No. 754,211. PATENTED MAR. 8, 1904.

T. W. GLEESON & R. HAMILTON.

TELEPHONE OR TELEGRAPH SYSTEM.

APPLICATION FILED MAY 1, 1903.

NO MODEL. 6 SHEETS—SHEET 1.

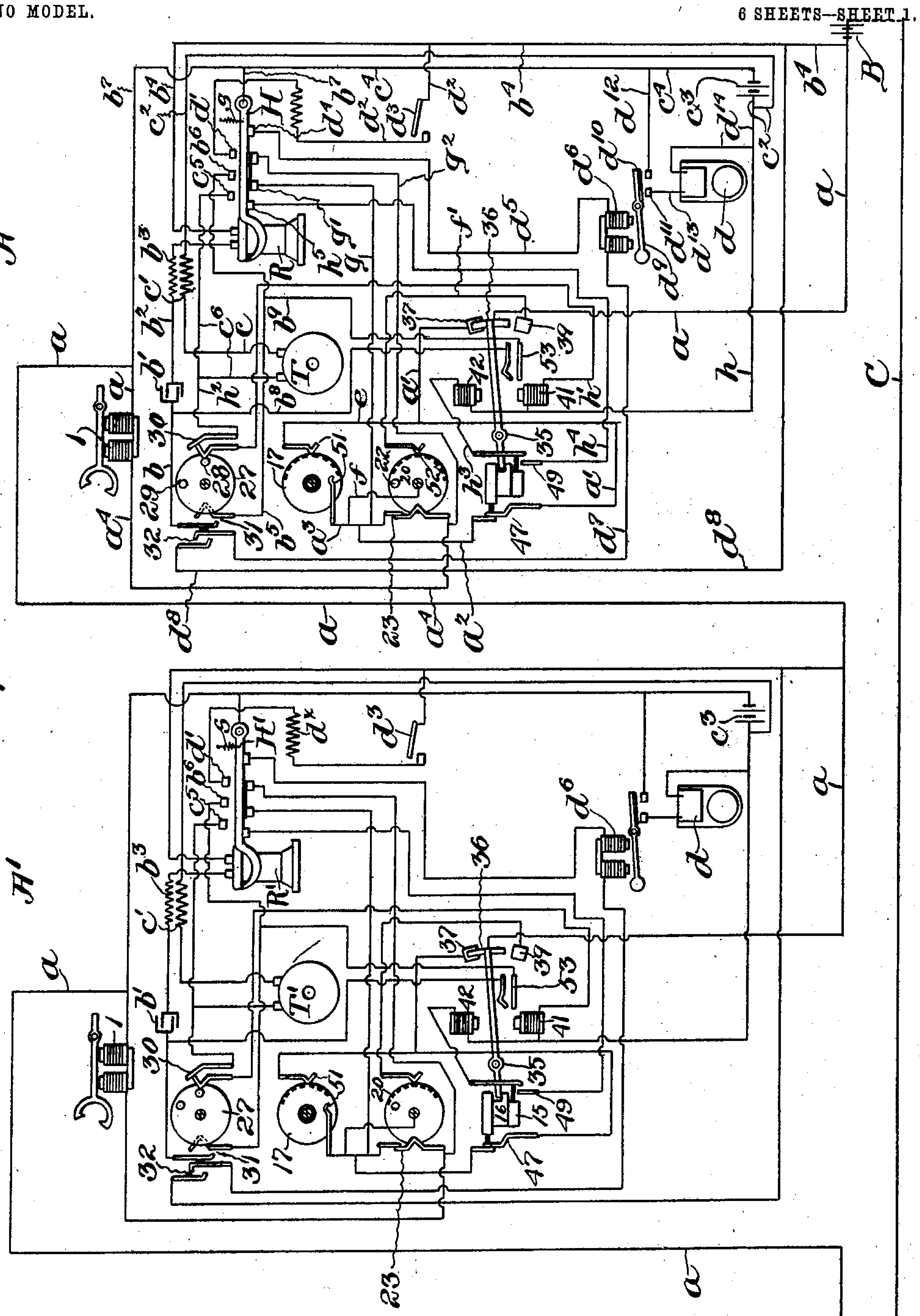

Fig. 1.

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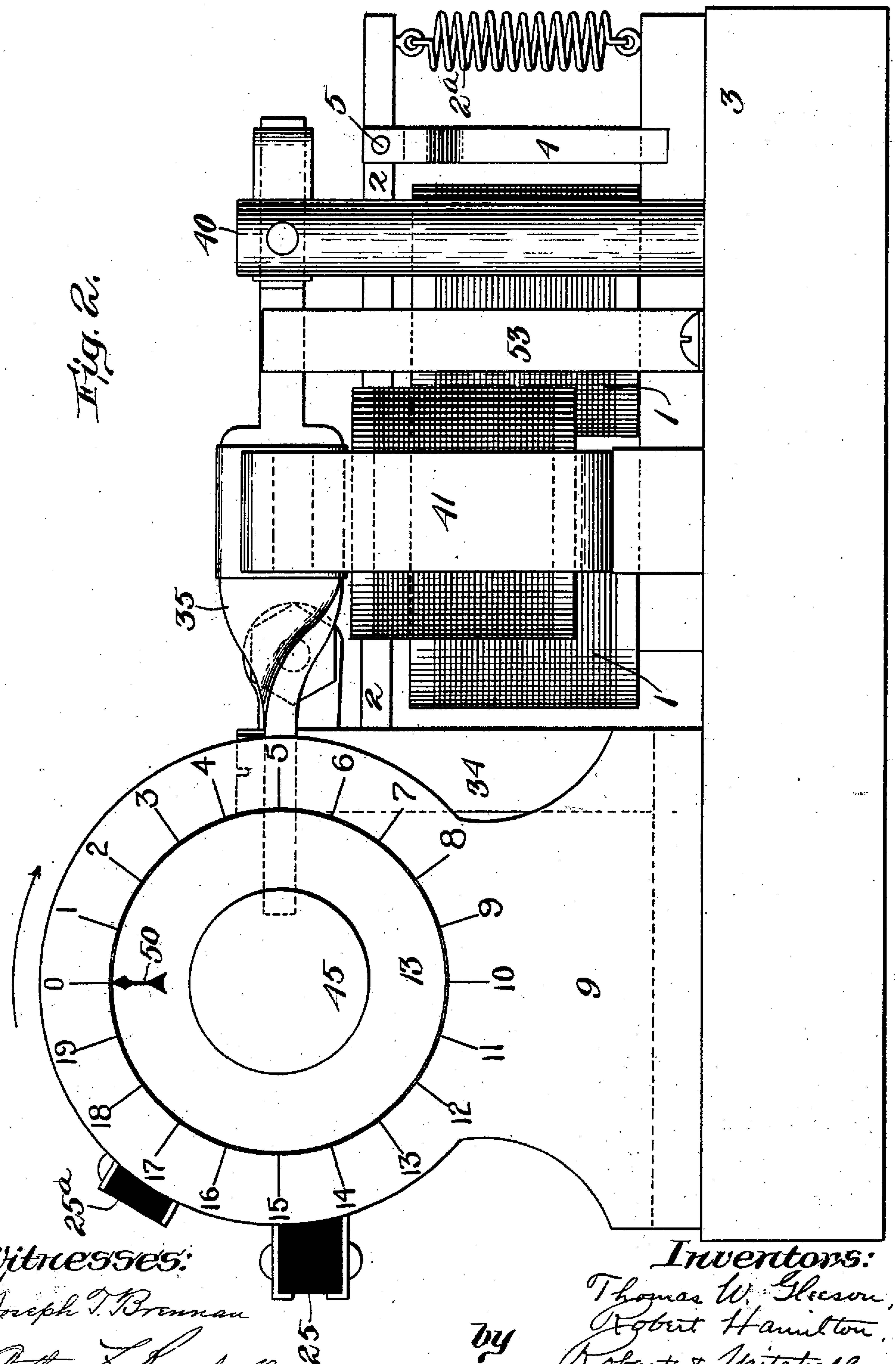
6 SHEETS—SHEET 2.

Fig. 2.



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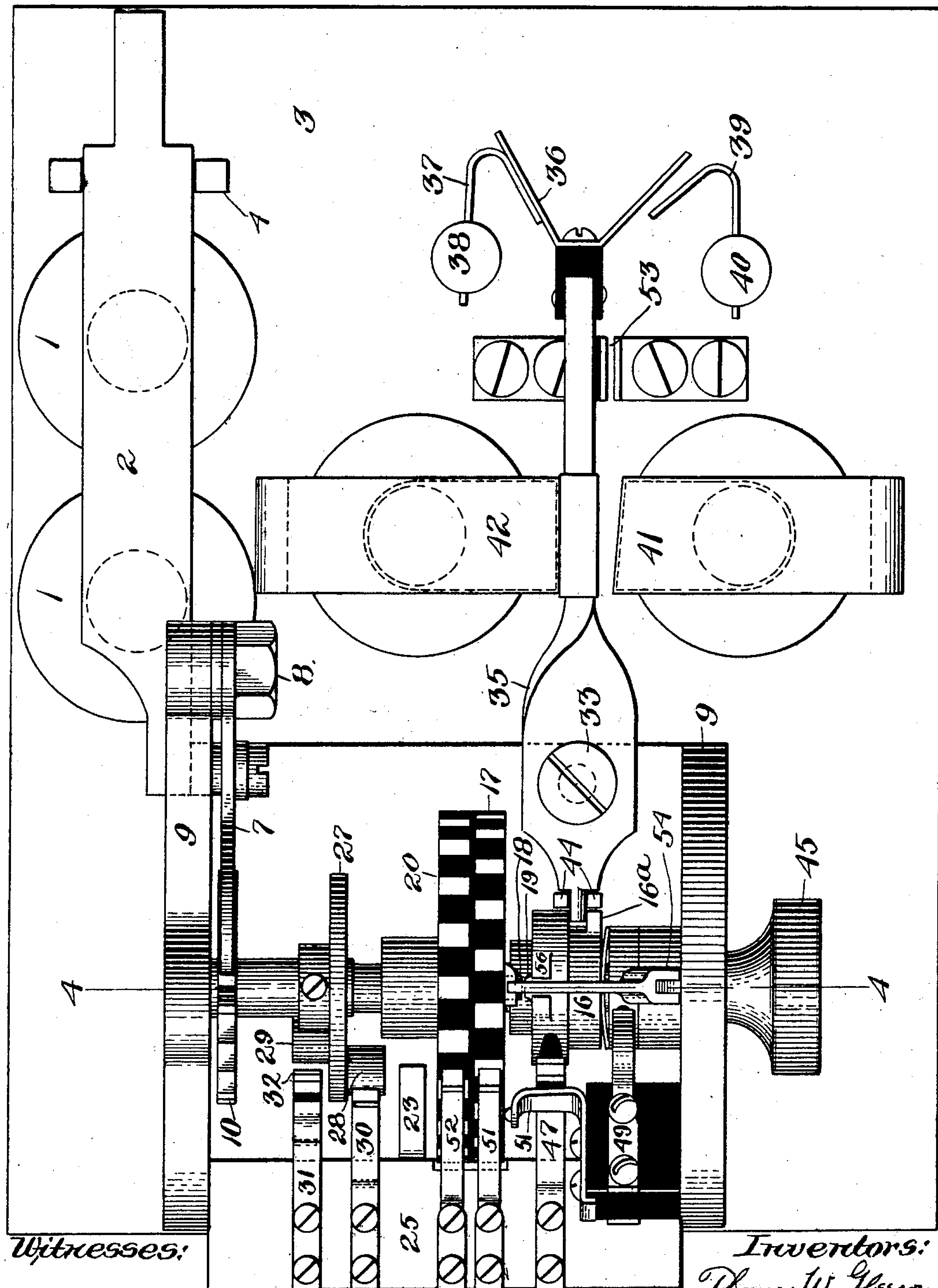

Fig. 3.

