J. ERICKSON.

TRUNK SELECTING SWITCH.

APPLICATION FILED JULY 7, 1913.

1,186,471.

Patented June 6, 1916.

5 SHEETS—SHEET 1.

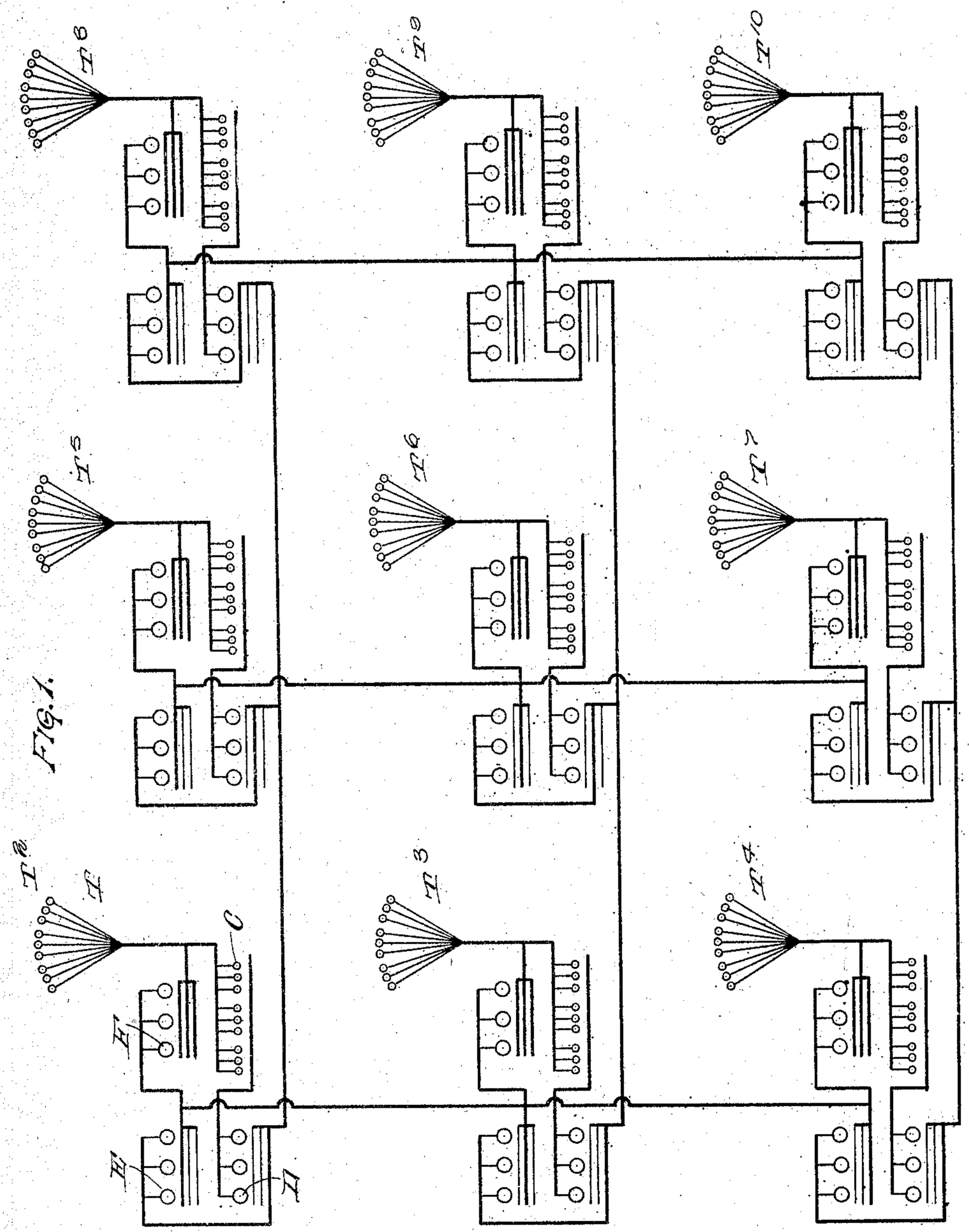

Fig. 1.

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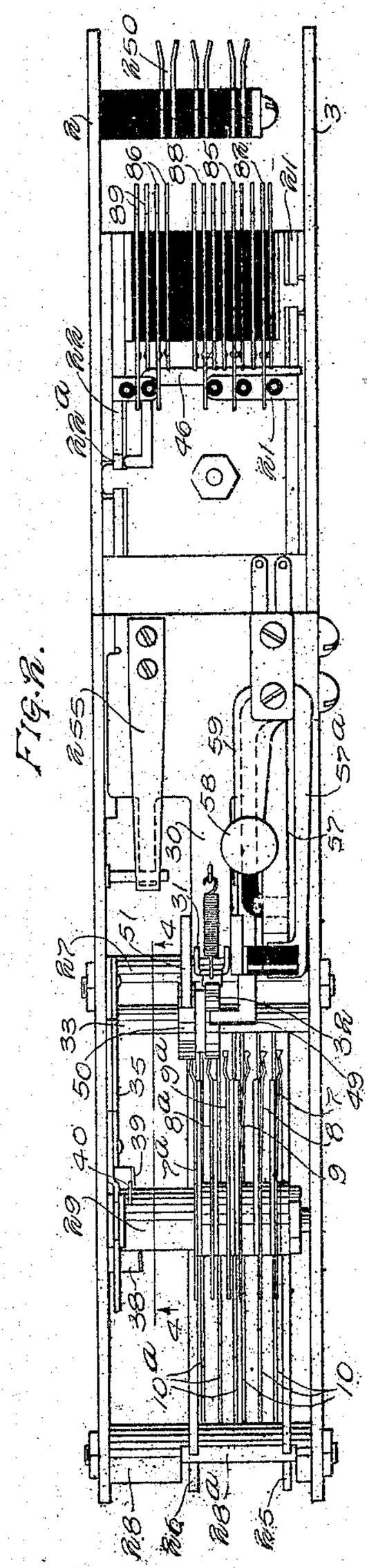

FIG. 2.

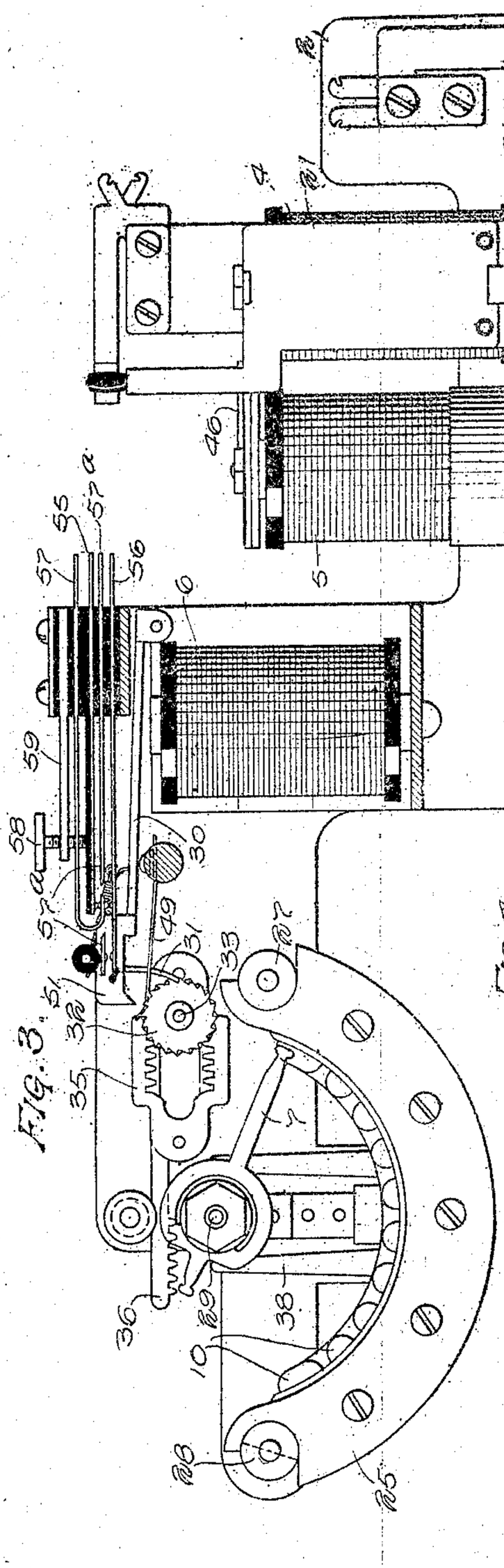

FIG. 3.

