(No Model.) 4 Sheets—Sheet 1.

C. F. GOODHUE.

AUTOMATIC HEAT REGULATING APPARATUS.

No. 473,699. Patented Apr. 26, 1892.

FIG. 1.

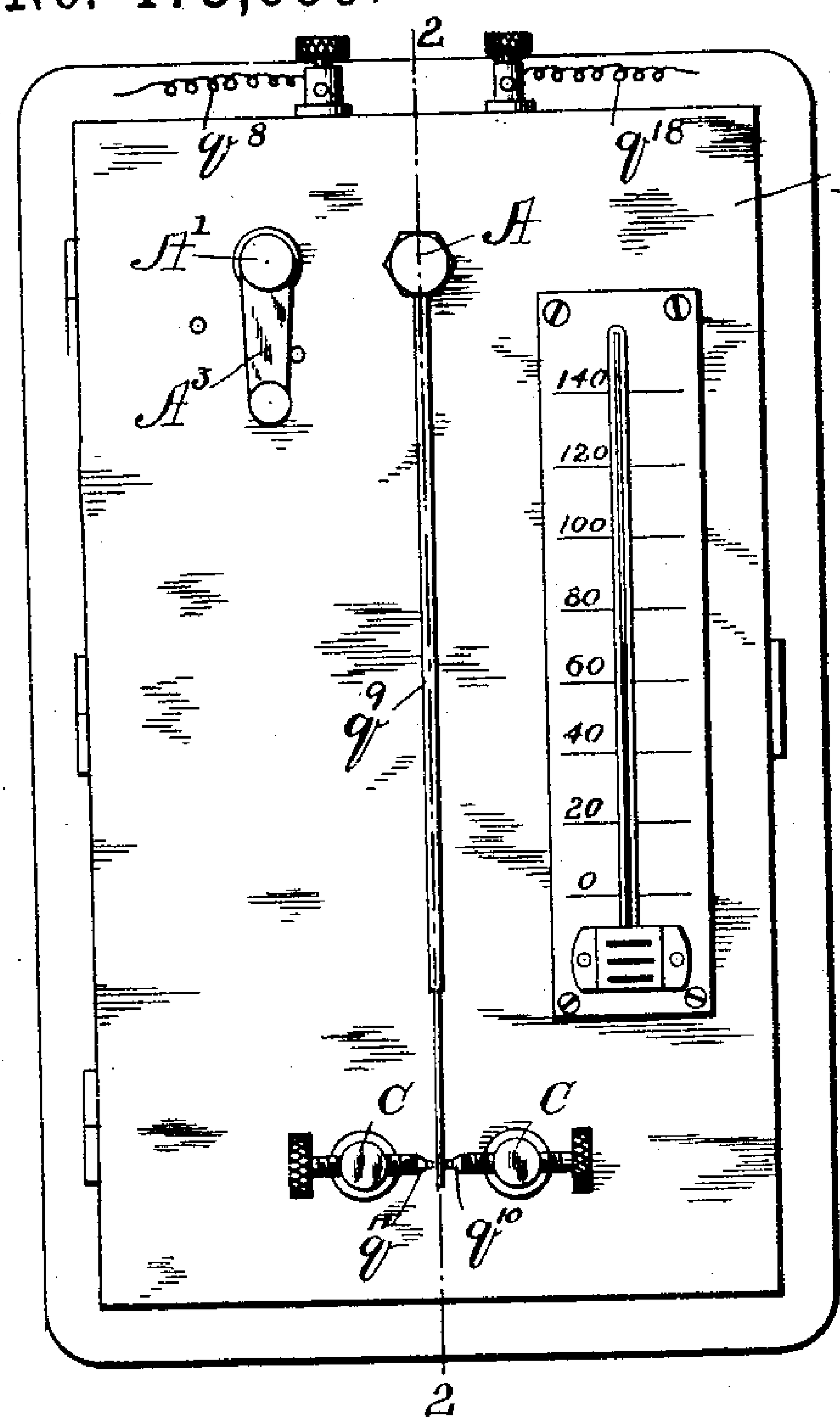
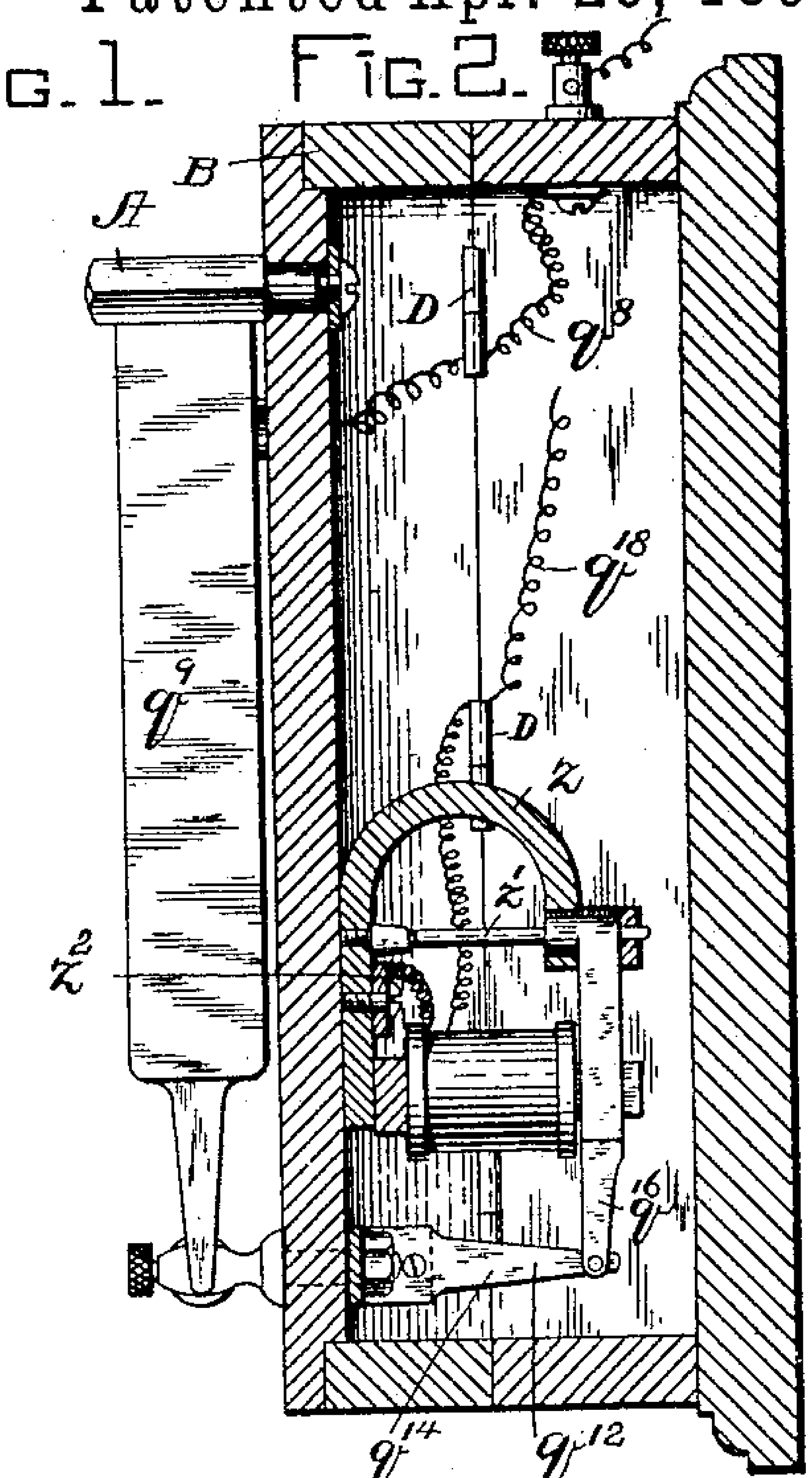


