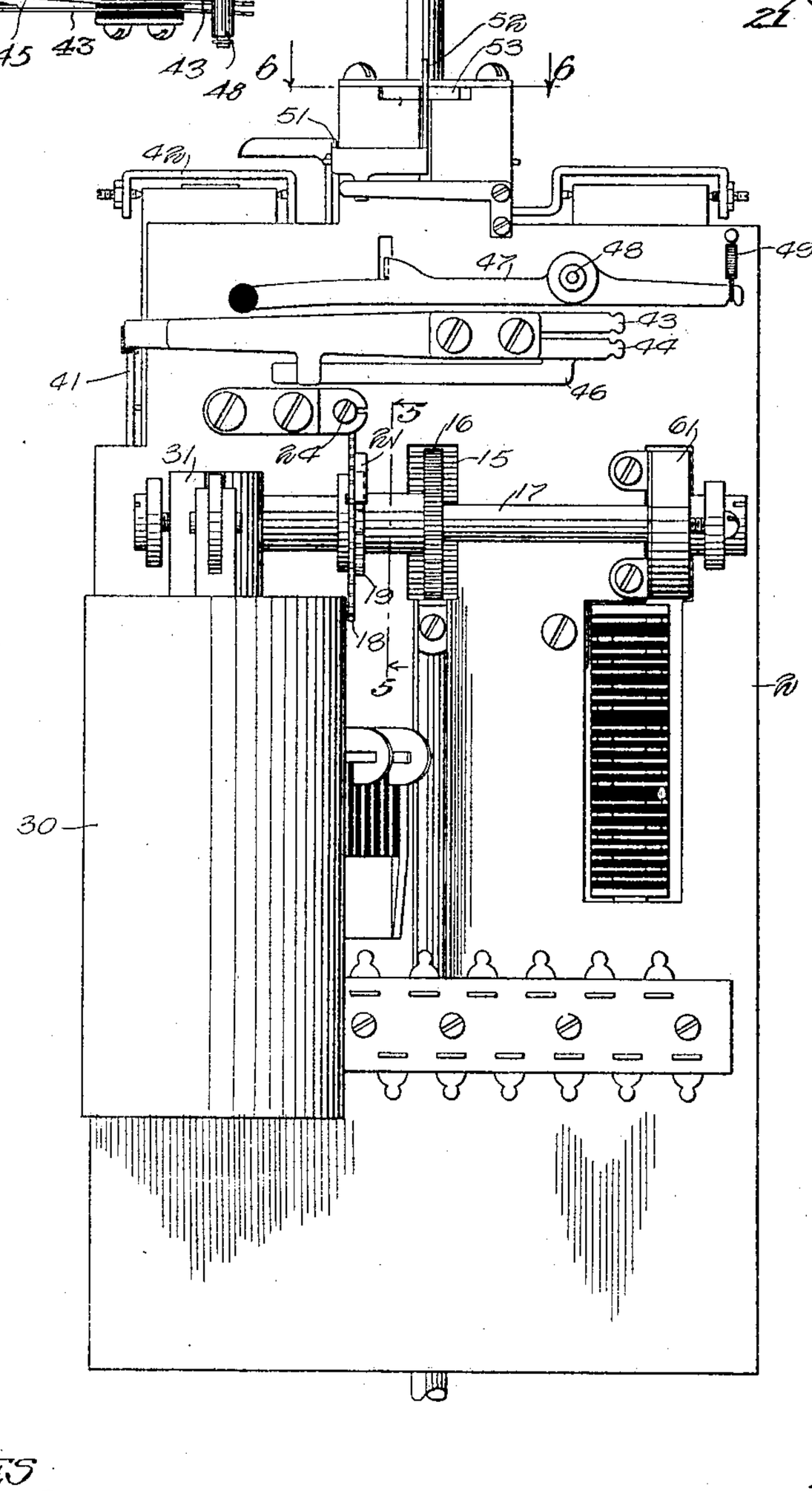


FIG. 2

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4 SHEETS—SHEET 3.