FIG. 5.

FIG. 4.

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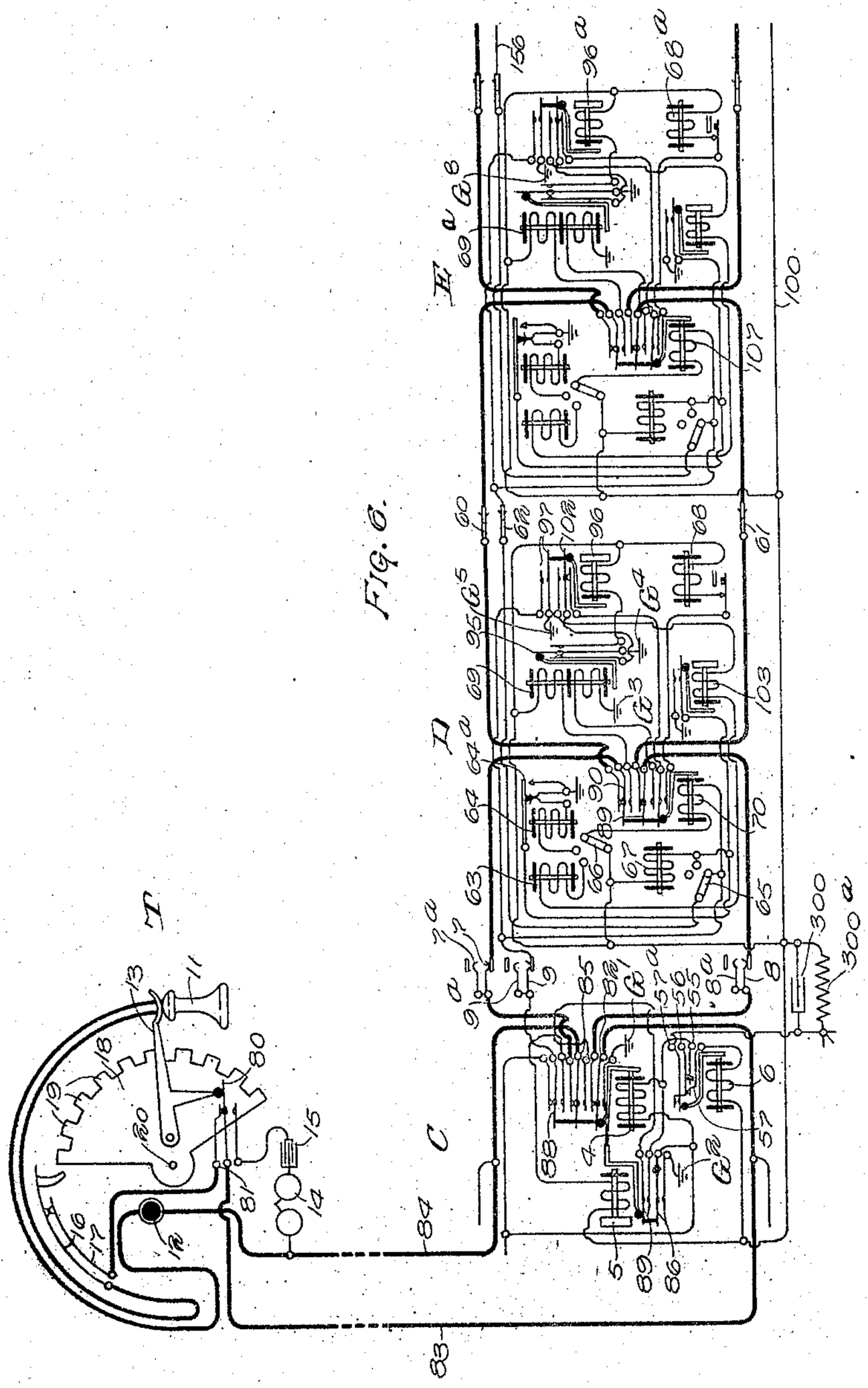

FIG. 6.

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5 SHEETS—SHEET 4.

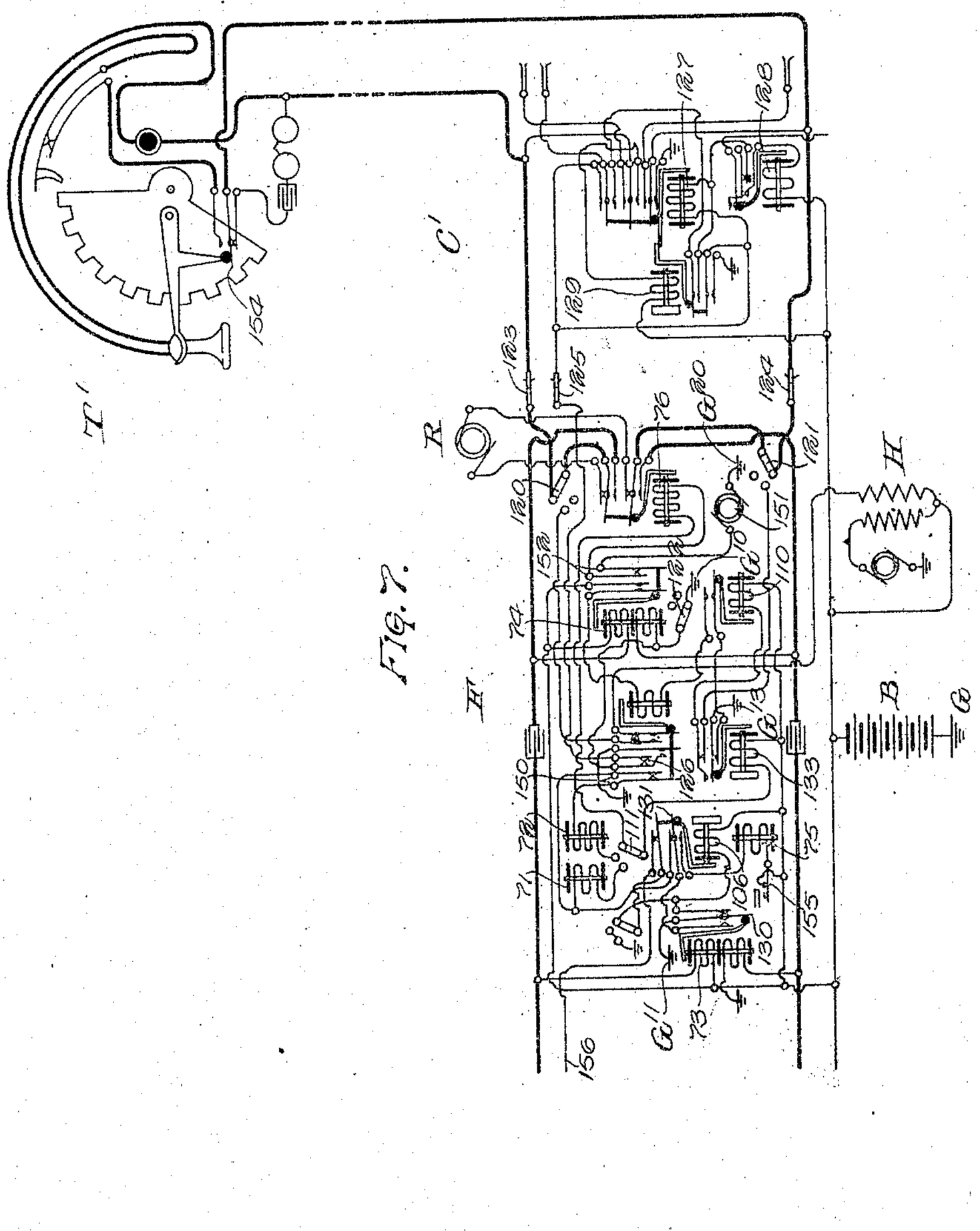

FIG. 7.