FIG. 2.



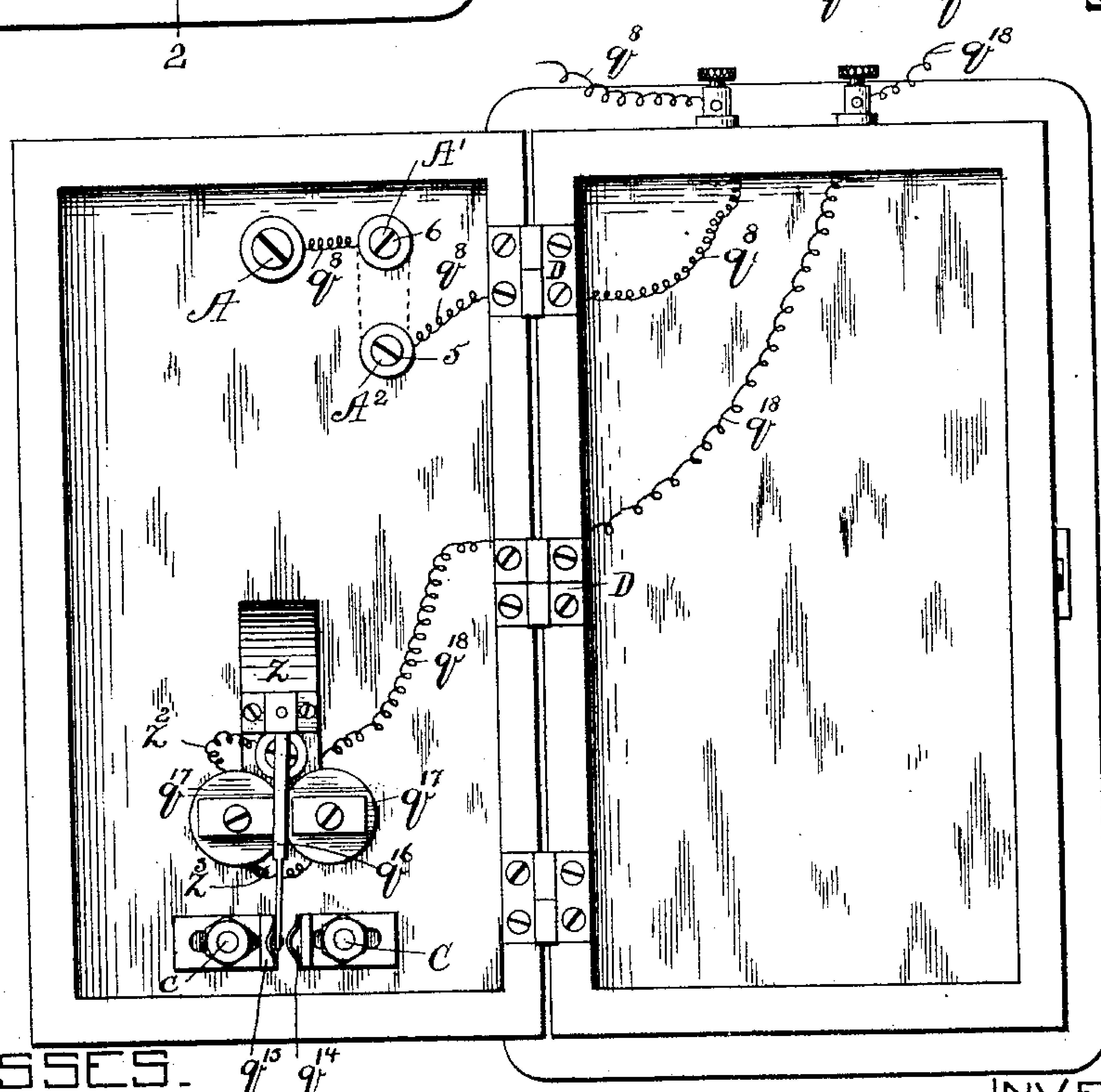


FIG. 3.

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(No Model.)