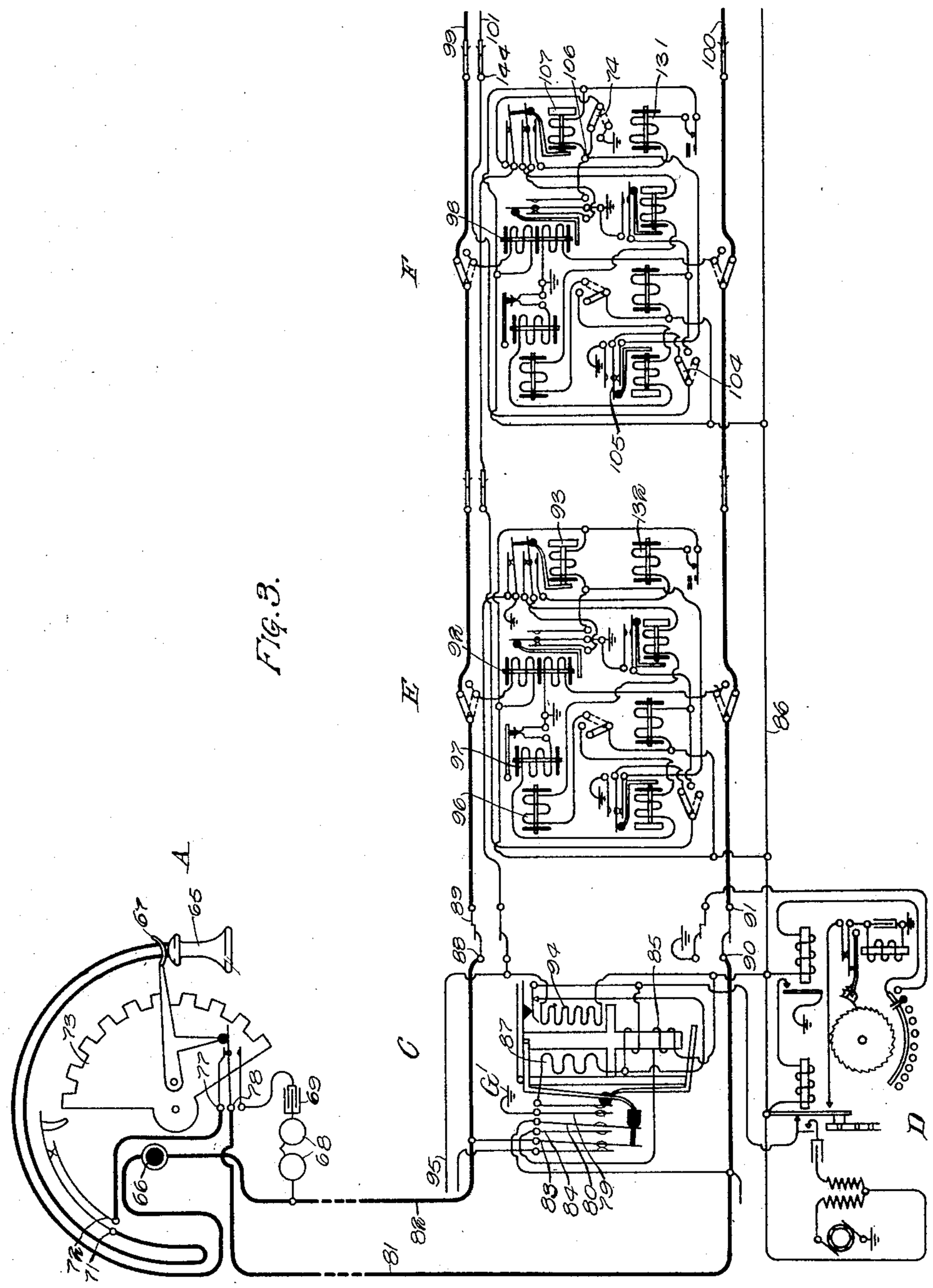

FIG. 3.

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4 SHEETS—SHEET 4.

