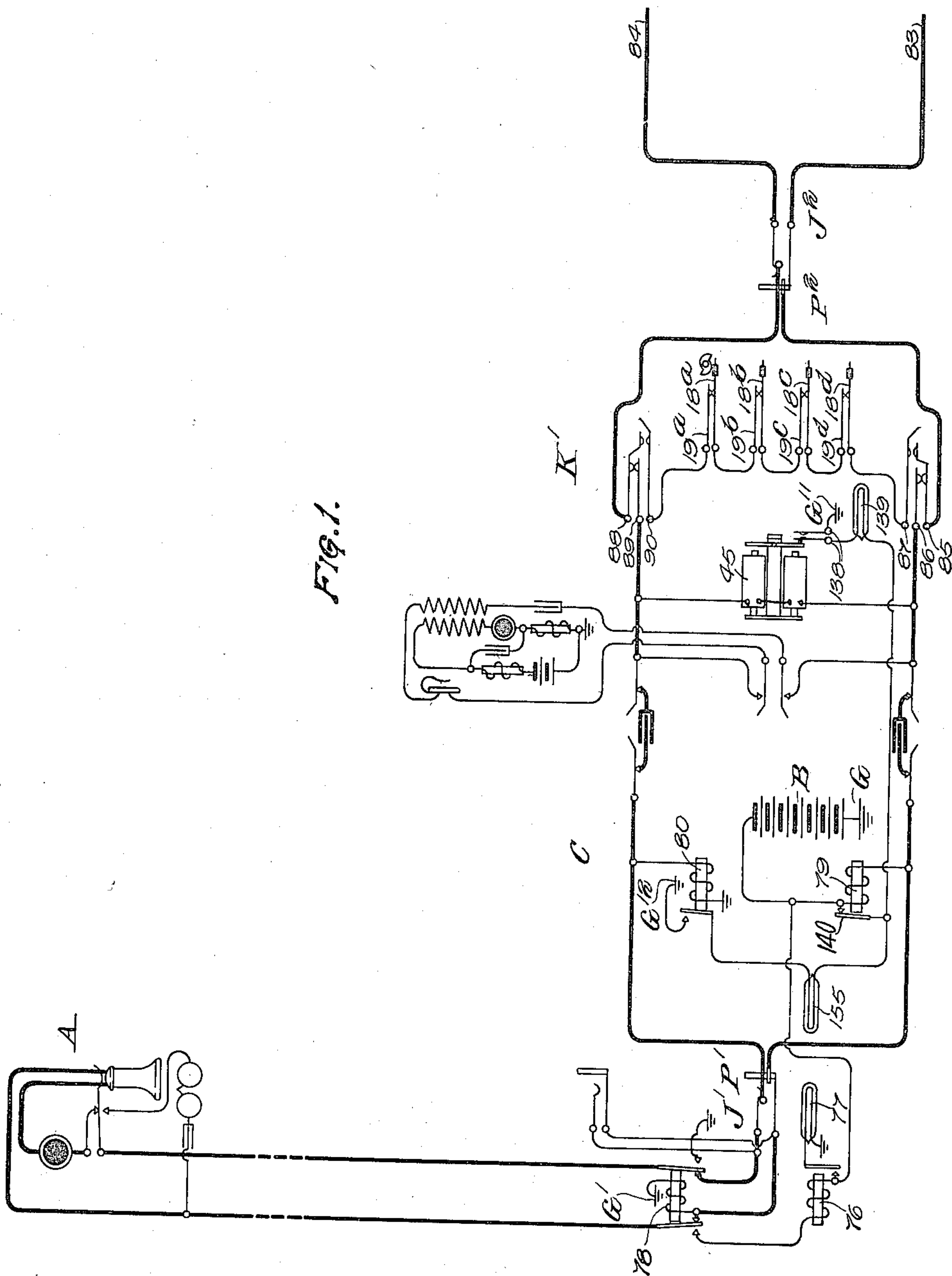


1,209,303.

A. E. KEITH.
MULTIPLE DIAL CALLING DEVICE.
APPLICATION FILED JUNE 28, 1911.

Patented Dec. 19, 1916.
4 SHEETS—SHEET 1.



WITNESSES

H. A. Swenarton
A. J. Ray

INVENTOR:

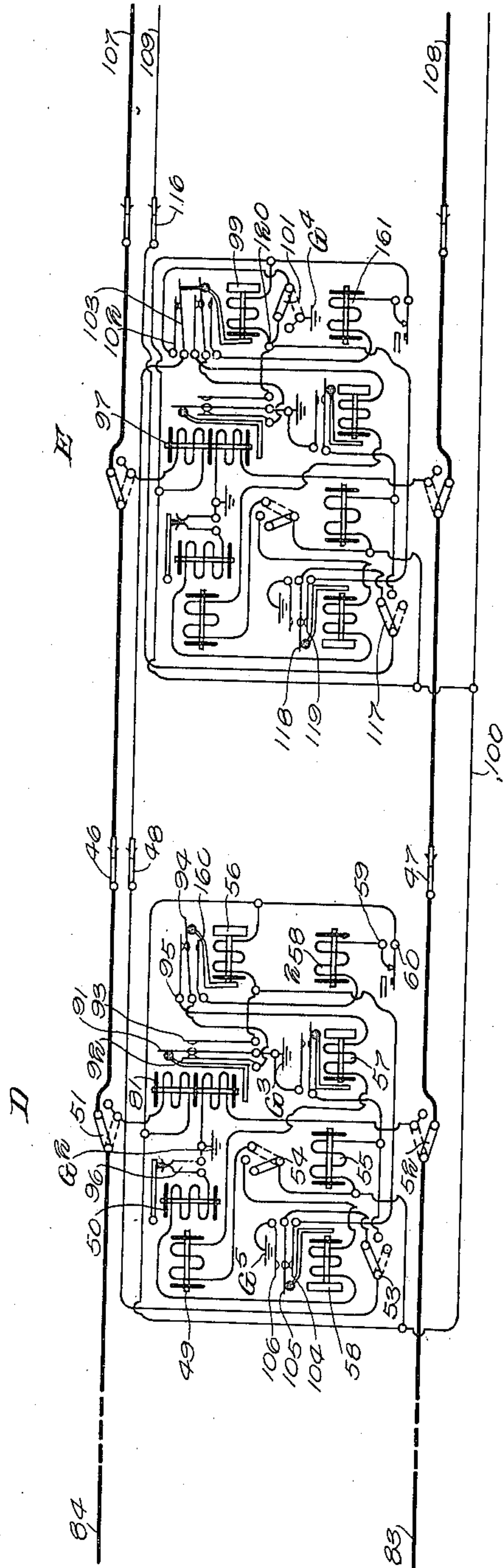
Alexander E. Keith
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FIG. 10.