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NO MODEL. 6 SHEETS—SHEET 4.

Fig. 4.

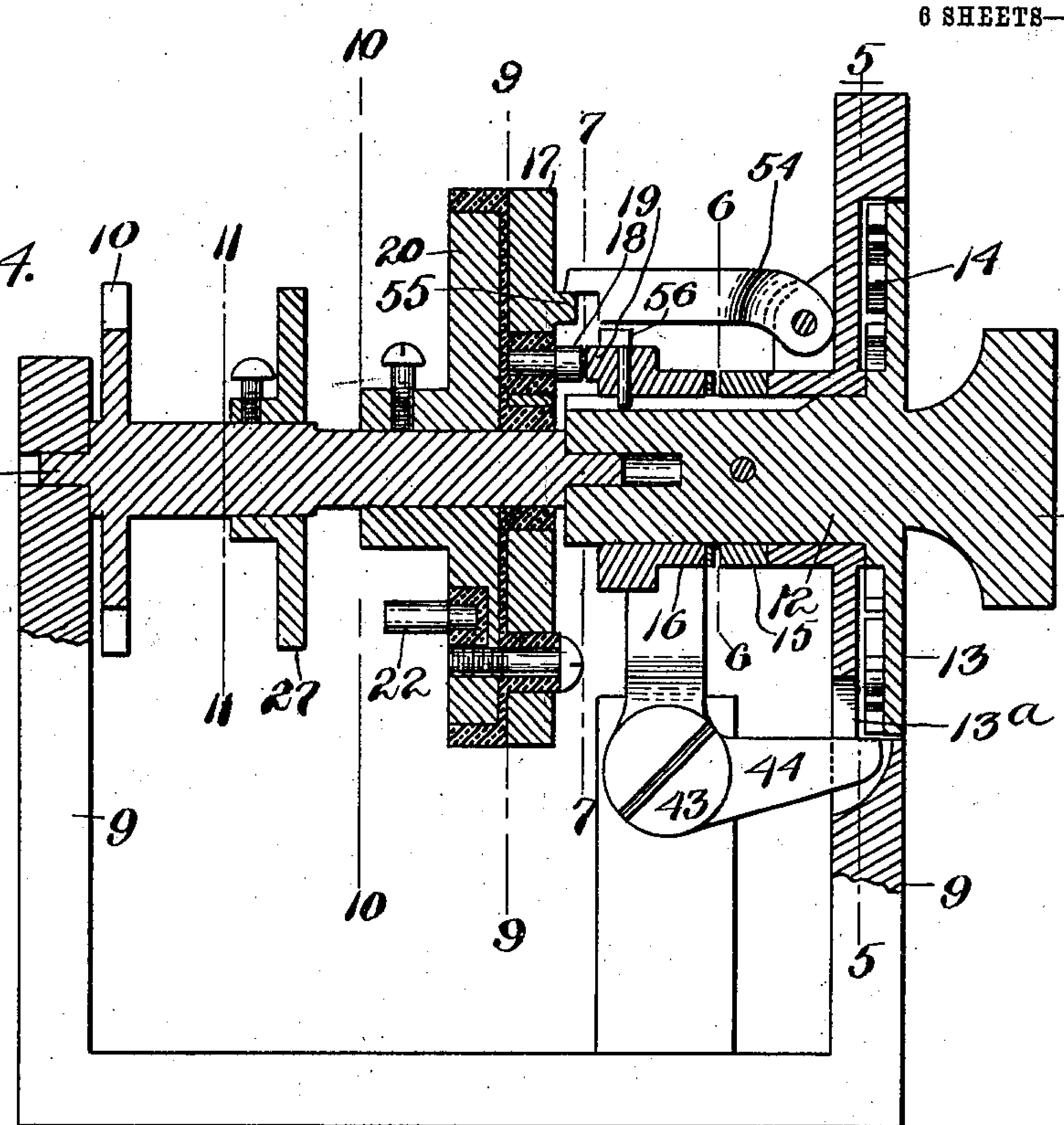


Fig. 5.

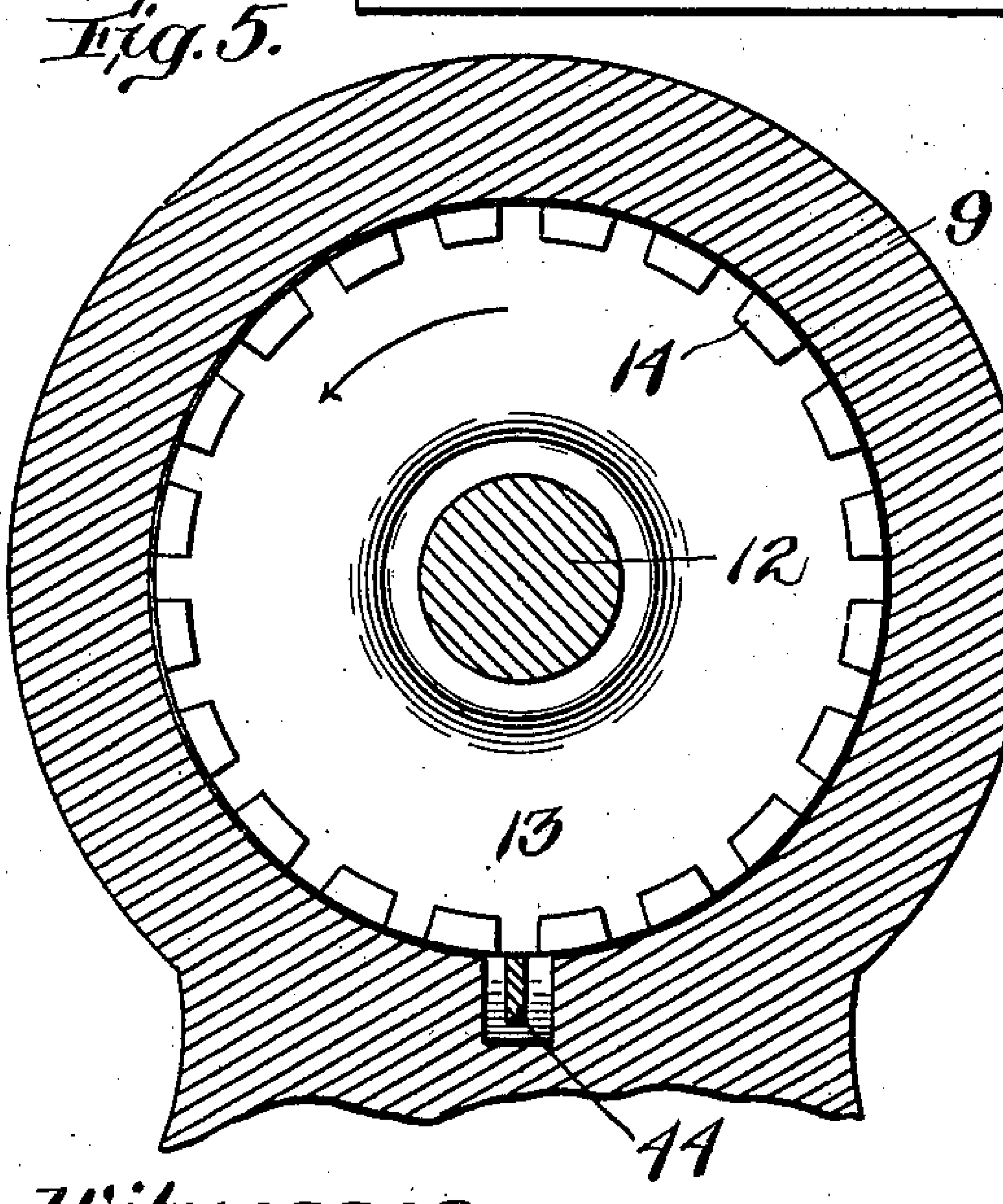
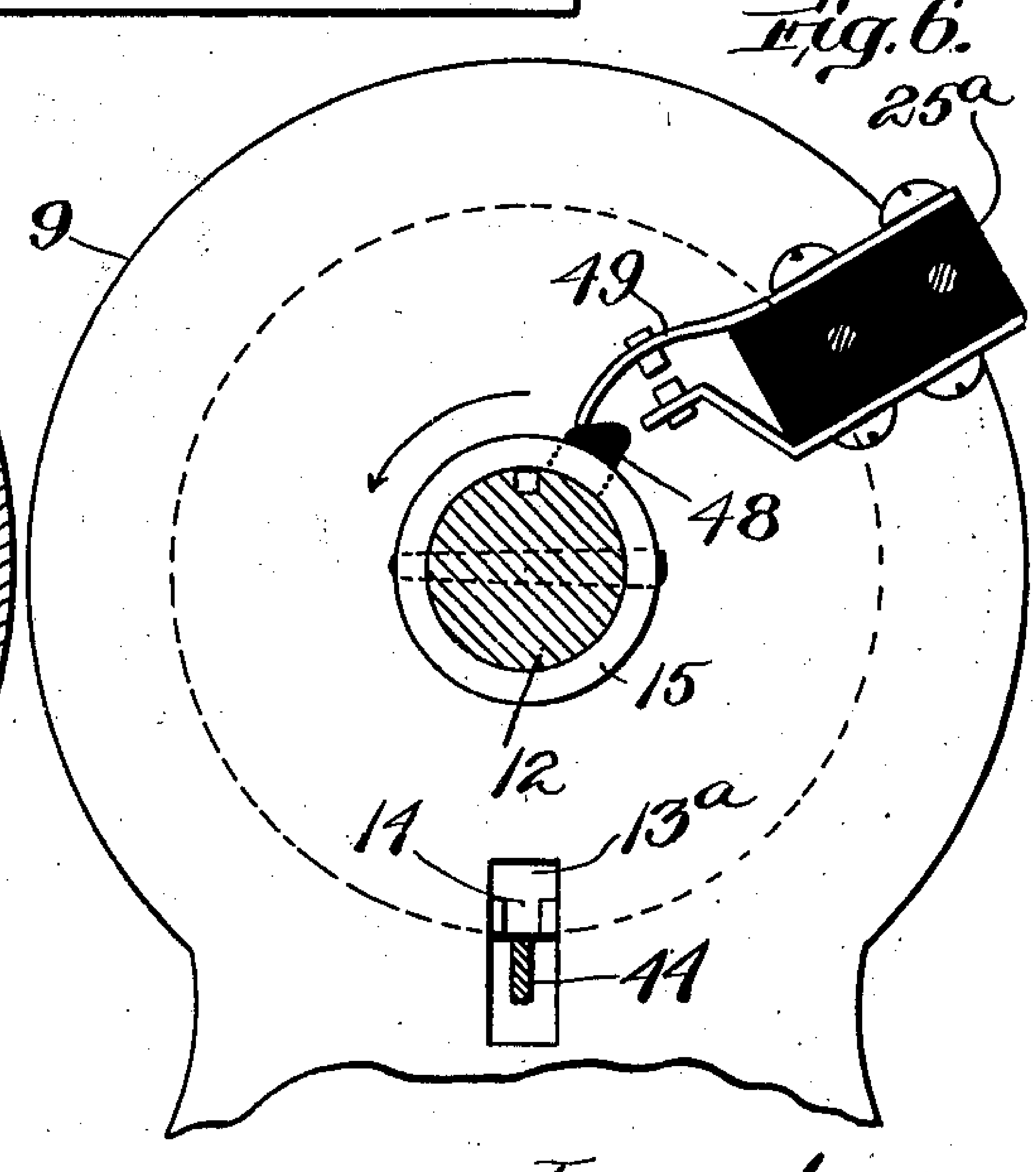


Fig. 6.



