

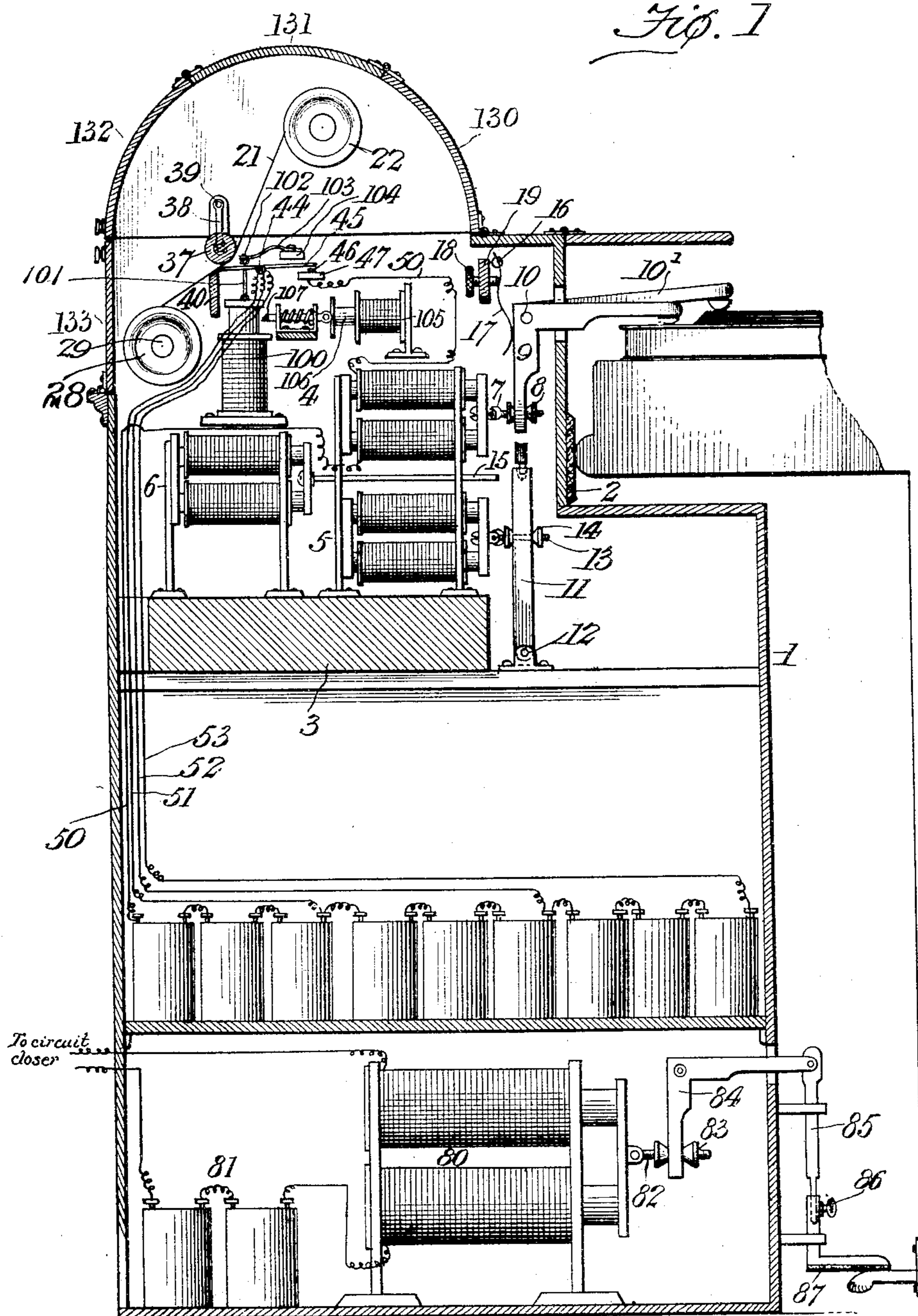
No. 808,774.

PATENTED JAN. 2, 1906.

H. McPHAILL.
PIANO PLAYING ATTACHMENT.

APPLICATION FILED APR. 18, 1903.

7 SHEETS—SHEET 1.



Witnesses
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John E. Carter

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7 SHEETS—SHEET 2.

Fig. 3.

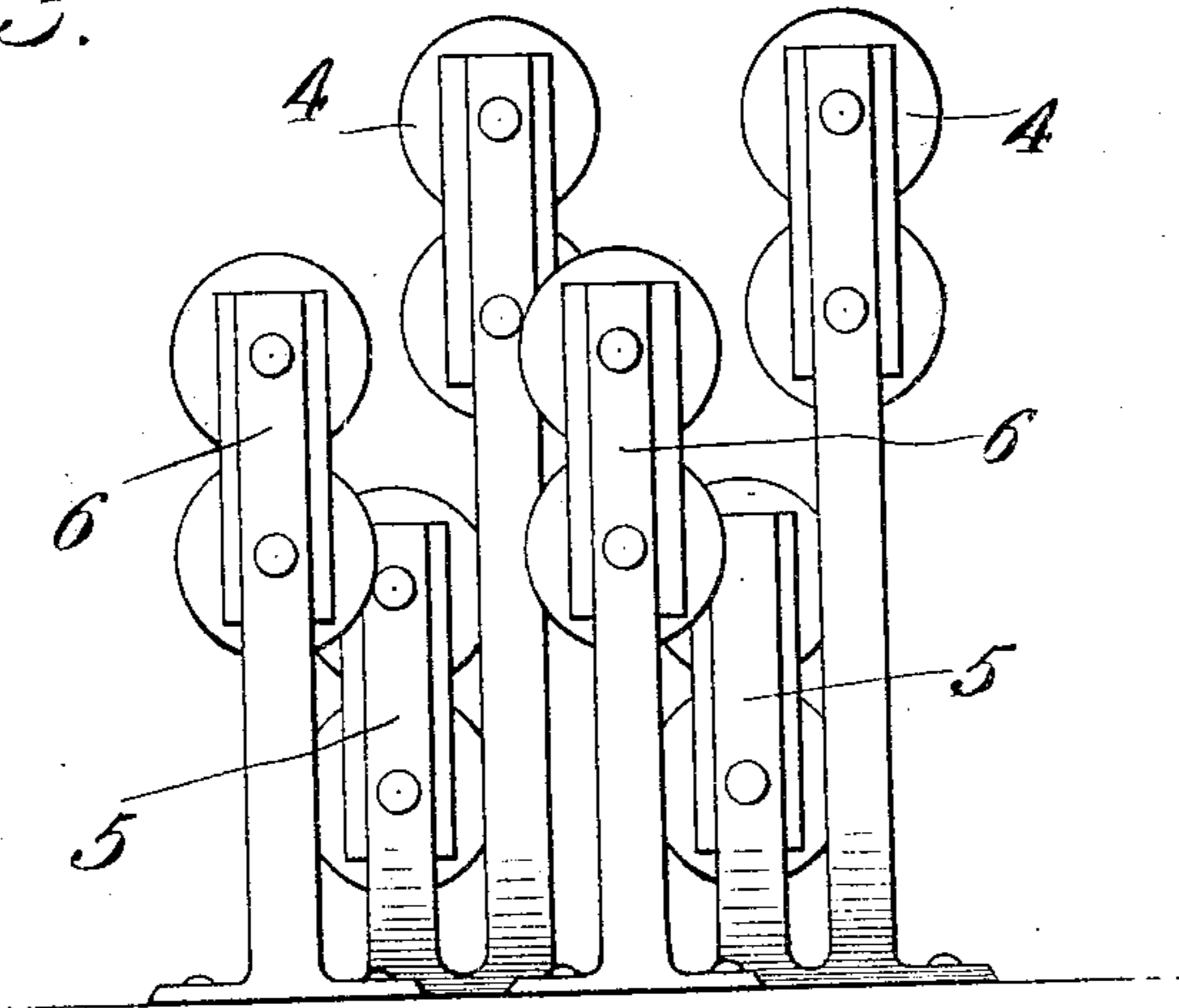


Fig. 13.

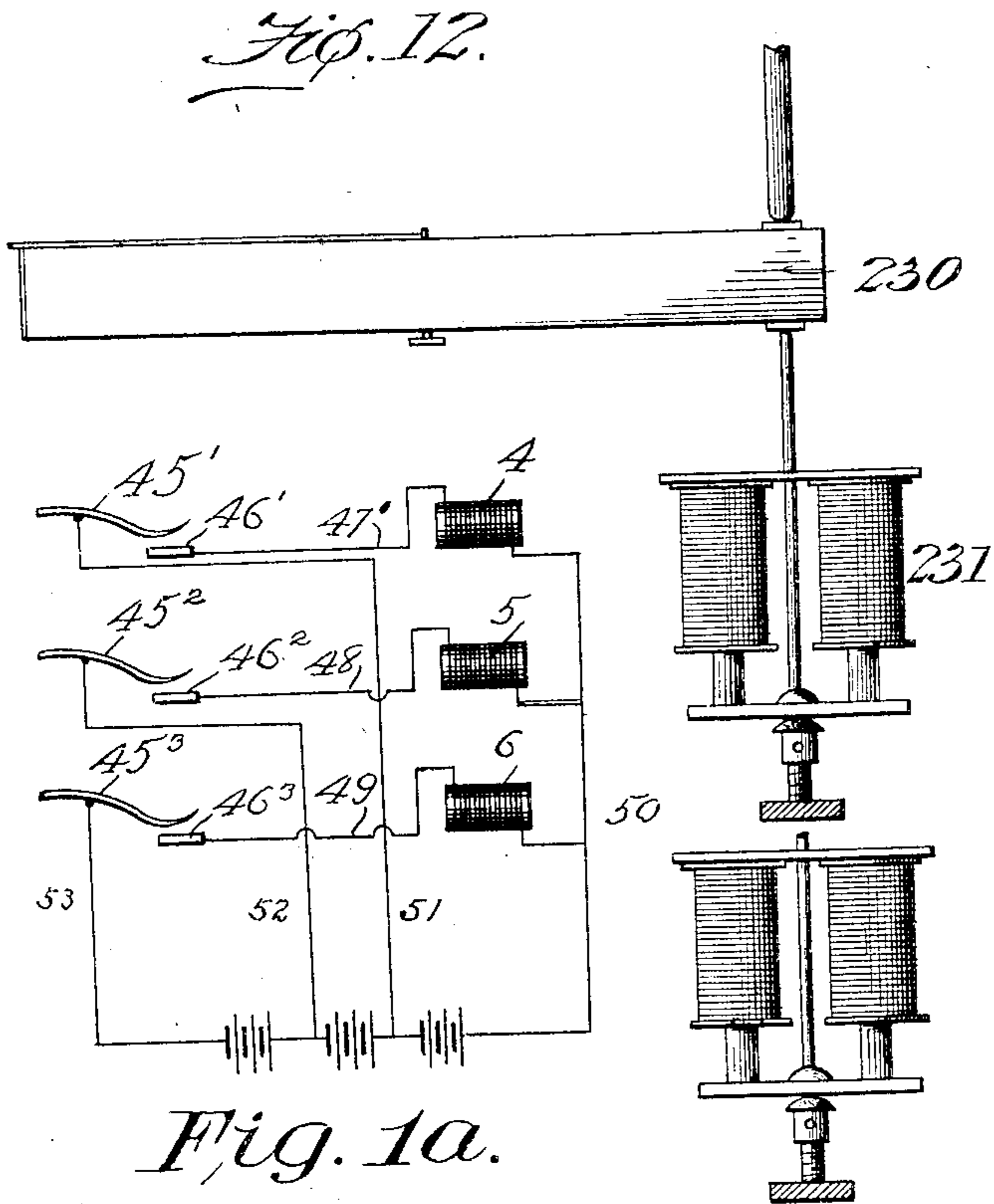


Fig. 1a.