WITNESSES

H. A. Swenarton
A. J. Ray.

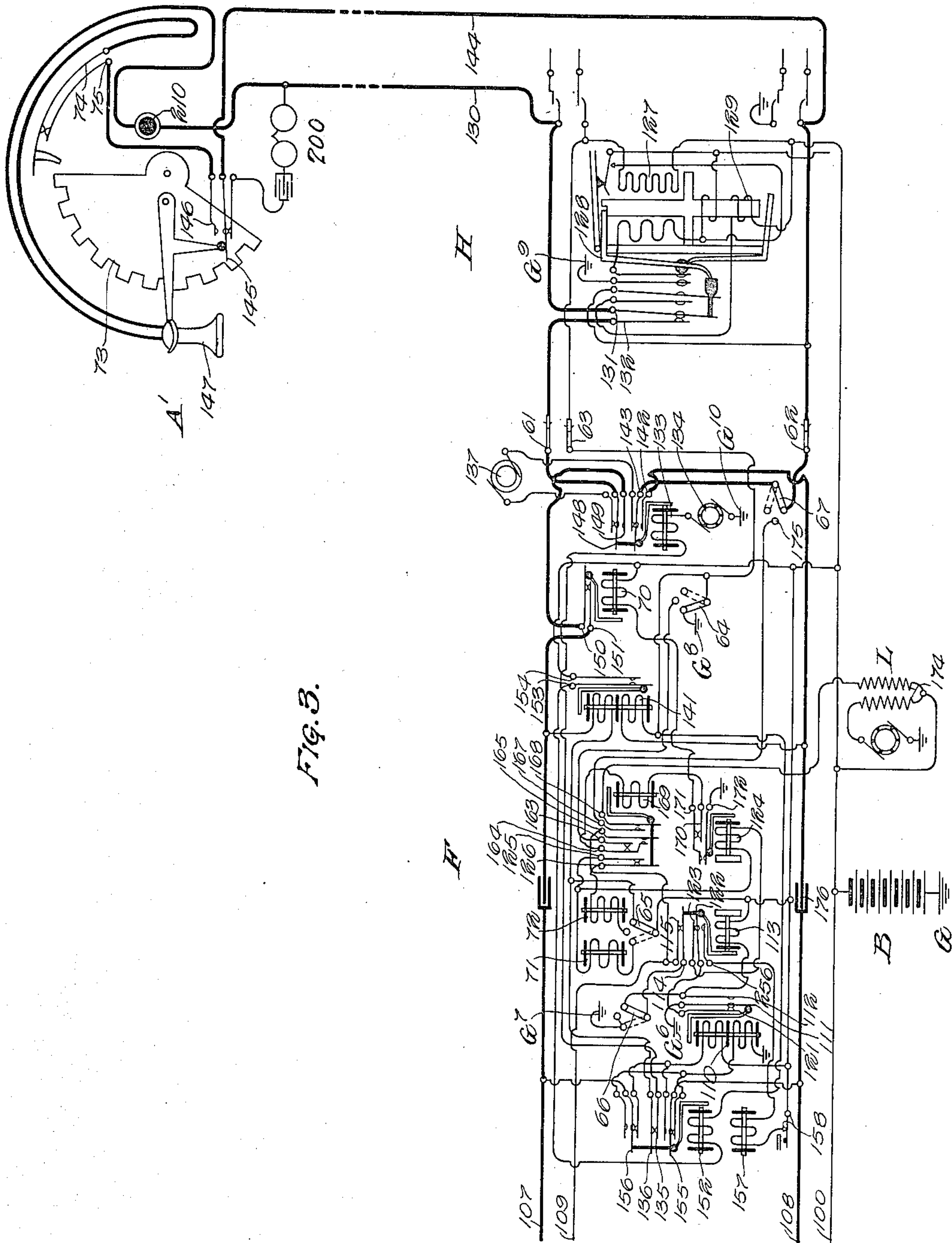
INVENTOR:

Alexander E. Keith
By Bulkley & Durand
ATTORNEYS

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APPLICATION FILED JUNE 28, 1911.

Patented Dec. 19, 1916.
4 SHEETS—SHEET 3.



WITNESSES

H. A. Swanton
R. J. Ray

INVENTOR:

Alexander E. Keith
By Bulkeley & Leland
ATTORNEYS,

1,209,303.

Patented Dec. 19, 1916.

4 SHEETS—SHEET 4.

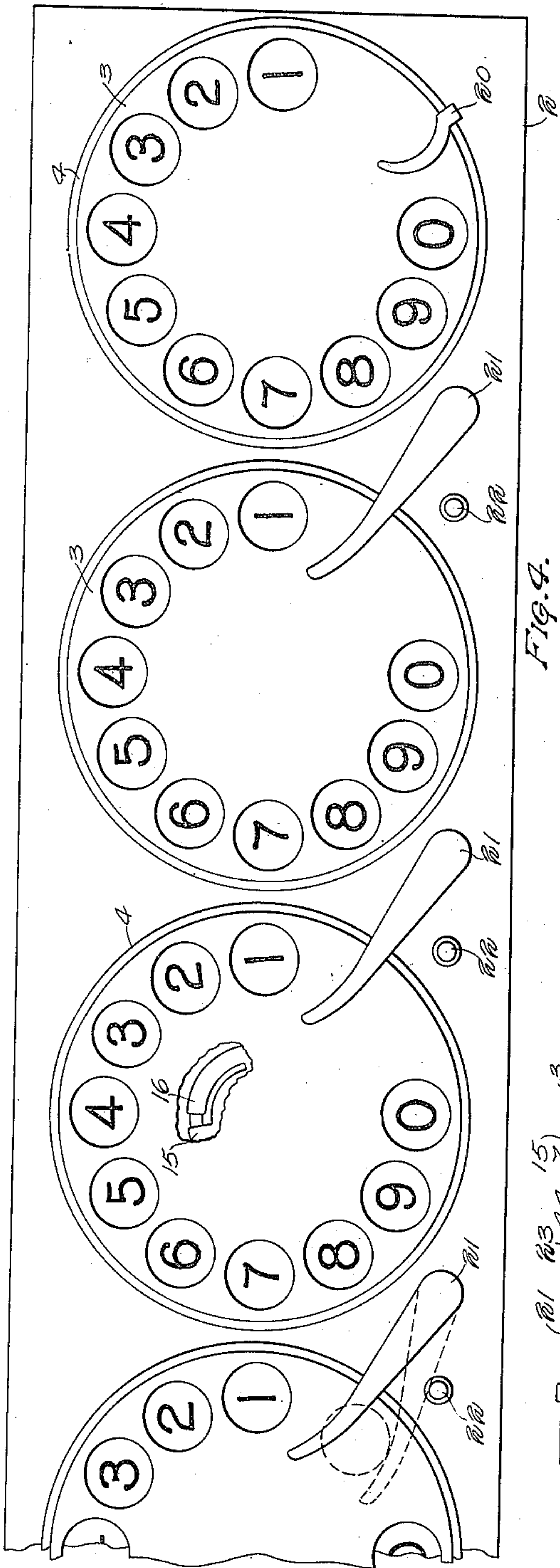


Fig. 4.