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NO MODEL. 6 SHEETS—SHEET 5.

Fig. 7.

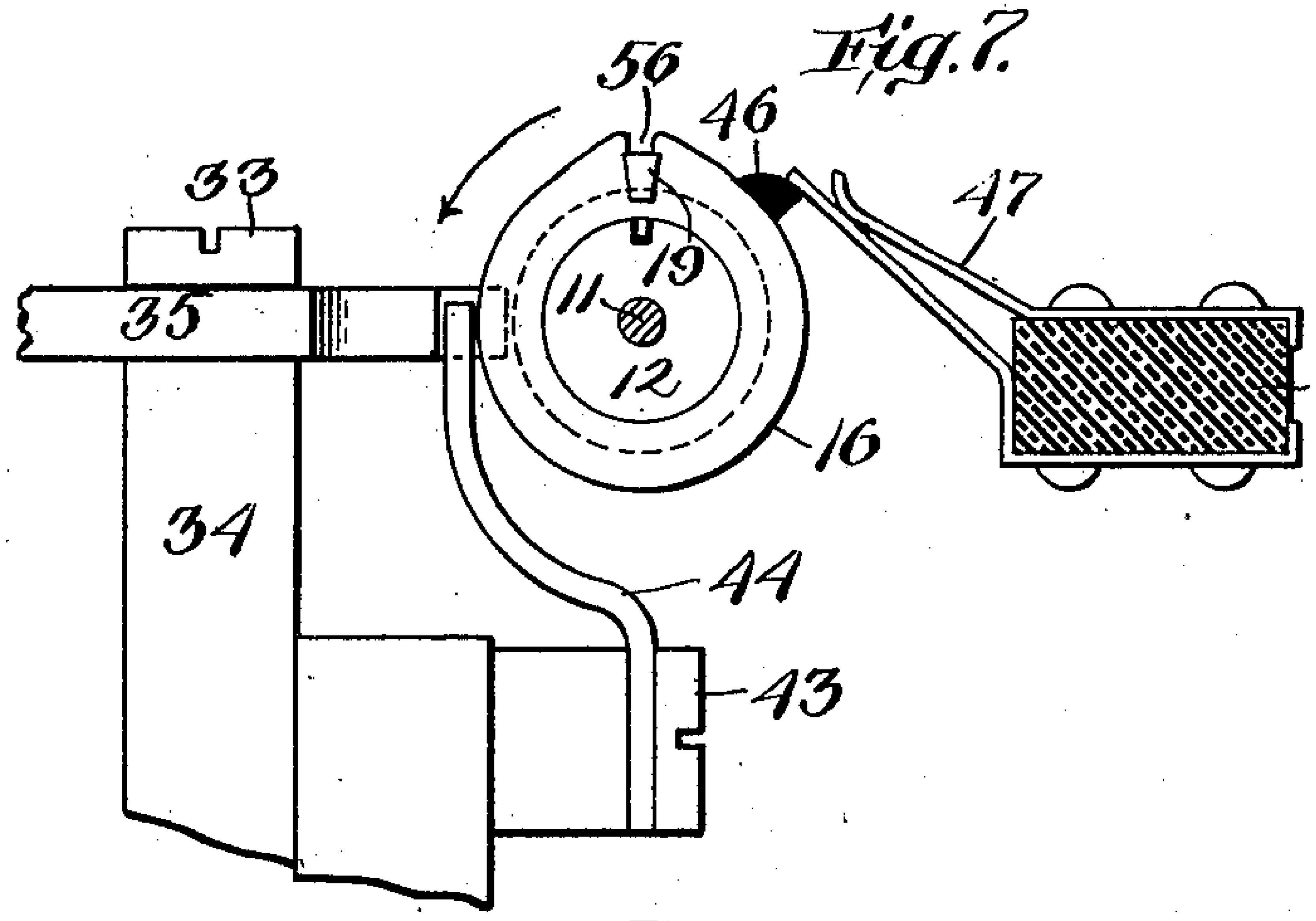


Fig. 8.

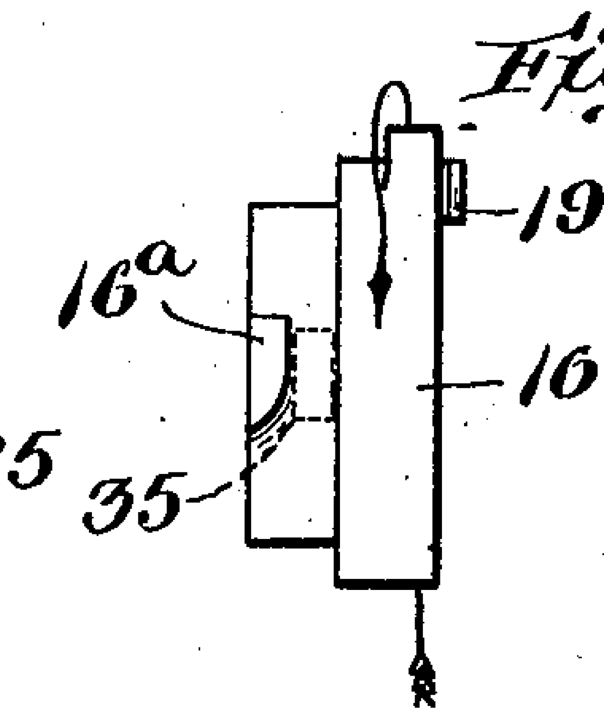


Fig. 9.

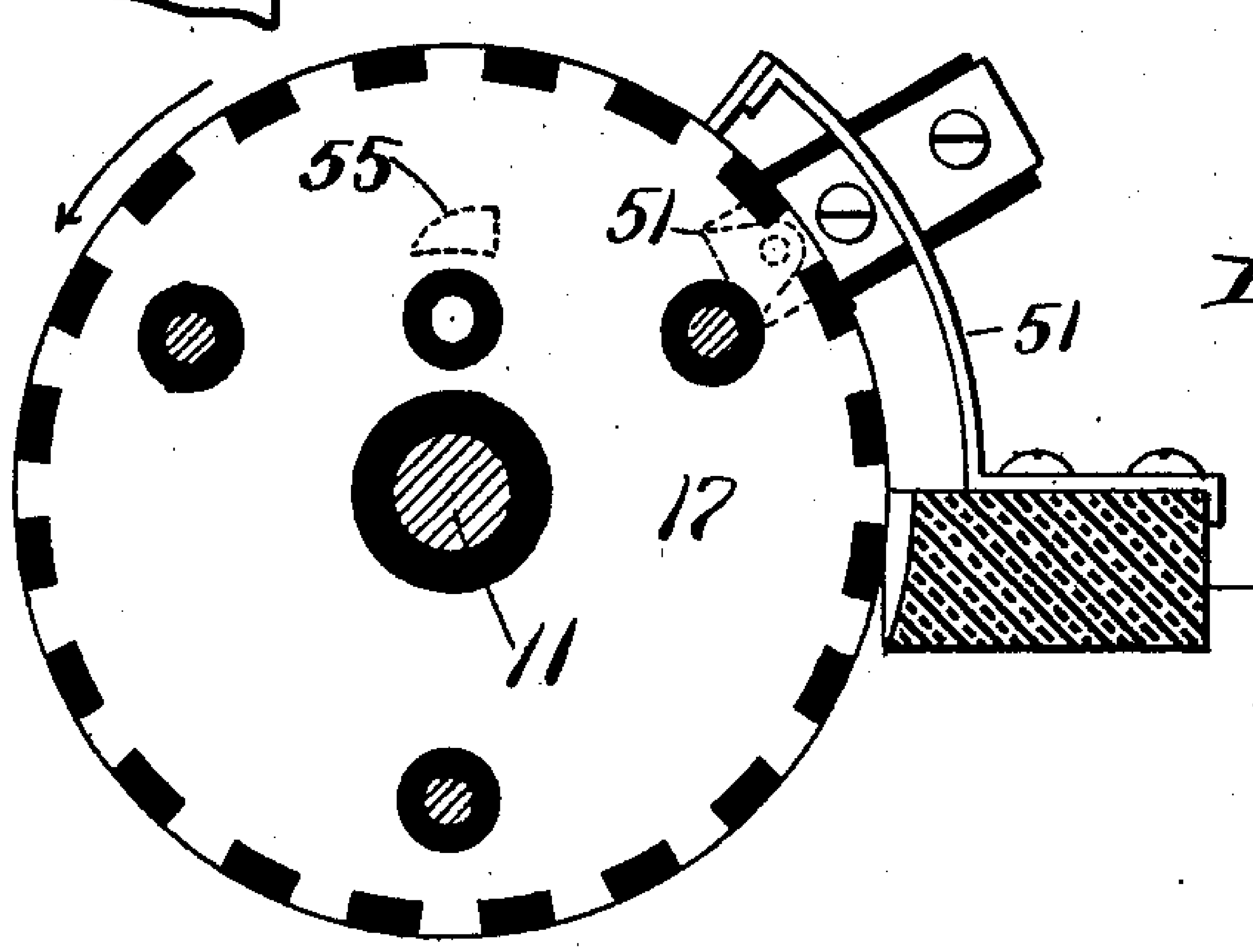
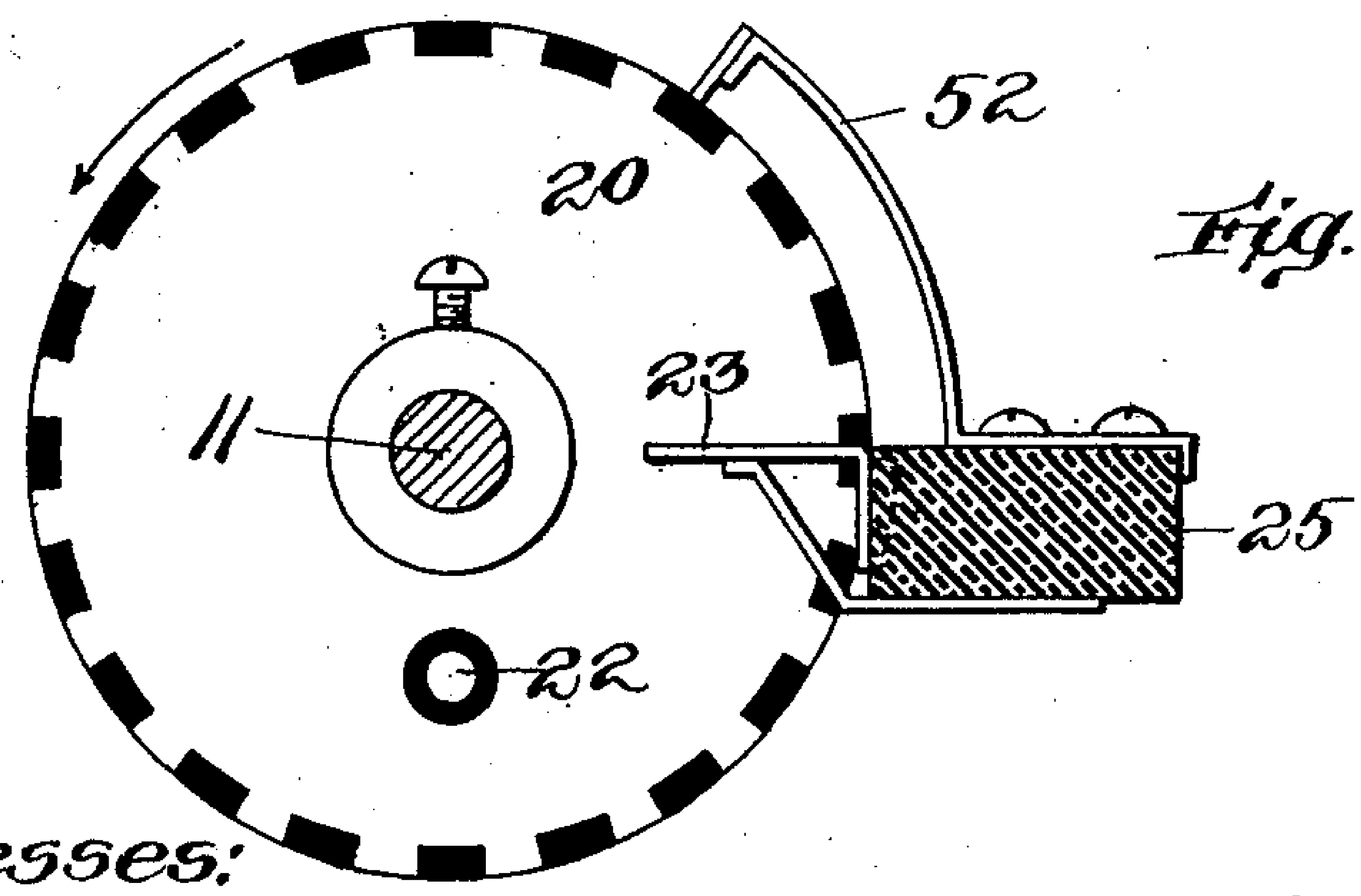