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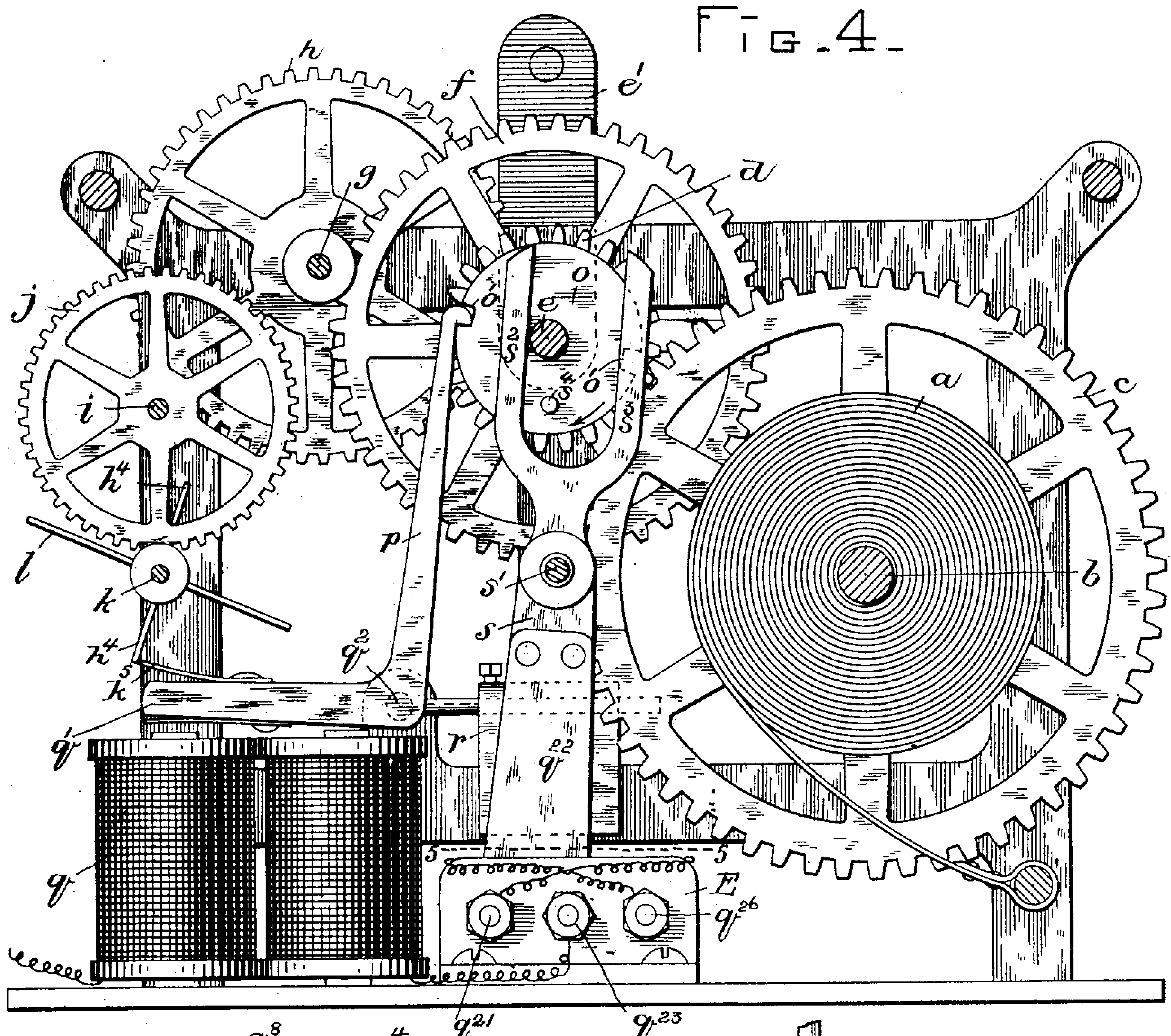
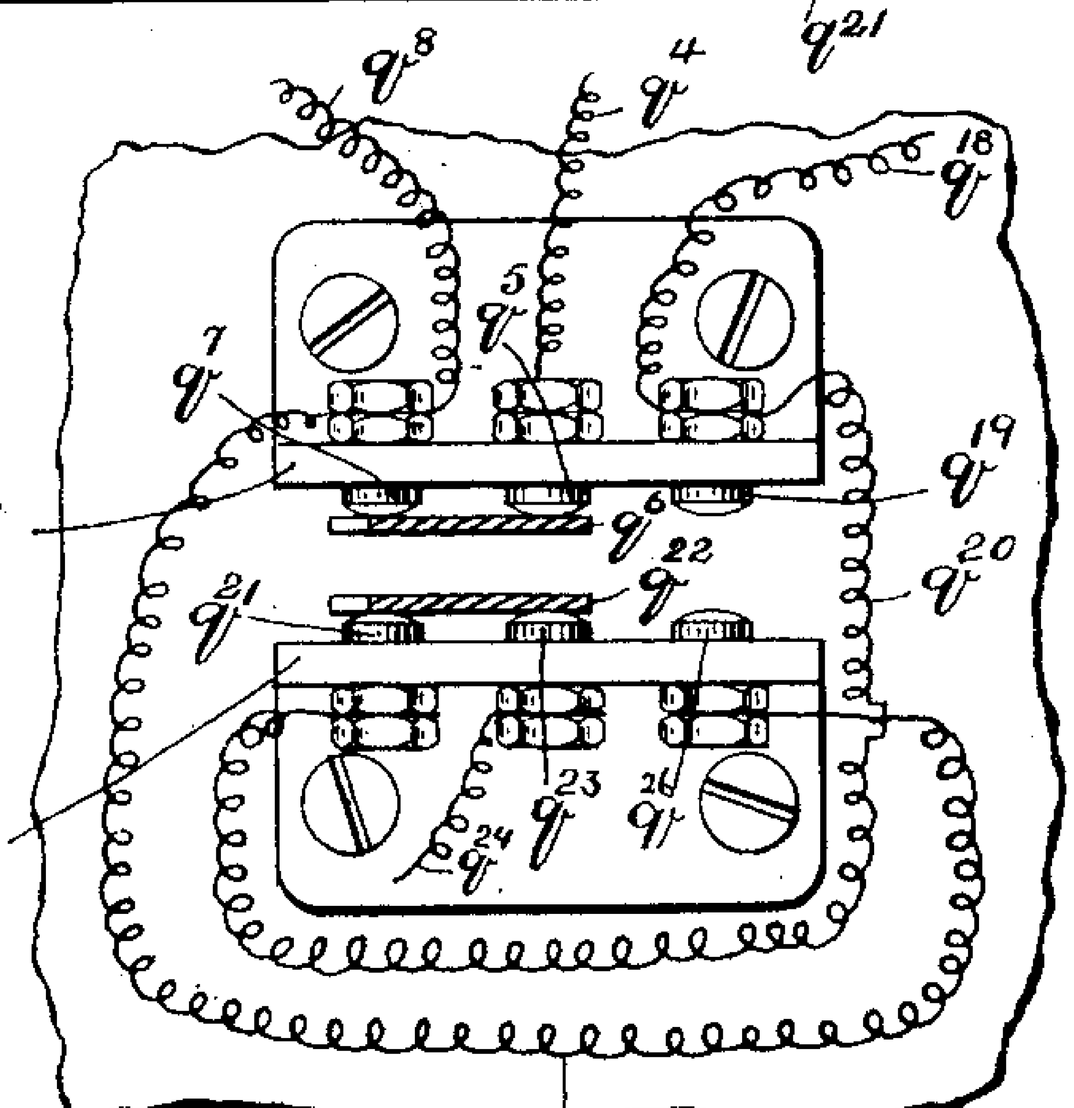
FIG. 4.