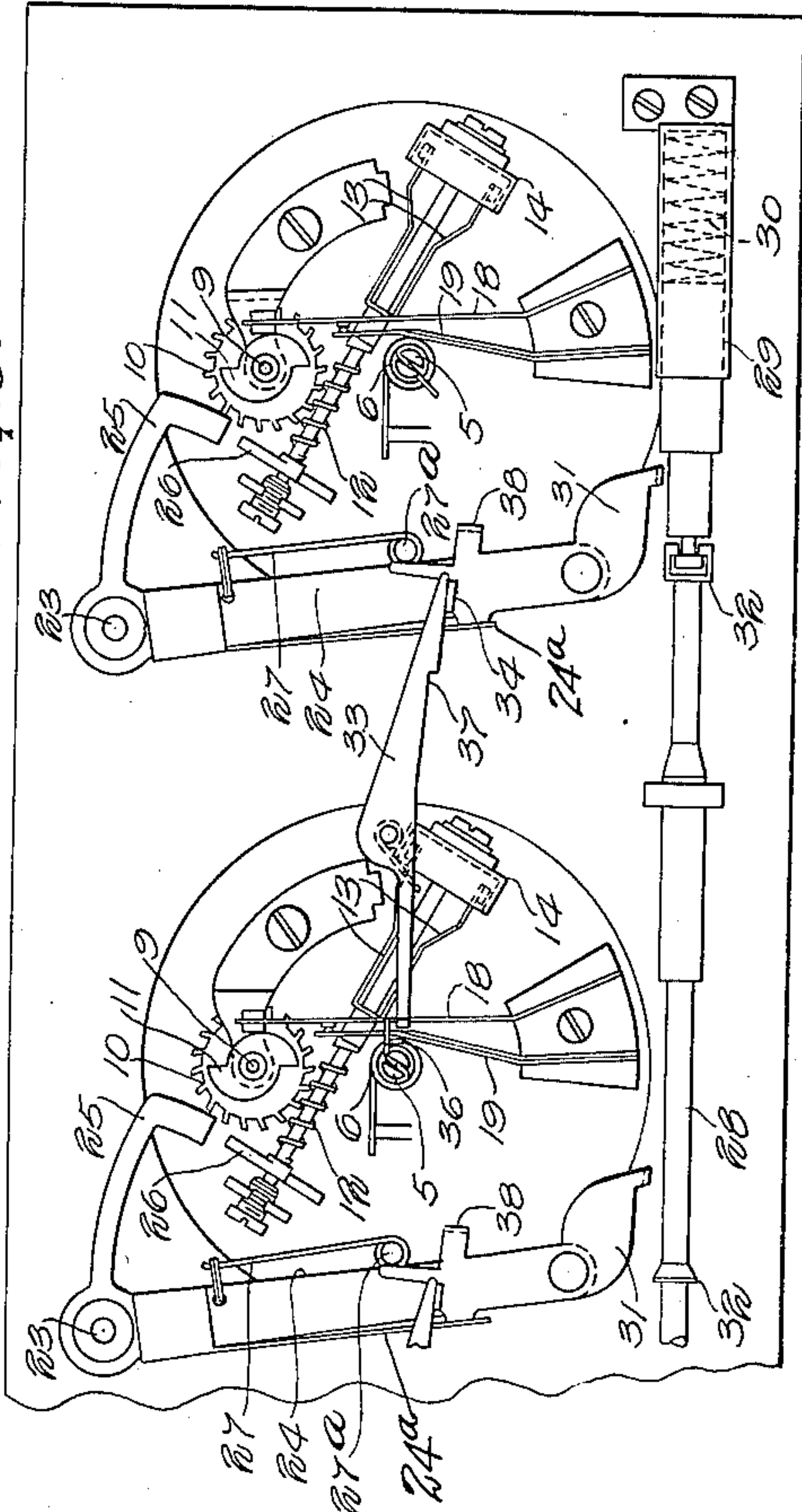


Fig. 6.

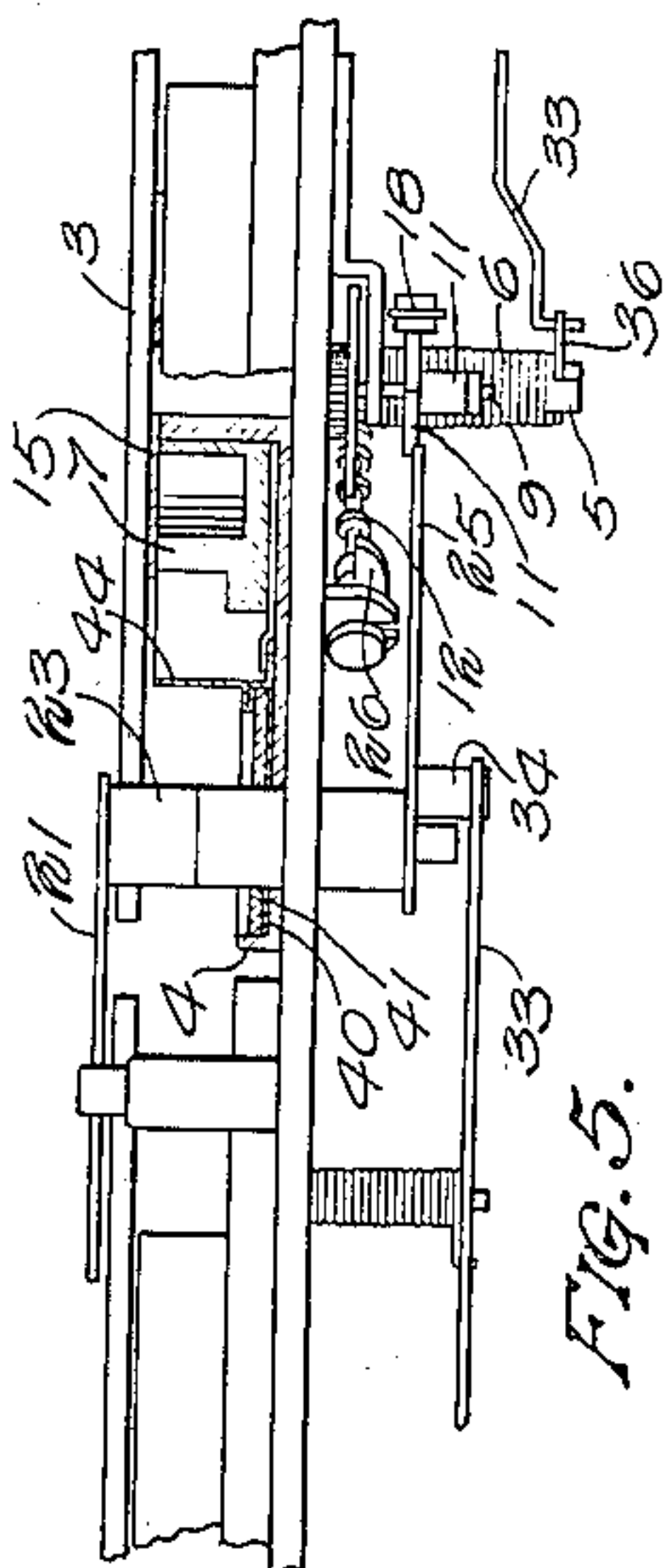


Fig. 5.