Fig. 10.



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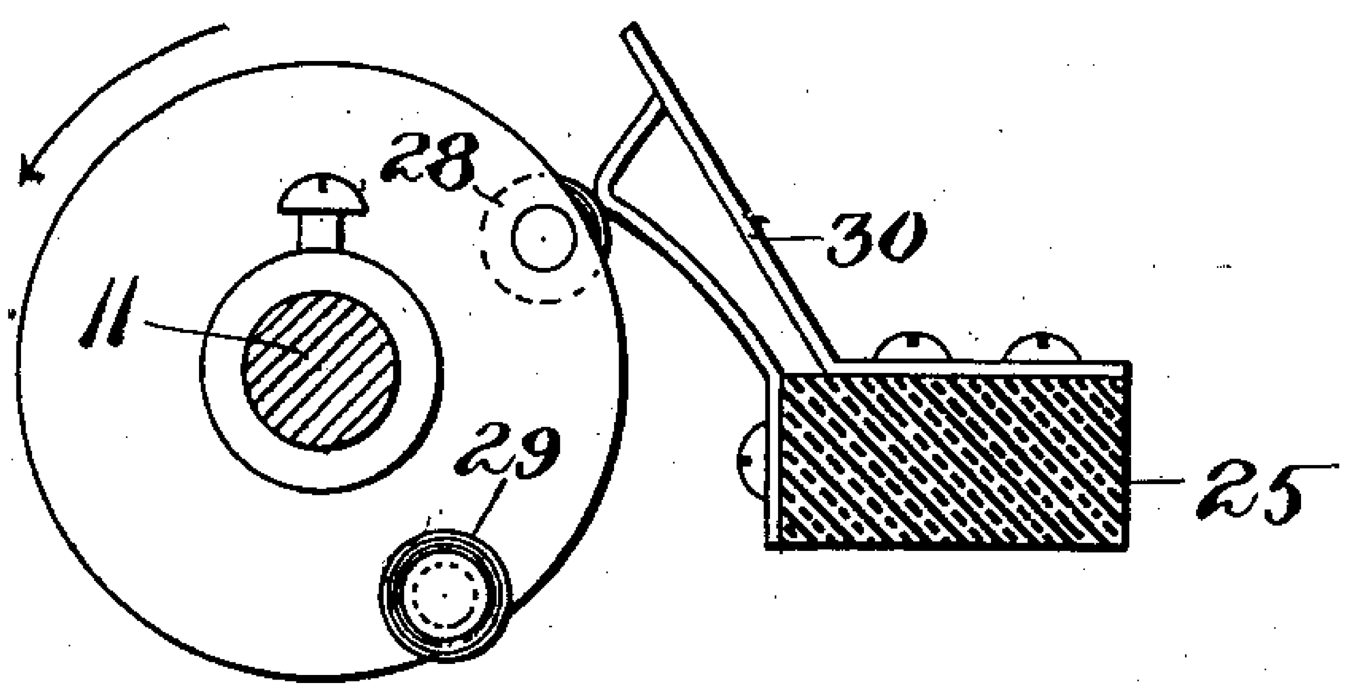
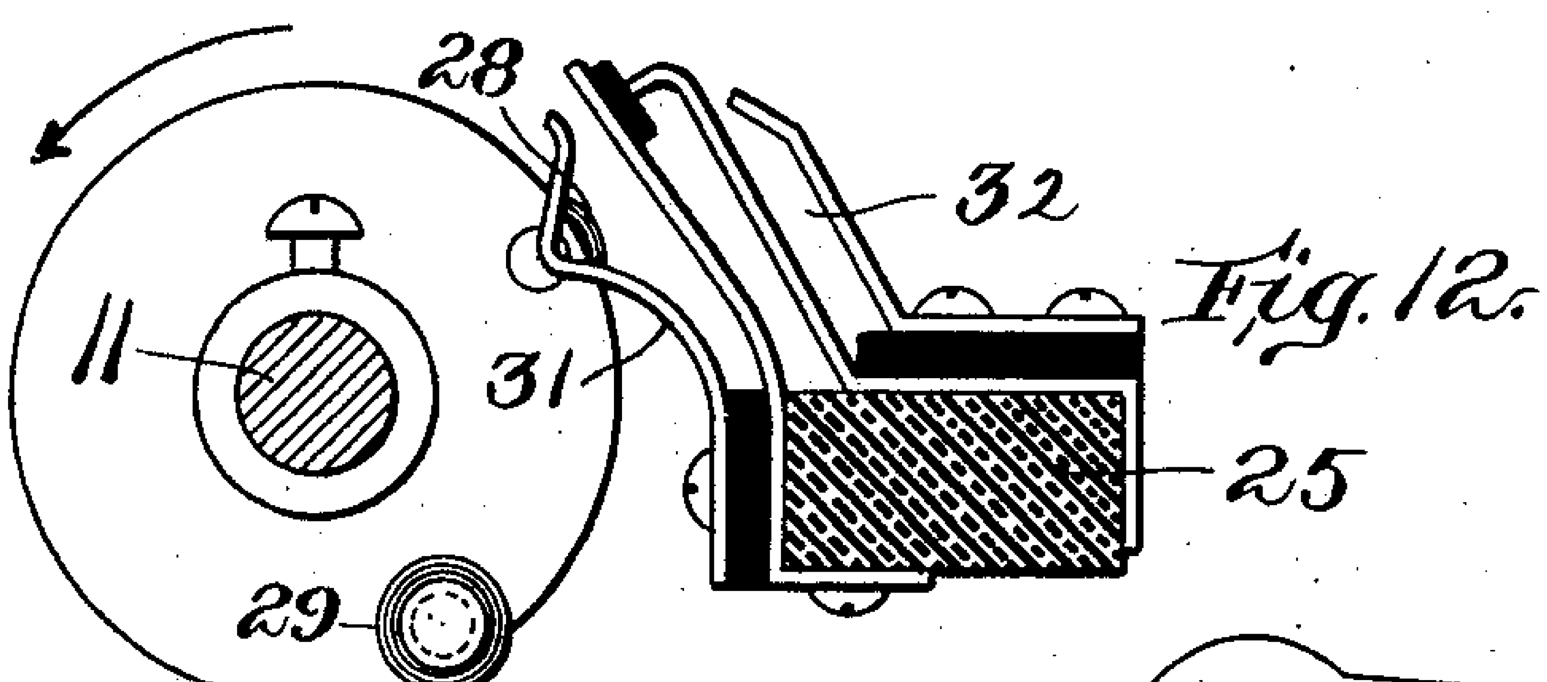
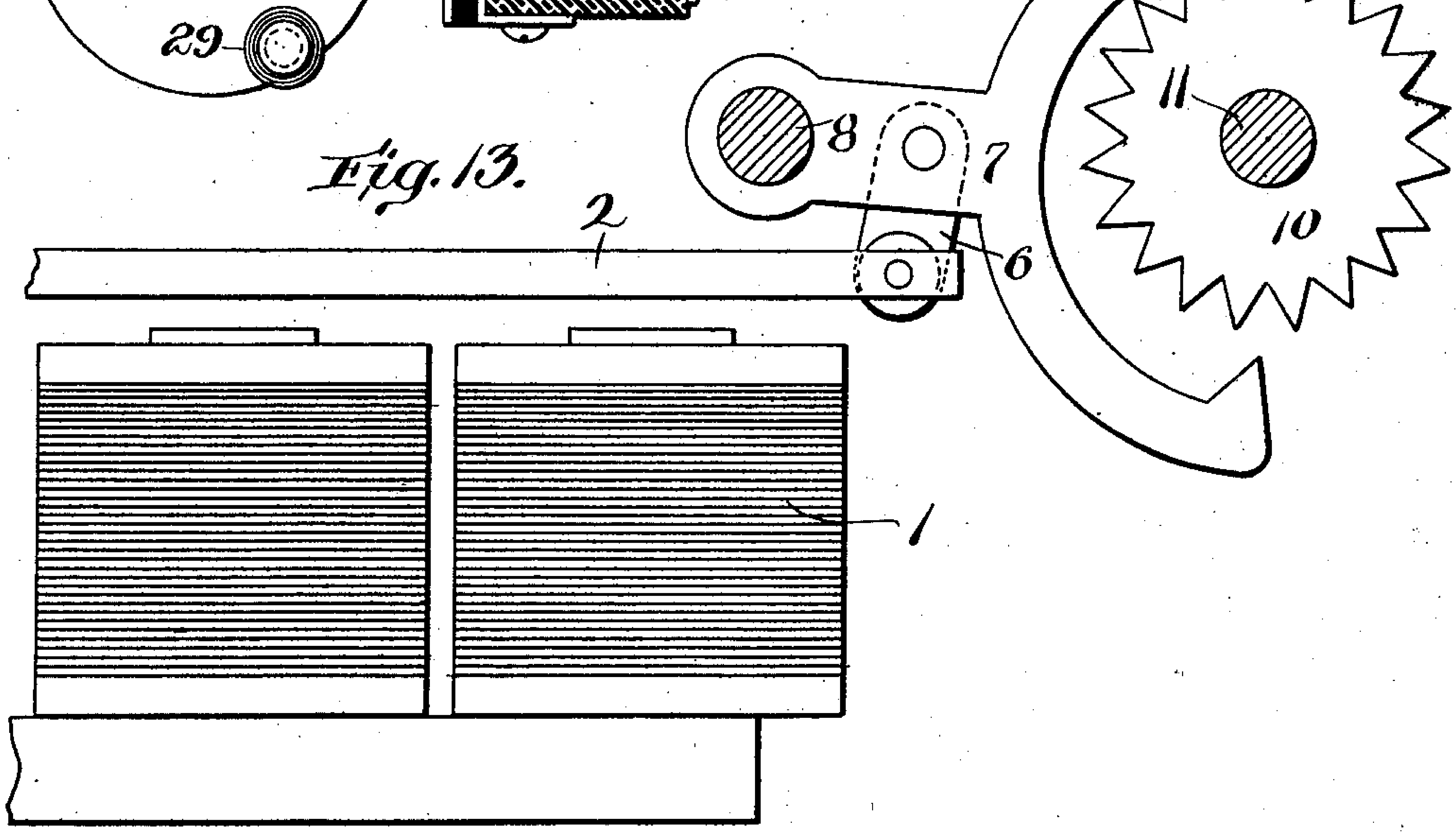
TELEPHONE OR TELEGRAPH SYSTEM.