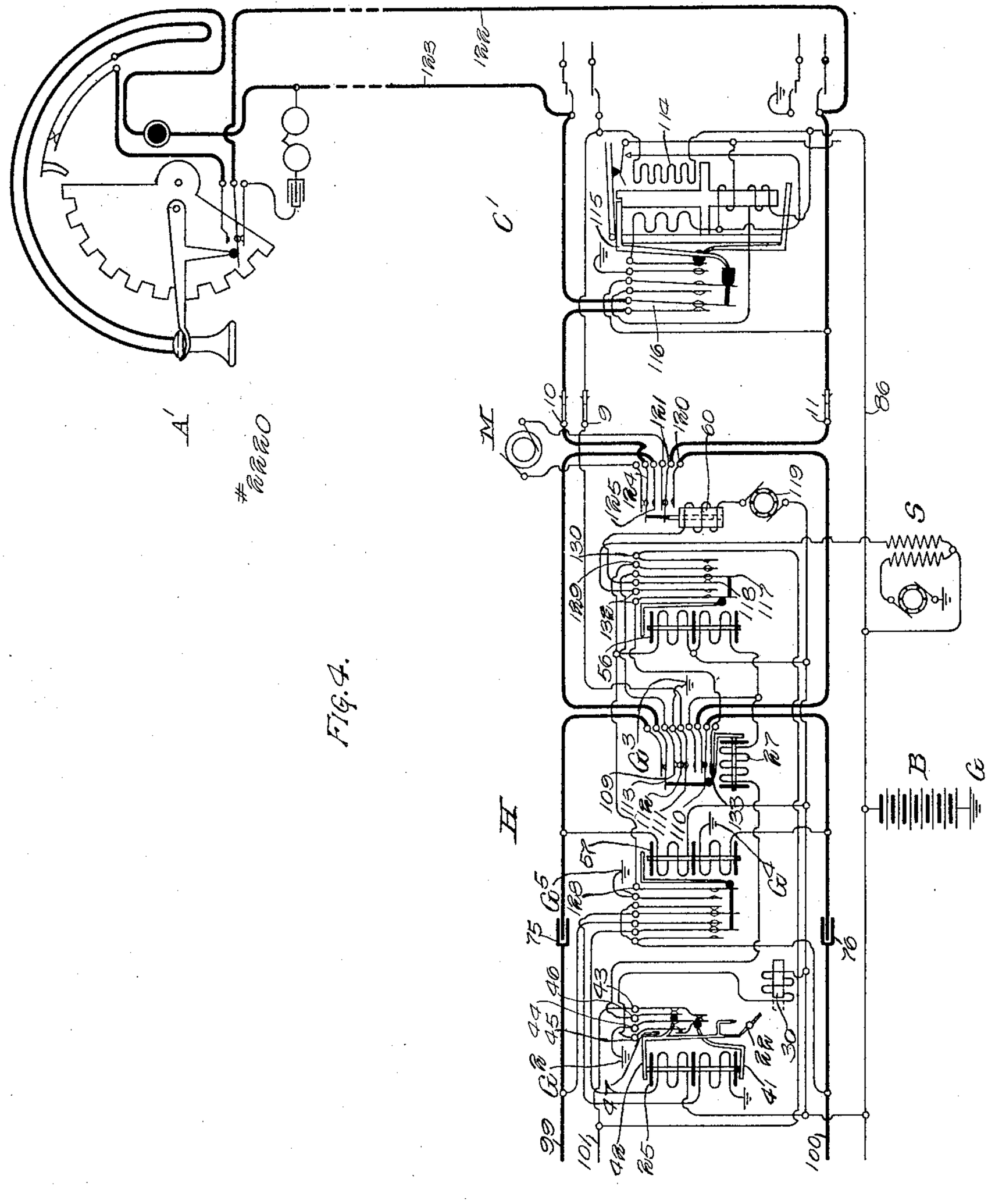

FIG. 4.

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UNITED STATES PATENT OFFICE.

JOHN G. BLESSING, OF CHICAGO, ILLINOIS, ASSIGNOR TO AUTOMATIC ELECTRIC COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF ILLINOIS.

AUTOMATIC SELECTING-SWITCH.

1,218,048. Specification of Letters Patent. Patented Mar. 6, 1917.

Application filed March 29, 1912. Serial No. 687,044.

To all whom it may concern:

Be it known that I, JOHN G. 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 Selecting-Switches, of which the following is a specification.

My invention relates to an automatic telephone system, and more particularly to an improved switch for employment in such a system.

My invention is in the nature of an improvement upon that type of switch having downward and rotary selecting motions, and one in which the movement of the switch arms is continuous, but the extent of this movement is controlled by a step-by-step-operated mechanism.

Among the objects of my invention is to improve the general construction of such a switch and to render its operation more certain.

One of the principal objects of my invention is the provision of improved means to keep the release circuit and the circuit of one of the controlling relays open while the line relay is operating, and to cause the release circuit to be closed if the line relay comes to rest in a deënergized position, or to cause the controlling relay to be energized if the relay comes to rest in an energized condition. In the present instance these functions are brought about by the provision of a line relay having a quick acting armature and a slow acting armature, and the provision of an armature for the controlling relay which is not responsive to short impulses of current passing through the magnet of this controlling relay.

A further feature is the provision of means for positively maintaining the release circuit of the switch closed until the switch has reached normal position.

A further feature is the improved manner of mounting the contact springs in a single bank, whereby the assembling of the switch is greatly facilitated.

These and other objects and features of my invention will be more clearly understood by reference to the accompanying drawings, in which I have illustrated one embodiment of my invention.

In the accompanying drawings—

Figure 1 is a front elevation of the switch embodying the principles of my invention.

Fig. 2 is a rear view of the same.

Figs. 3 and 4 show a complete connection between a calling and a called substation in a system embodying the principles of my invention.

Fig. 5 is a partial sectional view taken on the line 5—5 in Fig. 2.

Fig. 6 is a sectional view on the line 6—6 in Fig. 2.

The switch shown in Figs. 1 and 2 resembles the switches shown in United States Letters Patent Nos. 815,321 and 815,176, issued March 13, 1906, to Keith, Erickson and Erickson, in that it comprises a bank of contacts which are adapted to be engaged by a set of wipers carried upon a shaft or spindle which is capable of both vertical and rotary motion. In the above figures, 2 represents a plate upon which the various parts are mounted. The banks 3, only a portion of one of which is shown in Fig. 1, are mounted upon rods 4 and 5 attached to the lower end of the plate 2. These banks may be of any suitable construction and usually comprise ten horizontal rows of contacts with ten contacts in each row. The shaft 6 is mounted in the bearings 7 and 8 upon the front of the plate 2. On the lower end of the shaft there is shown one wiper 9. It will be understood that there may be a plurality of wipers attached to the shaft and a separate bank of contacts provided for each wiper.

Loosely mounted upon the shaft 6 there is a cylinder 12. There is a pin 13 on the shaft which extends through a slot 14 in the cylinder. On the back of the cylinder 12 there is a series of gear teeth 15 which mesh with a gear wheel 16 on a shaft 17. On the back of the plate 2 there is a solenoid 30, the plunger 31 of which is provided with gear teeth which mesh with a pinion on the shaft 17. Loosely mounted upon the shaft 17 there is a notched wheel 18 upon the face of which there is a pawl 21 which engages a ratchet wheel 19 on the shaft 17. By means of this arrangement of pawl and ratchet the wheel

