

March 3, 1931.

E. W. DENMAN

1,795,013

CONTROL SYSTEM

Filed May 21, 1927

2 Sheets-Sheet 1

Fig. 1.

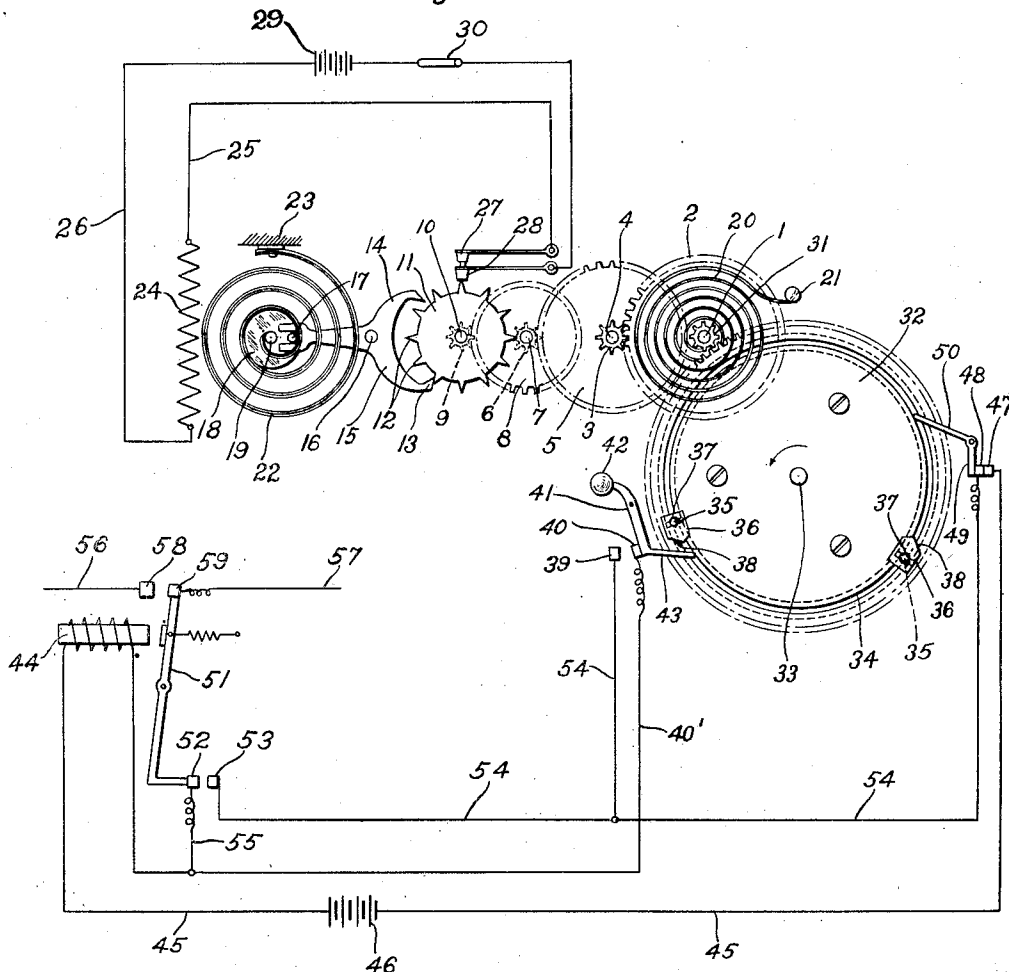
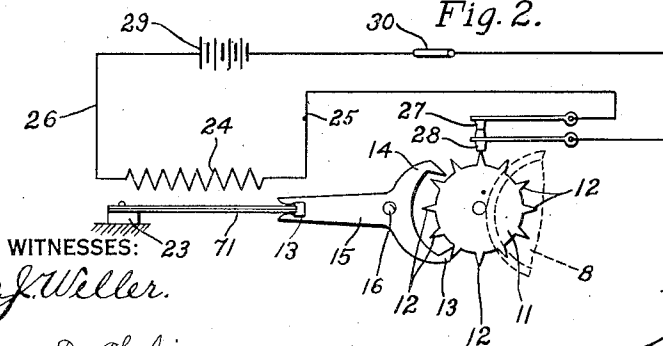


Fig. 2.