APPLICATION FILED MAY 1, 1903.

NO MODEL. 6 SHEETS—SHEET 6.







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No. 754,211. Patented March 8, 1904.

UNITED STATES PATENT OFFICE.

THOMAS W. GLEESON, OF BOSTON, AND ROBERT HAMILTON, OF MILTON, MASSACHUSETTS.

TELEPHONE OR TELEGRAPH SYSTEM.

SPECIFICATION forming part of Letters Patent No. 754,211, dated March 8, 1904.

Application filed May 1, 1903. Serial No. 155,117. (No model.)

To all whom it may concern:

Be it known that we, THOMAS W. GLEESON, a resident of Boston, in the county of Suffolk, and ROBERT HAMILTON, a resident of Milton, in the county of Norfolk, State of Massachusetts, citizens of the United States, have invented new and useful Improvements in Telephone or Telegraph Systems, of which the following is a specification.

Our invention relates to telephone and telegraph systems, and particularly to the so-called "automatic" type of telephone, which is so constructed and arranged as to dispense with a central office by making it possible for an operator at any station to connect his station with any one of the others of the system, providing, in most cases, that the system is not already in use by any other two stations. Systems of this class have heretofore been provided wherein each station of the system was equipped with a spring-actuated step-by-step mechanism for controlling the telephone-circuits of the system. The operation of each step-by-step mechanism was controlled by the armature of a magnet acting through an escapement, there being one magnet and escapement for each step-by-step mechanism. These magnets were all in series in a common magnet-circuit, and the magnet-circuit was controlled and operated by a spring-actuated make-and-break mechanism that was manually controlled. An operator at any station by freeing the spring-actuated make-and-break mechanism and regulating by means of an adjustable stop the extent of movement of the make-and-break mechanism could operate the magnet-circuit the desired number of times corresponding to the number of the station he desired to call. This operation of the magnet-circuit resulted in the step-by-step mechanisms of all the stations being operated in unison by their springs a number of steps corresponding to the number of times the magnet-circuit was operated, but only the station corresponding in number to the number of times the magnet-circuit was operated was put into communication with the calling-station, the other stations being excluded from use of the system until it was restored to normal condition again by the operator at the calling-station. This exclusive control of the system was secured to the operator at the calling-station by means which automatically and mechanically locked the make-and-break mechanism of all the other stations except the calling-station, so that the other stations could not "listen-in" or interfere with the connections established by the operator at the calling-station. An illustration of a system of this character will be found in United States Patent to U. S. Jackson, dated May 7, 1901, No. 673,796.

The above-described construction, however, has required the use of very complicated mechanism and circuits, the latter comprising at least three line-wires or two line-wires and the ground—one line-wire for the talking-circuit, one line-wire for the magnet-circuit, and the other line-wire or ground as a return-conduit common to both the magnet and talking circuits.

The use of separate line-wires for the talking-circuit and the magnet-circuit is in practice a serious if not fatal objection to the above-described system by reason of the expense both of installing and maintaining the two wires.

A most important object of our invention is to dispense with one of the wires and make a single wire do the work of the two. Another objectionable feature incident to the old construction above described has been the necessity at regular intervals manually to wind up the spring at each station which actuates the make-and-break mechanism at that station. Failure to keep the spring of any station of the system wound up would throw the whole system out of order.

A further object of our invention is therefore to provide instead of independent springs for actuating the mechanisms controlling the telephone-circuits at the several stations a series of motors for actuating those mechanisms, one at each station, all of which may be controlled from any one of the stations.

Still another defect in the old construction has been that after using the system only the operator at the calling-station could return the system to its normal position, and he had to do it by a manual operation. Failure on his part to perform this operation rendered the system inoperative. By the means provided by our invention the system is automatically returned to its normal position with all the instruments at zero by the mere replacing of the receiver upon the receiver-hook.

Other features will be hereinafter pointed out.

Our improved telephone system comprises two or more telephone-stations connected by a motor-circuit having a battery which may be termed a "main-battery circuit." In the main-battery circuit is arranged a series of switch-operating motors, one for each station. Each telephone has a primary and a secondary telephone-circuit. The ends of the secondary telephone-circuit at each station are connected with the battery-circuit, so that the secondary telephone-circuit constitutes a shunt in the battery-circuit. In each secondary telephone-circuit is a condenser (which constitutes a barrier to the battery-current, but not to the induced current of the secondary circuit) and also a normally open switch, the latter operated by the motor of its respective station. A normally closed switch is provided in the battery-circuit between the ends of each secondary circuit also operated by said motor. Means is provided at each station by which the operator of that station can operate the motor or battery circuit and all the motors therein so as to cause the motor of any one of the other stations to operate the two switches controlled by it. Thereby the operator at any one of the stations of the system is enabled to close the normally open switch in the secondary circuit of the telephone and to open the normally closed switch of the battery-circuit of any one of the other stations, so that after he has also closed the secondary circuit of the telephone at his own station he is in telephonic communication with the other station. By this construction we are enabled to reduce the number of essential line-wires to one, using the ground as a return. We prefer, however, to employ an all-metallic circuit—that is, two line-wires. The use of an all-metallic circuit avoids interference from induced currents occasioned by the presence in the ground of other electrical conductors so numerous in cities.

By using motors instead of independent springs, as heretofore, for operating the switches in the secondary circuits we obviate the necessity of winding up clockwork at each station to keep the system in working order.

Mechanisms and electrical connections embodying these and other features will now be more specifically pointed out.

In the accompanying drawings, Figure 1 is a diagram showing two adjacent stations of my improved telephone system. Fig. 2 is an elevation of the step-by-step mechanism in my improved system, showing the same on an enlarged scale. Fig. 3 is a plan view of the mechanism shown in Fig. 2. Fig. 4 is a section on line 4 4 of Fig. 3. Fig. 5 is a section on line 5 5 of Fig. 4 viewed in the direction indicated by the arrow. Fig. 6 is a section on line 6 6 of Fig. 4. Fig. 7 is a section on line 7 7 of Fig. 4. Fig. 8 is a detail showing the construction of the stop-sleeve shown in Fig. 7 and hereinafter described. Fig. 9 is a section on line 9 9 of Fig. 4. Fig. 10 is a section on line 10 10 of Fig. 4. Figs. 11 and 12 are sections on line 11 11 of Fig. 4 and are hereinafter described. Fig. 13 is a detail view of the motor hereinafter described.

In order to fully understand the construction and operation of the system shown diagrammatically in Fig. 1, an understanding of the construction and operation of the mechanism shown on an enlarged scale in Figs. 2 to 13, inclusive, is necessary. This mechanism comprises a motor made up of a magnet 1 and armature 2. The magnet 1 is fixed to a base 3, and fast to base 3 is a post 4, to which the armature 2 is pivoted at 5. Armature 2 is moved in one direction by magnet 1 and in the opposite direction by a spring 2^a. One end of armature 2 is connected through a link 6 with a pallet 7, pivoted to a frame 9, fixed to base 3. It will thus be observed that if the circuit of magnet 1 be opened and closed successively pallet 7 will be vibrated.

The pallet 7 engages a pallet-wheel 10, fixed to an arbor 11, one end of the latter being journaled in the frame 9 and the other end in the hollow end of an arbor 12. The arbor 12 is also journaled in frame 9 at its outer end and carries a disk 13, provided on its inner face with a crown-rack 14. Disk 13 occupies a chamber provided for it in the side of frame 9, and the crown-rack extends past a perforation 13^a through said frame. Pinned fast to arbor 12 next to frame 9 is a sleeve 15, and next to sleeve 15 is a sleeve 16, splined to arbor 12, so that arbor 12, sleeve 15, and sleeve 16 rotate together; but sleeve 16 is movable endwise on arbor 12. Next to the sleeve 16, but fixed to the other arbor 11, is a disk 17, carrying an insulated stop-pin 18, adapted to coöperate with a lug 19 on the adjacent end of sleeve 16. Disk 17 is secured to a second disk 20, fixed to arbor 11, disk 20 being electrically connected with arbor 11, while disk 17 is insulated from both arbor 11 and disk 20. The peripheries of the two disks 17 and 20 are notched, and the notches are filled with blocks of insulation. Projecting from the side of disk 20, opposite to disk 17, is an insulated stud 22, which coöperates with a pair of contacts 23, carried by a cross-bar 25, of rubber or the like, fixed at its ends to frame 9. Next to disk 20 and fixed to arbor 11 is a wheel 27, carrying two insulated studs 28 and 29, and stud 28 coöperates with a pair of contacts 30, also fixed to cross-bar 25.