18 may remain stationary while the shaft 17 is rotated in one direction, but is forced to rotate with the shaft in the other direction. The toothed wheel 18 meshes with a worm gear 18ª on a shaft pivoted between the screws 23 and 24 (Figs. 1, 2 and 5), and to which shaft there are secured two escapement fingers 22 which coöperate with an escapement lever on the armature 42 of the relay magnet 25. On the lower portion of the shaft 6 there are a number of notches 35 just below which there is a hub 26. Mounted upon the base plate there is a pawl 34 which is adapted, when released from the spring 39, to engage the teeth 35 and prevent downward movement of the shaft 6. When the shaft is in its uppermost position the hub 26 forces the pawl 34 out until a lug on the spring 39 drops in front of a lug on the back of the pawl, which thereafter holds the pawl out of the path of the notches 35 until the relay 27 is energized to force the spring 39 backward to release the pawl. The stationary detent 40 engages a vertical slot in the sides of the notches 35 during the vertical movement of the shaft while in normal rotary position, but when the shaft is rotated in any of its vertical positions the detent 40 engages one of the notches 35 and prevents the shaft from being returned to its normal vertical position without first being returned to its normal rotary position. Upon the back of the switch there is a group of contact springs 43, 44, 45 and 46 (Fig. 6) which are controlled by the armatures of the relay 25 and by the arm 47 which is pivoted at the point 48. As long as the cylinder 12 is in its normal position the arm 47 is held in the position shown in Fig. 2 against the tension of the spring 49 by a pin 50 on the cylinder 12. When the armature 41 of the relay 25 is attracted it forces the spring 44 into engagement with the spring 43 and moves the spring 45 outward far enough so that when the cylinder 12 and switch shaft 6 move downward from their normal positions, the end of the arm 47 may drop down behind the spring 45. When the armature 42 of the relay 25 is attracted it forces the spring 46 into engagement with the spring 43. It will be noted that in Fig. 6 of the drawings a portion of the spring 44 is shown broken away near the middle to more clearly show the position of the spring 46 which contacts with spring 44. When the armature 41 is released, the spring 44 returns to its normal position and disengages the spring 43, but if the switch shaft is out of normal position, so that the end of the arm 47 is behind the spring 45, said spring is engaged by the spring 44 when it returns to its normal position. When the switch shaft is returned to its normal position, the arm 47 is lifted from behind the spring 45 and said spring thereupon moves out of contact with the spring 44. Near the top of the plate 2 there is a lever 51 pivoted on the edge of the plate and provided with an arm 52 which extends vertically behind the switch shaft. On top of the plate 2 there is a collar 53 which surrounds the shaft 6 and through which the shaft may slide vertically, but which is forced to rotate with the shaft. On the front of the switch there is a rod 54 which is attached to the lever 51, upon the lower end of which rod there is a collar 55. Upon the top of the collar 55 rest projections from the armatures of the relays 27 and 56, so that whenever either of the relays 27 and 56 is energized, the lever 51 is operated and the projection 52 thereon tipped toward the shaft 6. On the collar 53 there is a projection which, when the shaft is in its normal rotary position, prevents the arm 52 from moving toward the shaft, and therefore prevents the armatures of the relays 27 and 56 from being attracted far enough to operate their contact springs, but does allow the armature of the relay 27 to depress the spring 39 far enough to release the pawl 34. The relays 27, 56 and 57 control respective groups of contact springs through the medium of the rods 58, 59 and 160, the rods 58 and 59 being capable of moving a short distance before operating their springs. These three groups of contact springs are all mounted in one group, thereby simplifying the construction and assembling of the switch.

The magnetic circuits of the two windings of the relay 25 are rendered separate by the collar 62 on the core of the magnet, by means of which collar the magnet is mounted upon the heel piece upon which its armatures are pivoted. The armature 42 is provided with a residual screw 63 which prevents the armature from coming into direct contact with the core of the magnet, so that said magnet is not influenced by the residual magnetism and can vibrate in synchronism with the rapid impulses of current through the winding. The armature 41 has no residual screw or similar device, and therefore comes directly into contact with the core, whereby when the magnet is energized and deënergized rapidly, the residual magnetism maintains the armature attracted between impulses, so that it does not vibrate but remains in its operated position continuously while impulses are being transmitted. The ringing relay 60 is of the solenoid type.

In general, the operation of the switch is as follows: The cylinder 12 is normally held in its uppermost position, as shown in Fig. 1, against gravity and the tension of the spring 61 on the shaft 17 by the engagement of one of the escapement fingers 22 with the armature 42 of the relay 25, whereby the entire mechanism is locked. The shaft 6, being free, rests with the pin 13 at the