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7 SHEETS—SHEET 4.

Fig. 4.

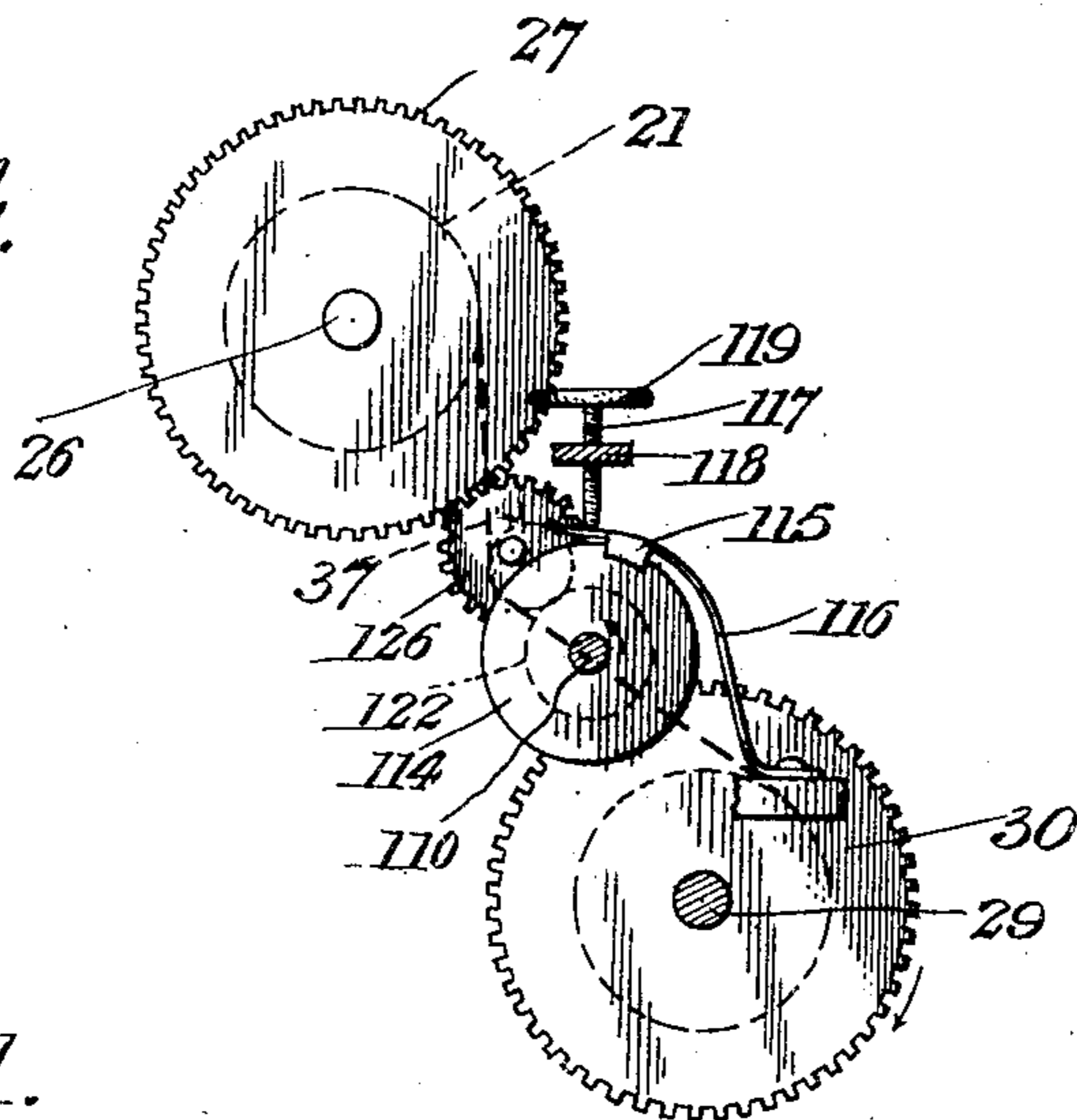


Fig. 11.

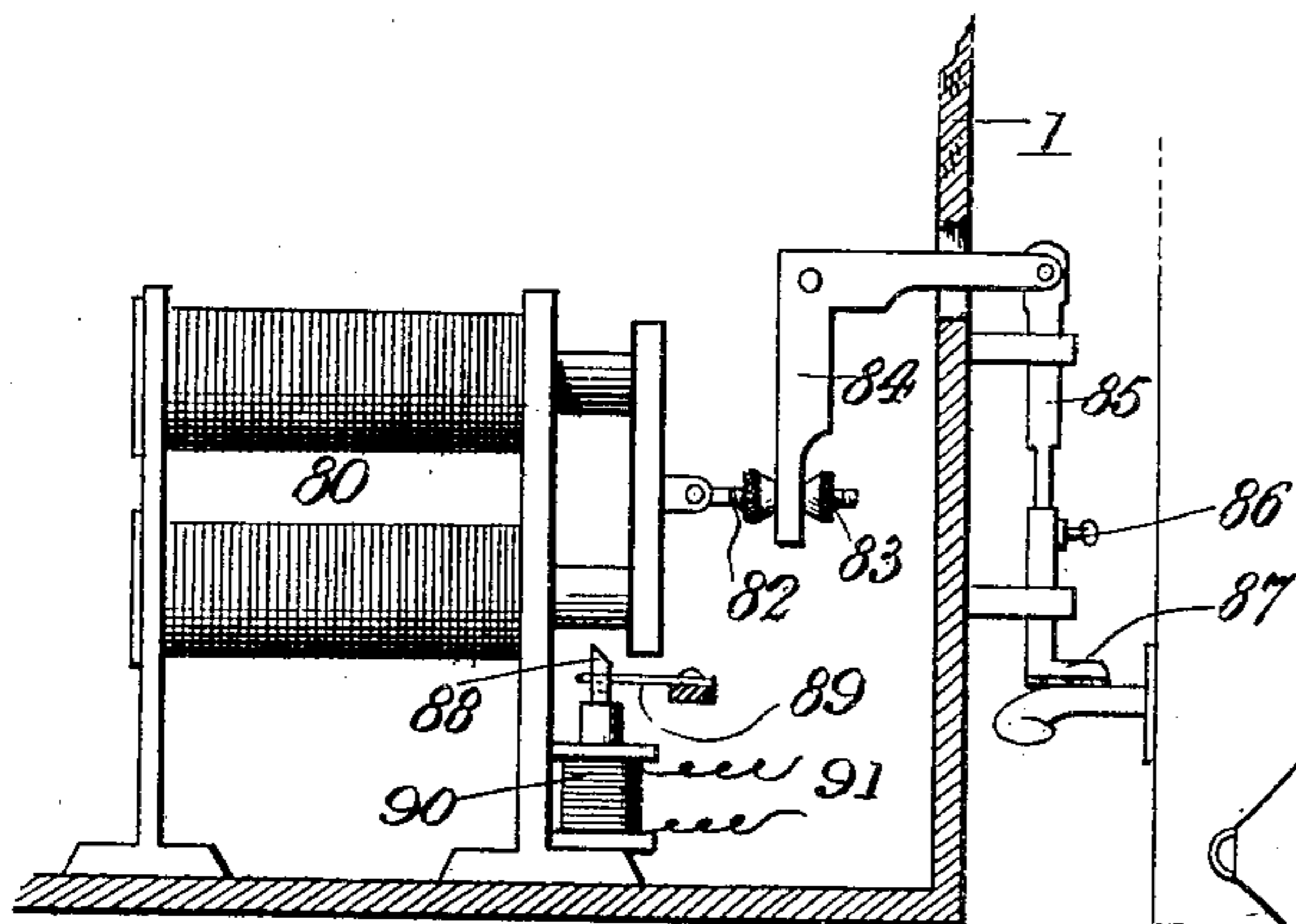


Fig. 6.