Pivoted at 33 to a post 34, projecting up from frame 9, is an armature 35, one end of which engages sleeve 16, and the opposite end carries a contact 36. One arm of contact 36 coöperates with a stationary contact 37, fixed to a post 38, projecting up from base 3, and the other arm thereof coöperates with a stationary contact 39, fixed to a post 40, projecting up from base 3. The armature 35 is moved in one direction by a magnet 41, fixed to base 3, and in the opposite direction by a magnet 42, also fixed to base 3. When swung in one direction by magnet 41, armature 35 shifts sleeve 16 endwise on arbor 12 toward disk 17, which carries lug 19 into the path of pin 18. Of course, however, this movement of sleeve 16 and armature 35 is not possible while the two arbors 11 and 12 are in normal position, because the normal relative position of lug 19 and pin 18 is with the lug and pin directly in line with each other, so that it is only after the operator has angularly adjusted arbor 12 and parts carried thereby that pin 18 is not in line with lug 19 and sleeve 16 is free to be moved endwise toward disk 17 by armature 35. When armature 35 is returned to normal position by magnet 42 after having shifted sleeve 16 toward disk 17, sleeve 16 does not return to its normal position with said armature; but at a later time while the sleeve is rotating with arbor 12 a cam-shaped lug 16^a on sleeve 16 strikes the end of armature 35, and thereby the sleeve is shifted from disk 17, this return movement of the sleeve occurring just as arbor 12 reaches normal position with index 50 on disk 13, Fig. 2, at zero.

Pivoted at 43 to a post projecting up from frame 9 is a bell-crank lever 44, one arm of which is forked and straddles the end of armature 35. The end of the other arm of bell-crank 44 extends into perforation 13^a and normally occupies a position below and out of engagement with the crown-rack 14.

At its outer end arbor 12 is made with a thumb-piece 45, which is used only by the operator at a calling-station to adjust arbor 12 angularly and with it sleeve 16 to position stop-lug 19 relatively to stop-pin 18.

Sleeve 15 carries a pin 48, of ivory or the like, which is adapted to coöperate with a pair of contacts 49, fixed to a block 25^a, while sleeve 16 carries a pin 46, also of ivory or the like, that is adapted to coöperate with a pair of contact-fingers 47.

Pivoted at one end to frame 9 is an arm 54, and the other end of arm 54 is engaged by a cam-lug 55 on disk 17. This arm 54 serves as a locking-bolt, it being adapted at times and as hereinafter described to engage with a notch 56 on sleeve 16. Normally, however, arm 54 is held out of engagement with notch 56 by cam-lug 55. As will be obvious, if disk 17 is first angularly adjusted arm 54 will drop into notch 56 and lock arbor 12, so that it cannot be angularly adjusted until disk 17 is returned to normal position, but normally arbor 12 is not locked by arm 54 and is free to be angularly adjusted.

Coöperating with disk 17 is a pair of contacts 51, fixed to bar 25, one of which bears on the periphery of said disk and the other on the side thereof. Coöperating with disk 20 is a contact 52, also fixed to bar 25, and which bears on the periphery of disk 20.

Alongside of armature 35 is arranged a pair of contacts 53, adapted to be closed by said armature when the latter is moved in one direction and to spring apart when the armature is moved in the opposite direction.

Normally pin 18 and lug 19 stand directly opposite each other with the index 50 of disk 13 registering with the zero-mark of a circular row of number on that part of the outer face of frame 9 surrounding disk 13, Fig. 2. When the two arbors 11 and 12 occupy these normal positions, pin 46 holds contacts 47 closed, Fig. 7, pin 48 holds contact 49 open, Fig. 6, sleeve 16 is away from disk 17, with pin 18 in line with lug 19, Figs. 1 and 4, so that sleeve 16 is locked by pin 18 in this normal position so far as movement by armature 35 is concerned. Both contacts 51 are on the metal of disk 17, Fig. 9, contact 52 is on one of the insulation-blocks of disk 20, Fig. 10, pin 22, Fig. 10, is separated from contacts 23 a definite angular distance which differs at the different stations of the system. Therefore contacts 23 are normally closed, stud 28 holds contacts 30 closed, Fig. 11, stud 29 is separated from contacts 31 32 the same angular distance as pin 22 is separated from contacts 23, so that when pin 22 opens contacts 23 stud 29 closes the two pairs of contacts 31 32, Fig. 12, contacts 53 are open, and, lastly, as current is flowing through magnet 1 its armature is held depressed with spring 2^a under tension. This is the construction and normal condition of the mechanism provided at each of the stations of our improved system, which is shown diagrammatically in Fig. 1 of the drawings, wherein A represents one station of the system, and A′ another station.

The magnets 1 are arranged in series in a normally closed circuit, the main wire of which is the only essential line-wire of the system. It is used in part as part of the secondary telephone-circuit, which the operator at a "calling-station" establishes between his station and the "called station," as hereinafter described.

The normally closed circuit of magnets 1 is traced as follows, reference now being had to Fig. 1: Starting with wire *a* at the right of the station A or directly from the return C, as indicated by dotted lines, the current passes through wire *a* to contact 36, carried by armature 35, through contact 37, wire a', contacts 47, wire a^2, wire a^3 to contacts 23, from contacts 23 through wire a^4 to one end of the coil of magnet 1 of station A, from the other end of coil of magnet 1 of station A through the wire a, leading to the contact 36 of station A′. From contact 36 of station A′ the circuit continues, as at A, through contact 37, wire a', contacts 47, wires a^2 and a^3, contacts 23, wire a^4, magnet 1, and thence through the next wire a to the contact 36 of the next station to the left of station A′, and so on through all of the stations of the series in that direction. The last wire a leading from the last station to the left is connected, as indicated by dotted line, with the return C, which at its other end joins the wire a of the station at the opposite end of the series, thus completing the motor or magnet circuit. In this magnet-circuit is arranged a battery B, which supplies the power by which all of the mechanisms of the several stations are worked. Two other functions for this battery B are pointed out below. It will now be clear that if the magnet-circuit through battery B be opened and closed a definite number of times all of the armatures 2 and pallets 7 will be vibrated the same number of times and all of the arbors 11 will be turned in unison in the direction indicated by the arrows a corresponding number of steps, all of said arbors and parts carried thereby being thus moved the same angular distance.

As stated above, the studs 29 on the wheels 27 of the different stations are disposed on wheels 27 at different angular distances from their respective contacts 31, so that only the stud 29 at one station closes its contacts 31 32 at one time, the different studs 27 being so timed as to operate the different contacts 31 32 successively during one revolution of arbors 11.

Assuming for illustration that the station A′ is station No. 6 of the system, that the station at A is station No. 5, and that stations Nos. 4, 3, 2, and 1 are to the right of station No. 5 at A, then the completion of the first step movement of the arbors 11 causes the stud 29 of station No. 1 to reach and close its contacts 31 and 32. The completion of the second step movement of arbors 11 causes the stud 29 of station No. 1 to pass and open its contacts 31 and the stud 29 at station No. 2 to reach and close its contacts 31. The completion of the third step movement of the arbors 11 causes the stud 29 at station No. 2 to pass and open its contact 31 and the stud at station No. 3 to reach and close its contacts 31. Thus, as herein shown, the studs 29 at stations 1, 2, 3, 4, 5, and 6 are angularly distant one, two, three, four, five, and six steps, respectively, from their respective contacts 31. So it is obvious that by operating the circuit of the magnets 1 a number of times corresponding to the number of the station with which it is desired to communicate the operator at a calling-station can close the contacts 31 of any one of the other stations of the system he may select.

Each pair of contacts 31 is in that part of the secondary circuit of the telephone located at its respective station. That part of the secondary telephone-circuit of the station located at A is from one contact 31 through wire b to a condenser b', thence through wire b^2, secondary coil b^3, receiver R, and wire b^4, which joins the wire a at the right of station A and at one side of magnet 1 of said station. The other contact 31 is connected by a wire b^5 with a contact b^6, arranged above the receiver-hook H, which latter is lifted into contact with b^6 by its usual spring s when receiver R is removed. From hook H the circuit is continued through a wire b^7, which joins the wire a at the left of station A and at the opposite side of magnet 1.

As explained above, only the stud 29 of one station—*i. e.*, the called station—is moved the proper angular distance to close its contacts 31 and 32, so that all of the other pairs of contacts 31 and 32 of the system, including that pair at the calling-station, are open. For this reason it becomes necessary to provide some means by which the operator at the calling-station can close the secondary telephone-circuit at his own station which is open at the contacts 31 of his instrument. The secondary telephone-circuit at each station is provided with a normally open shunt around the contacts 31, made up of a wire b^8, connected at one end to wire b and at its other end to one of the contacts 53, and a wire b^9, connected at one end to the other contact 53 and at its other end with wire b^5. Only the operator at the calling-station closes this shunt, and he does this by closing the contacts 53 when he calls up any of the other stations. When contacts 53 are thus closed, the secondary telephone-circuit traced in part as above is continued from wire b^7 of station A through wire a to station A′, through wire b^4 of station A′, receiver R, wire b^2, and secondary coil b^2, condenser b', wires b and b^8, contacts 53, wires b^9 and b^5, contact b^6 to hook H′, and thence through wire b^7 to the wire a leading to the station to the left of station A′, if there be one. The station to the left of station A′ is constructed and wired the same as stations A and A′, so that at this station to the left of station A′ the secondary circuit, which has been traced as far as the wire a at the left of station A′, continues through wire a to the contact 36 of the next station, contact 37, wire a', contacts 47, wires a^2 and a^3, contacts 23, wire a^4, magnet 1, and thence, if that station be the last of the series in that direction, to return-wire C and back to the wire a at the right of station A.

Each station A A′, &c., is provided with a local primary telephone-circuit in which is arranged the transmitter T. Each transmitter is connected by a wire c with the primary coil c', and coil c' is connected by a wire c^2 with one pole of a battery c^3. The other pole of battery c^3 is connected, through a wire c^4 and part of the wire b^7, with the receiver-hook. Above the receiver-hook is arranged a contact c^5, onto which the receiver-hook strikes when the operator removes the receiver and the hook is lifted by its spring s. This contact c^5 is connected with the other binding-post of the transmitter, so that when hook H is up the primary telephone-circuit is complete.

From the construction as so far described it will be seen that an operator at any station can operate the series of magnets 1, and thereby open the contacts 30 of all of the stations, close the contacts 31 and 32 of the called station, and open contacts 23 of the called station. By means of the shunt made up of wires b^8 and b^9 he can also close a second normal break in that part of the secondary at his own station which is at contacts 53 of his own station.

The reason for providing the contacts 23 and for causing stud 22 to open said contacts when contacts 31 are closed is to prevent a short-circuit in the secondary telephone-circuit at the called instrument. If contacts 23 were not provided and arranged to be opened when contacts 31 were closed, then the secondary telephone-circuit at the called station would be a local short-circuit from receiver R through coil b^3, wire b^2, condenser b', wire b, contacts 31, wire b^5, contact b^6, hook H, wire b^7, wire a, magnet 1, wire a^4, contacts 23, wires a^3 and a^2, contacts 47, wire a', contacts 37 and 36, wire a, and thence through wire b^4 back to receiver R.

It will now be seen that when the two operators at the calling and called stations remove their receivers R R' from the hooks H H' each not only closes its respective primary telephone-circuit by permitting the spring s to lift the receiver-hook into contact with c^5, but also closes one of three normal breaks in any complete secondary circuit of the system through the receiver-hook which contacts with b^6. The other two normal breaks at 31 of the called station and at 53 of the calling-station, respectively, are closed by an act on the part of the operator of the latter.

