Jan. 7, 1936. J. D. ROSS 2,026,596

AUTOMATIC CONTROLLING DEVICE

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Fig. 1.

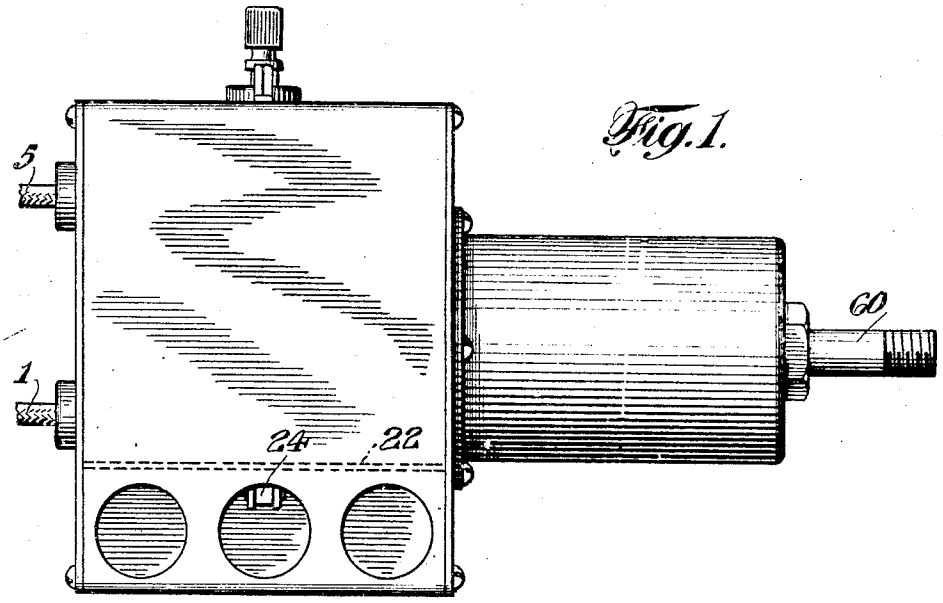



Fig. 2.

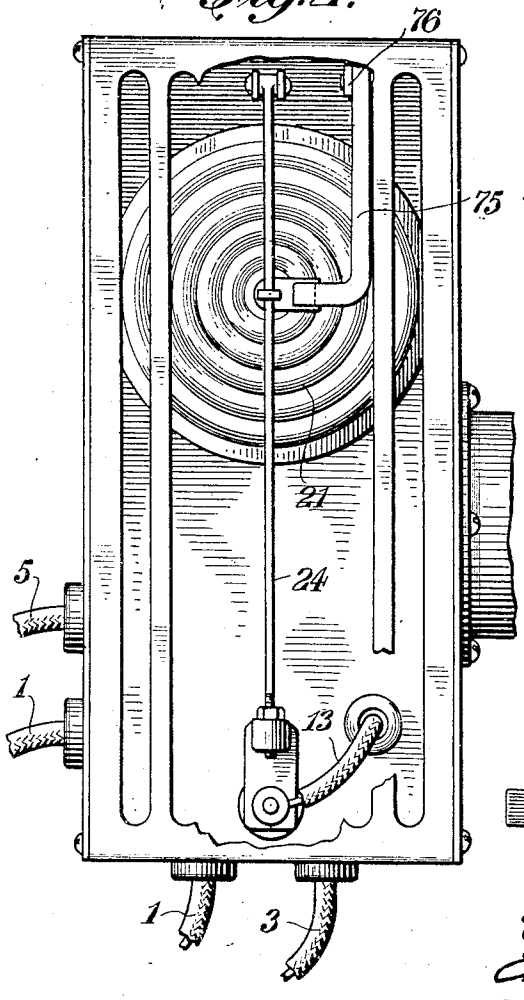
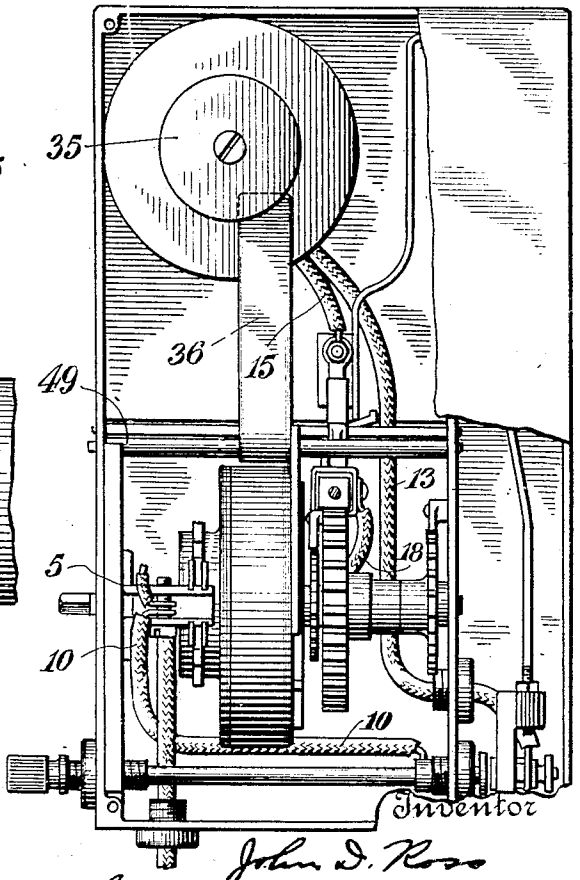