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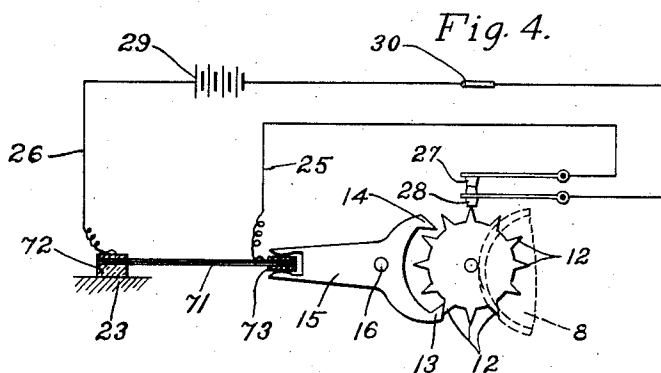
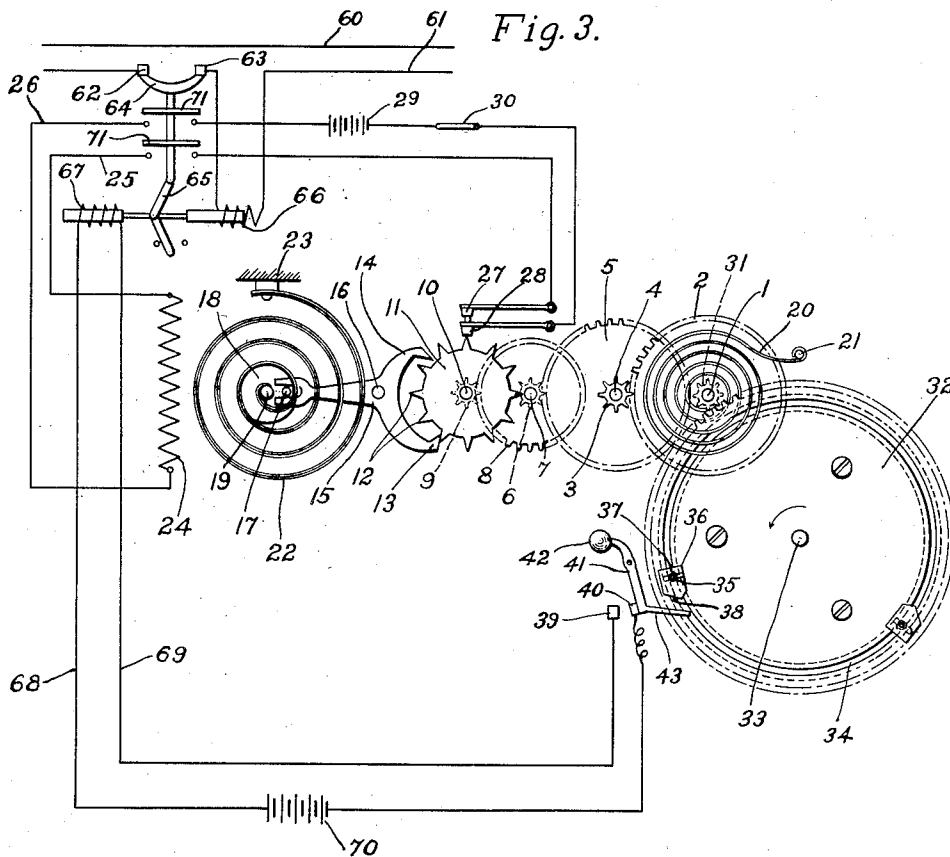
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CONTROL SYSTEM

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2 Sheets-Sheet 2



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CONTROL SYSTEM

Application filed May 21, 1927. Serial No. 193,222.

My invention relates to a control system and comprehends a method of and apparatus for effecting a control to produce an indication, vary the application of an agent, change the magnitude of a quantity or condition, or for any other desired purpose.

In accordance with my invention, the magnitude or rate of movement of a member actuated by a source of power and either directly or indirectly effecting the desired control is rendered independent of the quantity or amount of energy applied to said member by the source of power.

Further in accordance with my invention, the aforesaid source of power may comprise a spring motor actuating a gear train, movement of which is intermittently effected in response to changes in magnitude of current traversing an electrical circuit; and more particularly, intermittent movement of the gear train occurs in response to change in configuration of a device influenced by temperature varying in magnitude in accordance with said changing current.

My invention resides in the method, apparatus and system of the character hereinafter described and claimed.