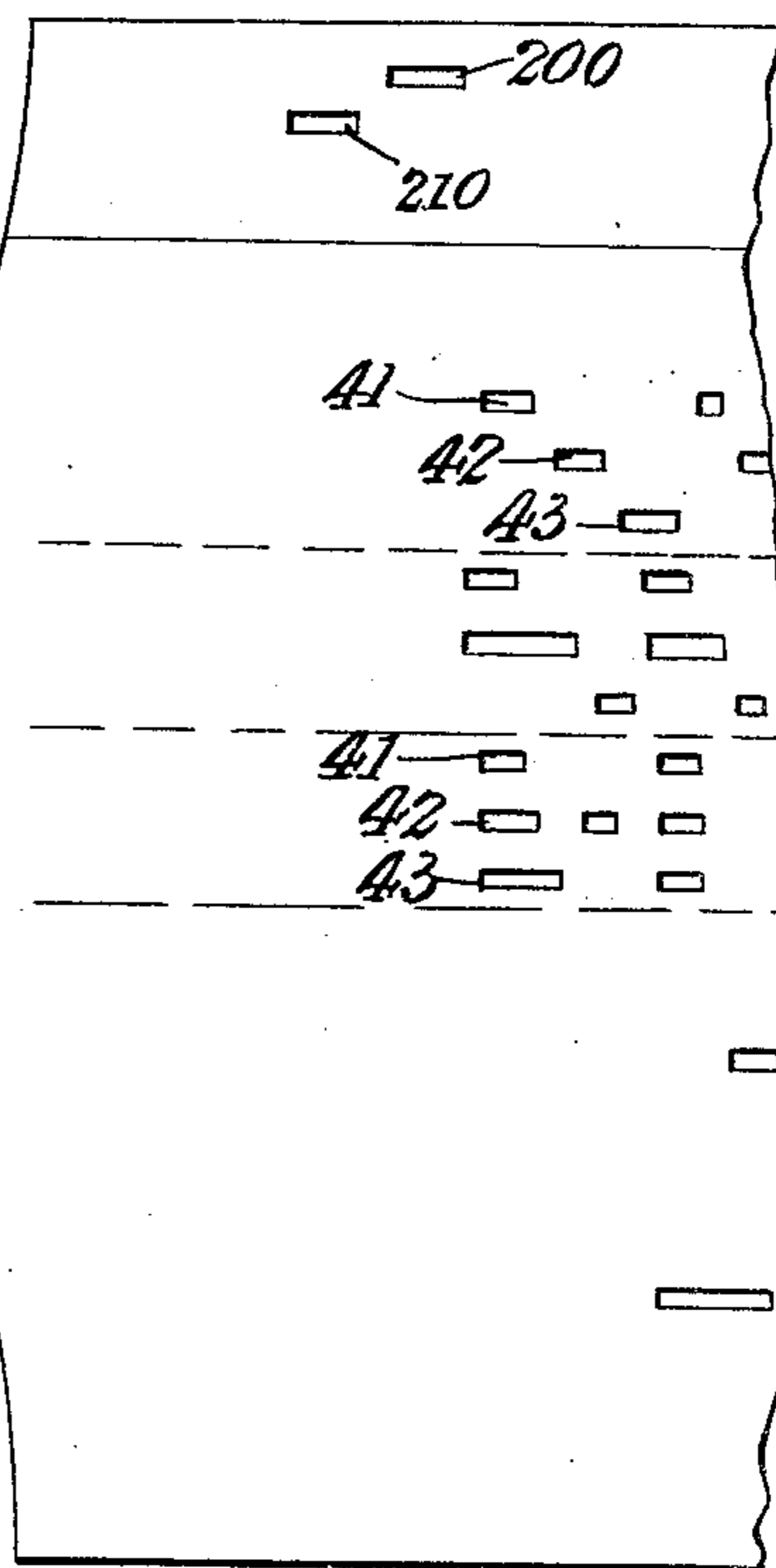
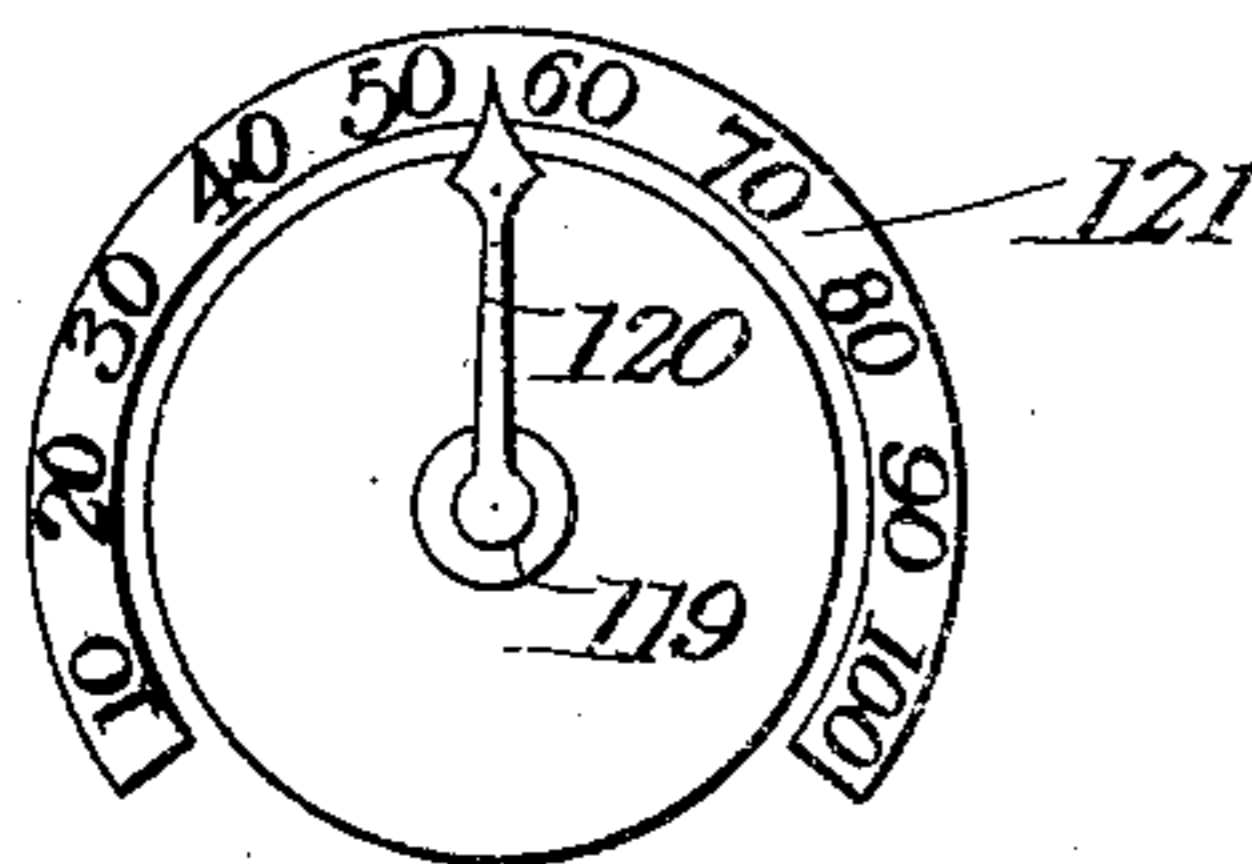


Fig. 7.



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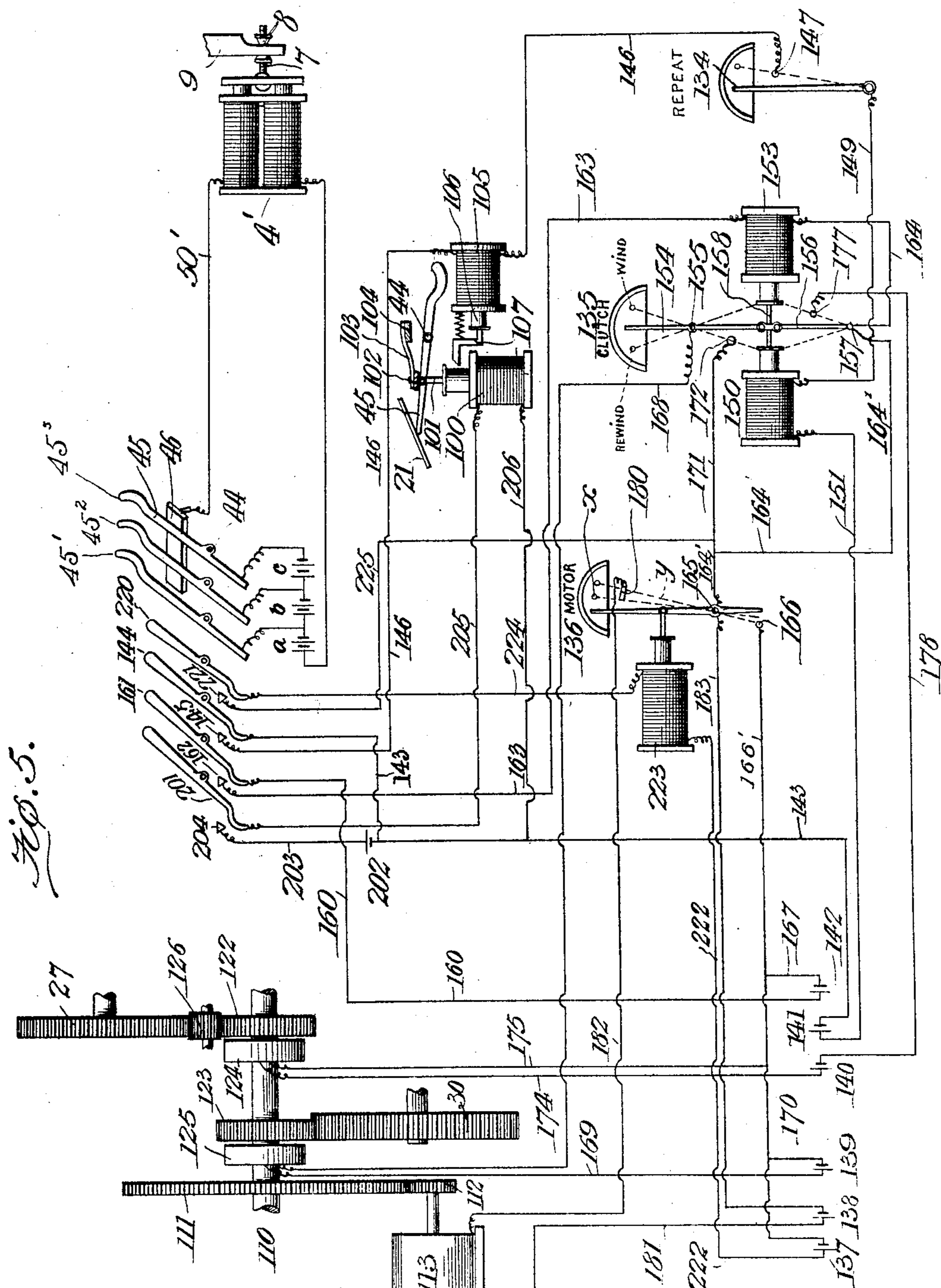
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7 SHEETS—SHEET 5.



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7 SHEETS—SHEET 6.

Fig. 8.