bottom of the slot 14, in which position the wiper 9 rests just above and to the left of the bank 3. If, now, the relay 25 be energized, the attraction of the armature 42 permits the escapement levers 22 to turn through half a revolution, permitting the cylinder and shaft to move downward a short distance. If, now, the relay 25 be deënergized and energized rapidly a number of times, the coöperation of its armature 42 with the escapement device 22 will permit the cylinder 12 and shaft 6 to move downward one step by each complete deënergization and energization of the relay, allowing the shaft to move downward a distance equal to the distance between the successive rows of contacts in the switch bank. After the shaft has been moved downward a sufficient distance the relay 27 is energized. The relay 27, upon energizing, presses back the spring 39, releasing the pawl 34 to allow said pawl to engage one of the notches 35. If, now, the deënergizing and energizing of the relay 25 is continued, the cylinder 12 will continue to move downward in the same manner as before; but since the pawl 34 is in one of the notches 35, the shaft 6 cannot descend any farther and therefore, during the downward movement of the cylinder 12, the pin 13 has a movement upward relative to the slot 14. Since the slot 14 is in the form of a helix, this relative movement of the pin and slot causes the shaft 6 to rotate, thus causing the wiper 9 which is carried thereby to move successively over the contacts in the row or level of bank contacts which corresponds to the notch 35 with which the pawl 34 is engaged. During the rotation of the shaft 17 to permit the cylinder 12 to descend, it raises the plunger 31 of the solenoid 30. When it is desired to restore the switch shaft to normal position, the solenoid 30 is energized and, by drawing its plunger downward, rotates the shaft 17 to restore the cylinder 12 to its upper position. As has been explained, the stationary detent 40 engages a notch 35 in the switch shaft 6 when the said shaft is rotated. Therefore, during the first part of the restoring movement of the cylinder 12, the shaft 6 is prevented from moving vertically and is, therefore, forced to rotate back to its normal rotary position by the slot 14 and pin 13. When the switch shaft reaches its normal rotary position, the slot in the side of the shaft comes opposite the detent 40, and the pin 13, being at the bottom of the slot 14 in the cylinder 12, the shaft 6 then moves vertically with the cylinder to its normal position. Upon reaching said position the hub 26 forces the pawl 34 out so as to be engaged by the spring 39, and the entire apparatus is therefore restored and remains locked in normal position by reason of the engagement of the escapement fingers 22 with the armature 25. During the restoring movement of the shaft 17 the pawl 21 slides backward over the teeth of the ratchet wheel 19 and the notched wheel 18 remains stationary.

In order to give a clearer understanding of my invention, it will be described in detail how a connection is extended from the calling substation A (Fig. 3) to the called substation A′ (Fig. 4), in which connection the connector switch H (Fig. 4) is of the type of switch shown in Figs. 1 and 2. The automatic telephone system through which this connection is established is assumed to be of the well-known type of automatic system employing subscribers' individual or line switches, first selectors, second selectors and connectors, the connection shown being established through the medium of a line switch C, first selector E, second selector F and connector H. As shown herein, the substation A comprises the usual receiver 65, transmitter 66, switch hook 67, ringer 68 and condenser 69. 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 Fig. 3, however, the calling device is represented diagrammatically by a pair of impulse springs 71 and 72 and a toothed impulse wheel 73, which latter is 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 operated; but as the dial returns to normal position, said springs are separated momentarily a number of times, corresponding to the digit called.

The line switch C and 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 said United States Letters Patent No. 815,321, 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 circuit in series.

The selector F is similar to the selector E, with the addition of the side switch wiper 74.

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

As has been stated, the connector H is of the type of switch represented in Figs. 1 and 2, only the circuit connections and portions of the apparatus being shown diagrammatically in Fig. 4. As far as possible the same reference numerals are used in Fig. 4 as are used in Figs. 1 and 2. As shown in Fig. 4, the connector is provided with three wipers, namely, a private wiper 9 and two line wipers 10 and 11. The talking circuit through the connector is divided into two sections by the condensers 75 and 76. The relay 25 is the line relay, its two windings being bridged across the front side of the talking circuit in series with the battery through the springs of the so-called back-bridge relay 57. The relay 27 is a line switching relay, among its functions being that of completing the talking circuit through the switch after the wipers have been placed in contact with the terminals of the desired line. The function of the ringing relay 60 is 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. At S there is shown a busy signaling machine for producing the ordinary interrupted busy signaling current. At B there is shown a battery having one terminal grounded at G for the purpose of supplying current for operating the central office apparatus and for talking purposes.

The line switch C′ and the substation A′ are in all respects the same as the line switch C and the substation A.

A general description of the apparatus involved in the connection having been given, its complete operation will now be explained. It will be assumed that the number of the called substation is 2220. When the receiver is removed from the switch hook at the calling substation preparatory to making a call, the talking circuit is bridged across the line through the switch hook springs 77 and 78, whereupon a circuit is closed from ground G′ at the central office through the springs 79 and 80, line conductor 81, thence through the receiver and transmitter at the substation A and back over the line conductor 82, springs 83 and 84 and line winding 85 of the switch C to the battery lead 86, thence through battery B to ground G. The winding 85, upon energizing, closes the circuit of the operating winding 87, which operates to cause the switch C to extend the line connection through the bank springs 88 and 89 and 90 and 91 to the first selector E, after which the magnet of the switch C is disconnected from the line. When the connection is extended to the first selector E its line relay 92 becomes energized by reason of the closed bridge across the line at the calling substation. The relay 92, upon energizing, closes the circuit of the relay 93. The relay 93, upon energizing, completes an energizing circuit for the holding winding 94 of the line switch C and extends a guarding ground potential over the conductor 95 to the connector private bank contacts of the calling line. When the calling subscriber operates his calling device for the first digit 2 of the number of the called substation, the circuit of the selector line relay 92 is broken twice momentarily by the separation of the substation impulse springs 71 and 72. The relay 93 and other similarly represented relays throughout the drawings are slow acting—that is, slow to deënergize during momentary interruptions of their circuits. Each time the line relay 92 is deënergized a circuit is closed through the vertical magnet 96. The magnet 96 receives two impulses and operates to raise the switch shaft and wipers two steps, after which the side switch passes to second position. After the side switch passes to second position the rotary magnet 97 operates in a well-known manner to rotate the wipers onto an idle trunk line, after which the side switch passes to third position, whereby the relay of the first selector is disconnected from the line and the connection is extended to the second selector F. The line relay 98 of the second selector thereupon becomes energized in the same manner in which the relay 92 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 second selector F operates in the same manner as the first selector E to extend the connection over the trunk conductors 99 and 100 to the connector H (Fig. 4). When the connection is thus extended to the connector its line relay 25 becomes energized in the same manner in which the line relays of the selectors became energized when connection was first extended thereto. The relay 25, upon energizing, attracts both its armatures 42 and 41. The armature 41, upon being attracted, forces the spring 44 into engagement with the spring 43, whereby a circuit is closed from ground G^2 through the springs 44 and 43, trunk line conductor 101, private bank wiper 144 of the selector F, side switch wiper 104, springs 105 to the point 106, whence the circuit branches, one branch passing through the relay 107, while the other branch passes through the side switch wiper 74, thence back to and through the relay 93 of the selector E to the battery lead 86. The engagement of the springs 44 and 43 of the connector line relay 25 therefore provides a holding circuit for the release relays 107 and 93 of the selectors F and E, and also provides guarding ground potentials for the selector private bank con-