For an understanding of my method and for an illustration of some of the forms my apparatus may take, reference is to be had to the accompanying drawings, in which;

Figure 1 is a diagrammatic view of apparatus constructed in accordance with my invention.

Fig. 2 is a diagrammatic view of apparatus of a modified form.

Fig. 3 is a diagrammatic view of apparatus of another modified form, and

Fig. 4 is a diagrammatic view of apparatus of still another modified form.

Referring to Fig. 1, there is illustrated a shaft 1, on which is disposed the gear wheel 2 meshing with and driving the pinion 3 mounted on a shaft 4. Carried by the shaft 4 is a second gear wheel 5 meshing with and driving the pinion 6 mounted on a shaft 7 carrying a gear wheel 8 meshing with and driving a pinion 9 mounted on a shaft 10. A ratchet element or disk 11 likewise mounted on the shaft 10 is provided with spaced, peripheral teeth

or projections 12 adapted to successively engage the spaced ends 13 and 14 of a lever 15 mounted for oscillatory movement on a pivot 16. Lever 15 is bifurcated for the reception of a pin 17 carried by a disk 18 disposed for oscillatory movement on a shaft 19.

As a motive device for actuating the aforesaid gear train, there may be utilized a spiral spring 20, one end of which is secured to the shaft 1 and the other end to a member 21 by which, upon movement in a clockwise direction, Fig. 1, the spring is wound.

The structural arrangement described above constitutes an escapement device of a well-known kind, and is commonly used as the actuating mechanism for clocks. In operation, the rate at which the lever 15 oscillates is dependent upon the amount of energy stored in the spring motor 20, since, as is well understood, the energy imparting oscillatory movement to the lever 15 is transferred thereto from the spring motor by way of the intervening gear wheels and ratchet 11. From the standpoint of accurate time indication, particularly during a short period, such an arrangement is objectionable in that the spring motor 20 when first wound, releases its energy at a greater rate than it does during a substantially later period. With the ordinary clock, however, this mode of operation is generally unobjectionable, particularly over a long period of time, since the abnormal rapid rate at which it first operates is counteracted by a subsequent abnormal slower rate.

In accordance with my invention, the rate of movement of the above-described gear train or any member comprised therein is controlled independently of the spring motor 20 and hence the rate at which the spring unwinds is rendered independent of the amount of energy stored therein. To this end, as illustrated in Fig. 1, either the shaft 19 or the disk 18 has secured thereto one end of a member 22 having the characteristic of changing its configuration in response to temperature change. In the example illustrated, member 22 is a bimetallic strip comprising dissimilar elements, for example, steel and brass, steel and nickel, or the like. At its other end, element 22 is secured to a fixed support 23.

As one example of an arrangement for controlling the configuration of the element 22, there is illustrated in Fig. 1, a resistor 24 so arranged with respect to said element 22 that upon passage of an electric current there-
 through with consequent generation of heat, the heat is applied to the element 22. In the example illustrated, the resistor 24 is included in a circuit comprising the conductors 25 and 26, the former terminating in the fixed contact 27, and the latter in the movable contact 28. As hereinafter described, contact 28, upon actuation by a tooth 12, is moved into engagement with the fixed contact 27. Included in the aforesaid circuit is a source of current 29 and a switch 30.

With the parts in the position illustrated in Fig. 1, current traverses the resistor 24 with consequent generation of heat, thereby causing the element 22 to change its configuration and impart counter-clockwise rotation to disk 18 and projection 17, whereby the lever 15 is gradually rotated in a clockwise direction. Eventually, the end 13 of said lever 15 becomes detached from the tooth 12 engaged thereby, and spring 20 rotates the gear train and ratchet 11 until a tooth 12 engages the end 14 of the lever 15. In so doing, the tooth 12 heretofore engaging the movable contact 28 passes from engagement therewith, and, since the permissible rotation of the ratchet 11 for each operation of lever 15 is one-half the distance between neighboring teeth 12, contact 28 assumes a position removed from contact 27, and in so doing breaks the circuit through resistor 24. Generation of heat by the resistor 24 now ceases, and as the spiral bimetallic element 22 cools, it tends to wind itself more tightly, with consequent movement of disk 18 and projection 17 in a clockwise direction, Fig. 1. Eventually, such movement of disk 18 causes the tooth 14 of lever 15 to become detached from the tooth 12 coacting therewith. Thereupon, spring 20 again becomes effective to rotate the gear train and ratchet 11 until a tooth 12 thereon comes into engagement with end 13 of lever 15. Thus intermittently the lever 15 is actuated to permit release of a fraction of the energy stored in spring 20. By properly designing the bimetallic element 22 and heating resistor 24, operation of the lever 14 to release the gear train may be effected during intervals of substantially exact uniformity, and the magnitude of these intervals is not dependent upon the amount of energy stored in the spring motor 20.