Fig. 3.




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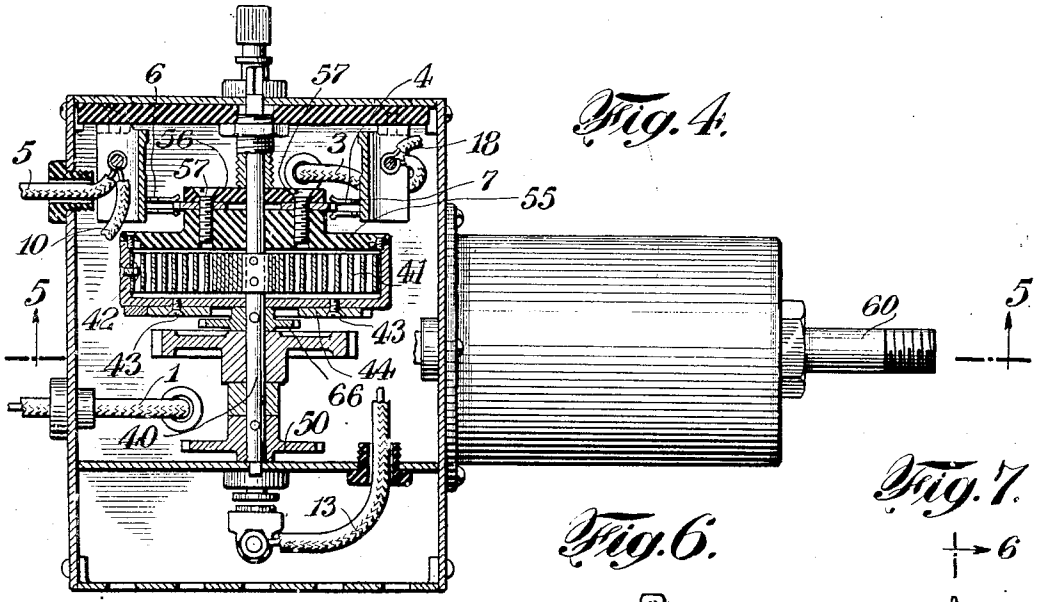



Fig. 4.

Fig. 7.

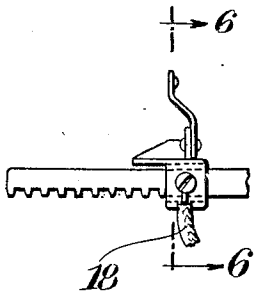



Fig. 6.