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5 SHEETS—SHEET 5.

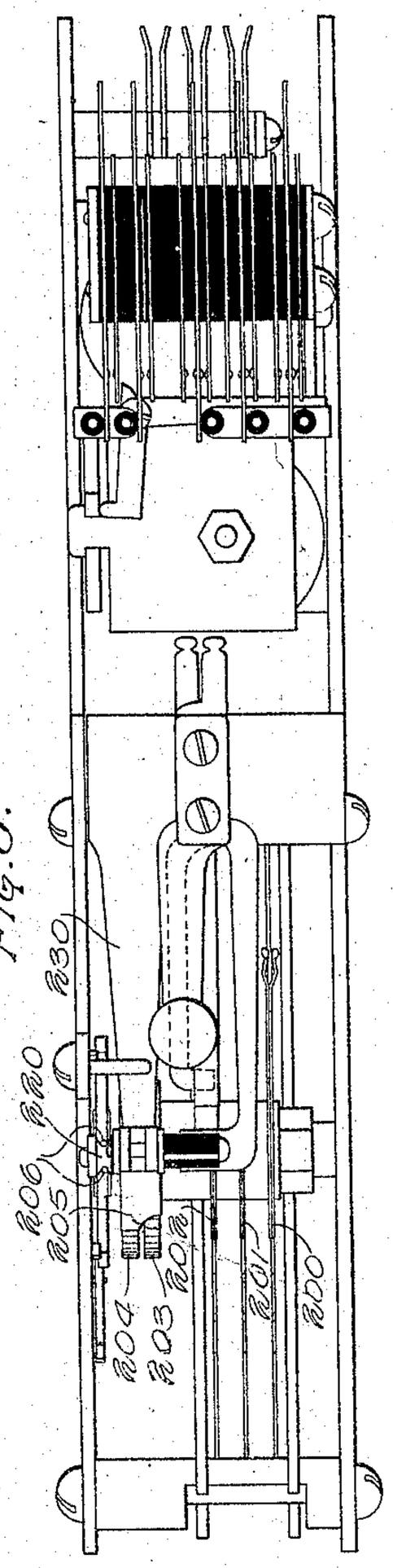

Fig. 8.

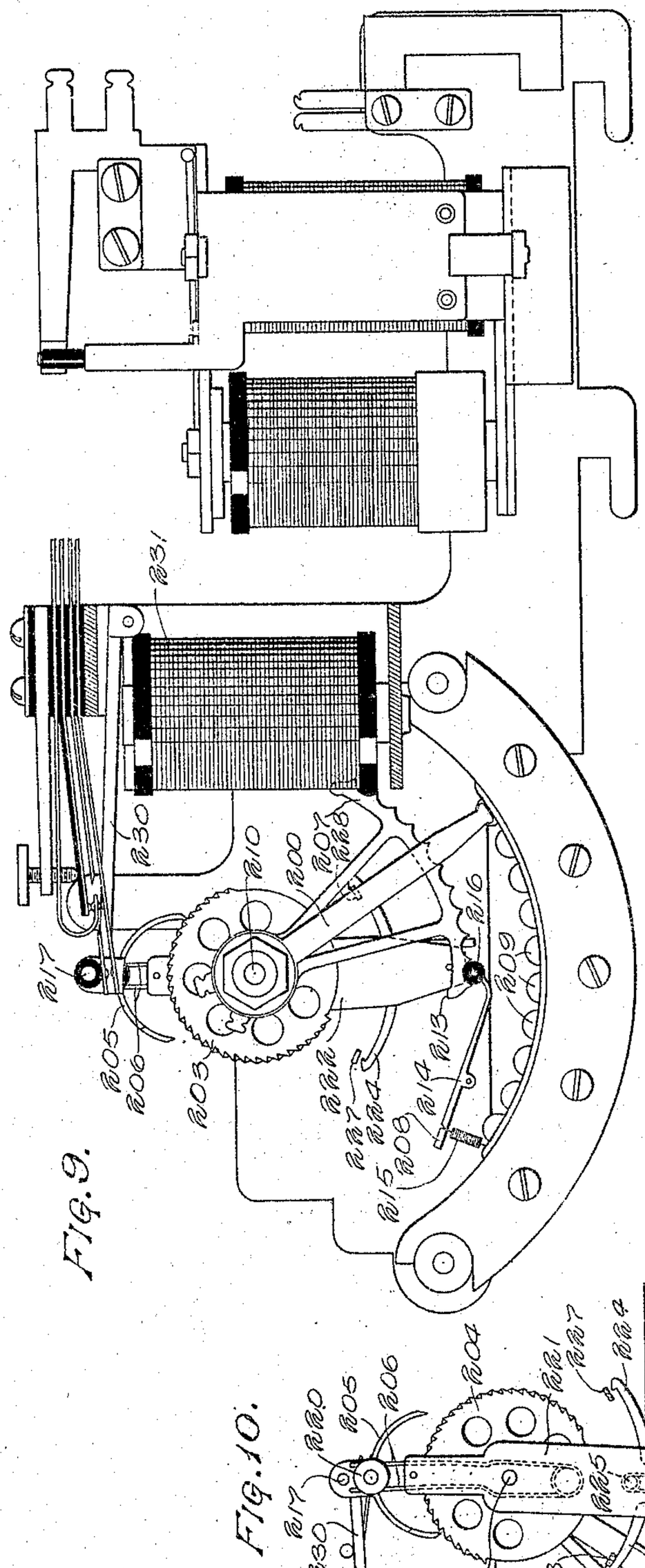

Fig. 9.

Fig. 10.

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TRUNK-SELECTING SWITCH

1,186,471. Specification of Letters Patent. Patented June 6, 1916.

Application filed July 7, 1913. Serial No. 777,675.

To all whom it may concern:

Be it known that I, JOHN ERICKSON, a citizen of the United States of America, and resident of Chicago, Cook county, Illinois, have invented a certain new and useful Improvement in Trunk-Selecting Switches, of which the following is a specification.

My invention relates to improvements in trunk-selecting switches, and more particularly to a non-numerical trunking switch provided with line wipers which are moved to and fro over a series of trunk terminals for the purpose of selecting an idle trunk.

It relates to a switch of the type in which the line wipers are normally in contact with the last trunk terminal employed by that switch, which wipers pass off this contact when the next call is made only in case this contact is busy. Heretofore, in switches of this type, the wipers were rotated continuously.

The object of my invention, however, is to provide a switch of this character in which the wipers move back and forth from one end of the row of trunk terminals to the other and select trunks in both directions.

My invention is, therefore, in the nature of an improvement upon my co-pending application Serial No. 249,499, filed March 10, 1905, in which there is disclosed a non-numerical trunk selecting switch which selects trunks when moving in one direction only. My invention is also in the nature of an improvement upon the co-pending application of John and Charles J. Erickson, Serial No. 379,180, filed October 16, 1905, in which there is shown a master switch for controlling the non-numerical trunk selecting switches.

A further object is the provision of two separate series of trunk terminals, the wipers of the trunking switch contacting with one series during movement in one direction and contacting with the trunk terminals of the second series during movement in the opposite direction, whereby the switch has access to twice as many trunk lines as there are trunk terminals in a single row.

A further object of my invention is the provision of improved means for shunting the springs of the interrupter magnet by a condenser to reduce the sparking at the contact springs. Ordinarily a separate condenser has been employed for each interrupter magnet. By my present invention, however, a single condenser is so connected that it is used in common by a plurality of switches, this condenser being momentarily connected with the interrupter magnet of these switches when that particular switch is operated.

These and other objects of my invention will be more clearly understood by referring to the accompanying drawings, in which I have illustrated my improved line switch in connection with a complete automatic system of a well-known type.

The selector and connector switches shown and described are well known in the art, and I do not in any way wish to limit my invention to use in connection with the particular type of system illustrated.