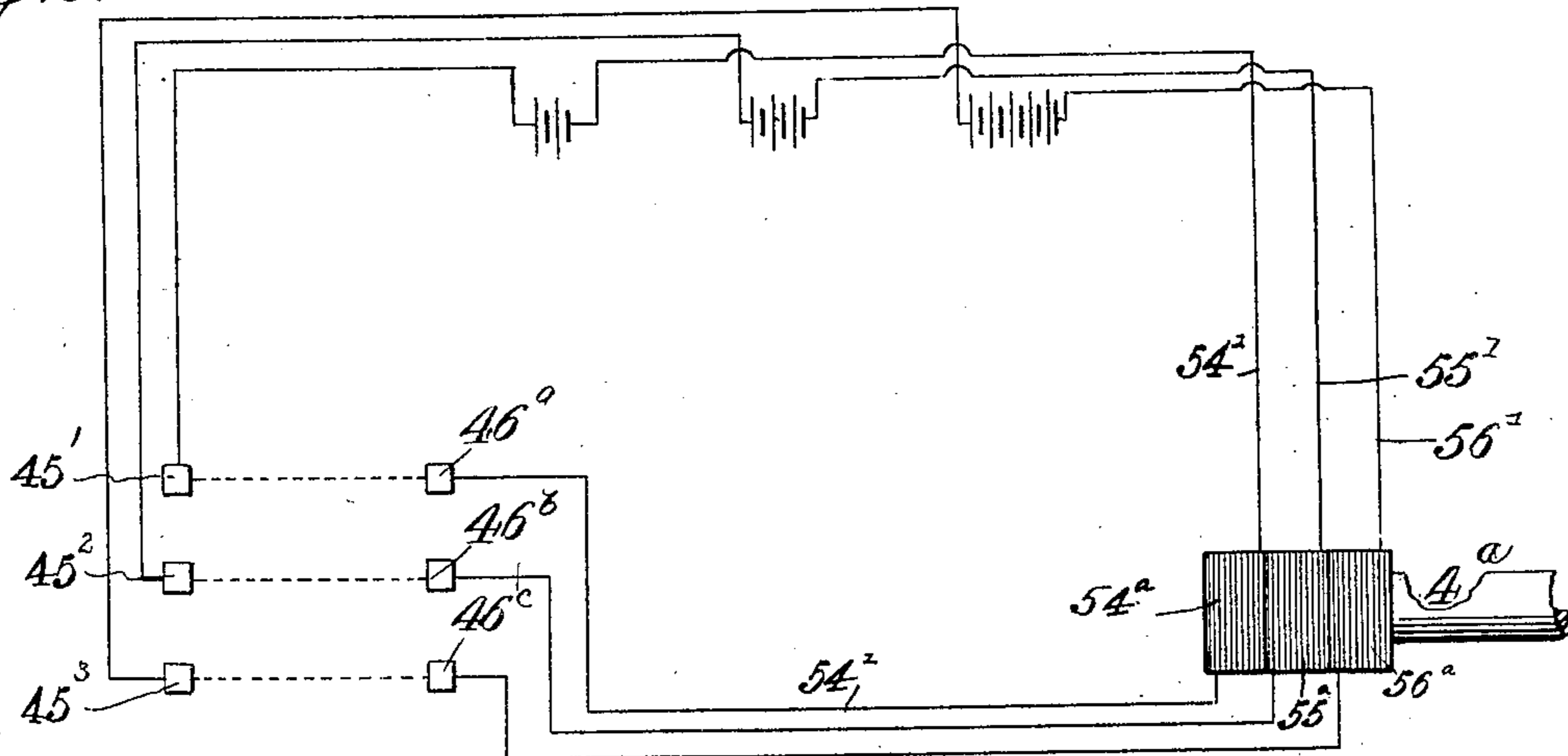


Fig. 9.

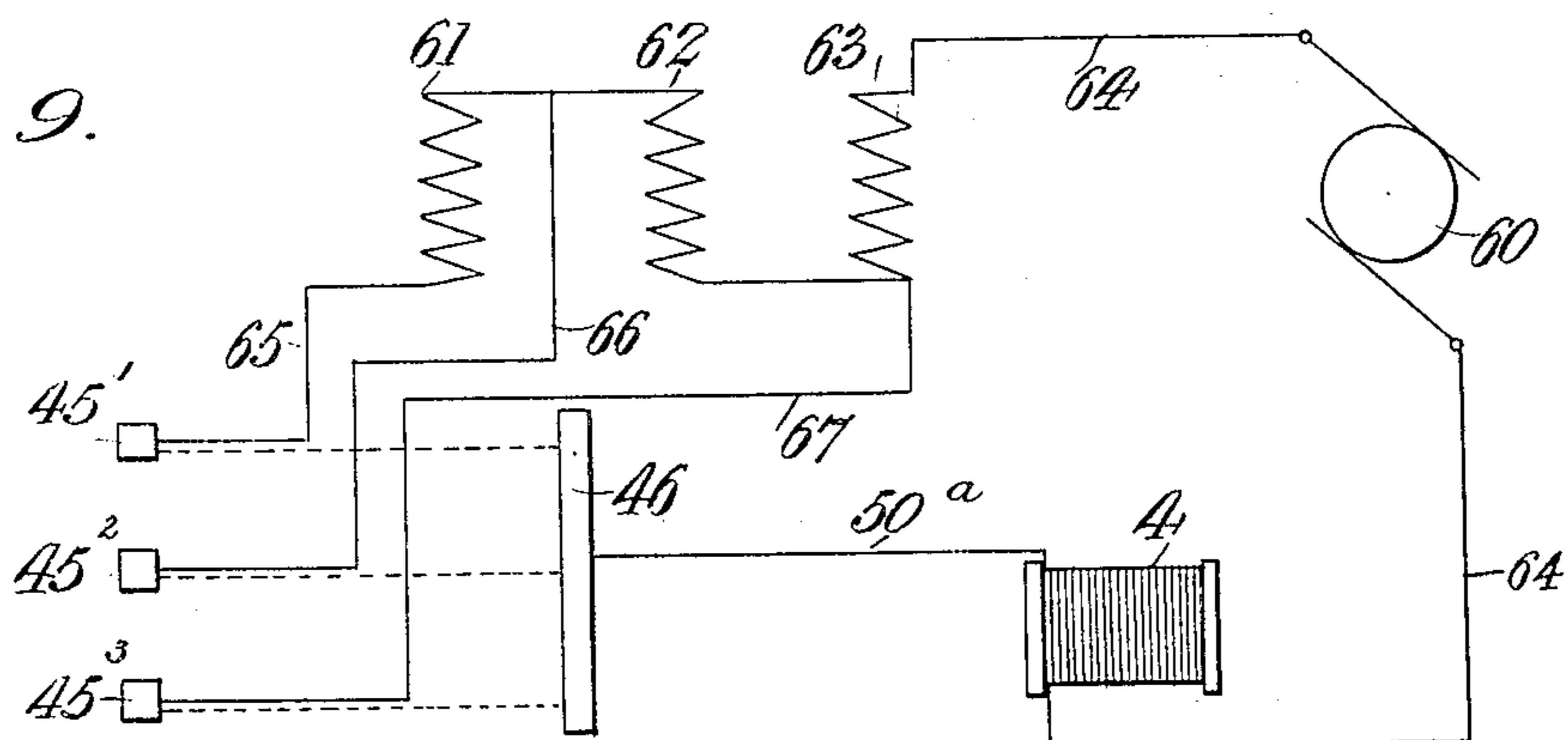
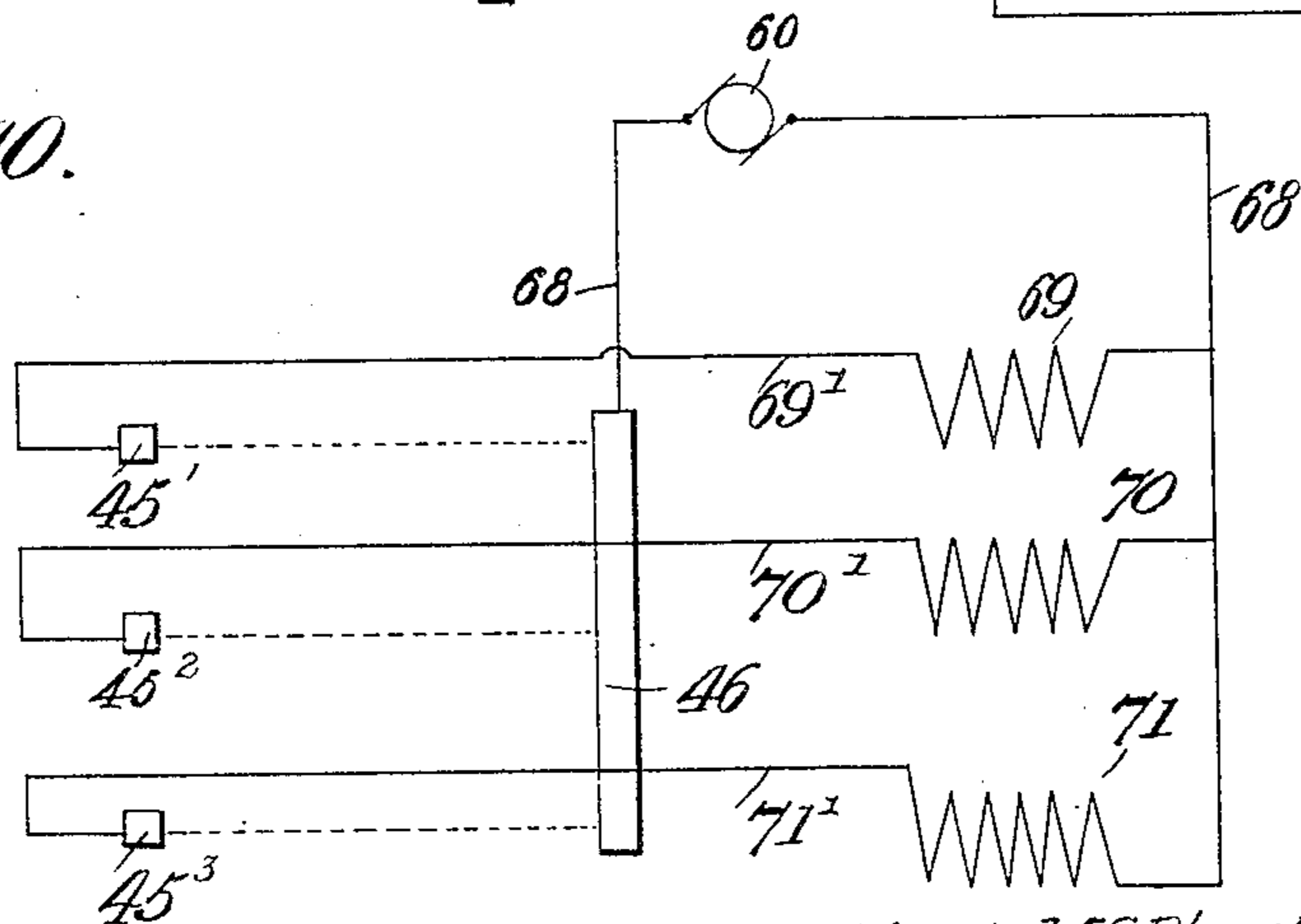


Fig. 10.