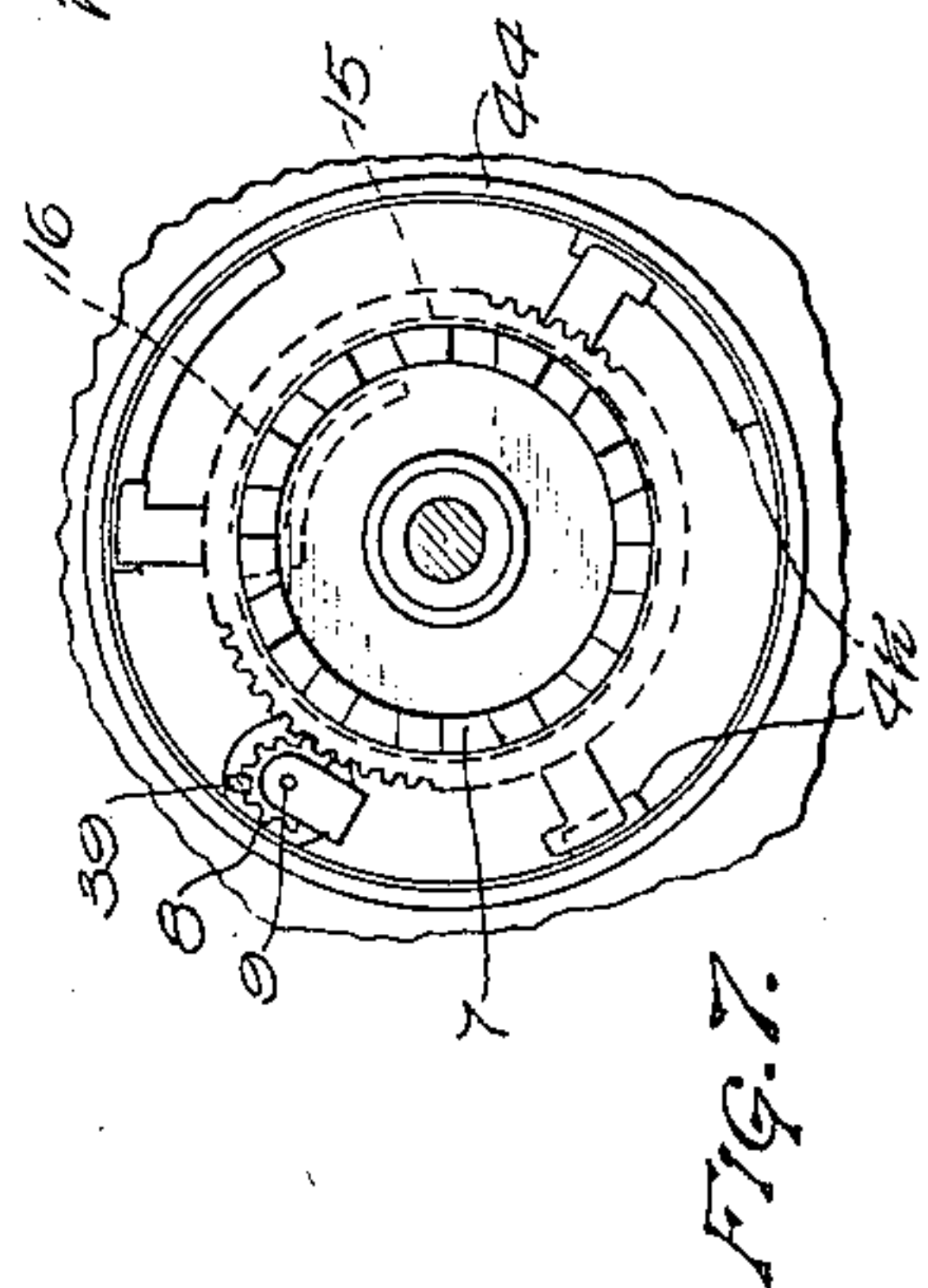


Fig. 7.

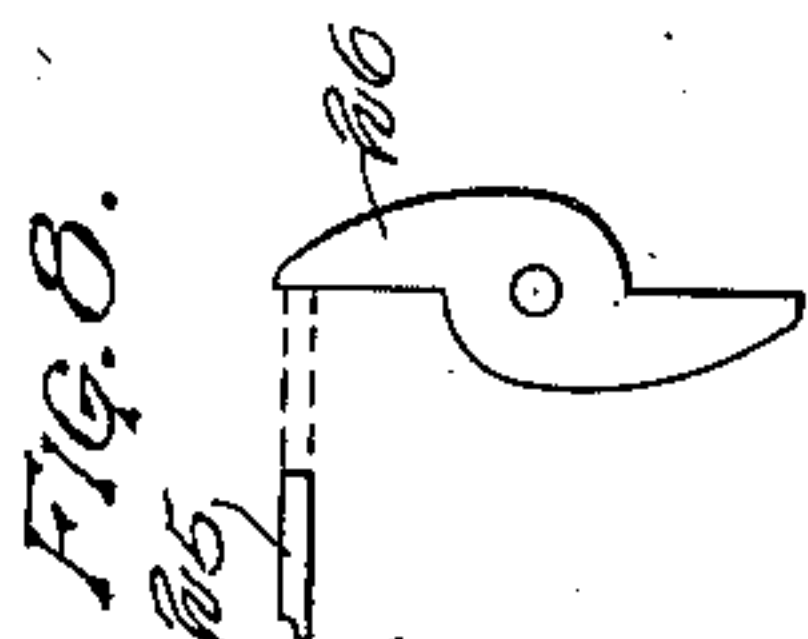


Fig. 8.

WITNESSES

H. A. Swenarton
 A. J. Ray.

INVENTOR:

Alexander E. Keith
 By Bulkeley & Purand
 ATTORNEYS

UNITED STATES PATENT OFFICE.

ALEXANDER E. KEITH, OF HINSDALE, ILLINOIS, ASSIGNOR TO AUTOMATIC ELECTRIC COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF ILLINOIS.

MULTIPLE-DIAL CALLING DEVICE.

1,209,303.

Specification of Letters Patent.

Patented Dec. 19, 1916.

Application filed June 28, 1911. Serial No. 635,698.

To all whom it may concern:

Be it known that I, ALEXANDER E. KEITH, a citizen of the United States of America, and resident of Hinsdale, Dupage county, Illinois, have invented a certain new and useful Improvement in Multiple-Dial Calling Devices, of which the following is a specification.

My invention relates to automatic or semi-automatic telephone systems in general, but more particularly to an improved form of calling device for use in such systems. In the ordinary calling device, which comprised a rotary dial, as heretofore used, it was necessary to wait until all of the impulses for one digit had been sent in before the calling device was operated for the next digit. In calling a number of four or five digits this, of course, required some little time. When this calling is done by manual operators in a semi-automatic system, this amount of time required is very objectionable.

It is, therefore, an object of my invention to provide a calling device by means of which the operator can complete her part in setting up the connection in a very short time.

More specifically, my calling device comprises a plurality of separate impulse devices or dials, preferably one for each digit of the numbers to be called. The impulse springs for all the dials are connected in series, so that the operation of any dial will operate the automatic switches. In making a call, the operator calls the first digit on the first dial, the second digit on the second dial, the third digit on the third dial, and so on, the dials being operated one after the other in rapid succession without having to wait for one to complete its operation before the next one is set.

A further object of my invention is to provide a calling device of the rotary dial type having certain novel features of construction.

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

Figures 1, 2 and 3 taken together represent a complete connection between a manual telephone A (Fig. 1) and an automatic telephone A' in a system embodying the principles of my invention. Fig. 4 is a top view of my improved calling device. Fig. 5 is a side elevation, partly in section, of a portion

of two of the individual impulse devices of the calling device. Fig. 6 is a bottom view of a portion of the calling device. Fig. 7 is a top view of one of the individual impulse devices with the dial removed. Fig. 8 is a detail view of some of the parts of the apparatus.

The manual substation may be of any suitable type, the one shown herein being well known. The cord circuit C is adapted to connect the manual telephone with an automatic selector switch D (Fig. 2). The calling end of the cord is provided with a polarized supervisory relay 45 for controlling the supervisory signal 139 in a manner to be hereinafter described. A key K' is provided for bridging a calling device of the character hereinafter described across the conductors of the calling plug P². This calling device is represented diagrammatically by the springs 18^a, 19^a, 18^b, 19^b, etc.

The selector D (Fig. 2) is of the type of selector switches disclosed in United States Letters Patent No. 815,321, granted March 13, 1906, to Keith, Erickson & Erickson, the circuits being modified, however, in order to operate in a two-wire system, *i. e.*, a system in which the central office switches are controlled over the two sides of the calling line in series. Among other details the selector D comprises a set of wipers 46, 47 and 48 carried upon a shaft (not shown) having a vertical motion controlled by the vertical magnet 49 and a rotary motion governed by the rotary magnet 50 in a manner well understood in the art. The usual side switch, comprising the wipers 51, 52, 53 and 54, is controlled by the so-called private magnet 55 in a well-known manner. The relays 56, 57 and 58 are slow-acting, *i. e.*, slow to deenergize after their energizing circuits have been broken. The usual release magnet 258 releases the shaft immediately upon energizing, as shown in United States Letters Patent No. 815,176, granted March 13, 1906, to Keith, Erickson & Erickson, for connector switches, rather than by its deenergization as shown in said selector patent. The springs 59 and 60 are permitted to separate only when the switch shaft is raised one or more steps from its lowest position.

The selector E is essentially the same as the selector D.

The connector F (Fig. 3) is of the general type disclosed in United States Patent No.