In the accompanying drawings Figure 1 is a diagrammatic layout of an automatic telephone system in which I have chosen to illustrate my invention. Fig. 2 is a front elevation of an automatic trunk-selecting switch embodying the principles of my invention. Fig. 3 is a side view of the same with the side plate 3 (Fig. 2) removed. Fig. 4 is a detail sectional view on the line 4—4 in Fig. 2. Fig. 5 is a detail sectional view on the line 5—5 in Fig. 4. Figs. 6 and 7 show a complete connection between a calling telephone T and a called telephone T′ in the system represented in Fig. 1. Fig. 8 is a front elevation of a modified form of the switch shown in Figs. 2 and 3. Fig. 9 is a right side view of the same with the side plate removed. Fig. 10 is a fragmentary left side view with the side plate removed.

The telephone system shown in Fig. 1 is an automatic telephone exchange of a well known type comprising subscribers' individual switches C, so-called first selectors D, second selectors E and connector switches F. In the drawing there is represented, on a scale of three to ten, three thousands of an exchange of ten thousand line capacity. The substation T and the lines connected thereto are divided into groups T^2, T^3 and T^4, etc., usually of one hundred lines each. On a scale of three to ten, therefore, the groups T^2, T^3, and T^4 represent one complete thousand and the groups T^5, T^6, and T^7 represent another thousand, etc. With each group of subscribers' lines there is associated in the central office a group of individual or line switches C, one for each line, a group of first

selector switches D, a group of second selectors E and a group of connector switches F. The selector and connector switches represented herein comprise banks of contacts arranged in horizontal rows or levels, usually ten in number. The levels are represented diagrammatically by horizontal lines which extend across a group of switches, thereby indicating that the corresponding contacts of all the switches of the group are multipled together. All the line switches C belonging to a single group of subscribers' lines have common access to a group of first selectors D. The bank contacts of all the first selectors of corresponding hundreds are multipled throughout the different thousands. The bank contacts of the first level of these first selectors are connected to trunk lines leading to second selectors associated with the first thousand, the contacts of the second level are connected to the trunk lines leading to the second selectors E associated with the second thousand, etc. All the second selectors associated with a given thousand are multipled together and the first level is connected to trunk lines leading to connectors which have access to the lines of the first hundred group of that thousand. The second level of the second selectors is connected to trunk lines leading to connectors having access to the lines of the second hundred of the thousand, etc. This trunking arrangement of an automatic exchange is generally well known and explanation in greater detail is not thought necessary.

In Figs. 6 and 7 there is shown a subscriber's telephone T connected to conductors terminating at the central office in an individual or line switch C similar to that shown in Figs. 2 and 3. By means of wipers 7, 8 and 9, and 7^a, 8^a and 9^a, together with a bank of contacts, this switch extends the line connection of the calling subscribers to a first selector D. A number of line switches C have common access to trunks leading to the above-mentioned selectors, which in turn have access to other trunk lines leading to second selectors E. The second selector E with which the subscriber obtains connection extends the line connection to a connector switch F, by means of which, connection may be completed with the subscribers' lines. Associated with the connector F is a ringing generator R and a busy signaling machine H. Current for the purpose of operating the central office apparatus and for talking purposes is supplied by a battery B, one pole of which is grounded at G. The line switch C′ is the same in detail as the line switch C.

Before describing the complete operation of the system as a whole, a detailed description will be given of the construction and mode of operation of the switch shown in Figs. 2, 3, 4 and 5. A bank of contacts is secured between two plates 2 and 3 (Fig. 2), this bank comprising two sets of contacts 10 and 10^a, and two sets of wipers 7, 8 and 9 and 7^a, 8^a and 9^a are provided for wiping over and making contact with these contacts. These wipers are mounted on a shaft 29 journaled between the plates 2 and 3. The shaft 29 is adapted to be oscillated through a portion of a revolution so as to carry the wipers back and forth over their respective rows of contacts. The two sets of wipers are so arranged that only one set is in engagement with the contacts at a time and the shaft is adapted to be shifted endwise at each end of its travel, so as to move one set of wipers out of engagement with its contacts and the other set into engagement with its contacts. The contacts are suitably mounted and insulated between two plates 25 and 26, which in turn are held in place by means of two posts 27 and 28 clamped between the plates 2 and 3. The complete bank of contacts is readily removed from the switch by turning the post 28 around until the flat portion 28^a of the post is facing the edge of the plates 25 and 26, thereby taking away the means of support from this end of the bank. The bank is then drawn off the post 27. The means for oscillating the wipers over the bank contacts comprise an electromagnet 6 with its armature 30, the pawl 31 and ratchet wheel 32. The ratchet wheel 32 is secured to the shaft 33 on which is mounted a gear segment 34 (Fig. 4) which is adapted to engage with one or the other of the toothed portions of a double rack 35, which is slidably mounted on the plate 2. Secured to the double rack 35 there is a rack 36 which engages a gear segment on the wiper shaft 29. By causing the magnet 6 to be energized and deënergized a number of times in succession, the wheel 32 and shaft 33 may be rotated in a step by step manner in a clockwise direction, as shown in Figs. 3 and 4. During the first half of the revolution the segment 34 will engage the upper set of teeth in the rack 35 and move said rack, together with the rack 36, to the right, thereby rotating the shaft 29 in a clockwise direction. During the second half of the revolution of the shaft 33, the gear segment 34 engages the lower teeth of the rack 35 and moves said rack and the rack 36 back toward the left, whereby the shaft 29 is rotated in the opposite or counter-clockwise direction. Thus it is seen that by continuously energizing and deënergizing the magnet 6, the wipers of the switch are caused to rotate back and forth in a step by step manner from one end to the other of their rows of contacts. A detent 49 (Fig. 3) is provided for preventing all backward rotation of the ratchet wheel 32. There is also provided an additional toothed wheel 50

which is secured to the shaft 33 and which is engaged by a detent 51 on the armature 30 each time said armature is drawn down by the energization of the magnet 6. This is to prevent the wipers from rotating more than one step at a time. The armature 30 is attracted against the tension of the spring 255, by means of which said armature is returned to normal position when the magnet 6 deënergizes.

The manner in which the wipers are shifted from one set of contacts to the other at the end of the rows is as follows: In Figs. 4 and 5 there are shown two springs 38 and 39 which are adapted to engage the opposite sides of a cam 40 on the shaft 29. The inner ends of these springs rest upon a stationary lug 41. When the shaft is in the position shown in Figs. 2, 3, 4 and 5—that is, when the wipers rest on the last contact at the right-hand end of their rows—the shaft is held by the spring 39 in its upper position, as shown in Fig. 2—that is, in its lower position, as shown in Fig. 5. In this position the wipers 7, 8 and 9 are in engagement with their respective rows of contacts and the wipers 7^a, 8^a and 9^a are lifted off their contacts. Assume now that the shaft 29 is rotated in a clockwise direction, as shown in Figs. 3 and 4. During this movement of the shaft the cam 40 moves in a clockwise direction, as shown in Figs. 4 and 5, passing beneath the lug 41. As the shaft continues its rotation, the cam 40 passes between the lug 41 and the spring 38. The lug 41 prevents the shaft from moving upward, and consequently the spring 38 is forced downward until the wipers reach the last contact, when the spring 38 will have been depressed considerably from its normal position. When the wipers make their last step in this direction, the right-hand end of the cam 40 passes beyond the left-hand end of the lug 41, so that the spring 38 is then able to shift the shaft endwise until the cam 40 comes above the plane of the lug 41. In this position the wipers 7, 8 and 9 are shifted out of engagement with their rows of contacts and the wipers 7^a, 8^a and 9^a engage their contacts. As the shaft begins its return movement, the cam 40 passes along the top of the lug 41 and underneath the spring 39 until it reaches the end of its travel, when it passes the lug 41, and the spring 39 is then free to shift the shaft back to its original position.