Movement for control purposes may be obtained from any part of the above-described movable system. To this end and in the example illustrated, shaft 1 has connected thereto a pinion 31 meshing with and driving a gear 32 mounted on a shaft 33. The gear ratio may be such that gear 32 rotates but once during any desired period, for example,

once during each twenty-four hours. Concentric with the shaft 33 and adjacent the periphery of gear 32 is a T-shaped slot 34, the wider portion of which receives the head of a bolt 35 passing through a member 36, a nut 37 on the end of bolt 35 serving to clamp the member 36 in any desired adjusted position. Any number of the members 36 may be provided, depending upon the type of control desired and each preferably comprises a cam face 38.

Suitably arranged adjacent the gear 32 is a fixed contact 39 with which coacts a contact 40 mounted on a pivoted lever 41, suitably biased in a counter-clockwise direction, Fig. 1, as by the weight 42. Lever 41 comprises a projection or member 43 adapted when actuated by the cam face of a member 36 to cause said lever 41 to be swung in a clockwise direction Fig. 1, to bring contact 40 into engagement with contact 39. A conductor 40' connects the movable contact 40 to one end of the winding of a relay 44, the other end of the relay winding being connected by a conductor 45 through a battery, or other source of electrical energy 46, to a fixed contact 47 with which coacts a contact 48 mounted on a pivoted lever 49 having an actuating arm 50 extending into the path of the members 36.

The relay 44, when energized, rotates its armature 51 in a counter-clockwise direction, Fig. 1, and moves a contact 52 into engagement with a contact 53 connected by a conductor 54 to the aforesaid fixed contact 39 and to the aforesaid movable contact 48. Contact 52 is connected by a conductor 55 with the aforesaid conductor 40' which, as heretofore stated, branches from the movable contact 40.

In the example illustrated, relay 44 controls an electrical circuit comprising the conductors 56 and 57, the former being connected to a fixed contact 58, and the latter to a contact 59 carried by armature 51. Current traversing the conductors 56 and 57 may be utilized for any desired purpose, as for power, illumination, or otherwise. For example, the conductors 56 and 57 may include the resistors of an electrical range, or the like.

The operation is as follows:

Having determined the time at which closure of the circuit comprising conductors 56 and 57 is desired, a member 36 is fixed in such position on gear 32 that, at the selected time, cam face 38 by engagement with member 43 will move contact 40 into engagement with contact 39. Thereupon, relay 44 is energized and the circuit comprising the conductors 56 and 57 is closed at its contacts 58 and 59.

When relay 44 attracted its armature 51, contact 52 moved into engagement with contact 53 to close a locking circuit for said relay through the contacts 47 and 48, but not through the contacts 39 and 40. According-

ly, as member 36 passes beyond the member 43 and the lever 41 swings in a counter-clockwise direction, Fig. 1, under the influence of its weight 42, the circuit through relay 44 is not opened.

After predetermined time according to the setting of another member 36, the lever 49 is engaged thereby and swung in a clockwise direction, Fig. 1, and the circuit through relay 44 is opened at the contacts 47 and 48. As a result, the circuit comprising the conductors 56 and 57 is opened with consequent discontinuance of operation of the device included in that circuit.

Although my invention has been herein illustrated as controlling passage of electrical current in a circuit, it shall be understood that the application or supply of any other agent, as chemical, physical, mechanical, or the like may be controlled. Further, the motive device 20 itself, or equivalent, or any member driven thereby may be utilized for effecting any other type of control, indication, or other desired purpose.

In Fig. 3, there is illustrated a phase of my invention wherein the occurrence of some event instigates operation of the control system, which thereupon functions after the lapse of a predetermined period, to perform any desired act, as the restoration of the condition existing before occurrence of the aforesaid event. In accordance with this form of my invention, there is illustrated a circuit comprising the conductors 60 and 61 in one of which are interposed the fixed contacts 62 and 63 bridged by the circuit-closing member 64 of a switch or circuit breaker comprising the operating toggle 65, moved to position, opening the circuit at contacts 62, 63 by a relay or winding 66 responsive to some abnormal condition, as overload in the circuit comprising the conductors 60 and 61. For moving the aforesaid toggle in reverse direction, or to position closing the circuit of conductors 60 and 61, there may be utilized the relay or winding 67 connected by conductors 68 and 69 to the aforesaid fixed and movable contacts 39 and 40, a battery 70 being included in one of the conductors 68 or 69.