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7 SHEETS—SHEET 7.

Fig. 14.

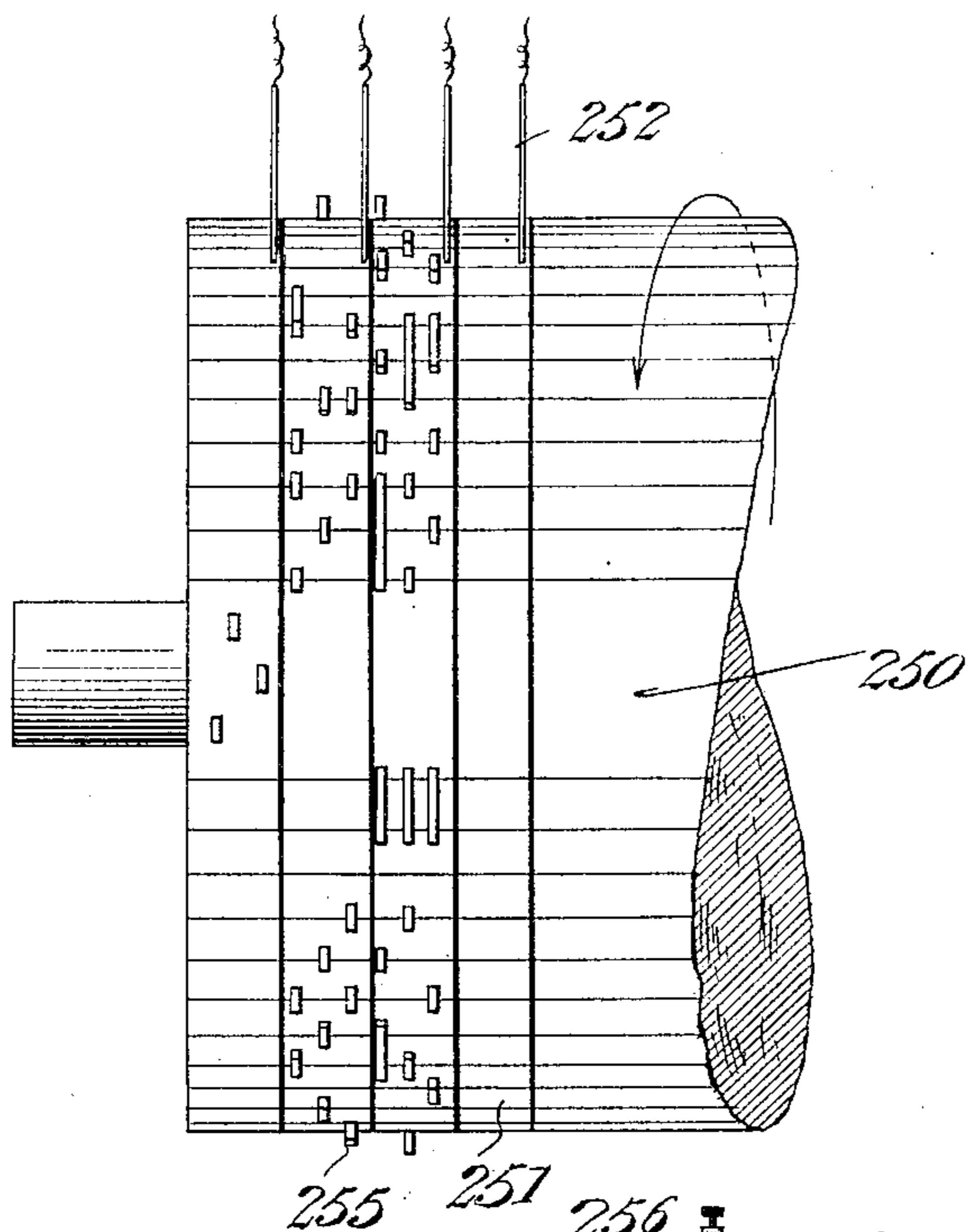
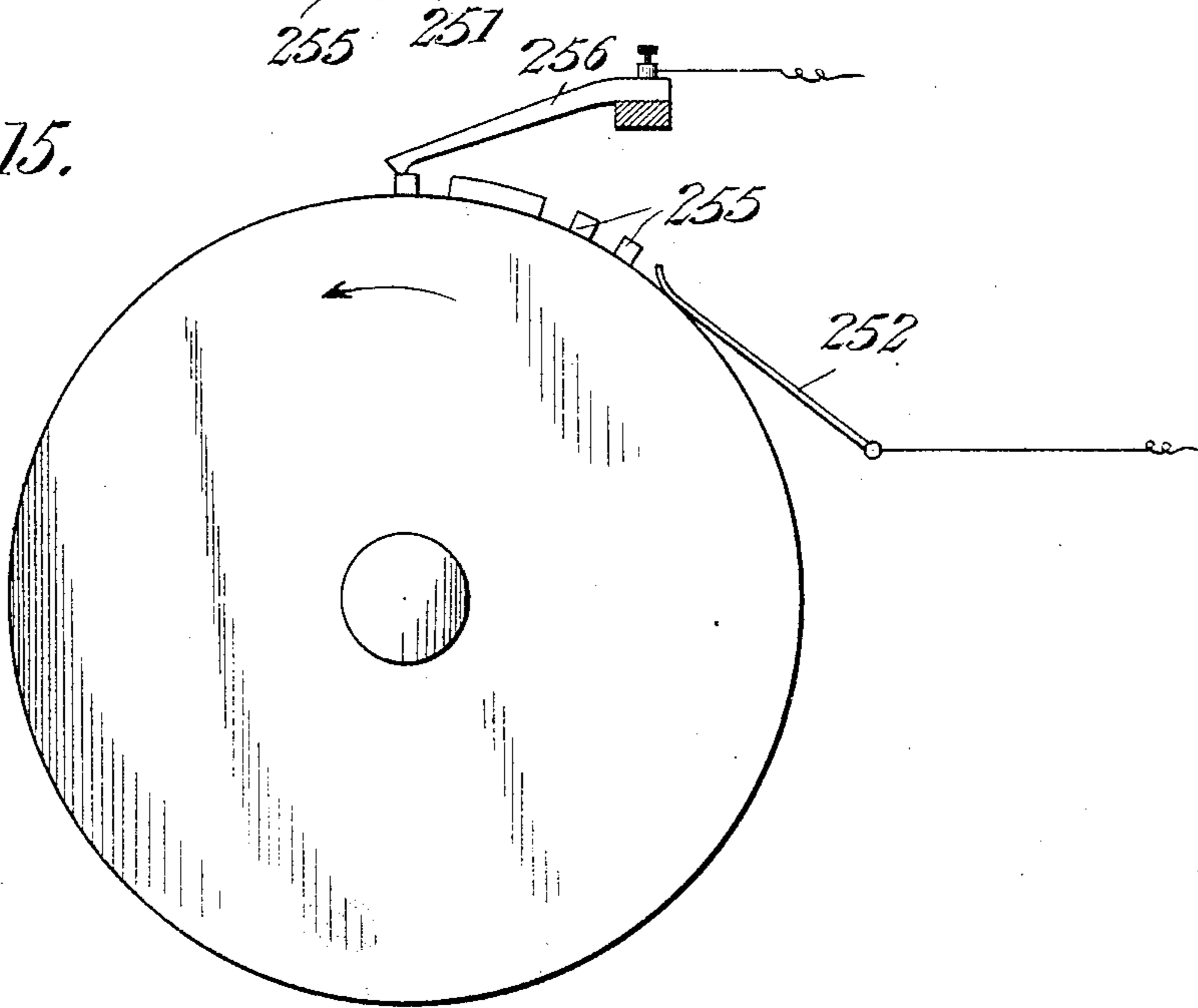


Fig. 15.



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Attorneys

UNITED STATES PATENT OFFICE.

HUGH McPHAILL, OF VISALIA, CALIFORNIA, ASSIGNOR OF ONE-FOURTH TO ALTA McPHAILL, ONE-FOURTH TO LEWIS L. CLARK, AND ONE-TWENTIETH TO CARL H. HOLLEY, OF TULARE COUNTY, CALIFORNIA.

PIANO-PLAYING ATTACHMENT.

No. 808,774.

Specification of Letters Patent.

Patented Jan. 2, 1906.

Application filed April 18, 1903. Serial No. 153,286.

To all whom it may concern:

Be it known that I, HUGH McPHAILL, a citizen of the United States, residing at Visalia, in the county of Tulare and State of California, have invented a new and useful Piano-Playing Attachment, of which the following is a specification.

This invention relates to certain improvements in mechanisms of that class employed for playing pianos, organs, and other musical instruments, and has for its principal object to provide a device in the nature of an attachment which may be adjusted to position and used in connection with the musical instrument, although it will be understood that many of the features of the invention may be employed in the construction of self-playing musical instruments without departing from the invention.

The device is one of that class in which a perforated sheet is employed in connection with a plurality of contacts arranged in different circuits in which electromagnets are included, the perforations permitting movement of the contacts to close the circuits.

One object of the invention is to provide a device of this character in which a plurality of electromagnets are used in connection with each key of the instrument, the magnets of each key being arranged in circuits of different strength or otherwise so connected as to move the keys with greater or less force, as dictated by the composition being played.

A further object of the invention is to provide a device of this character in which the music sheet or strip is so arranged between a pair of spaced guiding devices that it may at all times occupy the same position with respect to the circuit-closers without regard to the gradual increase in diameter of the take-up roller and, further, in which the contact members engage the strip at a point between spaced supports or guards, so that they may freely pass into or through the perforations without coming into contact with any resistant body, such as a guide or roller, as commonly practiced in similar devices where the contact member engages a fixed bar or roller and effects the closing of the desired circuit or circuits.