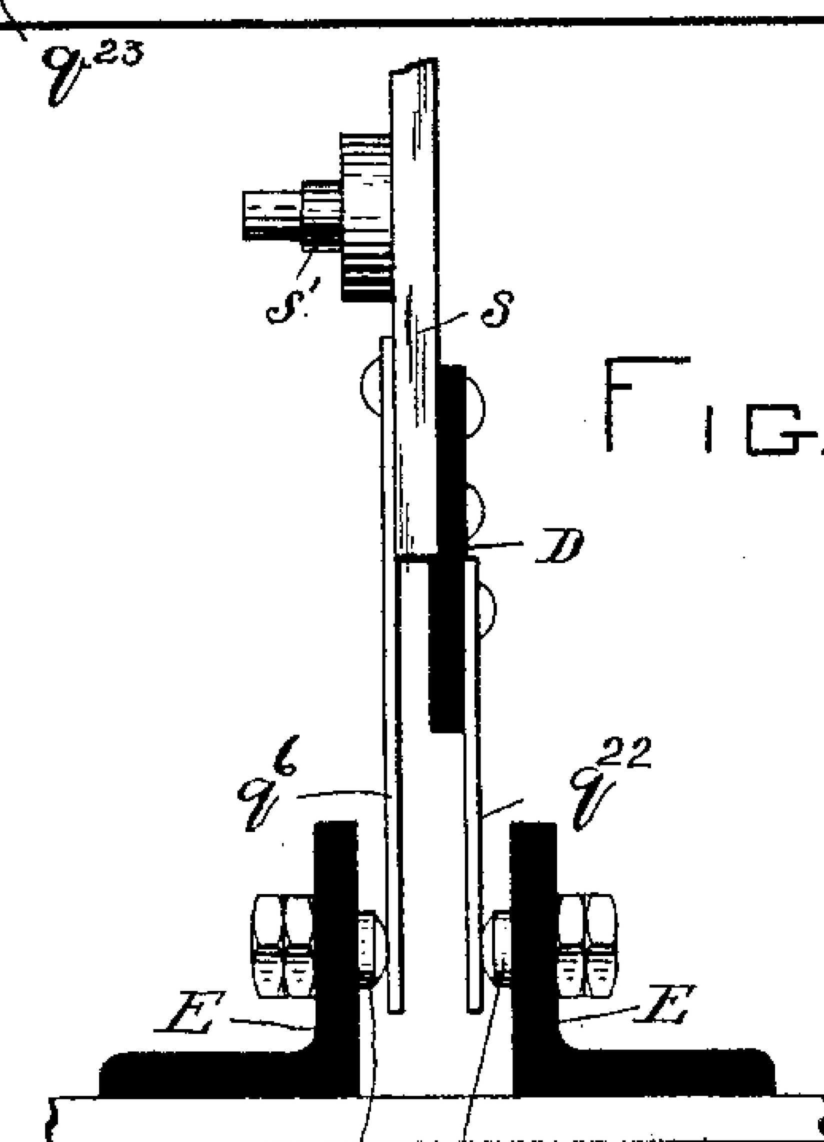


FIG. 6.

WITNESSES. FIG. 5.

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AUTOMATIC HEAT REGULATING APPARATUS.

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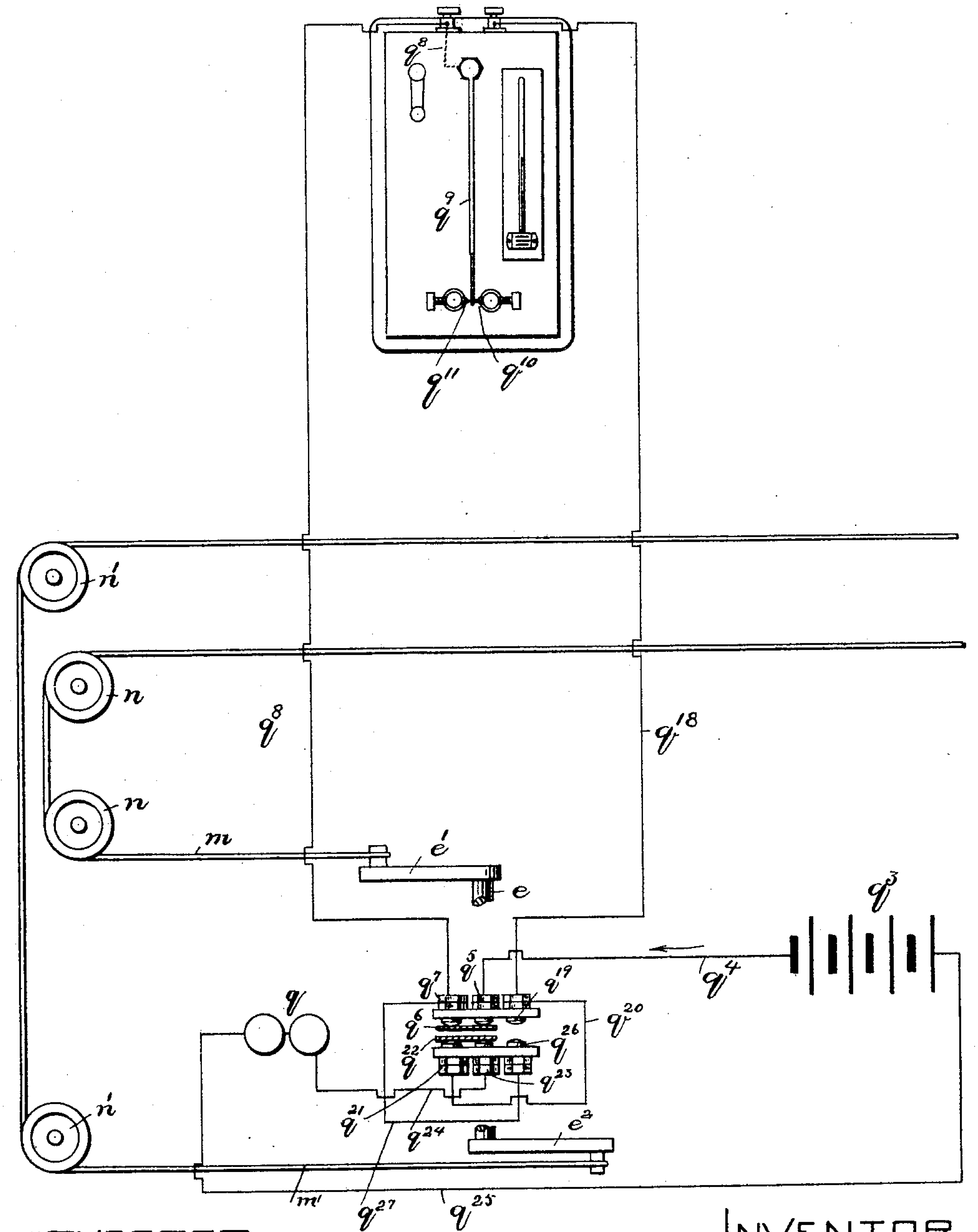