815,176, above mentioned, but, like the selectors, is modified to operate in a two-wire system. The following well-known features, viz., the shaft wipers 61, 62 and 63, the side switch comprising the wipers 64, 65, 66 and 67, private magnet 70, vertical magnet 71, rotary magnet 72 and release magnet 157 will be readily recognized from the description of their operation which follows.

The called substation A' may be of any suitable automatic common battery type and, as shown herein, is the same as a simple manual substation with the addition of a calling device, which is represented diagrammatically by a toothed impulse wheel 73 and a pair of impulse springs 74 and 75. This calling device might be similar to one of the separate impulse devices of the operator's calling device shown in Figs. 4, 5, 6 and 7, or, if desired, might consist of a plurality of such devices arranged as shown in said figures.

The called line is provided with an individual line switch H, but since it plays no part in the operations described herein it will not be described in detail. This line switch is similar to the line switch shown in British patent to A. E. Keith, No. 1421 of 1910.

Referring now to Figs. 4, 5, 6 and 7, the calling device shown therein comprises a plurality of separate impulse devices mounted upon a common base plate 2. Each separate impulse device comprises a pair of impulse springs 18 and 19 and mechanism for operating them which is controlled by the operator through the medium of a dial 3 provided with suitable finger holes. Beneath each impulse device there is an opening in the plate 2 to allow the mechanism to project therethrough. The mechanism of each impulse device is mounted upon a separate plate 4. The dial 3 is secured to a rotatable shaft 5 around the lower end of which is secured a helical spring 6. One end of the spring 6 engages a lug on the under side of the plate 4, while the other end of said spring engages a slot in the end of the shaft 5, and is provided with a laterally extending end portion, as clearly shown in Figs. 5 and 6. In the sides of this slot there are notches which are adapted to be engaged by the end of the spring 6, so that said spring not only serves as a means for returning the dial to normal position, but also prevents it from being lifted up. Loosely mounted about the shaft 5 and bearing on the plate 4 there is a gear wheel 7 provided with both spur and crown teeth. The spur teeth of the wheel 7 mesh with a pinion 8 (Fig. 7) which is secured to a shaft 9. To the lower end of the shaft 9 there is secured a toothed wheel 10 and a cam 11. The wheel 10 engages a worm 12 to which there is secured a pair of governor springs 13. When

the mechanism is operated, the ends of the springs 13 fly out and rub on the inside of a stationary cup 14, thereby producing a braking effect to govern the speed of the device. Secured to the under side of the dial there is a flat member 15 (shown dotted in Fig. 7 and in the broken out portion of the second dial in Fig. 4) provided with a flexible tongue 16. When the dial is rotated in a clockwise direction (Fig. 4), the tongue 16 slips over the crown teeth in the wheel 7, but, as the dial is returned in the opposite direction by the spring 6, the tongue 16 comes into engagement with one of these teeth and forces the wheel 7 to rotate with the dial. The motion of the wheel 7 is transmitted through its spur teeth to the pinion 8 and shaft 9, causing the cam 11 to rotate to separate the springs 18 and 19.

Between each two adjacent dials there is a rotatable pin 23 carrying upon its upper end a lever 21 which projects into the path of the finger holes of the dial on the left of said pin. On the lower end of the pin 23 there is a locking dog 25 adapted, when the lever 21 is pulled down in a manner to be hereinafter described, to be brought into the path of the locking member 26 of the dial on the right of said pin 23. As long as the dog 25 remains in the path of the member 26, the mechanism controlled by that dial is locked in position. The dog 25 is normally held away from the member 26 by the spring 27 coiled upon a pin 27^a, and connected at its upper end with the arm 24, which is also mounted upon the lower end of the pin 23 and is rigid with the arm 25. Pivoted upon the lower end of the arm 24 is a cam 31 which is adapted, when the lever 21 is pulled down, to slide over and come behind a shoulder 32 on a shaft 28 which is slidably mounted upon the under side of the plate 2. Integrally connected with this cam 31 there is an upwardly extending arm having a lug 34 extending forwardly therefrom, and an angular lug 38, the purpose of which will be hereinafter pointed out. A spring 24^a presses against the left hand lug of cam 31 to hold the said cam in its normal position. One end of the shaft 28 is attached to the plunger of a dash-pot 29. The spring 30 serves to hold the shaft 28 in its extreme left-hand position. Each of the impulse devices except the last one to the right is also provided with a catch arm 33 provided with a shoulder 37 adapted to catch the lug 34 and hold the arm 24 in its operated position. When the dial is in normal position, the end 36 of the spring 6 engages the rear end of the catch arm 33 and holds it out of engagement with the lug 34.

The manner of operation of the calling device is as follows: In order to call any number, a finger is inserted in the finger hole in the first dial to the left, which cor-

responds to the first digit of the number to
 be called. The dial is then rotated until the
 finger strikes the lever 21 and forces it down
 against the stationary pin 22, as shown in
 the dotted position in Fig. 4. The finger is
 then removed and the second dial is oper-
 ated in a similar manner for the second
 digit, the third dial for the third digit and
 so on. As each dial is rotated by the finger,
 the tongue 16 on the under side of the dial
 passes over a number of the crown teeth on
 the wheel 7, corresponding to the digit
 called. As the dial is returned to normal
 position by the spring 6, after being released,
 the wheel 7 is forced to rotate with it,
 thereby causing the cam 11 to separate the
 springs 18 and 19 a number of times, corre-
 sponding to the digit called. When the first
 lever 21 is pulled down, it rotates its dog
 25 into the path of the locking member 26
 of the second dial, carries its pawl 31 behind
 the corresponding shoulder 32 on the shaft
 28 and becomes locked in this position by
 the engagement of the lug 34 with the shoul-
 der 37 on the latch 33. The first dial be-
 gins to rotate back to normal position as
 soon as the finger is removed from the finger
 hole. If the second dial is operated before
 the first one has reached its normal position,
 it does not begin to return immediately, but
 remains in its advanced position by reason
 of the engagement of the member 26 with
 the locking dog 25. When the first dial
 reaches normal position, the end 36 of the
 spring 6 strikes the end of the catch arm 33,
 thus rotating this arm sufficiently to release
 the lug 34 from the shoulder 37. The arm
 24 under the tension of the spring 27 then
 begins to rotate to normal position. This
 movement of the arm 24 is retarded, how-
 ever, by the engagement of the pawl 31 with
 the shoulder 32 on the shaft 28, whereby the
 motion of the arm 24 is governed by the
 action of the dash-pot 29. The locking dog
 25 is so positioned with respect to the cam
 26 that it is not disengaged from said cam
 until the arm 24 reaches normal position.
 Finally, when the arm 24 reaches this posi-
 tion, the locking dog 25 is disengaged from
 the member 26 and the second dial is per-
 mitted to begin its return movement. Thus,
 by means of the arm 24 and its associated
 parts and the dash-pot 29, it is evident that
 a certain predetermined time interval elapses
 between the completion of the return mo-
 tion of the first dial and the beginning of
 the return of the second dial. When the
 arm 24 reaches normal position, the pawl 31
 slips off the shoulder 32, thereby permitting
 the shaft 28 to return to normal position so
 as to be ready to control the release of the
 third dial after the second dial has com-
 pleted its operation. In like manner, the
 fourth dial is locked until shortly after the
 third one has come to rest. Although only

four dials are shown herein, it will be evi-
 dent that any desired number may be used.
 Since, in the arrangement I have shown, the
 last dial does not have to control any others
 beyond it, it has no lever 21 and associated
 parts, but is simply provided with a station-
 ary finger stop 20.

While each of the arms 24 is being held
 in its operated position by the engagement
 of the catch arm 33 with the lug 34, the
 pawl 31 is tipped down until the lug 38
 strikes the arm 24, thereby holding the
 point of the pawl up out of the path of the
 shoulder 32 so as not to interfere with the
 operation of the shaft 28 by the preceding
 pawls.