A still further object of the invention is to provide a device of this character in which the strip has suitable perforations for con-

trolling the manipulation of the pedals or other similar appliances and, further, to control the operation of the mechanism for moving the strip during both the playing of the selection and the rewinding of the strip on the initial or containing roller and for stopping the mechanism.

A still further object of the invention is to provide an improved mechanism for automatically removing the contacts from engagement with the strip at the completion of the playing of a selection and holding the same in disengaged position during the return movement of the strip in order to prevent damage to said strip.

A still further object of the invention is to provide a record-controlled switch mechanism which in part is manually adjustable to permit a single operation of the mechanism and the playing of a single selection or to permit the repeated playing of the same selection for an indefinite period.

With these and other objects in view, as will hereinafter appear more fully, the invention consists in the novel construction and arrangement of parts hereinafter described, illustrated in the accompanying drawings, and particularly pointed out in the appended claims, it being understood that various changes in the form, proportions, size, and minor details of the structure may be made without departing from the spirit or sacrificing any of the advantages of the invention.

In the accompanying drawings, Figure 1 is a transverse sectional view of a piano-playing attachment constructed in accordance with the invention and illustrating the same as applied to the keyboard of the piano. Fig. 1^a is a diagram of the wiring connections partly illustrated in Fig. 1. Fig. 2 is a front elevation of the upper portion of the mechanism, the casing being removed. Fig. 3 is a front elevation of a portion of the mechanism, illustrating more particularly the staggered order in which the key-actuating magnets are disposed. Fig. 4 is a transverse sectional view of a portion of the mechanism on the line 4-4 of Fig. 2. Fig. 5 is a diagram illustrating the arrangement of the circuits for controlling the key-actuating magnets and the operating devices. Fig. 6 is a detail view of a portion of one of the record-strips employed. Fig. 7 is a detail plan view of the head of the speed-

adjusting screw or governor and its indicating-segment. Figs. 8, 9, and 10 are diagrams illustrating methods of connecting the key-actuating magnets to the circuit-breakers. 5 Fig. 11 is an elevation showing a slight modification of the pedal-actuating mechanism. Fig. 12 is a side elevation illustrating the application of the electromagnets to the rear or inner end of a piano-key. Fig. 13 is an end 10 elevation of the same. Figs. 14 and 15 are views illustrating a slight modification of the invention.

Similar reference characters are employed to indicate corresponding parts throughout 15 the several figures of the drawings.

The mechanism is mounted in a suitable casing 1 of suitable shape and size, and by preference a strip of felt or similar cushioning material is placed at the rear of the casing, as indicated at 2, for contact with the front of the piano. Within the casing is arranged a longitudinal supporting-bar 3, carrying electromagnets for actuating the keys. The electromagnets are preferably in the form of solenoids 25 having stationary core members of soft iron to more readily attract and when necessary hold the movable cores at an expenditure of comparatively small current. As the keys of an ordinary piano are narrow and arranged 30 closely together and as it is desirable to employ electromagnets of relatively large diameter, the entire series of magnets cannot be conveniently placed in the same plane throughout the width of the keyboard, and for this reason 35 said electromagnets are arranged in staggered sets of three, as indicated at 4, 5, and 6. The electromagnet 4 is connected, by means of a threaded pin 7 and adjustable nuts 8, to the vertical arm 9 of a bell-crank lever pivoted 40 at 10 to the casing, the horizontal arm of said lever being adapted to engage and depress one of the keys of the musical instrument. The connection between the threaded pin 7 and the movable cores of each magnet is pivotal 45 in order to permit the necessary free swinging movement of the key-actuating levers without causing the cores to bind within the spools. Key-actuating levers 10' are also hung on the pivot-bar 10, which extends throughout the length of the attachment and carries all of the levers. The vertical arm of the key-lever 10' has a loose connection with the upper end of a lever 11, pivoted to a small bracket or lug 12, carried by the stationary 50 frame, and connected by a bolt 13 and adjustable nuts 14 to the cores of the electromagnet 5, this arrangement of the levers being desirable in order that all of the levers may receive uniform movement without regard to 60 the positions of their operating-magnets. The electromagnet 6 is disposed in front of the electromagnets 4 and 5 and in a horizontal plane about midway between the horizontal planes in which the magnets 4 and 5 are disposed, and the cores of the electromagnet 6

are connected by a rod 15 to one of the key-operating levers. This method of distributing the electromagnets is followed throughout the entire keyboard, the electromagnets being arranged in groups of three, each group operating on a single key. 70

The frame of the device supports a bar 16, to which are secured springs 17, one for each of the key-operating levers, the springs serving to restore the levers to initial position 75 when the electromagnets are deenergized, and each of said springs has a separate adjusting-screw 18, carried by a supporting-bar 19.

The operation of the key-levers is controlled by a strip which is mounted on suitable operating devices at the upper front portion of the casing, while the electromagnets and key-operating levers are below the strip and at the rear portion of said casing. This permits 80 of the ready removal of one strip and the substitution of another without rendering it necessary to remove or adjust any of the key-levers or electromagnets. The strip 21 is mounted on a roller 22, having at one end a stud 23, fitting within a spring-pressed socket 85 member 24, supported by the frame, and at the opposite end of said roller is a spindle 25, the end of which interlocks with a revoluble spindle 26, adapted to suitable bearings in the frame and provided with a gear-wheel 27, to 95 which motion is transmitted in the manner hereinafter described. Below and in front of the roller 22 is a record take-up roller 28, which may be mounted in fixed bearings, its spindle or shaft 29 being provided with a 100 gear-wheel 30, to which movement is transmitted during the playing of a selection. During the movement of the strip the stud 23 turns freely in the socket 24 and the gear 27 revolves with the roller; but on the return movement, when the strip is being re- 105 wound on the roller 22, the gear 27 is positively driven and the gear 30 turns freely. To prevent the strip unwinding too freely, each of the spindles 26 and 29 is provided 110 with a friction-disk 31, against which bears a small friction-block 32, carried by a spring-arm 33, the tension of which may be adjusted by a screw 34. The strip 21 passes under a roller 37, carried by links 38, that are hung 115 on pins 39, the weight of the roller resting against the strip and forcing the same down into contact with a guiding-bar 40, extending across the machine at a point to one side of the vertical plane of the axis of the roller. 120 The strip is thus guided between the roller 37 and the bar in a line oblique to the horizontal and retains a fixed position with respect to the circuit making and breaking devices or "reading-fingers," as they are termed. This 125 arrangement is considered necessary owing to the fact that if the strip led directly from roller to roller its angular position would be constantly changing as the diameters of the rollers varied during the unwinding of the 130

strip from one roller and its winding up on the other. The record-strip is provided with two or more rows of perforations for each key, three being employed in the present instance, as indicated at 41', 42², and 43³. In connection with these a corresponding number of circuit-closing devices are used. Extending longitudinally of the casing is a pivot-bar 44, which may be formed of insulating material or provided with an insulating-sleeve. On this bar are pivoted the circuit-closers or reading-fingers 45. The forward ends of the fingers are shorter than the rear ends, the superior weight of such rear ends serving to keep the front ends in close contact with the lower face of the strip and to force said front ends upward into the perforations of the strip without necessarily coming into contact with the periphery of the roller 37. The heavier rear ends of the fingers are arranged above contact-plates 46, carried by a bar or strip 47 of insulating material extending parallel with the bar 44, there being a separate plate for each circuit-closing finger, or each of said plates being of a width sufficient to make contact with all of the reading-fingers of one group—three in the present instance. When an imperforate portion of the strip is passing over the front ends of the fingers, the rear ends thereof are held out of engagement with the contact-plates 46; but when a finger enters a perforation its rear end falls into engagement with the contact-plate 46, and thus completes a circuit through one or other of the lever-actuating electromagnets. Each circuit-closing plate 46 is connected by a wire to one of the electromagnets. On referring to Fig. 1^a, which illustrates the wiring of the apparatus, as shown in Fig. 1, it will be seen that the three reading or contact fingers of a group have for convenience been designated 45', 45², and 45³ and the contact-plates 46', 46², and 46³. The wire 50 connects all of the electromagnets 4, 5, and 6 to one side of a group of series-connected cells. The several fingers 45', 45², and 45³ are respectively connected by independent wires 51, 52, and 53 to the cells. In the present instance nine cells are shown, and the circuit of the first finger 45' is closed through three of the cells, wire 50, electromagnet 4, wire 47', plate 46', contact-finger 45', and wire 51. The circuit of the second finger is closed through six of the cells, wire 50, electromagnet 5, wire 48, contact-plate 46², contact-finger 45², and wire 52. The circuit of the third contact-finger is closed through all nine cells, wire 50, electromagnet 6, wire 49, contact-plate 46³, contact-finger 45³, and wire 53. It will thus be seen that currents of different strength may be employed for the operation of each key-lever and the latter moved with any degree of force into contact with the key of the piano, thus imitating, more or less, the human touch. It is evident that the same result—i. e., varia-

tions of force—may be accomplished by coupling a number of cells to the same electromagnet—as shown, for instance, in Fig. 5. In this case a single electromagnet 4' is connected by a wire 50' to a single plate 46 of a width sufficient to permit all of the contact-fingers in a single group to engage with it. Movement of the finger 45' will cause two cells, as *a*, to be included in the circuit with the electromagnet 4'. The depression of finger 45² will cause four cells *a b* to be included in the circuit, and the depression of the third finger 45³ will cause six cells *a, b, and c* to be included in said circuit. The connections may, however, be further modified in the manner shown in Fig. 8, wherein a single electromagnet 4^a is provided with a plurality of windings, each of which is independent of the others, and each contact-plate is formed in three sections 46^a, 46^b, and 46^c. The circuit from the plate 46^a is through a wire 54' to one of the windings 54^a and two cells and thence to contact-finger 45'. The circuit from plate 46^b is through the second winding 55^a, wire 55', and contact-finger 45², and in this circuit three cells are connected. The circuit from plate 46^c is through wire 56', winding 56^a, and contact-finger 45³, this latter circuit including five cells, so that each of these separate windings may be separately energized and exercise greater or less force in the operation of the key-lever. In some cases the perforations may be so arranged that two or three of the contacts will be engaged simultaneously, so that the circuit through the windings may include two cells, three cells, five cells, seven cells, eight cells, or ten cells. In Fig. 9 is illustrated a still further modification. In this case the contact-plate 46 is connected by wire 50^a to the electromagnet 4 and the circuit is continued by a wire 64 to a source of energy, in the present instance a small generator 60. In this circuit are arranged three resistance-coils 61, 62, and 63, and the circuit to the finger 45' may be completed by a wire 65, which includes all three of the resistance-coils in series. The finger 45² is connected by a wire 66 in a circuit including two of the resistance-coils. The third finger or circuit-closer 45³ is connected in a circuit through wire 67, including only the resistance-coil 63, thus altering the effective force employed in operation of the key. A still further modification of this portion of the invention is illustrated in Fig. 10, wherein the generator 60 is connected by a wire 68 to the contact-plate 46 and is connected in multiple with three windings 69, 70, and 71 of an electromagnet, the spool of the latter containing three separate wires which may be of the same or of different diameter. The coil 69 is connected by a wire 69' to the first of the reading-fingers 45'. The second coil 70 is connected by a wire 70' to the second finger 45² and the coil 71 is connected by a wire