The magnet 6 is provided with a set of interrupter springs 55, 56, 57 and 57^a. The spring 57 is curved on the end, so as to engage the underside of the spring 55 and the upper side of spring 56. This spring has a slight downward tension, but this is normally overcome by the greater tension of the spring 56, so that the three springs 56, 57 and 55 are normally in electrical engagement with each other. When the armature 30 is attracted the bushing on the end thereof first forces the spring 57^a into engagement with spring 56, and the two springs move downward together. The spring 57 follows the spring 56 and immediately breaks contact with the spring 55. Before the stroke of the armature is completed the spring 57 engages the strip of insulation on the top of the spring 55 and is brought to rest, and thereby caused to break contact with the spring 56. The thumb screw 58 in the arm 59 forms a means of adjusting the spring 55. The switch is also provided with two relays 4 and 5 which control two groups of contact springs through the medium of the respective armatures 21 and 22. Pivotally mounted on a plate above the coils of the relays 4 and 5 there is a bell crank lever 46, one end of which engages a lug 22^a on the armature 22 of the relay 5, while the other end is provided with a notch which lies in the path of the upwardly extending arm of the armature 21 of the relay 4. This end of the lever 46 normally forms an obstruction for the armature 21, so that it can be attracted only far enough to break the back contacts of the relay springs and not far enough to close the front contacts. When the relay 5 is energized, its armature 22 rocks the lever 46 far enough to carry its end out of the path of the armature 21, so that if the relay 4 is energized at this time it may attract its armature all the way and close its front contacts. The springs 250 are the usual jack springs, through the medium of which connections are made with the switch.

The circuits of the switch C are shown in Fig. 6, in which the relay 5 is shown to be the line relay and the relay 4 the cut-off relay. The corresponding wipers 7 and 7^a, 8 and 8^a, and 9 and 9^a are electrically connected together and the two sets of contacts 10 and 10^a (Fig. 2) form terminals of separate trunk lines, and thus it is seen that the switch wipers engage different trunk lines when traveling in one direction from those which they engage when traveling in the other direction, so that the total number of trunk lines to which the switch has access is twice as great as the number of contacts in one row. The switches C, as shown herein, are individual to the subscribers' lines and the bank contacts of a plurality of these switches are multipled together and lead to a common group of first selectors D.

At 300 there is shown a condenser which is common to a plurality of switches C, the purpose of which is to prevent excessive sparking at the interrupter contacts of the magnet 6. The manner in which this is accomplished will be explained later.

The substation T may be of any suitable common battery type. As shown herein, it

comprises the usual receiver 11, transmitter 12, switch hook 13, ringer 14 and condenser 15. Being an automatic substation, it is also provided with the impulse springs 16 and 17 and an impulse wheel 18. The impulse wheel carries upon its periphery the impulse teeth 19 and is secured to a shaft 20, to which latter there is also attached a dial (not shown) provided with finger holes through the medium of which the impulse wheel may be rotated. As the impulse wheel is returned to normal position by a spring (not shown) after it has been rotated for any digit, each of the teeth 19 which passes the end of the spring 16 forces it out of engagement with the spring 17. The number of times these springs are separated depends upon the digit called.

The selector D is of the general type of selector switches disclosed in United States Letters Patent No. 815,321, granted March 13, 1906, to Keith, Erickson and Erickson, being modified, however, to operate in a two-wire system. It comprises, among other details, a set of wipers 60, 61 and 62 carried upon a shaft (not shown) which has a vertical motion controlled by a magnet 63 and a rotary motion controlled by a magnet 64. The usual side switch comprising the wipers 65 and 66 is controlled by the private magnet 67 in a well known manner. For the purpose of restoring the switch to its normal position, there is provided a release magnet 68 which restores the switch immediately upon energizing, rather than upon deënergizing as shown in the selector patent referred to above. A double-wound line relay 69 is connected to the line through the springs of the line-switching relay 70. The relays 96 and 103 are slow acting—that is, slow to deënergize after their circuits are broken. The second selector E is similar to the first selector D.

The connector switch F (Fig. 7) is of the general type of switch disclosed in United States Letters Patent No. 815,176, granted March 13, 1906, to Keith, Erickson and Erickson, being modified, however, like the selectors, in order to operate in a two-wire system. The switch comprises, among other details, the usual vertical and rotary magnets 71 and 72, the line relay 73, back-bridge relay 74, release magnet 75, ringing relay 76 and the private magnet 110.

In order to give a clearer understanding of the invention, I will describe in detail how the subscriber at the substation T may obtain connection with the substation T'. We will assume the number of the called substation to be 2220. In the system shown herein, the subscribers' lines are divided into groups and the individual switches C of all the lines belonging to the same group have common access to the same group of selectors—that is, each trunk line leading to a first selector is connected in multiple to the corresponding bank contact of all the individual switches of a group. The switches C shown herein do not release and return to normal position upon the termination of a conversation, but remain on the contact of the trunk line which was last used by the switch. Therefore, when a subscriber at the substation A makes a call, the wipers of the switch C may be standing on the contacts of a busy trunk, or on the contacts of an idle trunk. If the wipers are standing on the contacts of an idle trunk when the subscriber at the substation makes a call, they remain stationary and the relay 4 operates to connect the line through to the first selector D. If the trunk upon which the wipers are standing is busy, they will be rotated to an idle trunk before the line is connected with them. When the subscriber at the substation I removes his receiver from the switch hook preparatory to making a call, the engagement of the hook switch springs 80 and 81 closes a circuit through the line relay 5 of the switch C, said circuit extending from ground G' through the back contact of the spring 82, conductor 83, through the subscriber's telephone, back over the conductor 84, through the back contact of the spring 85 and through the relay 5 to the battery lead 100. The relay 5, upon energizing, completes a circuit extending from ground G^2 through the contacts of the springs 86, relay 4, interrupter springs 55, 56 and 57, through the motor magnet 6 to the battery lead 100, thence through the battery B to ground G. If the wipers of the switch C are standing on an idle trunk, the closure of this circuit causes the relay 4 to be energized, but the resistance of this relay is high enough to prevent sufficient current to flow through the magnet 6 to cause it to be operated. However, if the wipers are resting on a busy trunk line, the wiper 9 will be grounded. Therefore, when the relay 5 energizes, the relay 4 will not be energized, owing to a short-circuit extending from the grounded contact on which the wiper 9 is standing, through said wiper, back contact of the spring 88, springs 89 of the relay 5 and through the relay 4 and springs 86 to ground G^2. Upon the short-circuiting of the relay 4, the magnet 6 is allowed to pull up to advance the wipers of the switch one step and to interrupt its own circuit at the springs 55, 56 and 57. If the next trunk is also busy, the motor magnet 6 will be again energized to advance the wipers in the same manner. In fact, the operation is repeated until an idle trunk is reached. As soon as the wipers reach an idle trunk line the relay 4 ceases to be short-circuited and its armature is attracted, the circuit being traced above. When the relay 4 energizes, the

springs 82 and 85 break contact with their back contacts and make contact with their front contacts, thus disconnecting ground G′ and the line relay 5 from the calling line and extending the line connection through the wipers 7, 8 and 9 to a first selector D. When the connection is thus extended, the line relay 69 becomes energized over a circuit extending from ground G³ through the lower winding of the relay 69, back contact of the spring 89, line wiper 8, front contact of the spring 82, conductor 83, through the telephone at the substation T, back over the conductor 84, front contact of the spring 85, line wiper 7, back contact of the spring 90 and through the upper winding of the relay 69 to the battery lead 100. The relay 69, upon energizing, completes a circuit from ground G⁴ through the front contact of the spring 95 and slow acting relay 96 to the battery lead 100. The relay 96, upon energizing, extends a guarding potential from ground G⁵ through the springs 97 to the private bank contacts of the trunk leading to the selector D in all the individual switches which have access to said trunk. The wiper 9 being in contact with one of these contacts, a circuit is closed through the relay 4 and magnet 6 to battery. The relay 96 thus provides a holding circuit for the relay 4 to prevent it from being deënergized when the relay 5 deënergizes. A guarding potential is also provided from ground G⁵ at the selector D to the private contacts at the connectors of the calling line through the front contact of the spring 88.

Each time the magnet 6 is energized, the condenser 300 is shunted around said magnet and its interrupter springs at the instant the circuit of the magnet is broken, so as to provide an inductive shunt across the contacts to prevent excessive arcing when the circuit is broken. The condenser is shunted around the magnet by the engagement of the spring 57ª with the spring 56 just before the circuit of the magnet is broken at the springs 56 and 55. The armature of the magnet continues to move toward its core for a short distance after the circuit of the magnet is broken, so that finally the shunt through the condenser is broken by the separation of the springs 56 and 57. Thus it is seen that the condenser is disconnected from the magnet either when the armature is in its normal position or when it is fully attracted, so that notwithstanding the fact that the condenser is common to a plurality of switches, the momentary connections of ground to the common terminal of the condenser by a magnet which is operating can have little or no effect on the operation of any other magnet which is operating at the same time. The condenser 300 is preferably bridged by a high resistance 300ª which furnishes a discharge path for it, but does not affect the operation of the switches.