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FIG. 7.

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AUTOMATIC HEAT REGULATING APPARATUS.

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FIG. 8.

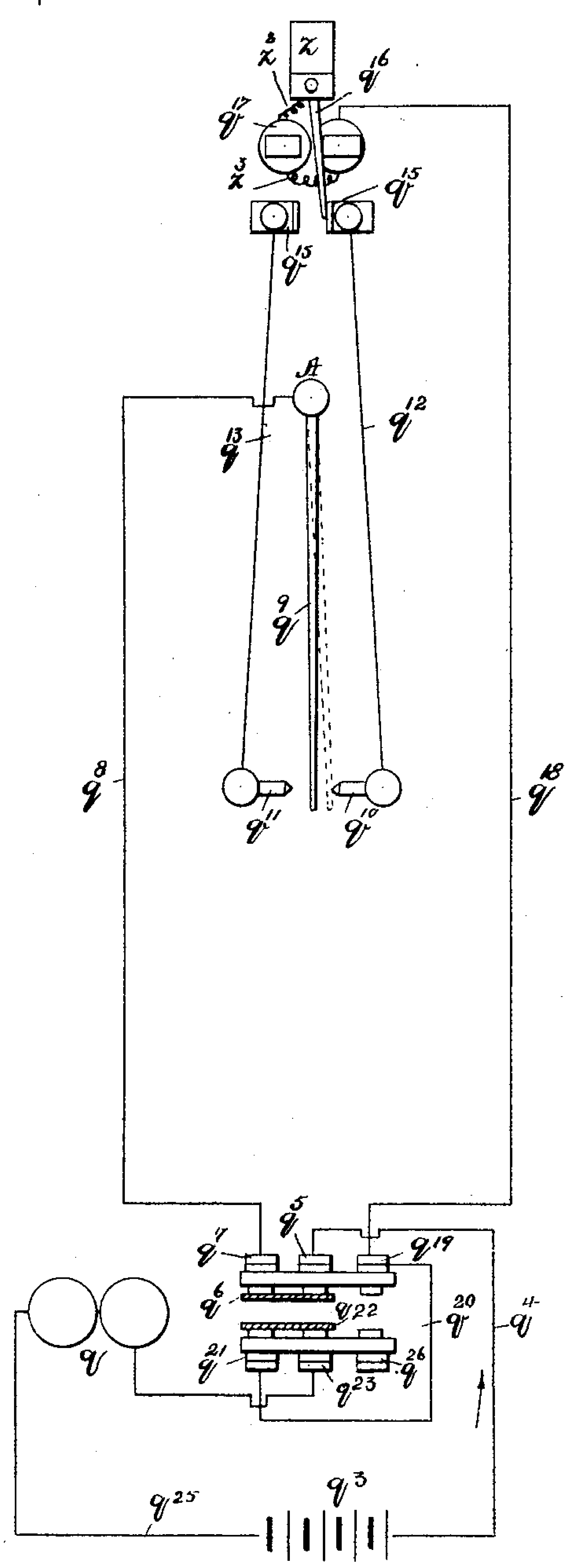
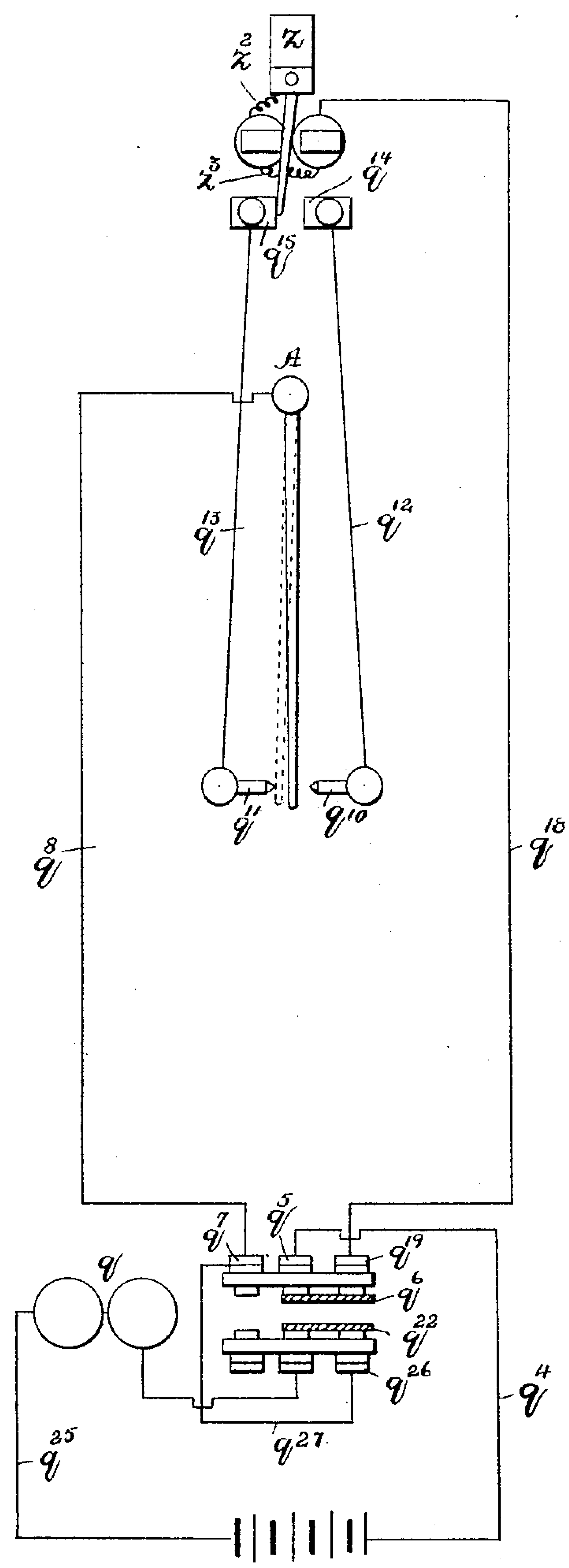