Fig. 5.




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AUTOMATIC CONTROLLING DEVICE

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Fig. 8.

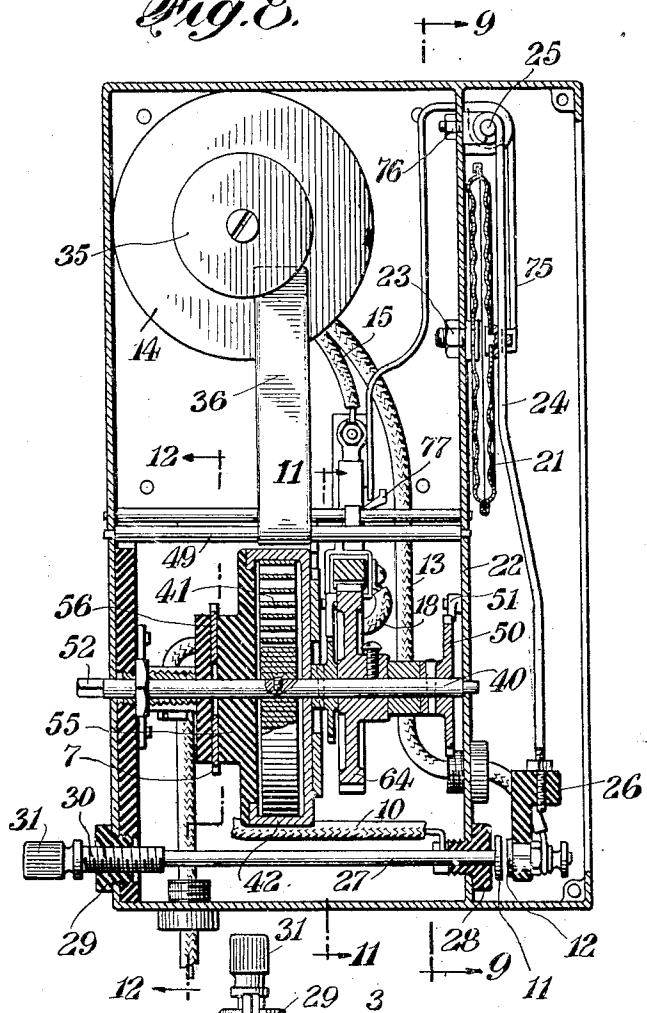



Fig. 9.

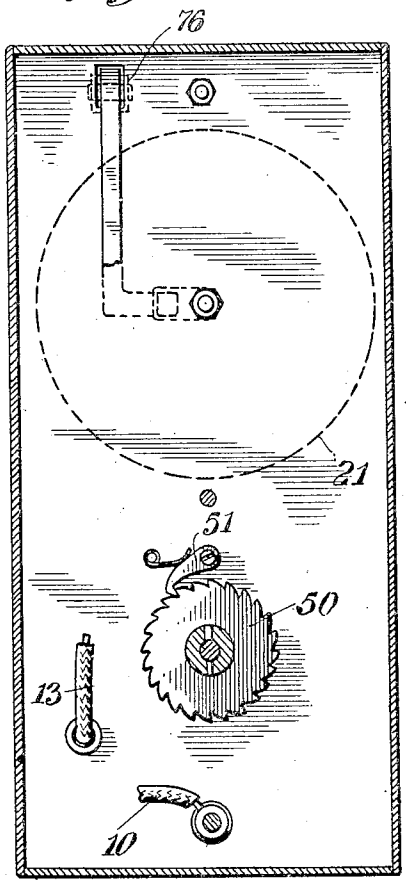
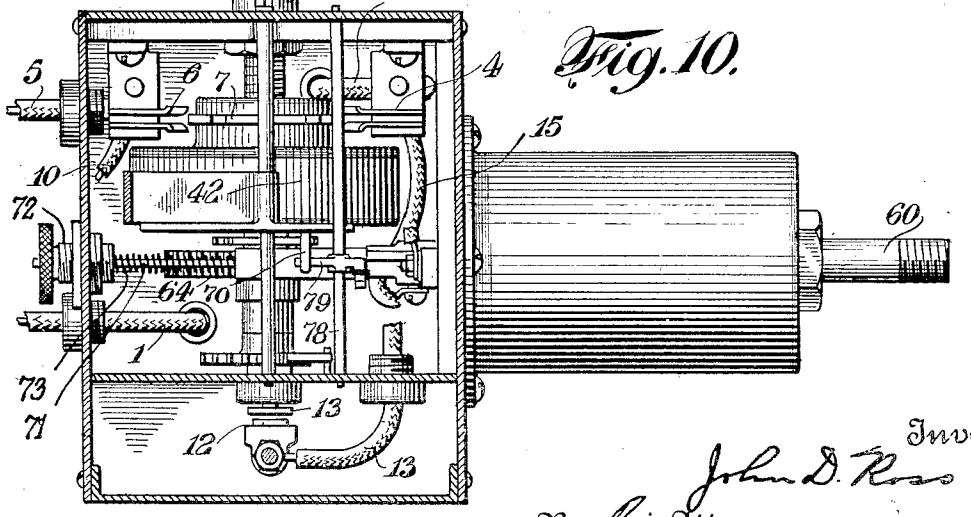