The line relay 5 is slow acting, so as to maintain the circuit of the relay 4 until after the relay 96 at the selector D has had time to send back ground from ground G⁵.

The above operations take place upon the subscriber taking his receiver from the switch hook preparatory to making a call. The subscriber now operates his dial in the usual manner for the transmission of the first series of impulses for the digit 2. The contact of the impulse springs 16 and 17 is momentarily broken twice, thus breaking the circuit of the line relay 69 a corresponding number of times. The relay 96 being slow acting does not have time to deënergize during the momentary interruption of its circuit by the relay 69. Each time the armature of relay 69 drops back a circuit is closed through the vertical magnet 63, said circuit extending from ground G⁴ through the back contact of the spring 95, front contact of the spring 102, slow acting relay 103 and through the vertical magnet 63 and side switch wiper 66 to the battery lead 100. Upon the vertical magnet being energized twice, the switch shaft is raised two steps. The relay 103 is energized by the impulses passing through it and, being slow acting, retains its armature until after the last impulse of the series has been transmitted. In its energized position this relay closes the circuit of the private magnet 67. This circuit is broken when the relay 103 deënergizes after the last impulse of the digit is transmitted and the private magnet, on deënergizing, trips the side switch to second position in a well known manner. The side switch wiper 66, on passing to second position, closes the circuit of the rotary magnet 64, which, through the medium of its interrupter springs, begins to operate in a manner similar to that of a buzzer to rotate the shaft wipers in search of an idle trunk line. Each time the magnet 64 energizes, it closes the circuit of the private magnet 67 by way of the contact 64ª. The magnet 67 energizes the first time this circuit is closed and remains energized until the first time the rotary magnet 64 deënergizes, with the private wiper resting on the contact of an idle trunk line, at which time the private magnet deenergizes and the side switch passes to third position. The side switch wiper 66, by passing from second to third position, breaks the circuit of the rotary magnet and closes the circuit of the switching relay 70. This circuit extends from ground G⁵ through the springs 97, relay 70 and side switch wiper 66 to battery. The relay 70, upon energizing, disconnects the line relay 69 from the line and extends the connection to the second selector E, whereupon the relays 69ª and 96ª become energized. The relay 96ª,

upon energizing, extends a holding circuit back from ground G^8 through the relay 70 of switch D to maintain it energized after its original circuit is broken by the deënergization of the relay 96. The subscriber now operates his dial for the second digit 2, in response to which the switch E operates in the same manner as explained for the switch D to extend the connection to an idle connector F, energizing the line relay 73 and the slow relay 106. Upon the slow relay 106 energizing, a holding circuit is established for the relays 107, 70 and 4 of the second and first selectors and the line switch C, respectively. The subscriber now operates his calling device for the third digit 2, whereupon the line relay is operated twice momentarily to energize the vertical magnet 71, thereby raising the switch shaft two steps and opposite the row of contacts in which is situated the terminals of the called subscriber's line.

The circuit of the vertical magnet is traced from ground G^{11}, back contact of the spring 130, front contact of the spring 131, vertical magnet 71, side switch wiper 111 and slow acting relay 133 to battery. Upon the relay 133 energizing, a circuit is closed from ground G^{13} through the private magnet 110, which energizes to prepare for the escapement of the side switch to second position in the usual manner. Upon the side switch wiper 111 passing to second position when the relay 133 and the magnet 110 deënergize after the last impulse for the digit is delivered, battery current is transferred from the vertical to the rotary magnet 72. The substation calling device is now operated for the last digit 0 and the connector line relay 73 is deënergized ten times, sending ten impulses through the rotary magnet 72, which rotates the wipers 123, 124 and 125 around ten steps onto the contacts of the called subscriber's line. The circuit of the rotary magnet is very similar to that described in connection with the vertical magnet 71, being traced from ground G^{11} through the springs 130 and 131, as for the magnet 71, thence through the contact of the springs 150, rotary magnet 72 and through the side switch wiper 111 and relay 133 to battery B. The relay 133 and magnet 110 operate as for the previous digit to cause the side switch to pass from second to third position after the last impulse is delivered. Upon the wipers 120 and 121 reaching third position, the line connection is completed between the calling and called lines. The side switch wiper 122, upon passing to third position, places a guarding potential on all the private contacts in multiple with the one on which the wiper 125 is resting. This guarding potential extends from ground G^{10} through the side switch wiper 122, contact of springs 126 and private wiper 125 to said contacts. A circuit also extends from the contact on which the wiper 125 is resting through the relay 127, contact of the interrupter springs of the magnet 128 and through said magnet to battery. The high resistance coil 127 does not allow sufficient current to pass through the magnet 128 to operatively energize it. The line relay 129 does not energize when the substation to which it belongs is being called. Therefore, when the armature of the relay 127 is attracted, it is only permitted by the armature of the relay 129 to pull up half the distance between its back and front contacts, thus cutting out of the line circuit the line relay 129 and at the same time not connecting the line to the wipers of the switch C'. The side switch wiper 111, upon passing to third position, completes the circuit of ringing relay 76 from ground G^{20}, ringing interrupter 151, contact of the springs 152, relay 76, side switch wiper 111 and through the relay 133 to battery. The relay 133 does not operatively energize in this circuit, owing to the high resistance of the ringing relay 76. The relay 76 is intermittently energized and deënergized by means of the interrupter 151 to break the connection between the calling and called subscribers' lines and to bridge the ringing generator R across the line of the called subscriber to ring the latter's bell. Upon the called subscriber removing his receiver to answer the call, a circuit is closed through the back-bridge relay 74 at the springs 154, which, upon energizing, opens the circuit of the ringing relay 76, thus preventing further interruption of the connection between the calling and called lines. Had the called line been busy, the side switch would not have passed to third position, thus making the connection impossible, for a ground potential would be on the private contact on which the wiper 125 came to rest. This busy circuit is well known in the art and it is thought unnecessary to trace it at this time. Upon the completion of the conversation, the central office apparatus is returned to normal by the calling subscriber hanging up his receiver, thus breaking the circuit of the line relay 73 in the connector switch. This relay deënergizes, thereby breaking the circuit of the slow relay 106, which also deënergizes, and a circuit is closed from ground G^{11} through the springs of the line relay 73 and slow relay 106, through the release magnet 75 and off-normal springs 155 to battery B. The release magnet energizes to return the switch shaft to normal, at which time the circuit of said magnet is opened by the shaft at the springs 155. Ground is also taken off the release trunk 156 upon the deënergization of the relays 73 and 106, thus destroying the holding circuits of the relays 107, 70 and 4

of the switches E, D and C, respectively. In the case of the relays 107 and 70 deënergizing, the circuits of the release magnets 68ª and 68 are closed in a manner similar to that of the release magnet 75 in the connector switch and the switch shafts are returned to their normal positions. Upon the relay 4 in the switch C deënergizing, the line connection to the first selector is broken at the springs of said relay and the line relay is again bridged across the line of the substation T, leaving the central office apparatus in a condition to be used for another call.