To the lower side of each dial there is se-
 cured a pin 39 (Fig. 7) which engages the
 teeth of the pinion 8 when the dial is in
 normal position, thereby locking the mecha-
 nism and also serving as a stop to bring the
 dial to rest when it reaches normal.

The gear wheel 7 is surrounded by a cas-
 ing 44 (Figs. 5 and 7) which is held in place
 by means of lugs 42 which slip under the
 arms 43 which project from a flat disk be-
 neath the wheel 7. The numbers seen
 through the finger holes in the dial are
 printed on a paper ring 41 which is clamped
 beneath a glass ring 40 which is held down
 by a ridge extending around the casing 44
 near its lower end.

In order to give a clearer understanding
 of my invention I will give a detailed de-
 scription of the operations by means of
 which one subscriber obtains connection with
 another in the system shown herein.

The operations by means of which the
 subscriber at substation A calls the sub-
 scriber at substation A' are as follows:
 When the receiver is removed from the
 switch hook at the substation A a circuit
 is closed through the line relay 76 at the
 central office in the usual manner. The re-
 lay 76, upon energizing, completes the cir-
 cuit of the line lamp 77. The operator
 thereupon plugs into the jack J' of the call-
 ing line with the plug P'. A circuit is
 thereupon closed from ground G' through
 the cut-off relay 78, sleeve of the jack J' and
 plug P' and supervisory relay 79 to battery
 B and thence to ground G. The cut-off
 relay 78, upon energizing, cuts off the line
 relay 76 and completes the connection be-
 tween the calling line and the cord C. The
 calling line is thereafter provided with talk-
 ing current from battery B through the re-
 lays 79 and 80 of the answering end of the
 cord.

To call the automatic subscriber desired
 the operator inserts the plug P² into a jack
 J², throws the key K' to connect the call-
 ing device with the line and operates the
 dials for the successive digits of the number
 desired. It will be assumed that the num-

ber of the substation A' is 2220. The first, second and third dials are each operated for the digit 2 and the last dial is operated for the digit 0, as explained above. When the
 5 plug P² is first inserted into the jack J², a circuit is closed from ground G² (Fig. 2) through the lower winding of the selector line relay 81, side switch wiper 52, conductor 83, jack J² and plug P², springs 85 and
 10 86, relay 45, springs 89 and 88, plug P² and jack J², conductor 84, side switch wiper 51 and upper winding of the relay 81 to battery lead 100. The relay 81, upon energizing, closes a circuit from ground G³ through
 15 the springs 91 and 93 and relay 56 to the battery lead 100. When the key K' at the cord is thrown, the relay 45 is cut off and the bridge across the conductors 84 and 83 is maintained through all the springs of the
 20 calling device in series. Now, as has been explained, as the first dial returns to normal position after having been operated for the digit 2, the springs 19^a and 18^a, which correspond to the springs 19 and 18 of Fig.
 25 6, are separated twice. This means that the bridge across the conductors 84 and 83 will be momentarily opened twice, and will then remain closed for a short time before the second dial begins to operate. Likewise,
 30 each of the other dials will open the bridge across the trunk line 84—83 a number of times corresponding to the digit called on that dial, and then maintain the bridge closed for a period longer than the interval
 35 between impulses before permitting the next dial to begin to operate.

Each time the bridge across the trunk 83—84 is opened by the first set of impulse springs, the line relay 81 of the selector D de-
 40 energizes. Since the relay 56 is slow acting, it does not have time to deenergize during the momentary interruption of its circuit by the relay 81. Consequently, each time the spring 91 engages the spring 92, a cir-
 45 cuit is closed from ground G³ through the springs 91 and 92, 94 and 95, relay 57, vertical magnet 49 and side switch wiper 54 to the battery lead 100. Since the digit called is 2, the vertical magnet 49 receives two
 50 impulses over this circuit and operates to raise the switch shaft and wipers two steps to a position opposite the second row or level of bank contacts. The private magnet relay 57, which is included in the energizing
 55 circuit of the vertical magnet, is energized by the first impulse, but, being a slow acting relay, does not have time to deenergize until the last impulse for the digit is delivered. This relay deenergizes during the pause
 60 which ensues between the last impulse for the first digit and the first impulse for the second digit. In its energized position the relay 57 operates to close the circuit extending through the private magnet 55. When
 65 the relay 57 deenergizes, after the last im-

pulse is delivered to the vertical magnet, this circuit through the private magnet is broken. The private magnet, upon energizing and deenergizing, allows the side switch
 70 to pass to second position. The movement of the side switch wiper 54 from first to second position disconnects the battery from the vertical magnet 49 and completes an energizing circuit through the rotary magnet
 75 50. This circuit extends from ground G² through the interrupter springs 96, rotary magnet 50, relay 58 and side switch wiper 54 to the battery lead 100. Upon the closure of this circuit the rotary magnet attracts its armature, which operates to rotate
 80 the shaft wipers one step, to press down the armature of the private magnet 55, and to open the circuit of its own magnet at the interrupter springs 96. When the circuit of the rotary magnet is thus opened, its arma-
 85 ture falls back, and if the first trunk line upon which the wipers have just been rotated is not already in use, the private magnet armature also falls back and permits the side switch to pass to third position. If, how-
 90 ever, the first trunk line of the second level is already busy, the private wiper 48 finds the first contact which it engages provided with a guarding ground potential. When the wiper 48 thus engages the grounded con-
 95 tact, a locking circuit is completed through the side switch wiper 53 (in second position) and the private magnet 55 to the battery lead 100. The private magnet thus becomes energized and locks the side switch in sec-
 100 ond position. As long as the side switch remains thus locked, the rotary magnet continues to operate in a manner similar to that of a buzzer, to rotate the selector wipers step by step until an idle trunk line is found. 105
 When the private wiper 48 engages the non-grounded contact of an idle trunk, the private magnet 55 deenergizes and permits the side switch to pass to third position, thereby breaking the circuit of the rotary magnet. 110
 The movement of the side switch wipers 51 and 52 from second to third position disconnects the line relay 81 from the line and extends the line connection through the shaft wipers 46 and 47 to the second selector E. 115
 The line relay 97 in the selector E then becomes energized in the same manner in which the relay 81 of the selector D was energized when the connection was first extended to that selector. The energization of 120
 the relay 97 serves to close an energizing circuit through the slow acting relay 99 in the same manner in which the circuit of the relay 56 was closed by the relay 81. The relay 99, upon energizing, extends a guarding
 125 potential from ground G⁴ through the side switch wiper 101 and springs 102 and 103 to the private bank contacts of the seized trunk in the banks of all the selectors D which have access to this trunk. A circuit 130

also extends from ground G^4 through the said selector private bank contacts, private wiper 48, side switch wiper 53, springs 105 and 104 and relay 56 to the battery lead 100.

5 This circuit prevents the relay 56 from de-energizing after its former circuit is broken by the deenergization of the relay 81 when the side switch of the selector D passes to third position. A short period of time
10 elapses between the time when the side switch of the selector D passes to third position and the time when the relay 99 energizes to extend a guarding potential back to the first selector private bank contacts
15 from ground G^4 . During this interval the trunk line leading to the selector E is guarded by a ground potential extending from ground G^5 through the springs 106 and 105, side switch wiper 53 and private wiper 48
20 to the private bank contacts. It will be remembered that the relay 58 is included in the operating circuit of the rotary magnet 50, and, since it is a slow acting relay, it remains energized for an instant after the
25 rotary magnet is deenergized for the last time. Thus the relay 58 is already energized at the time when the side switch passes to third position, and a guarding potential is extended from ground G^5 in the
30 manner described. The relay 58 is quicker than the relay 56 and thus deenergizes in time to close a new energizing circuit for the relay 56 before it has time to deenergize.