71' to the third finger 45³. In this case the variation in strength of the current is effected by passing the current through one or two or all of the coils, and to accomplish this the strip is provided with perforations which will permit simultaneous movement of the desired reading-fingers. To control, further, the volume of sound, the strip is provided with suitable perforations through which circuit-closers may pass to close circuits through electromagnets 80, Figs. 1 and 11, these being of the same character as those already described, but preferably of larger size. The circuit-closing devices are the same as those already described and are connected in series with a source of electrical energy and the electromagnets. When the device is used in connection with a piano, a separate electromagnet is used for each of the pedals, and the core of each magnet is connected by a pivotally-mounted screw 82 and nuts 83 with one arm of a pivoted bell-crank lever 84, the opposite horizontal arm of which extends outward through an opening formed in the rear of the casing and is connected to a vertically-guided bar 85. This bar is preferably made in two sections, which may be connected by a telescopic joint and locked in any position of adjustment by a set-screw 86. The lower section of the bar 85 has a laterally-projecting foot-piece 87 for engagement with the pedal. This mechanism may be employed, with suitable modification for operating the stops of an organ or for controlling the volume of sound in musical instruments of various character. In many cases it is desirable to hold the pedal down for a considerable period of time, especially the soft pedal of a piano, and if the circuit through the battery is maintained closed all this time the perforation in the strip would be of such considerable length as to weaken the strip, and at the same time the life of the cells would be materially lessened. To overcome this difficulty, the circuit is first closed through the electromagnet 80 by the entrance of one of the reading-fingers or circuit-closers into a perforation of the strip, and as the electromagnet is energized the core moves inward and the core-connecting bar is caught by a latch 88, Fig. 11, having a beveled face for contact with the core-bar and provided with a spring 89 in order to force the latch upward after its core-bar has passed beyond the same. The latch will hold the core in position and the pedal depressed after the perforation of the strip has passed beyond the reading-finger or circuit-closer and the electromagnet is deenergized. The latch 88 is connected to the core of an electromagnet 90, arranged in circuit with a battery to wires 91, a suitable contact-closer or reading-finger being also introduced into the circuit and adapted to close said circuit through the electromagnet 90 when a perforation of the strip permits such operation, so that at the completion of the pe-

riod of time for which the pedal should be depressed the electromagnet 90 will be energized and withdraw the latch from engagement with the core-bar of the electromagnet 80, permitting the latter to reassume its initial position and removing the foot 87 of the bar 85 from engagement with the pedal. This mechanism is intended principally for use where the pedal is to be depressed for a considerable period of time and avoids waste of the battery and weakening of the strip by the formation of long slits. When the production of the musical selection is completed, it is desirable to move the reading-fingers or circuit-closers from engagement with the strip before the latter starts on its return movement, so that tearing of the strip will be avoided. To accomplish this automatically, an electromagnet 100 is employed. This electromagnet is disposed immediately below the front portion of the reading-fingers, and to its core is secured a vertically-disposed rod 101, connected to the central portion of a bar or strip 102, that extends over all of the fingers, but normally is held up out of contact therewith by means of springs 103, carried by supports 104 at or near each end of the casing, the strip being held elevated to such an extent as to permit freedom of movement of the front ends of the reading-fingers during the introduction of the musical selection. At the completion of the playing the circuit is automatically closed by the strip through electromagnet 100, the core of the latter being drawn down, carrying with it the strip 102 and all of the reading-fingers 45, the front ends of the latter being depressed below the path of travel of the strip, so that the latter may be rewound on the initial roller without coming into contact with said fingers. To avoid the waste of battery during the rewinding operation, an auxiliary electromagnet 105 is employed, this electromagnet having a movable core 106, carrying a spring-pressed catch 107, which may be of the construction shown in Fig. 1 or that shown in Fig. 5, the latter construction being employed where economy of space is desirable. This catch automatically engages the core of the electromagnet 100 when the latter moves to its lowest position and holds the same down, together with all of the reading-fingers, until the strip has been rewound on the initial roller. When this occurs, the strip may automatically close the circuit through the electromagnet 105 to withdraw the catch 107 and permit the core of electromagnet 100 to move upward and release the fingers, or by means of a manually-controlled switch the fingers may still be held down in order to avoid the repetition of the same selection.

Before entering into a description of the circuits of the electromagnets 100 and 105 attention is directed to the mechanism for operating the music sheet or strip carrying

rollers 22 and 28, these being provided, as previously described, with gears 27 and 30, respectively. At a point near one end of the casing are bearings for the support of a shaft 110, at one end of which is a gear-wheel 111, intermeshing with a pinion 112, carried by the armature-shaft of a small electric motor 113, and in order to control the speed of the motor the shaft 110 is provided with a friction-disk 114, Fig. 4, against which bears a friction-block 115, carried by a spring 116, secured at one end to a supporting-block within the casing. The free end of the spring is immediately under a screw 117, having a left-hand thread and passing through a threaded opening in a block or support 118. At the top of the screw is a milled knob 119, provided with a hand or pointer 120, which may be traveled over a graduated dial 121, provided with designating characters to indicate the speed of rotation of the shaft, and the various parts are so proportioned that by turning the indicator or pointer to proper position on the dial the speed of the shaft may be accurately governed in accordance with the character of the selection being played. On the shaft 110 is mounted a pair of loose pinions 122 and 123, and secured to the shaft are two electromagnetic clutches 124 and 125, adapted, respectively, to clutch the pinions 122 and 123 to the shaft when energized by the closing of a circuit therethrough. The pinion 122 when clutched to the shaft turns the gear 27 through an intermediate pinion 126, while the pinion 123, when clutched to the shaft, operates the gear-wheel 30. The electromagnetic clutches 124 and 125 have hollow cores which will hold the pinions without moving them out of mesh with the gears to which they are connected, and to transmit a current to these clutches the shaft 110 is provided with two sets of collecting-rings 127 128 and 127' 128', suitable brushes bearing on these rings and serving to convey the current to and from the clutches. The strip, as will be hereinafter described, is provided with suitable perforations to permit closing of the circuits through one of the clutches when the strip has reached limit of its movement in one direction in order to reverse the direction of travel of said strip.

For convenience in changing the music sheets or strips the upper rounded portion of the casing is divided into three hinged leaves or cover-sections 130, 131, and 132, and at the front is an additional door 133. All of these may be moved to open position and the interior of the casing exposed. The door 133 may remain open to permit the convenient operation of switches 134, 135, and 136. This figure also shows a number of cells 137, 138, 139, 140, 141, and 142 having different connections and supplying the operating-current for the motor and controlling solenoids. The switch 134 is employed to control the opera-

tion of the electromagnet 105, hereinbefore referred to, and when said switch is in closed position (indicated by dotted lines in Fig. 5) the circuit may be traced from the battery 141 through wire 143 to a finger or circuit-closer 144, arranged under the strip, and when allowed to move through a perforation in the strip said finger will engage a contact-plate 145 and complete the circuit through wire 146 to electromagnet 105 and thence to switch-point 147, switch-lever 134, wire 149, to a solenoid 150, and thence by wire 151 back to the battery 141, it being observed that if this switch 134 is moved to the dotted-line position the circuit will be closed on the arrival of the perforation of the strip at the proper point, and the solenoid 105 will be energized and will withdraw the spring-catch 107 from engagement with the core of the electromagnet 100, allowing all of the circuit-closers to again rise to operative position. This is accomplished only when it is desired to repeat the playing of a selection already rendered, and the lever is adjusted by the operator to the closed position—*i. e.*, in engagement with the switch-point 147—for this purpose. If it is desired to stop the mechanism at the completion of playing a selection, the switch is allowed to remain in the full-line open position, so that the latch will still retain the core of the solenoid 100 depressed. This switch further controls the shifting movement of a clutch-opening switch 135, said clutch 135 being movable either by hand or by solenoids 150 and 153 for the purpose of energizing one or other of the electromagnetic clutches on the shaft 110. The switch 135 is formed of two members, an upper switch member 154, pivoted at 155, and a lower switch-bar 156, that is pivoted at 157. These two members have a loose pivotal connection with a bar 158, that unites the cores of the solenoids 150 and 153, and both members are operated when either of the solenoids is energized. The circuit of the solenoid 150 has already been traced from the battery 141 in tracing the circuit from the switch 134. The circuit of the solenoid 153 may be traced from battery 142 through wire 160 to a circuit-closer 161, that is controlled by the strip, and is adapted to engage a contact 162, from which leads a wire 163 to the solenoid 153, and from this leads a wire 164 to the pivot-point 157 of the lower switch member 156. From this pivot-point 157 leads a wire 164' to a pivot-point 165 of switch 136. When switch 136 is in the dotted-line position *y*, (shown in Fig. 5,) its lower end is in engagement with a switch-point 166, from which leads a wire 166', that is connected by a wire 167 with the battery 142. This completes the circuit of the solenoid 153. The pivot-point 155 of the switch member 154 is connected to wire 168, leading to one of the brushes of the clutch 125, and from the opposite brush leads a wire 169 to a battery 139,

that is connected by a wire 170 to the wire 166'. This wire 166' leads to switch-point 166, and when the switch 136 is in the dotted-line position *y* the circuit will be closed through the switch pivot-point 165, wire 164', wire 171 to a contact-plate 172, disposed in the path of movement of the upper switch-arm 154, when said switch-arm is in one of the dotted-line positions shown in Fig. 5. When the clutch-
 10 switch therefore is in proper position—that is to say, with one of the members in engagement with the switch-point 172—a circuit will be closed through the switch 125 and the gear 27 will be clutched to the shaft, so that the
 15 gear 30 of the take-up roller will be positively driven, and this movement of the switch may be accomplished either by hand or by energizing the solenoid 150, the latter occurring, as previously described, when the switch-lever
 20 134 is adjusted to the dotted-line position shown in Fig. 5.