tacts of the trunk lines seized by the selectors. The attraction of the armature 42 of the relay 25 completes a circuit extending from ground G^2 through the springs 44, 43 and 46, relay 27 and the lower winding of the relay 56 to the battery lead 86. The relay 56 is not operatively energized over this circuit owing to the comparatively high resistance of the relay 27. The relay 27 is energized, but, as has been explained, said relay is prevented from operating its contact springs by the rod 54 and the lever 51 while the switch shaft is in normal rotary position, but is permitted to release the pawl 34. A further result of the attraction of the armature 42 is to permit the escapement device 22 to escape half a revolution, thereby permitting the switch shaft 6 and cylinder 12 to make one step downward, whereupon the pin 50 in the cylinder 12 allows the lever 47 on the switch to drop down behind the spring 45. This preliminary movement of the switch shaft, however, is not sufficient to cause the hub 26 to pass beyond the end of the pawl 34.

The calling subscriber now operates his calling device for the third digit 2 of the called number, thereby causing the circuit of the connector line relay 25 to be broken twice momentarily. As has been explained, the armature 41 of the relay 25 does not fall back immediately upon the breaking of the circuit of the relay, and therefore this armature remains in its operated position while the impulses are being transmitted through the relay. The armature 42 of the relay, however, vibrates in synchronism with the impulses and momentarily breaks the circuit of the relay 27 twice, and also permits the escapement lever 22 to make two complete revolutions. Each revolution of the escapement lever 22 permits the cylinder 12 and switch shaft 6 to drop down a distance equal to the distance between successive rows or levels of bank contacts, and therefore after two deënergizations of the relay 25 the switch wipers come to rest opposite the second level. The first time the circuit of the relay 27 is opened, said relay allows its armature to drop back to normal position, and since this occurs before the hub 26 on the shaft moves out of engagement with the pawl 34, the spring 39 again engages said pawl and holds it out of engagement with the notches 35. When the armature of the relay 27 is in its normal position it is separated from the core of its magnet by such a large air gap that it is not operated by the short impulses transmitted through the relay by the vibrations of the armature 42 of the line relay 25, and therefore the armature of the relay 27 remains in its normal position while the switch is operating in response to the impulses for the first digit. After the last impulse for the digit 2 is delivered, the armature 42 of the line relay remains in its attracted position and closes the circuit of the relay 27 for a longer time, whereupon said relay attracts its armature and releases the pawl 34 from the spring 39. The pawl 34 thereupon drops into the second notch 35 in the shaft, which notch is brought opposite the end of the pawl by the operation of the switch in response to the impulses for the digit 2. The calling subscriber now operates his calling device for the last digit 0, whereupon ten impulses are transmitted through the connector line relay 25. The armature 41 remains in its operated position during the entire time the impulses are being transmitted in the same manner as for the previous digit, while the armature 42 vibrates in response to said impulses. The first time the armature 42 is retracted it permits the relay 27 to deënergize, and said relay remains deënergized until after the last impulse is delivered in the same manner as for the previous digit. The ten vibrations of the armature 42 for the last digit permit the escapement lever 22 to make ten complete revolutions, thereby allowing the cylinder 12 of the connector to descend ten complete steps; but since the pawl 34 is in engagement with one of the notches 35, the shaft 6 cannot descend with the cylinder and is forced to rotate, thereby carrying the wipers 9, 10 and 11 ten steps onto the tenth set of contacts in the second level of the bank, which are the contacts of the desired line No. 2220. After the last impulse has been delivered to the line relay it again causes the relay 27 to be energized, and since the switch shaft has now been rotated, the said relay is permitted to operate its contact springs. The engagement of the springs 109 and 110 with their front contacts completes the talking circuit through the connector, as indicated by the heavy conductors. The engagement of the springs 111, 112 and 113 completes energizing circuits for the ringing relay 60 and for the cut-off winding 114 of the switch C′. The circuit for the winding 114 extends from ground G^3 through the springs 112 and 111, private wiper 9, connector private bank contact and winding 114 to the battery lead 86. This circuit also provides a guarding ground potential for the connector private bank contacts of the called line. The winding 114, upon energizing, attracts the armature 115, which disconnects the switch C′ from the called line and closes the contact 116 in the talking circuit. The circuit for the ringing relay 60 extends from ground G^3 through the springs 112 and 113, springs 117 and 118, relay 60 and interrupter 119 to the battery lead 86. The relay 60, upon energizing, disconnects the calling line from the called line and connects the ringing current generator M with the called line. When the called subscriber removes his receiver, or