After the operator at the calling-station A' has established communication with the called station A by establishing the circuits above described and before the receiver is removed from its hook at the called station it is necessary that the operator at A', the calling-station, signal the operator at A by ringing the bell d at A. Remembering that at this juncture hook H is down and hook H' up, it will be observed that the latter hook will be closed upon a contact d', connected by a wire d^2 and a resistance $d^\times$ in circuit with the wire b^4, which is now part of the secondary telephone-circuit connecting A' and A. In this wire d^2 is a normally open switch d^3, which may be controlled by an ordinary push-button. It will also be observed that hook H being down is also closed upon a contact d^4, connected by a wire d^5 with one end of the coil of a relay-magnet d^6. The other end of the coil of magnet d^6 is connected by a wire d^7 with one of the contacts 32, which open and close in unison with contacts 31, and therefore at this juncture are closed. The other contact 32 is connected by a wire d^8 with the wire b^4 of station A, the called station, and therefore it follows that when the operator at the calling-station A' closes switch d^3 magnet d^6 at the called station A is put in circuit with battery B and attracts its armature d^9.

The object of the resistance provided in the wire d^2 is to reduce the strength of current flowing therethrough, so that all of the magnets 1 which are in circuit will not be worked when the switch d^3 is closed at the calling-station. The bell-operating relay is of finer adjustment than the motors 1 2, and the bell-operating relay at the calling-station is in shunt with the magnet 1 of that station, and therefore will receive only enough current to operate its armature, the balance of the current passing through the magnet 1.

Armature d^9 carries a bridge-piece d^{10}, and when magnet d^6 attracts its armature bridge-piece d^{10} connects two terminals d^{11}. One of the terminals d^{11} is connected by a wire d^{12} with wire c^4 at one side of battery c^3, and the other terminal d^{11} is connected by a wire d^{13} with one binding-post of bell d, and the other binding-post is connected by a wire d^{14} with the wire c^2 at the other side of battery c^3. When the terminals d^{11} are connected as above described, a local circuit is closed through bell d of station A and maintained as long as the operator at the calling-station A' holds switch d^3 closed. This local circuit is made up of wires c^{12}, c^4, battery c^3, wires c^2 and d^{14}, bell d, wire d^{13}, terminals d^{11}, and bridge-piece d^{10}.

In responding to the call of station A' the operator at A removes his receiver R and spring s, lifts hook A and closes it onto contacts d', b^6, and c^5, and at the same time the circuit through magnet d^6 is broken at d^4. The contact of hook H with c^5 closes the primary telephone-circuit through battery c^3. The contact of hook H with b^6 closes the third and last break in the complete secondary circuit, which at the called station A is through contacts 31 and at the calling-station is through contacts 53. The contact of hook H with d' is an idle connection at the called station because switch d^3 is open.

After use of the system by the two connected stations the operators at the stations replace their receivers on hooks H and H', and the circuit of magnets 1 is again operated a number of times sufficient to return all of the wheels 27 to normal position.

In order that the operator at the calling-station may conveniently operate and control the circuit of the magnets 1 with the minimum amount of attention and labor on his part we employ the construction which we will now proceed to describe.

At each station wire a^3 connects with the contact 51, which engages the side of commutator-disk 17. The other contact 51 engages the periphery of commutator-disk 17 and is connected by a wire e with the wire a', leading to contact 37, so that normally the current through wire a^3 divides, part passing through wire a^2 and part through contacts 51, commutator-disk 17, and wire e. One reason for thus dividing the current is so that when the operator at the calling-station grips thumb-piece 45 and rotates arbor 12 in order to angularly adjust stop-lug 19 with relation to stop-pin 18 and contacts 47 are opened the mechanism of his station will not start in operation, because the circuit through magnets 1 is closed through the commutator-disk 17 of his station. Another reason for having this circuit through commutator 17 normally is to use it for returning the mechanisms of the several stations to normal positions, presently to be described.

A third circuit is provided for the magnet-circuit from wire a^3 to contact 36, which is normally open, and that is through a wire f connected with frame 9, commutator-disk 20, contact 52, and a wire f' to the contact 39.

It will now be seen that when contact 36 is closed onto contact 37 the circuit for magnets 1 is through commutator-disk 17 and the circuit through commutator-disk 20 is open, while if contact 36 be shifted from contact 37 to contact 39 the circuit is opened through commutator-disk 17 and the circuit through commutator-disk 20 is closed at 36 39.

The shifting of the contact 36 from contact 37 to contact 39 is the first act performed by the operator at the calling-station after he has angularly adjusted the disk 13 and arbor 12, Figs. 2 to 4, by hand, so that the arrow 50 points to the number of the station with which he desires to communicate, and when contact 36 is thus shifted the circuit through disk 20 is closed, the circuit through disk 17 is opened, and sleeve 16 is shifted endwise toward disk 17, so as to bring its lug 19 into the path of pin 17. Opening this circuit through disk 17 and closing it through disk 20 when contact 36 is thus shifted causes the springs 2^a each to swing its armature to the limit of its movement away from its magnet 1. This movement of the armatures 2 causes each to act through its link 6, pallet 7, and wheel 8 and move its arbor 11 to the extent of half a step, thus bringing the metal of disk 20 at the calling-station under contact 52, which restores the circuit through magnets 1. When the circuit through magnets 1 is thus restored, each attracts its armature, and acting through its link 6, pallet 7, and wheel 8 moves its arbor 11 another half-step, thereby completing a full step. Upon the completion of this second half-step another block of insulation on disk 20 is brought under contact 52, whereupon the circuit through magnets 1 is again broken and springs 2^a swing armatures 2 away from said magnets, causing the arbors 11 to make a third half-step, again bringing the metal of disk 20 opposite contact 52. In this manner armatures 2 continue to be vibrated and arbors 11 to rotate until pin 18 on disk 17 at the calling-station engages lug 19, when further movement of all of the arbors 11 is arrested because the operation of all of the magnets 1 is controlled at this stage by the disk 20 of the calling-station, so that when disk 20 on arbor 11 at the calling-station is stopped by its lug 19 the operation of all the other arbors 11 also ceases, because when pin 18 is stopped by lug 19 disk 20 is stopped with one of its blocks of insulation opposite contact 52. In this way lug 19 is caused to serve as a positive stop for pin 18 when arbors 11 are set in motion, as above described, and when the pin 18 at the calling-station reaches and strikes lug 19.

When the pin 18 is stopped by the lug 19, the stud 29 at the called station (indicated by the number opposite the arrow 50 at the calling-station) has traveled an angular distance sufficient to bring it into position to close its contacts 31, while the studs 29 of all the rest of the stations have either not reached their contacts 31 or have passed them.

As shown in Fig. 4, sleeve 16 is splined to arbor 12 and is shipped endwise on said arbor toward disk 17 by armature 35 and by the operator at the calling-station after he has adjusted arbor 12 angularly by means of thumb-piece 45 to select the station with which he desires to communicate. It will therefore be seen that when sleeve 16 is thus shipped toward disk 17 bell-crank 44, which serves as a locking-bolt for disk 13, is swung at the same time into one of the spaces between two of the teeth of rack 14 on the inner side of disk 13.

When the rotation of the arbor 11 at the calling-station is arrested by pin 18 striking lug 19, not only has the stud 29 at the called station been moved into position to close its contacts 31, but the stud 22 on disk 20 of the called station has also been moved into position to open its contacts 23. These contacts 23, as above described, are in the circuit of magnets 1, so that as each pair is successively opened the circuit of magnets 1 would be successively opened, except that at each station a wire g is provided, which is connected at one end with wire a^3 and at its other end with one of a pair of contacts g', normally connected by a bridge-piece carried by but insulated from the receiver-hook. The other contact g' is connected by a wire g^2 with wire a^4, so that when the contacts 23 are opened the circuit of magnets 1 is wholly through wire g, the contacts g' and their bridge-piece, and the wire g^2, while at other times it is divided, part traversing the wires just mentioned and part passing through contacts 23.

When the operator at the called station has responded to the signal of his bell d and removed his receiver R and the receiver-hook of his instrument is raised by its spring, the bridge-piece carried by said hook is separated from contacts g', and inasmuch as the main circuit of magnets 1 is broken at 23 at the called station this break at g' in the shunt around contacts 23 opens the circuit of magnets 1, so that magnets 1 cannot be operated and the two connected stations cannot be disturbed by any of the others.

Herein we have provided at each station means to automatically operate the armature 35 thereof, and to this end we make use of the receiver-hook, the battery c^3, and the two magnets 41 and 42. Connected with the wire d^{14}, which in turn is connected through wire c^2 with battery c^3, is a wire h, and this wire h at its other end is connected with one end of the coil of each of the magnets 41 and 42. The other end of the coil of magnet 41 is connected by a wire h' with one of the contacts 30, and the other contact 30 is connected by a wire h^2 with the wire c^6, leading to contact c^5. The corresponding end of the coil of magnet 42 is connected by a wire h^3 with one of the contacts 49, and the other contact 49 is connected by a wire h^4 with a contact h^5, against which the receiver-hook normally rests.

Normally the circuit of magnet 42 is open at 49 and although its circuit is made at 49 at the calling-station when the operator adjusts arbor 12 to select the station to be called, because sleeve 15 and stud 48 are adjusted with arbor 11, yet this make at 49 is an idle one, because armature 35 is then nearest magnet 42, and, moreover, this make is only temporary at this time, because as soon as the operator at the calling-station removes his receiver the receiver-hook leaves contact h^5 and the circuit of magnet 42 is opened at that point.

As stated above, the first action of the operator at the calling-station after having adjusted the arbor 11 of his instrument is to remove his receiver to use. This act on his part causes the receiver-hook to be raised by its spring onto contact c^5, which not only closes the primary telephone-circuit of his station, but also the circuit of battery c^3, through magnet 41, which attracts armature 35 and shifts contact 36 from contact 37 to contact 39 and bell-crank 44 into engagement with rack 14. At the same time contacts 53 in that part of the secondary telephone-circuit at the calling-station are closed. The shifting of contact 36 to contact 39 causes the arbors 11 of all the stations to start in motion, as above described, and to continue so until pin 18 on disk 17 of the calling-station strikes lug 19 on sleeve 16, which latter was shifted toward disk 17 by the movement imparted to armature 35 by magnet 41. The first part of the movement of the arbor 11 at the calling-station carries stud 28 away from the contacts 30, which spring apart, thus opening the circuit of battery c^3 through magnet 41 as soon as the latter has done its work. The same movement will occur at all the stations, thus preventing any of the other stations from calling into the line.