FIG. 9.



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UNITED STATES PATENT OFFICE.

CHARLES F. GOODHUE, OF BOSTON, MASSACHUSETTS.

AUTOMATIC HEAT-REGULATING APPARATUS.

SPECIFICATION forming part of Letters Patent No. 473,699, dated April 26, 1892.

Application filed May 29, 1891. Serial No. 394,504. (No model.)

To all whom it may concern:

Be it known that I, CHARLES F. GOODHUE, of Boston, in the county of Suffolk and State of Massachusetts, have invented certain new and useful Improvements in Automatic Heat-Regulating Apparatus, of which the following is a specification.

This invention relates to that class of automatic heat-regulating apparatus in which a mechanical motor adapted to alternately open and close a damper or other draft-regulating device is normally locked by a detent which is controlled by electrical means, including a thermostat located in an apartment in which the temperature is to be regulated, said thermostat when moved in one direction by a given change of temperature causing an electrical action which releases the motor and permits it to so change the position of the damper as to either increase or decrease the temperature, as the case may be.

In apparatus of this class as heretofore arranged two electrical circuits have been employed, one of which is closed by one position of the thermostat and operates to close the damper, so as to check the combustion and decrease the temperature, while the other is closed by the other position of the thermostat and operates to open the damper and cause an increase of temperature.

My invention has for its object to enable both movements of the valve or damper to be effected through the instrumentality of a single electric circuit, which shall effect both the closing and opening of the damper, thus obviating the complication and expense of two separate circuits.

To this end my invention consists in the improvements which I will now proceed to describe and claim.

Of the accompanying drawings, forming a part of this specification, Figure 1 represents a front elevation of a part of the apparatus embodying my invention. Fig. 2 represents a section on line 2 2, Fig. 1. Fig. 3 represents an elevation similar to Fig. 1, showing the cover of the box or casing thrown open. Fig. 4 represents a partial section and partial side elevation of a damper-operating motor forming part of my improved apparatus. Fig. 5 represents a section on line 5 5 of Fig. 4 and a plan view of the parts below said line. Fig. 6 represents an edge view of the lever *s* and parts co-operating therewith. Fig. 7 represents a diagrammatic view which includes the portions of the apparatus shown in Figs. 1 and 5 and parts of the appliances which operate the damper, said view showing, also, portions of the electrical connections. Figs. 8 and 9 represent diagrammatic views, omitting the damper-operating appliances and the casing shown in Fig. 1 and showing the electrical connections more completely.

The same letters of reference indicate the same parts in all the figures.

In carrying out my invention I provide a suitable motor adapted to alternately open and close the damper or draft-regulating device pertaining to a furnace or other heater, or, if preferred, to simultaneously open the damper which admits air to the fuel and close a damper which admits air to the smoke-flue between the fire-box and chimney, and vice versa, it being my purpose to apply my improvements, hereinafter described, to any form of combustion-regulating devices either by determining the quantity of air supplied to the fuel or by determining the rapidity of the draft, or both.

The motor shown in Fig. 4 comprises a spring *a*, applied to rotate a shaft *b*, to which is affixed a gear-wheel *c*, meshing with a pinion *d* on a shaft *e*. Said shaft has a gear-wheel *f* meshing with a pinion (not shown) on a shaft *g*, to which is affixed a gear-wheel *h*, meshing with a pinion (not shown) on a shaft *i*, the latter having a gear-wheel *j*, which rotates through a pinion (not shown) a shaft *k*, having a fan-governor *l*, which regulates the speed of the motion of the train when the latter is permitted to operate. The shaft *e* is provided with two crank-arms e' e^2, (shown in Fig. 7,) said arms projecting in opposite directions. To the arms e' is connected a cord or chain *m*, which passes over suitable pulleys *n n* to one of the heat-controlling devices—such, for example, as the damper which regulates the draft. To the crank e^2 is affixed a cord or chain m', which passes over pulleys n' n', and is connected with the other draft-regulating device, which may be the damper regulating the admission of air to the smoke-flue.

o represents a disk or wheel affixed to the shaft e and provided with notches o' o' at opposite points in its periphery.

p represents a lever or detent, which is electrically controlled, as hereinafter described, and normally engages with one of the notches o', so as to lock the motor-train and prevent its operation. When said detent is displaced by the electrical action, presently described, it releases the wheel o and permits the motor to operate until the wheel o has made a half-revolution, thus bringing its other notch o' in position to be engaged by the detent p, the latter being released after its displacement above mentioned before the second notch has reached it, so that it is free to enter said notch and again lock the train. It will be seen, therefore, that each operation of the train caused by a displacement of the detent p causes a half-rotation of the shaft e. The connection between the cranks e' e^2 of said shaft e and the draft-regulating devices is such that during one-half rotation of the crank said devices will be operated to check the draft and reduce the temperature, and during the next half-rotation they will be operated to increase the draft and temperature.