To operate the electromagnetic clutch 124, the battery 140 is utilized, and the circuit may be traced from said battery through the
 25 wire 174 to the clutch, thence back by wire 175 to the wire 166', to switch-point 166, switch-arm 136, to pivot-point 165, wire 164' to the pivot-point 157, switch member 156, and thence, when the switch member is ad-
 30 justed to the right, to a contact-point 177, wire 178, back to the battery 140, so that the electromagnetic clutch will be operated to effect the clutching of the pinion 122 to the shaft 110, and this adjustment may be accom-
 35 plished manually or by energizing the solenoid 153.

It will be observed that many of the connections are dependent on the position of the switch 136, and said switch is a primary switch
 40 which controls the motor-circuit. The switch 136 is pivoted at 165, and when in the full-line position shown in Fig. 5 all of the circuits are broken. When the switch is moved to the dotted-line position *x* of Fig. 5, it comes
 45 into engagement with the contact 180 and without coming into engagement with the contact 166 closes the circuit from battery 138, through wire 181, to the motor 113, and from the motor back through wire 182 to contact 180,
 50 thence through switch 136 to pivot-point 165, and back through the wire 183 to the battery 138, thus energizing the motor and starting the operation. The motor is started and allowed to develop a normal speed before the
 55 application of a load. The switch-arm 135 is then moved until the arm 154 comes into engagement with contact 172, closing the circuit through clutch 125, it being noted that that circuit is still broken between 165 and 166. The
 60 operator then moves switch 136 to the dotted-line position *y* and closes the circuit between 165 and 166, completing the circuit of the clutch 125 without disturbing the previously-closed motor-circuit, the contact-plate 180 be-
 65 ing sufficiently long to permit this second

movement of the switch-lever 136. The operation now continues until the selection is finished, the circuit-closers or reading-fingers being allowed to move and close the circuits through the electromagnets 4, 5, and 6 in the
 70 order determined by the positions of the perforations of the strip. At the completion of the selection a perforation 200 of the strip arrives opposite a circuit-closer or finger 201 and closes the circuit from a battery 202,
 75 wire 203, contact 204, the circuit-closer or finger 201, wire 205, electromagnet 100, wire 206, and wire 143, back to battery. The effect of this is to immediately draw down all of the circuit-closers from engagement
 80 with the strip, and the core of the solenoid 100 is automatically engaged and locked by the spring-catch 107 and held in position until a subsequent energizing of the electromagnet 105. As the strip continues to move a per-
 85 foration 210 comes opposite a circuit-closer 161 and permits the closing of a circuit from battery 142 to wire 160, circuit-closer 161, contact 162, wire 163, solenoid 153, wire 164, pivot 157, wire 164', pivot 165, switch 136,
 90 contact 166, wires 166' and 167, back to battery. This energizes the solenoid 153 and moves the switch members 154 and 156, the switch member 154 moving from engagement with the contact 172, while the switch mem-
 95 ber 156 comes into engagement with contact 177 and closes a circuit from battery 140 through wire 174, clutch 124, wire 175, wire 166', contact 166, switch-lever 136, pivot 165, wire 164', pivot 157, switch member 156, con-
 100 tact 177, wire 178, back to battery. This energizes clutch 124 and reverses the direction of movement of the strip. When the strip has been nearly rewound, a perforation comes opposite the circuit-closer 144, and if switch 134
 105 is in the dotted-line position of Fig. 5, in engagement with contact 147, the circuit will be closed from battery 141, wire 143, circuit-closer 144, contact 145, wire 146, solenoid 105, contact 147, lever 134, wire 149, solenoid
 110 150, and wire 151 back to battery 141. The energizing of the solenoid 105 withdraws the catch 107 and allows all of the circuit-closers or reading-fingers to reassume normal position. The energizing of the solenoid 150
 115 again changes the position of the switch 135 and energizes the clutch 125, so that the strip will again travel in the proper direction to repeat the selection. If it is desired to stop the mechanism after the completion of a single rendition of a selection, the switch 134 is
 120 allowed to remain in the full-line position, and as the circuit through solenoids 105 and 150 is fully broken the strip stops when it is rewound on its initial roller. It will be ob-
 125 served that the strip is tapered toward a central point at one end to permit its ready engagement with a securing device on the take-up roller. (See Fig. 2.) This construction permits of breaking of the motor-circuit
 130

through the medium of a circuit-closer 220, arranged at a convenient point near one edge of the strip, and when the end of the strip passes beyond the end of this circuit-closer the latter comes into contact with a plate 221, thus closing the circuit from battery 137 through wire 222, electromagnet 223, wire 224, circuit-closer 220, contact 221, wire 225, wire 164', pivot 165, switch 136, contact 166, wire 166' to battery 137. This energizes the solenoid 123, and the switch 136 is drawn to the full-line position, breaking all contact between 165 and 166 and also breaking contact between 165 and 180 and stopping the motor.

In some cases where a single strip contains a plurality of selections a perforation may be arranged between the end of one selection and the beginning of another in order to permit closing of the circuit in which the electromagnet 223 is included for the purpose of stopping the machine after a single selection has been played. This would prove of especial value where the mechanism is set into operation by the insertion of a coin.

It will be observed that the ends of the fingers or circuit-closers 144, 161, 201, and 220 are rounded in form, so that they may be kept in constant engagement with the strip—that is to say, in engagement with the strip during both the playing of the selection and the rewinding of the strip on the initial roller. This permits of the closing of some of the circuits while the strip is being rewound. The main fingers 45 are intended to engage the strip only during the playing of a selection.

The apparatus may also be employed in connection with direct-acting instruments as distinguished from an attachment, and in Figs. 12 and 13 is illustrated a piano-key 230 connected to the armature or core members of an electromagnet 221, and Fig. 13 particularly illustrates the arrangement of the electromagnets in staggered relation where the keys are comparatively narrow.

Referring now to the music sheet or strip, Fig. 6, it will be observed that there is a plurality of perforations for each degree of the scale, so that the intensity of a pitch or degree may be varied to any desired extent, and thus closely follow the operation of a human performer. The strip further provides for the carrying on of an independent accented melody or of specially-accented portions of the melody or independent notes with reference to a subdued or obligato accompaniment, so that the melody may stand out in relief.

The device is such as to control the amplitude of variation of a sounding-body of any character, and thus may be employed in connection with all kinds of musical instruments. In an upright or grand piano this may be effective by varying the stroke of the hammer on the strings, and in this connection it will be understood that the invention contemplates the actuation of the hammers direct without

the intervention of the keyboard. In mechanical pianos, where the hammer is first drawn back against the stress of the spring and is then returned to give the blow by retractile force of the spring, the necessary variation of intensity may be accomplished by varying the stress of the spring or by drawing back the hammer to a greater or less extent in accordance with the desired effect.

One modification of the invention is illustrated in Figs. 14 and 15, wherein 250 designates a cylinder formed of a plurality of rings 251, insulated from each other and each representing a degree of the scale. Against each of these rings bears a brush 252, forming one terminal of the circuit of the electromagnet, which operates to depress the keys or in similar manner serves to effect either directly or indirectly the vibratory movement of the sounding-body. Each ring is provided with a plurality of rows of contacts 255, against which bear brushes 256, the electrical connections being the same as previously described and resulting in variations in the intensity of the pitch or degree in accordance with the strength of the energizing-current of the electromagnet.

Having thus described the invention, what is claimed is—

1. In mechanism of the class described, electromagnets for actuating the keys of the instrument, a perforated music-sheet, pivotally-mounted circuit-closers, each having its center of gravity to the rear of the pivot-point, the forward end of each circuit-closer bearing against the strip and the rear end controlling one of the circuits, a bar extending over the front ends of all of the circuit-closers, and an electromagnetically-operated means for depressing the bar and moving the front ends of all of the circuit-closers down out of contact with the strip.

2. In mechanism of the class described, electromagnets for actuating the keys of the instrument, a perforated music sheet or strip, circuit-closers having their front ends bearing against the strip, and having their rear ends arranged to engage the terminals of the circuits in which said electromagnets are connected, a bar extending over all of the circuit-closers, an electromagnet having a core member connected to said bar, and a circuit in which said electromagnet is connected, said circuit being under the control of the strip.

3. In mechanism of the class described, a perforated music sheet or strip, key-actuating electromagnets, energizing-circuits for said magnets, circuit-closers forming the terminals of said circuits and under the control of said strip, a bar arranged above and normally out of contact with the circuit-closers, an electromagnet having operative connection with said bar, and an energizing-circuit for said electromagnet, the terminals of said circuit being under the control of said strip.

4. In mechanism of the class described, the combination with a perforated music sheet or strip, of key-actuating electromagnets, circuits for such magnets, strip-operated circuit-closers forming the terminals of said circuits, a bar normally held above and out of contact with said circuit-closers, an electromagnet connected to said bar and disposed in a circuit the terminals of which are under the control of the strip, a catch for holding the bar and circuit-closers in depressed position, and electromagnetically-operated means under the control of the strip for withdrawing the catch and permitting the bar and circuit-closers to assume normal position.

5. In mechanism of the class described, the combination with a perforated music sheet or strip, of key-actuating electromagnets, circuits for said magnets, strip-operated circuit-closers forming the terminals of said circuits, a bar normally held above and out of contact with said circuit-closers, an electromagnet connected to said bar and disposed in a circuit, the terminals of which are under the control

of the strip, a spring-pressed catch for holding the bar and circuit-closers in depressed position, out of contact with the strip, a solenoid-core carrying the catch, and a solenoid, the winding of which surrounds said core and is disposed in a circuit also under the control of the strip.

6. In mechanism of the class described, key-actuating electromagnets, circuit-closers connected thereto, a perforated music sheet or strip, strip-carrying rollers arranged one above and the other in front of the circuit-closers, a stationary guide-bar for the strip, and a roller serving in connection with the guide-bar to guide the strip at a point adjacent to the circuit-closers.

In testimony that I claim the foregoing as my own I have hereto affixed my signature in the presence of two witnesses.

HUGH McPHAILL.

Witnesses:

LEWIS L. CLARK,
JNO. E. PARKER.