When the operator at the calling-station replaces his receiver on its hook after using the system, the hook is depressed onto contact h^5, so that the circuit of battery c^3 is closed through magnet 42, sleeve 15 being then out of normal angular position and contacts 49 sprung together and closed. When the circuit of battery c^3 is thus closed through magnet 42, armature 35 is attracted by it, and contact 36 is shifted from contact 39 back to contact 37, while at the same time bell-crank lever 44 is freed from rack 14. Sleeve 16 is not shipped away from disk 17 by this return movement of armature 35, because the normal position of cam-lug 16^a is alongside of the end of armature 35, and at this time—that is, upon the occasion of the return of armature 35 to its normal position—sleeve 16 is out of normal angular position, and lug 16^a is therefore not alongside of the end of said armature. However, this return movement of armature 35 operates bell-crank 44 and frees arbor 12, and by shifting contact 36 over to contact 37 transfers the circuit of magnets 1 from disk 20 to commutator-disk 17, which causes magnets 1 to each resume the rotation of arbor 11 in the same direction it was traveling when stopped by the pin 18 at the calling-station engaging stop-lug 19, providing that the operator at the called station has replaced his receiver on his hook. If he has not done so, the circuit of magnets 1 is broken at g' at his station. If the operator at the calling-station is the first to replace his receiver, then the arbors 11 will be delayed in resuming their rotation back to normal position until the operator at the called station replaces his receiver on its hook. When the rotation of the arbor 11 at the calling-station is thus resumed with the others, the lug 19 at that station is still in the path of its pin 18, and the latter in turning with its arbor 11 carries lug 19, sleeve 16, arbor 11, and parts carried thereby with it. As the sleeve 16 nears its normal position cam-lug 16^a engages the side of the end of armature 35 and ships sleeve 16 endwise on arbor 12 away from disk 17, carrying lug 19 out of the path of pin 18. At almost the same time contacts 47 are closed and 49 opened by the pin 48, carried by sleeve 15, and commutator-disk 17 is then rendered inoperative and the operation of the magnets 1 ceases, owing to the permanent closure, so to speak, made at 47, which shunts the magnet-circuit around disk 17 when contact 51 is on the insulation of disk 17 of the calling-station, so that springs 2^a cannot pull armatures 2 from their magnets 1 and turn arbors 11.

What we claim is—

1. In a telephone system in combination, a plurality of stations; a main line common to

all of said stations; a telephone instrument at each station having the ends of its secondary joined to the main line; a number of switch-controlling motors in the main line, one at each station between the ends of the secondary thereof; a normally closed switch at each station arranged in the main line between the ends of the secondary; a normally open switch in each secondary; a condenser in each secondary, and means to enable the operator at any one of said stations to operate the motors to close the normally open switch of any one of the other stations and open the normally closed switch of that station, and to close the secondary circuit of his own station.

2. A telephone system comprising two or more stations; a main battery-circuit; an electric switch-operating motor at each station; a telephone at each station; a secondary circuit for each telephone, each having its ends connected with the main battery-circuit; a normally open switch in each secondary controlled by the motor of its respective station; a condenser in each secondary; and a normally closed switch in the main battery-circuit at each station arranged between the ends of the secondary and controlled by said motor.

3. A telephone system comprising two or more stations; a main battery-circuit common to all of the stations; a telephone at each station; a secondary circuit for each telephone each having its ends connected with the main battery-circuit; a normally open switch in each secondary circuit; a condenser in each secondary circuit; a normally closed switch in the main battery-circuit arranged between the ends of each of the secondary circuits; a number of motors in said main battery-circuit for operating said switches one motor for each station, and means at each station for operating the main battery-circuit to cause the motor of either one of the other stations to close its normally open switch and open its normally closed switch.

4. A telephone system comprising two or more stations; a main battery-circuit common to all of the stations; a telephone at each station; a secondary circuit for each telephone, each having its ends connected with the main battery-circuit; a normally open switch in each secondary circuit; a condenser in each secondary circuit; a normally closed switch in the main battery-circuit arranged between the ends of each of the secondary circuits; a number of magnets in series in said main battery-circuit, one for each station, for operating said switches; and means at each station for operating the main battery-circuit to cause the magnet of either one of the other stations to close its normally open switch and open its normally closed switch.

5. In a telephone system in combination, a main battery-circuit, a number of electric switch-operating motors in said circuit, one for each station of the system; a telephone at each station; a secondary circuit for each telephone each having one of its ends connected with the main battery-circuit at each side of the motor of its respective station; a condenser in each telephone-circuit; a normally open switch in each secondary telephone-circuit; a normally closed switch arranged in the main battery-circuit between the ends of each of the secondary circuits; and means at each station for operating the main battery-circuit so as to cause the motor of either one of the other stations to close the normally open switch and to open the normally closed switch of that station.

6. In a telephone system two or more stations; a main battery-circuit common to all the stations; a telephone at each station; a secondary circuit for each telephone each having its ends connected to the main battery-circuit; a normally open switch in each secondary circuit; a condenser in each secondary circuit; a number of normally closed switches in the main battery-circuit each arranged between the ends of one of the secondary circuits; a shunt in the main battery-circuit at each station extending around the normally closed switch thereof; a normally closed switch in each shunt controlled by the receiver-hook of its respective station; a number of motors in said main battery-circuit for operating the two first-mentioned switches, one for each station; and means at each station for operating the main battery-circuit to cause the motor of either one of the other stations to close its normally open switch and open its normally closed switch.

7. A telephone system comprising two or more stations; a main battery-circuit common to all of the stations; a telephone at each station; a secondary circuit for each telephone, each having its ends connected to the main circuit; a normally open switch in each secondary circuit; a condenser in each secondary circuit; a shunt in each secondary circuit around the normally open switch thereof; a normally open switch in each shunt controlled by the receiver-hook of its respective station; a number of normally closed switches in the main battery-circuit each arranged between the ends of one of the secondary circuits; a number of motors in the main battery-circuit, one for each station, and each arranged to operate the normally open switch in the secondary and the normally closed switch in the main battery-circuit at its respective station; and means at each station for operating the main battery-circuit to cause the motor of either one of the other stations to close its normally open switch and open its normally closed switch.

8. A telephone system comprising two or more stations; a main battery-circuit common to all of the stations; a telephone at each station; a secondary circuit for each telephone, each having its ends connected with the main battery-circuit; a normally open switch in

each secondary circuit; a condenser in each secondary circuit; a number of normally closed switches in the main battery-circuit each arranged between the ends of one of the secondary circuits; a number of switch-operating motors in the main battery-circuit, one for each station; means at each station for operating the main battery-circuit to cause the motor of either one of the other stations to close its normally open switch and open its normally closed switch; a signal-circuit at the called station; a signal in the signal-circuit; a relay for operating the signal-circuit; a relay-circuit at the called station connected at its ends with the secondary circuit of the telephone of that station and adapted to be opened by the operator at the called station in response to the operation of the signal at his station; a shunt at the calling station connected at its ends with the secondary circuit of that station at each side of the normally open switch of the secondary circuit of said calling-station, and a normally open switch in said shunt adapted to be closed by the operator.

9. A telephone system comprising secondary telephone-circuits; a normally open switch in each secondary telephone-circuit; a main battery-circuit; a series of electric motors in the main battery-circuit each arranged to operate one of the normally open switches of the secondary telephone-circuits, and means at each station and controlled by the operator thereof for automatically operating the main battery-circuit to cause the motor of either one of the other stations to operate its normally open switch.

10. In combination, a magnet; an armature operated by the magnet; an arbor; connections between the arbor and the armature; a pair of commutator-wheels on said arbor, one adapted to control the initial movement of the arbor and the other to control the return of the arbor to its normal position; contacts coöperating with the commutator-wheels, and electrical connections between said contacts and said magnet.

11. In combination, a magnet; an armature operated by the magnet; an arbor; connections between the arbor and the armature; a pair of commutator-wheels on said arbor one adapted to control the initial movement of the arbor and the other to control the return of the arbor to its normal position; contacts coöperating with the commutator-wheel; electrical connections between said contacts and said magnet; and adjustable stopping means for limiting the initial movement of the arbor.

12. In combination, a magnet; an armature operated by the magnet; an arbor; connections between the arbor and the armature; a pair of commutator-wheels on said arbor, one adapted to control the initial movement of the arbor and the other to control the return of the arbor to its normal position; contacts coöperating with the commutator-wheels; electrical connections between said contacts and said magnet; adjustable stopping means for limiting the initial movement of the arbor; a switch for controlling the circuits through the contacts and commutator-wheels; and connections between said switch and the adjustable stopping means for operating said switch when the stopping means is operated.

13. In combination, a magnet; an armature operated by the magnet; an arbor; connections between the arbor and the armature; a pair of commutator-wheels on said arbor, one adapted to control the initial movement of the arbor and the other to control the return of the arbor to its normal position; contacts coöperating with the commutator-wheels, electrical connections between said contacts and said magnet; adjustable stopping means for limiting the initial movement of the arbor; a switch for controlling the circuits through the contacts and commutator-wheels; connections between said switch and the adjustable stopping means for operating said switch in one direction when the stopping means is moved into operative position, and adapted to permit the switch to be moved in the opposite direction independently of the stopping means; and automatic means for returning the stopping means to normal position when the arbor is returned to its normal position.

14. In combination, a magnet; an armature operated by the magnet; an arbor; connections between the arbor and the armature; a pair of commutator-wheels on said arbor, one adapted to control the initial movement of the arbor and the other to control the return of the arbor to its normal position; contacts coöperating with the commutator-wheels; electrical connections between said contacts and said magnet; angularly-adjustable stopping means movable into and out of operative position for limiting the initial movement of the arbor; a switch for controlling the circuits through the contacts and commutator-wheels; connections between said switch and the adjustable stopping means for operating said switch in one direction when said stopping means is moved into operative position and adapted to permit the switch to be moved in the opposite direction independently of the stopping means; means to automatically lock the stopping means against angular movement when the latter is in operative position, and automatic means for unlocking the stopping means when the switch is moved independently in the opposite direction, and for returning the stopping means to normal inoperative position when the arbor is returned to its normal position.

15. In combination, a magnet; an armature operated by the magnet; an arbor; connections between the arbor and the armature; a pair of commutator-wheels on said arbor one adapted to control the initial movement of the arbor and the other to control the return of

the arbor to its normal position; contacts coöperating with the commutator-wheels; electrical connections between said contacts and said magnet; adjustable stopping means for limiting the initial movement of the arbor; and means for automatically locking the adjustable stopping means in normal position when the arbor is moved before the stopping means is adjusted.

16. In a telephone system, the combination with a switch-operating motor, and an armature for controlling the action of said motor, of a magnet arranged to move the armature in one direction to start the motor upon its initial movement; a circuit for said magnet; a normally open switch in said circuit adapted to be closed by the operator, and a normally closed switch in said circuit operated by the said motor and arranged to be opened by the motor when the latter is started upon its initial movement.

17. In a telephone system, the combination with a switch-operating motor, and an armature for controlling the action of said motor, of a magnet arranged to move the armature in one direction to start the motor upon its initial movement; a circuit for said magnet; a normally open switch in said circuit controlled by the receiver-hook of the telephone and adapted to be closed when the receiver is moved from its hook; said hook; and a normally closed switch in said circuit operated by said motor and arranged to be opened by the motor when the latter is started upon its initial movement.

18. In a telephone system, the combination with a switch-operating motor and an armature for controlling the action of said motor, of adjustable stopping means for regulating the operation of said motor operated by said armature when the latter is moved from its normal position in one direction; a magnet for returning the armature to normal position; a circuit for said magnet; a normally closed switch in said circuit controlled by the receiver-hook of a telephone, and arranged to be opened when the receiver is moved from its hook; and a normally open switch in said circuit which is operated by the stopping means and arranged to be closed when the latter is adjusted by the operator.

Signed by us at Boston, Massachusetts, this 21st day of April, 1903.

THOMAS W. GLEESON.
ROBERT HAMILTON.

Witnesses:
ROBERT CUSHMAN,
ARTHUR F. RANDALL.