The above operations of the rotary magnet 50 and the movement of the side switch to third position take place before the second impulse device begins to separate the
35 springs 18^b and 19^b. The separation of these springs, therefore, transmits impulses to the relay 97 of the selector E. The second selector E operates in response to the impulses for the second digit in the same manner as explained for the selector D and extends
40 connection to an idle connector F over the trunk lines 107 and 108. When the connection is thus extended to the connector F, its line relay 110 becomes energized in the same manner that the selector line relays are energized. The relay 110, upon energizing,
45 operates to complete a circuit extending from ground G^6 through the springs 111 and 112 and the slow acting relay 113 to the battery lead 100. The relay 113, upon energizing, extends a guarding potential from
50 ground G^7 through the side switch wiper 66, springs 114 and 115 and conductor 109 to all the selector private bank contacts which belong to the trunk line leading to the connector F. The energization of the relay 113
55 of the connector also provides a new holding circuit for the release relays 99 and 56 of the selectors D and E, respectively. This circuit extends from ground G^7 through the side switch wiper 66, springs 114 and 115,
60 conductor 109, private wiper 116 of the

selector E, side switch wiper 117 and springs 118 and 119 to the point 120. From the point 120 one branch of this circuit extends through the relay 99 to battery, while another branch extends through the side
70 switch wiper 101 (in third position) to and through the relay 56 of the selector D over a circuit which has been already traced. The calling device now begins to send in the impulses for the third digit 2 by momentarily separating the impulse springs 19^c
75 and 18^c. Each time these springs are separated for the third digit, the energizing circuit for the connector line relay 110 is broken momentarily. Since the relay 113
80 of the connector is slow acting, it does not have time to deenergize during the momentary deenergization of the relay 110. Consequently, the engagement of the springs 111 and 121 completes an energizing circuit
85 through the vertical magnet 71. This circuit extends from ground G^5 through the springs 111 and 121, springs 122 and 123, private magnet relay 124, vertical magnet 71 and side switch wiper 65 to the battery
90 lead 100. The vertical magnet receives two impulses over this circuit and operates to raise the shaft wipers 61, 62 and 63 two steps.

The private magnet relay 124 operates in
95 the same manner as the private magnet relay 57 of the selector D to close the circuit of the private magnet 70 while the vertical magnet is operating. This circuit is broken shortly after the last impulse is delivered
100 to the vertical magnet, whereupon the private magnet deenergizes and permits the side switch to pass to second position. The movement of the side switch wiper 65 from first to second position transfers the battery
105 connection from the vertical magnet 71 to the rotary magnet 72. The connector is then in position to receive impulses for the last digit 0. The operation of the calling device for this digit, which begins shortly
110 after the last impulse for the preceding digit is delivered, breaks the energizing circuit of the relay 110 ten times. Each time the relay 110 deenergizes it completes a circuit extending from ground G^6 through the
115 springs 111, 121, 122 and 123, relay 124, springs 125 and 126, rotary magnet 72 and side switch wiper 65 (in second position) to the battery lead 100. The rotary magnet 72 receives ten impulses over this circuit
120 and operates to rotate the wipers ten steps onto the contacts of the line number 2220. The private magnet relay 124 is energized by the first impulse to the rotary magnet and again closes the circuit of the private mag-
125 net 70. The circuit of the relay 124 is not opened long enough to permit it to deenergize until after the last impulse has been delivered to the rotary magnet. The relay 124 then deenergizes and breaks the circuit
130

of the private magnet 70, which, if the called line is not already busy, in turn de-energizes and permits the side switch to pass to third position, whereby connection is completed with the called line. The side switch wiper 64 (in third position) extends a guarding potential from ground G^8 through the private wiper 64 to the connector private bank contacts of the called line, and also provides an energizing circuit for the cut-off winding 127 of the line switch C' . The winding 127, upon energizing, attracts the armature 128, which operates to disconnect the line winding 129 and ground G^9 from the called line, and to extend the line conductor 130 through the springs 131 and 132 to the connector bank contact which is engaged by the wiper 61. When the side switch wiper 65 of the connector reaches third position, the energizing circuit is established for the ringer relay 133. This circuit extends from ground G^{10} through the interrupter 134, relay 133, springs 135 and 136 and side switch wiper 65 to the battery lead 100. Since this circuit includes the interrupter 134, the relay 133 is energized only intermittently. Each time the relay 133 is energized it operates to disconnect the calling line from the called line and to bridge the generator 137 across the called line to ring the bell 200.

After the operator's calling device stops operating, the key K' is restored to normal position, cutting off the calling device and connecting the relay 45 back onto the line. The relay 45 thereupon receives current in series with the line relay 110 of the connector F . This current causes the relay 45 to attract its armature in the proper direction to close the springs 138, whereby a circuit is closed through the supervisory lamp 139. This circuit extends from ground G^{11} through the springs 138, lamp 139 and armature 140 to battery.

When the called subscriber responds by removing his receiver, or as soon thereafter as the relay 133 deenergizes, if it happens to be energized at the time, the called station is provided with talking battery current from the central office. The circuit over which this talking current flows extends from ground G^8 through the side switch wiper 64, lower winding of the relay 141, ringer relay springs 142 and 143, side switch wiper 67, shaft wiper 62, line 144, hook switch springs 145 and 146, receiver 147, transmitter 210, line 130, springs 131 and 132, shaft wiper 61, ringer relay springs 148 and 149, private magnet springs 150 and 151, upper winding of the back-bridge relay 141 and side switch wiper 65 to the battery lead 100.

When the connector back-bridge relay 141 is energized by the talking current, it operates to close the circuit through the relay

152, this circuit extending from ground G^8 through the side switch wiper 64, relay 152 and springs 153 and 154 to the battery lead 100. The relay 152, upon energizing, operates to break the circuit of the ringer relay 133 at the springs 136 and 135. When the relay 152 is energized it also operates to shift the springs 155 and 156 out of engagement with their back contacts and into contact with their front contacts. By this operation the connections between the windings of the relay 110 and the trunk conductors 107 and 108 are interchanged. By this shifting of the connections of the relay 110 the current in the relay 45 at the cord C is reversed. This causes the armature of the relay 45 to be attracted in the opposite direction to open the springs 138, which causes the lamp 139 to be extinguished to signify to the operator that the called subscriber has answered.

When the calling subscriber hangs up his receiver upon the termination of the conversation, the relays 141 and 152 of the connector deenergize and restore the current in the relay 45 at the cord to its original direction, again lighting the lamp 139.

When the calling subscriber hangs up his receiver, the relay 80 deenergizes, while the relay 79 remains energized in series with the cut-off relay 78. This completes a circuit from ground G^{12} through the lamp 155 and armature of the relay 79 to battery. The simultaneous glowing of the two lamps signifies to the operator that both subscribers have hung up and that the connection may be taken down. The automatic switches are automatically released by the removal of the plug P^2 from the jack J^2 . When this plug is removed, the energizing circuit of the connector line relay 110 is broken. The relay 110, upon deenergizing, breaks the holding circuits of the release relays 113, 99 and 56 of the switches F , E and D , respectively.