I have not deemed it necessary to show the draft-regulating devices, as devices of this kind, capable of being connected with the cords or chains m m', are so well known that no invention would be required in operatively connecting the described motor to the draft-regulating devices of many forms of heaters now in general use.

I do not limit myself to the described form of motor, however, but may use any suitable motor adapted to be locked by a detent electrically controlled and to effect the given movement of the draft-regulating device or devices after each displacement of said detent and to be arrested by the detent in said movement.

q represents an electro-magnet, which is included in an electric circuit, hereinafter described, and has its poles arranged to act on an armature q', which is pivoted at q^2, and is affixed to the detent arm or lever p, the arrangement being such that when the electro-magnet is energized the attraction of the armature q' to the poles of said magnet will displace the detent p, and when the circuit through said magnet is broken the armature will be retracted by its retracting-weight r and cause the engagement of the detent with one of the notches of the wheel or disk o.

The electro-magnet q is included in a single electric circuit, which includes a battery q^3 or other source of electric energy, the wire q^4 extending from one pole of the battery to a contact q^5, and a spring or current-changer q^6, which, under the conditions now being described, connects the contact q^5 with another contact q^7, which is connected by a wire q^8 with the fixed end of a thermostatic arm or bar q^9. Said arm or bar q^9 has its free end located between two contacts q^{10} q^{11}, which are electrically connected, respectively, with contact arms or springs q^{14} q^{15}, between which is adapted to oscillate a polarized armature q^{16}, the latter being located between the poles of an electro-magnet q^{17}, which is suitably connected in the circuit, said electro-magnet and polarized armature being parts of a polarized relay. In practice the contacts q^{10} q^{11} are connected with the contacts q^{14} q^{15} by metal posts or studs passing through the part of the supporting frame or casing to which said contacts are attached, the contacts q^{14} q^{15} being directly behind contacts q^{10} q^{11}. I have shown the contacts q^{14} and q^{15} separated considerably from q^{10} and q^{11} in Figs. 8 and 9 and connected with the latter by wires q^{12} q^{13}, this showing being for the sake of greater clearness in the diagrammatic illustration of the electrical connections. From the electro-magnet q^{17} extends a wire q^{18} to a contact-point q^{19}, which is connected by wire q^{20} to another contact q^{21}. Said contact q^{21} is under the conditions now being described connected by a current-changer or spring q^{22}, which is a counterpart of and moves with the spring q^6 with a contact q^{23}. The latter is connected by a wire q^{24} with the electro-magnet q, and the latter is connected by a wire q^{25} with the battery q^3. q^{26} represents another contact which is located in line with the contacts q^{21} and q^{23} and opposite the contact q^{19}. The said polarized relay comprises the permanent magnet z, having the rod z', on which the armature q^{16} is hung, and the electro-magnet q^{17} q^{17}, one pole of which is connected by wire z^2 with the rod z', while the other pole is connected with wire q^{18}, the helices of said electro-magnet being connected by wire z^3. This is an ordinary Siemens polarized relay, and the poles of the electro-magnet are caused to alternately attract the armature q^{16}, one pole attracting said armature when the current is in one direction and the other when the current is in the opposite direction, so that said armature stands alternately in the positions shown in Figs. 8 and 9.

The contacts q^6 and q^{22} are metal plates mounted upon a lever s, which is pivoted at s' to the supporting-frame of the motor, and has at its upper portion two arms s^2 s^3, arranged at opposite sides of the shaft e and in position to be acted on alternately by a stud s^4, projecting from the wheel o. When the wheel o is locked by the detent p, the stud s^4 stands between the arms s^2 s^3, as shown in Fig. 4, and when said detent is displaced the rotation of said wheel o in the direction indicated by the arrow in Fig. 4 causes the stud s^4 to strike the arm s^2, and thus swing the lever s, causing it to move the current-changing springs q^6 and q^{22} from the position shown in Figs. 4, 5, 7, and 8 to that shown in Fig. 9, said springs being thus separated from the contacts q^7 and q^{21} and caused to connect the contact q^5 with the contact q^{19}, and the contact q^{23} with the contact q^{26}, thus causing a reversal in the direction of the current, which causes the armature q^{16} of the polarized relay to move from the position shown in Fig. 8 to that shown in Fig. 9, thus separating it from the contact-spring q^{14} and bringing it into contact with the spring q^{15}.

It will be observed by reference to Figs. 8 and 9 that when the circuit-changing springs q^6 q^{22} are in the position shown in Fig. 8 the the polarized armature q^{16} is in position to make the circuit complete when the free end of the thermostatic arm q^9 touches the contact-point q^{10}, and that when the circuit-changing springs are in the position shown in Fig. 9 the polarized armature q^{16} is in position to make the circuit complete through the contact q^{11} when the free end of the thermostatic arm touches said contact.