as soon thereafter as the ringing relay 60 becomes deënergized, if it is energized at the time, the called substation is provided with talking current over a circuit extending from ground G^4 through the lower winding of the back-bridge relay 57, spring 110 and its front contact, ringing relay springs 120 and 121, wiper 11, line 122, thence through the substation A′ and back over the line 123, contact 116, wiper 10, springs 124 and 125, spring 109 and its front contact and the upper winding of the relay 57 to the battery lead 86. The relay 57, upon energizing, completes a circuit from ground G^5 through the springs 128 and the upper winding of the relay 56 to the battery lead 86. The relay 56, upon energizing, breaks the circuit of the ringing relay at the springs 117 and 118 to prevent further application of ringing current to the called line after the called subscriber has answered. The closure of the springs 129 and 130 completes a locking circuit for the upper winding of the relay 56 to prevent it from deënergizing and again closing the circuit of the ringing relay in case the calling subscriber hangs up his receiver before the connection is released. A further result of the energization of the back-bridge relay 57 upon the response of the called subscriber is to transpose the connections between the windings of the line relay 25 and the trunk conductors 99 and 100, whereby the direction of the current flowing in the calling line is reversed. This reversal of the current is without function in the system shown, but is often employed for the purpose of operating call registers or operators' signals.

After the conversation is completed the entire connection is released upon the hanging up of the receiver at the calling substation. The hanging up of the receiver at the substation A destroys the energizing circuit of the connector line relay 25 and after a short time its armature 41 drops back. The separation of the springs 44 and 43 by the falling back of the armature 41 destroys the holding circuit of the release relays 107 and 93 of the selectors F and E, which, upon deënergizing, close the circuits of their respective release magnets 131 and 132, which magnets in turn, upon energizing, release their respective switches. The line switch C is released by the breaking of the holding circuit of its winding 94 by the deënergization of the relay 93 of the selector E.

The falling back of the armature 41 of the connector line relay 25 also closes the circuit of the release solenoid 30 because, as has been explained, when the connection is first extended to the connector, the spring 45 is moved slightly forward and the arm 47 allowed to drop behind it. Therefore, when the armature 41 drops back, a circuit is closed from ground G^2 through the springs 44 and 45 and the solenoid 30 to the battery lead 86. The solenoid, upon energizing, restores the shaft of the connector to normal position in the manner which has already been explained, and when the shaft reaches its normal position the lever 47 is forced from behind the spring 45 and said spring is allowed to disengage the spring 44 to break the circuit of the solenoid 30.

It having been explained how connection is completed with an idle line, it will now be explained how connection is prevented from being completed with a line which is already in use and how the calling subscriber is given the busy signal. In the foregoing explanation it has been shown how, whenever a line is in use, either by having made a call or on account of having been called, there is a guarding ground potential upon the connector private bank contact of the line. Therefore, when the private wiper 9 of the connector engages the guarded contact of a busy line, the ground potential is extended from said contact through said wiper and through the spring 111 and its back contact to a point in the connection between the relays 27 and 56. Thus if the private wiper is standing upon the contacts of a busy line upon the completion of the impulses for the last digit of the called number, the relay 27 is short-circuited and the circuit of the lower winding of the relay 56 is closed without interposed resistance. The relay 27, therefore, does not operate, but the relay 56 operates instead. The relay 27 not being energized, no connection is completed between the calling line and the busy called line, notwithstanding the fact that the wipers of the connector are standing upon the contacts thereof. The relay 56, upon energizing, completes a connection from the busy signaling machine S through the springs 132, springs 133 and 110, condenser 76, trunk conductor 100 and thence to and through the calling substation, back over the other side of the line, through the upper winding of the connector line relay to the battery lead 86 and then to the busy signaling machine S. The interrupted current flowing from the machine S over this circuit informs the calling subscriber that the called line is busy. When the calling subscriber hangs up his receiver the connection is released in the same manner as when an idle line has been called.

While I have shown and described one particular embodiment of my invention, it is to be understood that I do not wish to be limited to the exact construction shown and described, as various modifications and changes will readily suggest themselves to those skilled in the art, which changes would come within the scope of my invention.

What I claim as my invention is:—

1. In a telephone system, an automatic

switch having downward and rotary selecting motions, both of said motions being past contacts, a relay having a pair of armatures having different time constants for controlling the operation and release of said switch, and an energizing circuit for said relay.

2. In a telephone system, an automatic switch having downward and rotary selecting motions, both of said motions being past contacts, a relay having a pair of armatures having different time constants for controlling the operation and release of said switch, and means for controlling said relay over a circuit including two sides of a line circuit in series.

3. In a telephone system, lines divided into groups, an automatic switch having contact arms, means for moving said arms downward in one plane to select groups and in a plane at right angles thereto to find a line in a selected group, step-by-step means for controlling the extent of operation of said arms, a relay having a pair of armatures having different time constants for controlling the operation and release of said switch, and an energizing circuit for said relay.

4. In a telephone system, an automatic switch having downward and rotary selecting motions, both of said motions being past contacts, a line relay for said switch, means for transmitting a plurality of impulses through said relay, a quick acting armature responsive to said impulses for controlling the operation of said switch, and a slow acting armature for said relay which is not responsive to said impulses for controlling the release of said switch.