Although it has not been previously mentioned, it will be seen that when the side switch 66 of the connector passes from second to third position, the holding ground of the release relays 99 and 56 of the selector switches is transferred from ground G^7 to ground G^6 through the springs 112 and 111, so that the circuits of all the release relays are thereafter controlled by the connector line relay. When the relay 113 of the connector deenergizes, it completes a circuit from ground G^6 through the springs 111 and 121, springs 122 and 256, release magnet 157 and off normal springs 158 to the battery lead 100. The energization of the magnet 157 immediately restores the mechanism of the connector to normal position, thereby breaking the connection with the called line and allowing the winding 127 of the switch H to deenergize. The deenergization of the release relays 56 and 99 of the selectors D and

E closes the circuits of their respective release magnets. The energizing circuit for the release magnet 258 of the selector D extends from ground G^3 through the springs 92 and 91, springs 94 and 160, magnet 258 and off normal springs 59 and 60 to the battery lead 100. The circuit of the release magnet 161 of the selector E is similar to that just traced for the magnet 258. The energization of the magnets 258 and 161 restores the mechanism of their respective switches to normal position. When the shafts of the switches D, E and F reach their lowest positions, the energizing circuits of their respective release magnets are broken by the separation of the off normal springs, and all of the apparatus employed in the connection is left in readiness for another call.

The foregoing is an explanation of the manner in which connection is obtained with an idle line. It will now be explained how the calling subscriber is given the busy signal in case the called line is already in use when called by substation A. Whenever an automatic line is busy, either by reason of having made a call or by having been called, there is a guarding ground potential on the connector private bank contacts of the said busy line. Thus if the wipers of the connector F are rotated onto the contacts of a busy line, a ground potential is extended from the private bank contacts of that line through the private wiper 63, side switch wiper 64 (which is then in second position), springs 163 and 164 and relay 169 to the spring 170 of the private magnet relay 124. As the relay 124 deenergizes after the last impulse has been delivered to the rotary magnet of the connector, the spring 171 engages the spring 170 before it breaks contact with the spring 172. A holding circuit for the private magnet 70 is therefore maintained from the private bank contact of the busy line through the relay 169, causing the side switch to be still locked in second position after the relay 124 is deenergized. The energization of the relay 169 disconnects the rotary magnet 72 from the impulse spring 121, and shifts the holding ground of the relay 169 and private magnet 70 from the guarded private bank contact to ground G^7 by way of the springs 164 and 165, springs 115 and 114 and side switch wiper 66. In its energized position the relay 169 also completes a circuit over which busy signaling current flows from the busy signaling machine L to the calling substation. This circuit extends from the battery lead 100 through the secondary winding of the induction coil 174, springs 168 and 167, contact point 175, side switch wiper 67, ringer relay springs 143 and 142, condenser 176, thence over the heavy conductors shown in Figs. 2 and 1 to and through the substa-

tion A and back over the other side of the line through the upper winding of the connector line relay 110 to the battery lead 100. Although the wipers of the connector H are standing on the contacts of the called line while a calling subscriber is thus receiving the busy signal, there is no connection between the two lines. The connection is open on one side of the line at the private magnet springs 150 and 151, and on the other side at the side switch wiper 67, which is locked in second position. In this case the lamp 139 at the cord is not extinguished, so that when the calling subscriber hangs up his receiver, the operator is given the disconnect signal in the usual manner.

While I have illustrated my invention in connection with a semi-automatic two-wire system—that is, one in which the automatic switches are controlled over two sides of a line circuit in series—it will be understood that my invention is capable of other uses, and is not limited to such a two-wire system, but is equally well adapted for use in a system in which the switches are controlled in any suitable manner by impulses controlled by a calling device. I likewise do not wish to limit myself to a semi-automatic system, as it is obvious, if desired, my calling device could be used in connection with an entirely automatic system in which the calling device is located at the subscriber's station.

What I claim as my invention is:—

1. In a telephone system, a plurality of calling devices having means for transmitting impulses for a plurality of digits for a called number, and means common to said plurality of calling devices for delaying their operation between any two digits.

2. In a telephone system, a plurality of calling devices provided with means to transmit impulses for a plurality of digits for a called number, and a dash-pot associated with said devices and adapted to delay their operation between any two of said digits.

3. In a telephone system, a calling device comprising a plurality of impulse-transmitting devices, an operating dial provided with a series of finger holds for operating each of said devices, and means whereby said impulse devices are adapted to be operated successively, the first transmitter operating as soon as the respective operating dial has been operated.

4. In a telephone system, a calling device provided with a series of impulse-transmitting devices, means for operating each of said transmitting devices independently, and means whereby each of said transmitting devices when in operated position is adapted to lock the next one in the series in an operated position until the first-mentioned device has returned to normal.

5. In a telephone system, a calling device

comprising a series of transmitting devices, an operating dial provided with a series of finger holds for each of said impulse-transmitting devices, a movable finger stop for each of said dials, and means controlled by one of said stops for locking another of said dials in operated position.

6. In a telephone system, a calling device comprising a series of impulse-transmitting devices, an operating dial provided with a series of finger holds for each of said impulse-transmitting devices, a pivoted arm constituting a movable finger stop for one of said dials, and means controlled by said arm for locking another of said dials in operated position.

7. In a telephone system, a calling device comprising a series of impulse-transmitting devices, an operating dial provided with a series of finger holds for each of said impulse-transmitting devices, a movable finger stop for each of said dials, means controlled by one of said stops for locking another of said dials in operated position, and means for unlocking said second dial when said first-mentioned dial returns to normal position.

8. In a telephone system, a calling device comprising a series of impulse-transmitting devices, an operating dial provided with a series of finger holds for each of said impulse-transmitting devices, a pivoted arm constituting a movable finger stop for one of said dials, means controlled by said arm for locking another of said dials in operated position, and means for unlocking said second dial when said first-mentioned dial returns to normal position.

9. In a telephone system, a calling device comprising a series of impulse-transmitting devices, an operating dial provided with a series of finger holds for each of said impulse-transmitting devices, a movable finger stop for each of said dials, means controlled by one of said stops for locking another of said dials in operated position, means for unlocking said second dial when said first-mentioned dial returns to normal position, and means for delaying the operation of said unlocking means.

10. In a telephone system, a calling device comprising a series of impulse-transmitting devices, an operating dial provided with a series of finger holds for each of said impulse-transmitting devices, a pivoted arm constituting a movable finger stop for one of said dials, means controlled by said arm for locking another of said dials in operated position, means for unlocking said second dial when said first-mentioned dial returns

to normal position, and means for delaying the operation of said unlocking means.

11. In a telephone system, a calling device comprising a plurality of impulse-transmitting devices, means for variably operating said impulse transmitting devices, and means whereby said impulse-transmitting devices are adapted to transmit impulses as soon as the respective operating means have been operated.

12. In a telephone system, a calling device comprising a plurality of impulse-transmitting devices, means for variably operating said impulse-transmitting devices, means whereby said impulse-transmitting devices are adapted to transmit impulses as soon as the respective operating means have been operated, and means for preventing the second impulse-transmitting device from sending impulses until after the impulses from the first impulse-transmitting device have been transmitted.

13. In a telephone system, a calling device comprising a plurality of impulse-transmitting devices, means for variably operating said impulse-transmitting devices, means whereby said impulse-transmitting devices are adapted to transmit impulses as soon as the respective operating means have been operated, and automatic means for separating the groups of impulses transmitted from each transmitting device.

14. In a telephone system, a calling device comprising a plurality of impulse-transmitting devices each comprising an operating dial, an impulse wheel controlled by said dial, said impulse wheel always rotating in the same direction in the operation of said device, and means for preventing said impulse-transmitting devices from operating simultaneously.

15. In a telephone system, a calling device provided with a series of impulse-transmitting devices, means for operating each of said transmitting devices independently, means whereby each of said transmitting devices when in operated position is adapted to lock the next one in the series in an operated position until the first-mentioned device has returned to normal, and means for delaying the starting of the next transmitting device after the first-mentioned device has returned to normal.

Signed by me at Chicago, Cook county, Illinois, this 16th day of June, 1911.

ALEXANDER E. KEITH.

Witnesses:

ARTHUR J. RAY,
E. D. FALES.