Fig. 10.




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AUTOMATIC CONTROLLING DEVICE

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Fig. 11.

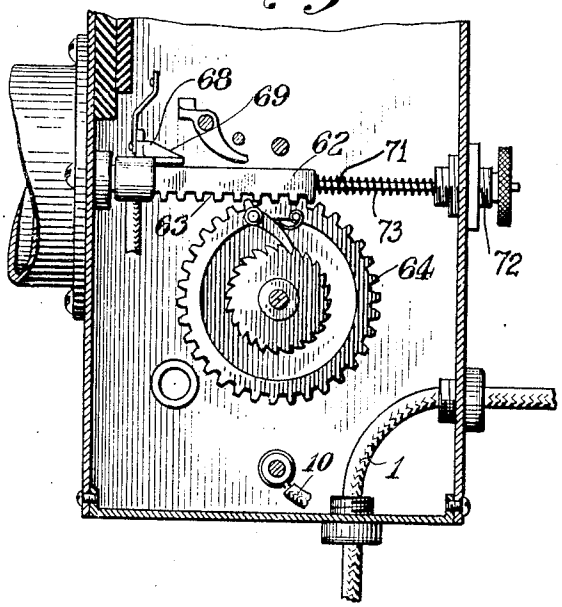



Fig. 12.

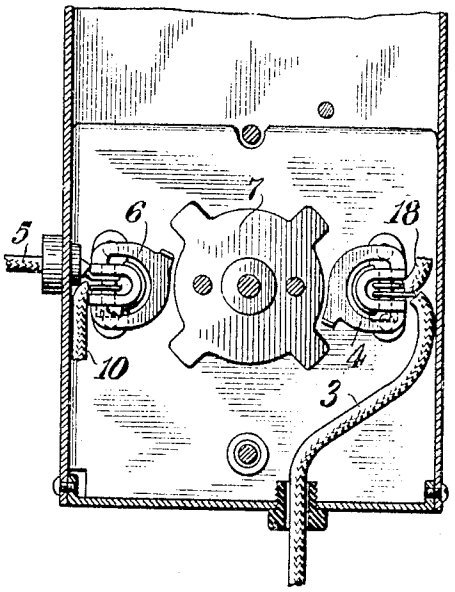



Fig. 13.