Movable with the aforesaid switch or circuit breaker is or are one or more contact members 71 adapted, when the circuit breaker is in closed and open positions, respectively, to break and close the circuit through the resistor 24.

Upon occurrence of abnormal condition in the circuit comprising the conductors 60 and 61, relay 66 is energized and member 64 moves downwardly, Fig. 3. The circuit through resistor 24 is closed and the control mechanism placed in operation. After the lapse of a predetermined time, which may be selected by placing member 36 in a desired position on gear 32, cam face 38 of member 36 coacting with member 43 closes contact 40

on contact 39 and energizes winding 67. As a result, the circuit breaker is closed and the circuit through resistor 24 opened by the members 71.

In Fig. 2, there is illustrated a form of my invention wherein a substantially plane-web-like bimetallic element 71 is utilized in lieu of the hereinbefore described spiral element 22. Obviously, in response to alternation and fall of temperature, the element 71 deflects first in one direction and then in reverse direction to oscillate the member 15.

In Fig. 4, a bimetallic element of the character illustrated in Fig. 2, is shown as connected directly in the circuit of conductors 25 and 26. With such an arrangement, there should be utilized the blocks 72 and 73 insulating the element 71 from the fixed support 23 and oscillatory member 15.

In those cases where a resistor, as member 24, is utilized for heating purposes, it is desirable that it be wound as a cylindrical coil and that the bimetallic element be positioned therewithin.

It shall be understood that the circuit comprising the conductors 25 and 26 may be utilized for any desired purpose in addition to its intended function of controlling the temperature of the bimetallic element. For example, lights to be flashed might be included in said circuit or there might be included structure for periodically changing the application of power.

In the appended claims, the expression "variable source of power" shall be understood as comprehending a device or structure, as the herein disclosed spring motor 20, a storage battery, or the like, wherein the energy output or tractive effort is greater during one period than it is during another period of the same length.

I claim as my invention:

1. A control system comprising a variable source of power, means for utilizing said source of power to effect a control, and means for mechanically controlling the application of said power by an element responsive to temperature change.

2. The combination with a source of power and means for utilizing said source of power to effect a control, of a temperature responsive device controlling the application of said power, and means for varying the temperature of said device.

3. The combination with a source of power and means for utilizing said source of power to effect a control, of a temperature responsive device controlling the application of said power, and means controlled by said source of power and comprising a circuit traversed by a varying electrical current for changing the temperature of said device.

4. The combination with a source of power and a member driven thereby, of means controlling said member for intermittent opera-

tion, and means for intermittently operating said first-named means comprising an electrical circuit alternately opened and closed by said member.

5 5. The combination with a source of power and a gear train including a ratchet wheel, of a member coacting with said ratchet wheel, and means for intermittently actuating said member to permit intermittent operation of
10 said gear train comprising an element influenced independently of said source of power.

6. The combination with a spring motor and a gear train controlled thereby and including a ratchet wheel, of a member co-acting
15 with said ratchet wheel, and means for intermittently actuating said member to permit intermittent operation of said gear train comprising an element influenced independently of said source of power.
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7. The combination with a spring motor and a gear train controlled thereby and including a ratchet wheel, of a member co-acting with said ratchet wheel, a temperature responsive device co-acting with said member,
25 and means for varying the temperature of said device.

8. The combination with a spring motor and a gear train controlled thereby and including a ratchet wheel, of a member co-acting with said ratchet wheel, a temperature responsive device co-acting with said member,
30 and means for varying the temperature of said device comprising an electrical circuit controlled by said spring motor.
35

9. The combination with a spring motor and a gear train controlled thereby and including a ratchet wheel, of a member co-acting with said ratchet wheel, a temperature responsive device co-acting with said member,
40 and means for controlling the temperature of said device comprising an electrical circuit alternately opened and closed by said ratchet wheel.

45 In testimony whereof, I have hereunto subscribed my name this 7th day of May 1927.

EARL W. DENMAN.

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