The switch illustrated in Figs. 8, 9 and 10 is essentially the same in principle as the one shown in Figs. 2, 3 and 4, with the exception that the wipers 200, 201 and 202 oscillate on the same contacts, unlike the wipers 7, 8 and 9, and 7ª, 8ª, and 9ª illustrated in Figs. 2 and 3, which latter, it will be remembered, are snapped over from one set of contacts to another upon said wipers reaching the end of the arc. There is also a difference in the driving mechanism, while the springs, contacts, magnets and relays are the same. Either line switch is capable of taking the place of the other without changing the circuits of the frame supports for the same. At 203 and 204 are seen two ratchet wheels secured to the shaft 210, together with the wipers 200, 201 and 202. There is also secured to the shaft 210 a notched segment 207 for the purpose of engaging with a retaining arm 208. This retaining arm is pivoted at 214, and at its end is provided with a bushing 216 which is pressed into the notches of the segment 207 by pressure exerted by the spring 215. The pressure on the segment 207 is sufficient to prevent the wipers 220, 201 and 202 from prematurely moving off one of the contacts 209 by a possible jar. The pressure, however, is not enough to retard the ordinary operation of the wipers. Associated with the ratchet wheels 203 and 204 is a double pawl 205 which is pivoted at 217 on the armature 230. One end of the pawl 205 engages one ratchet wheel to rotate the wipers in one direction, while the other engages the other ratchet wheel to rotate the wipers in the opposite direction. The respective teeth of the ratchet wheels are necessarily facing in opposite directions, as shown in Figs. 9 and 10. Secured to the center of the pawl 205 is a grooved projection 220 for the purpose of sliding between the guide springs 206, the function of which projection is to tilt the pawl one way or the other into engagement with one or the other of the ratchet wheels. The springs 206 are securely fastened between the plates 221 and 222 which are loosely mounted on one end of the shaft 210.

The manner in which the pawl 205 is tilted is as follows: When the wipers reach the end of the row of contacts in one direction, one or the other of the lugs 212 or 213 (depending on the way the wipers are traveling) on the segment 207 strikes the lower end of the arm composed of the plates 221 and 222 and moves said arm slightly in the same direction in which the wipers are traveling. This causes the upper end of the arm and the springs 206 to swing in the opposite direction to turn the pawl 205 on its pivot and reverse the position of the pawl 205, so that it now becomes operative to drive the shaft in the opposite direction. In order to hold the arm composed of the plates 221 and 222 in either of its positions, there are provided at its lower end two locking dogs 224 and 224ª which are adapted to engage the lugs 227 and 228, respectively, which project from the side plate. These locking dogs are in the shape of bell crank levers pivoted between the plates 221 and 222 at their elbows. One arm of each of the levers extends down into the path of the lugs 213 and 212 on the segment 207, so that before either of these lugs strikes the arm composed of the plates 221 and 222 it first engages the locking dog and disengages it from its lug 227 or 228, as the case might be. A small spring 225 between the dogs 224 and 224ª serves to bring them into engagement with their respective lugs when the arm is in the proper position. During the time when the wipers are rotating, the end of the pawl 205 which is not doing the driving engages its ratchet wheel when the armature 230 is in its fully attracted position, which prevents the wipers from being carried forward by their inertia after the armature 230 completes its stroke.

It will thus be seen that I have devised a very efficient form of line switch and one which is accessible to twice as many trunk lines as has heretofore been possible in connection with line switches of this type. By having the switch remain upon the last trunk with which it was in contact, movement of the switch is often obviated, and by having the switch select motion on both the forward and back movement, there is no idle or lost movement.

While I have illustrated my invention in connection with a full automatic system, it is to be understood that my line switch can be employed in connection with any automatic or semi-automatic system and in any position in which the line switches are employed. Various modifications in the structure of the switch itself will readily suggest themselves to those skilled in the art, but come within the contemplated scope of my invention.

What I claim as my invention is:—

1. In a telephone system, a trunking switch, trunk lines, said switch having line wipers always in electrical connection with some one of said trunks, which connected

trunk is always the last one employed by said switch for extending a call, and means for moving said switch to and fro over said trunk terminals to select an idle trunk if the connected trunk is busy.

2. In a telephone system, a trunking switch, a plurality of trunk lines, said switch having switch wipers normally in contact with one of said trunk lines, said connected trunk being the last one employed by said switch, means for moving said switch in one direction over said trunks to select an idle trunk when the connected trunk is busy, and means for reversing the movement of said switch and moving the same in the opposite direction over said trunks to select idle trunks when the limit of movement of said switch is reached.

3. In a telephone system, a trunk-selecting switch, a plurality of series of trunk terminals, line wiper conductors for said switch, and means for oscillating said conductors, said conductors being in contact with one of said series of terminals during movement in one direction and in contact with a second series of said trunk terminals during movement in the opposite direction.

4. In a telephone system, a trunk-selecting switch, a series of trunk terminals, a line wiper for said switch, an operating magnet therefor, means for intermittently energizing said magnet, and means for moving said line wiper over said trunk terminals in response to a continued series of intermittent energizations of said magnet in either of two directions to find an idle trunk whereby a talking circuit may be extended through said wiper.

5. In a telephone system, a non-numerical trunk-selecting switch, a plurality of series of trunk terminals, line wiper conductors for said switch, and means for oscillating said line conductors, said line conductors being in contact with one of said series of terminals during movement in one direction and in contact with a second series of said trunk terminals during movement in the opposite direction.

6. In a telephone system, a trunking switch, a plurality of series of trunk terminals, said switch having line wiper conductors always in electrical connection with a terminal of one of said series, which connected terminal is always the last one employed by said switch for extending a call, means for moving said conductors to and fro over said trunk terminals to select an idle trunk if the connected trunk is busy, and means for moving said conductors into a position to disengage from said first series and engage with a second series of trunk terminals.

7. In a telephone system, a trunking switch, a plurality of series of trunk terminals, said switch having line wiper conductors always in electrical connection with a terminal of one of said series, which connected terminal is always the last one employed by said switch for extending a call, means for moving said conductors to and fro over said trunk terminals to select an idle trunk if the connected trunk is busy, and means for causing said line conductors to engage with one of said series of terminals during movement in one direction and engage with a second series of trunk terminals during movement in the opposite direction.

8. In a telephone system, a non-numerical trunking switch, a plurality of series of trunk terminals, said switch having line wiper conductors always in electrical connection with a terminal of one of said series, which connected terminal is always the last one employed by said switch for extending a call, means for moving said wipers to and fro over said trunk terminals to select an idle trunk if the connected trunk is busy, and means for moving said conductors into a position to disengage from said first series and engage with a second series of trunk terminals.

9. In a telephone system, a non-numerical trunking switch, a plurality of series of trunk terminals, said switch having line wiper conductors always in electrical connection with a terminal of one of said series, which connected terminal is always the last one employed by said switch for extending a call, means for moving said conductors to and fro over said trunk terminals to select an idle trunk if the connected trunk is busy, and means for causing said line conductors to engage with one of said series of terminals during movement in one direction and engage with a second series of trunk terminals during movement in the opposite direction.

10. In a telephone system, a trunking switch, trunk lines, said switch having line wipers always in electrical connection with some one of said trunks, which connected trunk is always the last one employed by said switch for extending a connection, an operating magnet, means for intermittently energizing said magnet, and means for moving said line wipers to and fro over said trunk terminals in response to a continued series of intermittent energizations of said magnet to select an idle trunk if the connected trunk is busy.

11. In a telephone system, a trunking switch, a plurality of trunk lines, said switch having switch wipers normally in contact with one of said trunk lines, said connected trunk being the last one employed by said switch, an operating magnet, means for intermittently energizing said magnet, and means operated in response to a continued series of intermittent energizations

of said magnet for moving said switch wipers in one direction over said trunk lines to select an idle trunk when the connected trunk is busy and for then reversing the movement of said wipers for moving the same in the opposite direction over said trunks to select an idle trunk when the limit of movement of said switch is reached.

12. In a telephone system, a magnet provided with interrupter springs, a condenser, a shunt around said magnet and springs including said condenser, and means controlled by the armature of said magnet to close said shunt.

13. In a telephone system, a magnet provided with interrupter springs, a condenser, a shunt around said magnet and springs including said condenser, means controlled by the armature of said magnet to close said shunt, and means for opening said shunt when the armature reaches the limit of its stroke.

14. In a telephone system, a rotary trunk-selecting switch, an interrupter magnet controlling the rotation of said switch, said magnet provided with contact springs for controlling the circuit of said magnet, a condenser, a shunt around said magnet and springs including said condenser, and means controlled by the operation of said magnet to close said shunt.