The operation of the apparatus is as follows: The lever s and circuit-closing springs q^6 and q^{22} being in the position shown in Figs. 4, 5, 7, and 8, which, for the sake of description, may be assumed as the position they occupy after the motor has operated to check the draft and decrease the temperature, an increase of temperature will cause the free end of the thermostatic arm q^9 to move to the position shown in dotted lines in Fig. 9, thus making contact with the contact-point q^{11}, so that the circuit is closed and the current passes from the battery through the wire q^4, contact q^5, spring q^6, contact q^{19}, wire q^{18}, electro-magnet q^{17}, polarized armature q^{16}, contact-spring q^{15}, wire q^{13}, thermostatic arm q^9, wire q^8, contact q^7, wire q^{27}, which connects the contact q^7 with the contact q^{26}, circuit-changing spring q^{22}, contact q^{23}, wire q^{24}, electro-magnet q, and wire q^{25} to the battery. The electro-magnet q is thus energized and caused to attract the armature q', thus displacing the detent p. The wheel o is thus released and the motor commences to operate, its operation reversing the conditions of the draft-regulating devices of the heater and at the same time causing the stud s^4 to move in the direction required to swing the lever s and move the circuit-closing springs q^6 q^{22} from the position shown in Fig. 9 to that shown in Fig. 8. The direction of the current is thus changed and the polarized armature q^{16} is caused to assume the position shown in Fig. 8, thus breaking the circuit. This result takes place before the second notch o' in the wheel o reaches the detent p, so that the detent is released and allowed to engage said second notch when the latter reaches the detent. Hence the motor is arrested at the point when the desired change has been effected in the draft-regulating devices. The circuit now remains open until the thermostat, influenced by the change of temperature caused by the last adjustment of the draft-regulating devices, assumes the position shown in dotted lines in Fig. 8, thus making contact with the contact-point q^{10} and closing the circuit, so that the current passes from the battery through the wire q^4, contact q^5, current-changing spring q^6, contact q^7, wire q^8, thermostatic arm q^9, contact q^{10}, wire q^{12}, contact-spring q^{14}, polarized armature q^{16}, electro-magnet q^{17}, wire q^{18}, contact q^{19}, wire q^{20}, contact q^{21}, circuit-changing spring q^{22}, contact q^{23}, wire q^{24}, electro-magnet q, and wire q^{25} to the battery, as shown in Fig. 8. The electro-magnet q is thus again energized and caused to attract its armature, thus displacing the detent and permitting another operation of the motor, so that the conditions of the draft-regulating devices are again reversed. The operation thus continues, each change in the position of the thermostatic arm caused by a given variation of the temperature closing the circuit and causing the release of the motor and the movement of the current-changing device, so that whenever the thermostatic arm reaches an extreme of its movement it closes a circuit, reverses the conditions of the draft-regulating devices, and changes the direction of the current, thus breaking the circuit and preparing for the closing of the circuit when the thermostatic arm reaches the opposite extreme of its movement.

It will be seen that by the employment of the polarized relay in the circuit and a current changing or reversing device operated by the motor that moves the draft-regulating devices I am enabled to utilize a single circuit in releasing the motor preparatory to each operation of the draft-regulating devices.

I do not limit myself to the particular details of construction of the current reversing or changing devices, nor to the relative arrangement of the thermostatic circuit closing and breaking devices and the polarized relay herein shown and described, as the same may be varied in many particulars without departing from the spirit of my invention.

The thermostatic arm or bar q^9, which is composed of a plurality of strips of metal having different coefficients of expansion, is attached at one end to a post A, which is affixed to the hinged cover of a box or casing B, located in a room of the building heated by the heating apparatus controlled by my improved regulator. Said box contains the polarized relay, which is preferably attached to the cover of the box, as shown, the electrical connections between the contacts q^{10} q^{11} and the contact-springs q^{14} and q^{15} of the polarized relay being preferably posts C C, affixed to the cover and passing through the same. Portions of the wires q^8 and q^{18} are affixed to the cover of the box and are connected with the portions of said wires affixed to the body of the box through the hinges D D, Figs. 2 and 3. The wire q^8 on the cover is divided into two parts, as shown in Fig. 3, one of which extends from the post A to another post A′, while the other extends from one of the hinges D to a post A^2. A switch A^3 is pivotally connected with the post A′ and is adapted when in one position to connect the posts A′ and A^2, thus making the electrical connection between the main portion of the wire q^8 and the thermostatic arm complete. When said switch is thrown off from the post A^2, the connection between the main portion of wire q^{18} and the thermostatic arm is broken and the device will remain at rest, so that the motor cannot be operated until the switch is again returned to the post A^2.

In Fig. 4 I show as an additional means for locking or arresting the motor two arms h^4 h^4 on the shaft k, said arms being arranged to strike a spring k^5 on the armature q' when the latter is retracted, said spring being thus caused to arrest the train. If desired, the spring k^5 and arms h^4 may be relied on as the sole means for arresting the train, the detent p and notched wheel o being omitted. I prefer to employ both means, however, for the sake of greater certainty.

The current-reversing plates q^6 q^{22} are insulated from each other by insulation D and the contacts q^5, q^7, q^{19}, q^{21}, q^{23}, and q^{26} are supported by brackets E E of insulating material, Fig. 6.

I claim—

1. In a temperature-controlling apparatus, a single electric circuit having a thermostatic circuit-closing device and a polarized relay, combined with a damper-operating motor and a current-reversing device controlled by said motor, the armature of the polarized relay being adapted to be moved by each reversal of the current caused by said reversing device, as set forth.

2. In a temperature-controlling apparatus, the combination, with a motor adapted to alternately open and close a damper or draft-regulating device, of a detent which normally locks said motor, a single electric circuit, including an electro-magmet, which, when energized, displaces said detent and permits the operation of the motor, a current reversing or changing device operated by said motor, a polarized relay the armature of which is located between contact points or springs, and a thermostatic arm or bar located between contact-points which are electrically connected with the contact-points of the polarized armature, said thermostat closing the circuit by contact with either contact-point, and thereby energizing the electro-magnet and causing the release of the motor, the movement of the current-reversing device, the reversal of the direction of the current, and a change in the position of the relay-armature, as set forth.

3. In a temperature-controlling apparatus, the combination of a polarized relay, a thermostatic circuit-closing device, a damper opening and closing motor, a detent for said motor, electrical connections, substantially as described, comprising a single electric circuit, whereby the detent is displaced and the motor released by a closure of the circuit, and a current-reversing device operated by the motor, whereby each release of the motor is caused to reverse the direction of the current through the circuit and change the position of the relay-armature, as set forth.

4. The combination of the mechanically-impelled train or motor having a notched wheel on one of its shafts, a movable detent adapted to engage the notches of said wheel, an armature connected with said detent, an electro-magnet controlling said armature, a pivoted lever having current-reversing arms or springs and adapted to be moved by the motor, and a thermostatic arm or bar, a polarized relay, and electrical connections, substantially as described, including said current-reversing arms, thermostatic arm, and polarized relay, whereby upon each release of the motor caused by a closure of the circuit by a movement of the thermostatic arm the direction of the current is reversed and the armature of the relay is caused to make connections, whereby the next movement of the thermostatic arm will again close the circuit, as set forth.

In testimony whereof I have signed my name to this specification, in the presence of two subscribing witnesses, this 18th day of May, A. D. 1891.

CHARLES F. GOODHUE.

Witnesses:
C. F. BROWN,
A. D. HARRISON.