5. In a telephone system, an automatic switch having downward and rotary motions, both of said motions being past contacts, a line relay for said switch, means for transmitting a plurality of impulses through said relay, a quick acting armature responsive to said impulses for controlling the operation of said switch, a slow acting armature for said relay which is not responsive to said impulses for controlling the release of said switch, and means for controlling said relay over a circuit including two sides of the line circuit in series.

6. In a telephone system, an automatic switch having contact arms, means for moving said arms downward, means for then continuously rotating said arms, step-by-step means for controlling the extent of movement of said arms, a relay having a pair of armatures having different time constants for controlling the operation and release of said switch, and an energizing circuit for said relay.

7. In a telephone system, an automatic switch having contact arms, means for moving said arms downward, means for then continuously rotating said arms, step-by-step means for controlling the extent of movement of said arms, a relay having a quick acting armature and a slow acting armature, means for transmitting a plurality of impulses to operate said quick acting armature to control the operation of said switch, means whereby said slow acting armature remains in an energized position during the transmission of said impulses, and a release circuit controlled by said slow acting armature.

8. In a telephone system, an automatic switch having contact arms, means for moving said arms downward, means for then continuously rotating said arms, step-by-step means for controlling the extent of movement of said arms, a relay having a pair of armatures having different time constants for controlling the operation and release of said switch, and a circuit including two sides of a line circuit in series for controlling the operation of said relay.

9. In a telephone system, an automatic switch having contact arms, means for moving said arms downward, means for then continuously rotating said arms, step-by-step means for controlling the extent of movement of said arms, a relay having a quick acting armature and a slow acting armature, means for transmitting a plurality of impulses to operate said quick acting armature to control the operation of said switch, means whereby said slow acting armature remains in an energized position during the transmission of said impulses, a release circuit controlled by said slow acting armature, and a circuit including two sides of a line circuit in series for controlling the operation of said relay.

10. In a telephone system, an automatic switch including a shaft, a contact arm carried by said shaft, means for moving said shaft and contact arm vertically, a pawl normally disengaged from said shaft and adapted to engage the same to prevent vertical movement of said shaft, a relay, means for transmitting impulses through said relay to control the operation of said shaft, an armature responsive to said impulses, a second relay included in a circuit controlled by said armature, an armature for said second relay which is attracted only upon a prolonged energization of said second relay, and means whereby said second armature releases said pawl to permit it to engage with said shaft.

11. In a telephone system, an automatic switch, an operating shaft therefor, a pawl adapted to engage said shaft to prevent vertical movement thereof, a catch for normally maintaining said pawl disengaged from said shaft, means for transmitting a series of impulses to operate said shaft vertically, means for then transmitting a prolonged impulse, means for then transmitting a second series

of impulses to rotate said shaft, and a magnet having a circuit which is closed responsive to said series of impulses and said prolonged impulse, an armature for said magnet responsive only to said prolonged impulse for operating said catch to release said pawl to permit it to engage with said shaft.

12. In a telephone system, an automatic switch having vertical and rotary motion, a line relay for controlling the operation of said switch, a second relay controlled by said line relay, means for transmitting a series of impulses followed by a prolonged impulse through said line relay to operate said switch, an armature for said second relay responsive to said prolonged impulse, and means for preventing said armature from fully operating until said switch has left normal position.

13. In a telephone system, an automatic switch having downward and rotary selecting movement. a line relay for controlling the operation of said switch, a second relay controlled by said line relay, means for transmitting a series of impulses through said line relay followed by a prolonged impulse for controlling the operation of said switch, an armature for said second relay responsive only to said prolonged impulse, a catch normally preventing said armature from being fully attracted, and means for rendering said catch ineffective when said switch is rotated, to thereby permit said armature to be fully attracted.

14. In a telephone system, an automatic switch, a line relay for said switch, a slow acting armature for said relay, a pair of normally separated contact springs controlled by said armature, means for attracting said armature when said switch is operated to move both of said contact springs without bringing them into engagement, a member adapted to engage one of said contact springs to maintain the same in moved position until said switch has returned to normal position, whereby when said armature is released the contact springs are closed, and a release circuit controlled by said contact springs.

15. In a telephone system, lines, an automatic switch, a line relay for said switch, a pair of normally separated contact springs controlled by said relay, means for energizing said relay to operate said switch to connect with one of said lines, means for de-energizing said relay to close a release circuit through said contact springs, and a member for positively engaging said contact springs to maintain said release circuit closed until said switch has reached normal position.

16. In a telephone system, lines, an automatic switch having vertical and rotary motion, a line relay for controlling the operation of said switch to connect with one of said lines, an armature for said relay, a pair of contact springs controlled by said armature for controlling the release circuit for said switch, and a member adapted to positively engage one of said springs when said switch is released in order to maintain said springs in engagement until said switch reaches normal position.

17. In a telephone system, lines, an automatic switch, a line relay for operating said switch to connect with one of said lines, a release circuit for controlling the release of said switch, a pair of contact springs in said release circuit controlled by said relay, and means for closing the springs and separate means for holding said springs closed to maintain said release circuit closed until said switch has fully returned to normal position.

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

JOHN G. BLESSING.

Witnesses:

ARTHUR J. RAY,

ALBERT ANDERSEN.