15. In a telephone system, a rotary trunk-selecting switch, an interrupter magnet controlling the rotation of said switch, said magnet provided with contact springs for controlling the circuit of said magnet, a condenser, a shunt around said magnet and springs including said condenser, means controlled by the operation of said magnet to close said shunt, and means for opening said shunt when the armature reaches the limit of its stroke.

16. In a telephone system, a non-numerical rotary trunk-selecting switch, an interrupter magnet controlling the rotation of said switch, said magnet provided with contact springs for controlling the circuit of said magnet, a condenser, a shunt around said magnet and springs including said condenser, and means controlled by the operation of said magnet to close said shunt.

17. In a telephone system, a non-numerical rotary trunk-selecting switch, an interrupter magnet controlling the rotation of said switch, said magnet provided with contact springs for controlling the circuit of said magnet, a condenser, a shunt around said magnet and springs including said condenser, means controlled by the operation of said magnet to close said shunt, and means for opening said shunt when the armature reaches the limit of its stroke.

18. In a telephone system, a group of trunk-selecting switches, an operating magnet for each switch, contact springs controlled thereby, a condenser, a shunt around the contact springs of each magnet, each of said shunts including said condenser, and means for intermittently closing said shunt upon the energization of said magnet.

19. In a telephone system, a plurality of trunk-selecting switches, an interrupter magnet for each switch provided with contact springs for controlling the circuit thereof for controlling the rotation of each switch, a condenser, a shunt around the magnet and springs of each switch, each of said shunts including said condenser, and means controlled by the operation of said magnet to close said shunt.

20. In a telephone system, a plurality of trunk-selecting switches, an interrupter magnet for each switch provided with contact springs for controlling the circuit thereof for controlling the rotation of each switch, a condenser, a shunt around the magnet and springs of each switch, each of said shunts including said condenser, means controlled by the operation of said magnet to close said shunt, and means for opening said shunt when the armature reaches the limit of its stroke.

21. In a telephone system, a trunk-selecting switch, a series of trunk terminals, a line wiper for said switch, an operating magnet therefor, means for intermittently energizing said magnet, and means for moving said line wiper to and fro over said trunk terminals in response to a continued series of intermittent energizations of said magnet to select trunks in both directions, whereby a talking circuit may be closed through said wiper.

22. In a telephone system, a trunk selecting switch, a plurality of series of trunk terminals, line wipers for said switch normally in position to engage with one of said series of trunk terminals and to disengage with the other, and means for moving the disengaged wipers into, and the engaged wipers out of engagement with the terminals.

23. In a telephone system, a trunk selecting switch, a plurality of series of trunk terminals, line wipers for said switch, and means for oscillating said line wipers, means for holding some of said wipers in operative relation to the contacts of one of said series when the wipers are moved in one direction and for holding others of said wipers in operative relation to the contacts of another of said series when the wipers are moved in another direction.

24. In a telephone system, a non-numerical trunking switch, a plurality of series of trunk terminals, line wipers for said switch normally in position to engage with one of said series of trunk terminals and to disengage with the other, and means for moving the disengaged wipers into, and the engaged

wipers out of engagement with the terminals.

25. In a telephone system, a non-numerical trunk-selecting switch, a plurality of series of trunk terminals, line wipers for said switch, and means for oscillating some of said line wipers, means for holding said wipers in operative relation to the contacts of one of said series when the wipers are moved in one direction and for holding others in operative relation to the contacts of another of said series when the wipers are moved in another direction.

26. In a telephone system, a trunking switch, a plurality of series of trunk terminals, said switch having line wipers in electrical connection with a terminal of one of said series, and line wipers disengaged from a terminal of one of said series, said first terminal always the last one employed by said switch for extending a call, means for moving said wipers to and fro over said trunk terminals to select an idle trunk if the connected trunk is busy, and means for moving the disengaged wipers into engagement with said second series of terminals, and the engaged wipers out of engagement with the first series of terminals.

27. In a telephone system, a trunking switch, a plurality of series of trunk terminals, said switch having line wipers in electrical connection and wipers out of electrical connection with a terminal of one of said series, said first terminal always the last one employed by said switch for extending a call, means for moving said wipers to and fro over said trunk terminals to select an idle trunk if the connected trunk is busy, and means for causing the second mentioned line wipers to engage with one of said series of terminals during movement in one direction and the first mentioned line wipers to engage with a second series of trunk terminals during movement in the opposite direction.

28. In a telephone system, a non-numerical trunking switch, a plurality of series of trunk terminals, said switch having line wipers in electrical connection with a terminal of one of said series and wipers out of electrical connection with a terminal of a second of said series, said first terminal always the last one employed by said switch for extending a call, means for moving said wipers to and fro over said trunk terminals to select an idle trunk if the connected trunk is busy, and means for moving the first mentioned wipers into a position to disengage from said first series and the second mentioned wipers to engage with said second series of trunk terminals.

29. In a telephone system, a non-numerical trunking switch, a plurality of series of trunk terminals, said switch having line wipers in electrical connection and wipers out of electrical connection with a terminal of one of said series, said first terminal always the last one employed by said switch for extending a call, means for moving said wipers to and fro over said trunk terminals to select an idle trunk if the connected trunk is busy, and means for causing said second mentioned line wipers to engage with one of said series of terminals during movement in one direction and the first mentioned line wipers to engage with a second series of trunk terminals during movement in the opposite direction.

30. In a telephone system, a trunk selecting switch, a plurality of series of trunk terminals, a line wiper in said switch for one of said series, another wiper for another one of said series, means for moving one of said wipers along the terminals of one of said series for stopping it in engagement with any one of the terminals, and for moving the other of said wipers in the opposite direction along the contacts of another one of said series and for stopping it in engagement with one of the terminals whereby the circuit may be extended to the line through one of said contacts.

31. In a switch, a first series of line terminals in a plane, a contact for engaging any one of said terminals, a second series of terminals in a plane, a contact for engaging any one of the terminals in the second series, means for moving said contacts in planes parallel to the plane of said first series and for moving them in planes parallel to the plane of the second series, and means for moving said contacts first to one set of planes and then to the other.

32. In a telephone system, a non-numerical trunk selecting switch, a plurality of series of trunk terminals, a line wiper for each of said series, means for moving one of said wipers along the contacts of one of said series and for stopping it in engagement with any one of the contacts and for moving the other one of said wipers in the opposite direction along the contacts of another one of said series and for stopping it in engagement with any one of the contacts to find an idle trunk whereby a circuit may be closed therethrough.

33. In a telephone system, a non-numerical trunk selecting switch, a plurality of series of trunk terminals, a line wiper for each of said series, means for moving one of said wipers along the contacts of one of said series and for stopping it in contact with any one of the contacts and for moving another one of said wipers in the opposite direction along the contacts of another one of said series and for stopping it in contact with any one of the contacts to find an idle trunk whereby a circuit may be closed therethrough and a connection may be extended to the trunk, and means for holding

the wipers stationary until the connection is released.

34. In a telephone system, a trunk selecting switch, a series of trunk terminals, a line wiper for said switch, an operative magnet therefor, means for intermittently energizing said magnet, means for moving said line wiper over said trunk terminals in response to a continued series of intermittent energizations of said magnet in either of two directions to find an idle trunk whereby a connection may be extended to the trunk, and means for holding the wiper stationary until the trunk is released.

35. In a telephone system, a trunk selecting switch, a series of trunk terminals, a line wiper for said switch, an operating magnet therefor, means for intermittently energizing said magnet, means for moving said line wiper to and fro over said trunk terminals in response to a continued series of intermittent energizations of said magnet to select trunks in both directions whereby a connection may be extended to the selected trunk, and means for holding the wiper stationary until the connection is released.

36. In a telephone system, a trunk selecting switch, a plurality of series of trunk terminals, line wipers in said switch for one of said series, another wiper for another of said series, a magnet for moving one of said wipers along the contacts of one of said series and for stopping it in contact with any one of the contacts and for moving the other of said wipers in the opposite direction along the contacts of another one of said series and for stopping it in contact with any one of the contacts therein, whereby a circuit may be extended to a line therethrough.

Signed by me at Chicago, Cook county, Illinois, this 28th day of June, 1913.

JOHN ERICKSON.

Witnesses:

A. ANDERSEN,

G. YANOCHOWSKI.