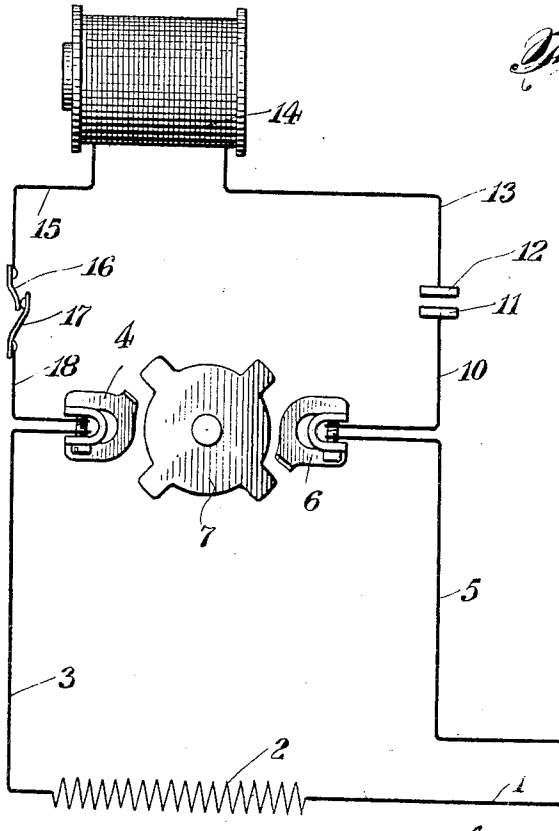
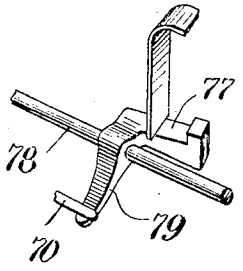



Fig. 14.




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Patented Jan. 7, 1936

2,026,596

# UNITED STATES PATENT OFFICE

2,026,596

## AUTOMATIC CONTROLLING DEVICE

John D. Ross, Bangor, Maine

Application May 24, 1926, Serial No. 111,469

32 Claims. (Cl. 219—20)

This invention relates to automatic controlling devices, and pertains more particularly to apparatus adapted to control the application of electric energy to a consumer element.

It is an object of this invention to provide a main circuit in which said consumer element is included, and a controlling circuit in which are included certain controlling elements, and to provide means including temperature and pressure sensitive elements adapted to cause said main circuit to be made or broken whenever certain predetermined conditions are attained.

Other objects and advantages of the invention will appear hereinafter.

A preferred embodiment of the invention selected for purposes of illustration is shown in the accompanying drawings, in which,

Figure 1 is a top plan view.

Figure 2 is a side elevation.

Figure 3 is a front elevation, part of the cover being broken away to better disclose the interior mechanism.

Figure 4 is a section on the line 4—4 of Figure 5.

Figure 5 is a section on the line 5—5 of Figure 4.

Figures 6 and 7 are detail views.

Figure 8 is a section on the line 8—8 of Figure 5.

Figure 9 is a section on the line 9—9 of Figure 8.

Figure 10 is a section on the line 10—10 of Figure 5.

Figure 11 is a section on the line 11—11 of Figure 8.

Figure 12 is a section on the line 12—12 of Figure 8.

Figure 13 is a semi-diagrammatic view illustrating the electrical circuits.

Figure 14 is a detail perspective view.

In the preferred embodiment illustrated, the invention has been applied to the control of an electric heating element such as may be used in connection with electrically heated steam radiators, for example, and will be particularly described with reference thereto. As will be apparent to those skilled in the art from the following description, however, the invention is susceptible of use in various other relations where it is desired to control the application of electric energy in accordance with predetermined temperature or pressure conditions. When used in connection with electrically heated steam radiators, the consumer element (shown diagrammatically in Figure 13) is inserted in the bottom of a radiator and is used to heat water contained therein to generate steam as will be understood.

Referring to the drawings and particularly to Figure 13 thereof, the lead 1 from a suitable source of electric current is connected to the consumer or heating element 2 which is connected by the lead 3 to the contact 4. A second lead 5 from the source of current is connected to the contact 6, so that when the rotary switch member 7 of the switch mechanism hereinafter described is rotated to bridge the contacts 4 and 6, current passes through the heating element 2 to heat the same. This circuit may be called the main circuit.

Also connected to contact 6 is a lead 10 to the contact 11 which with contact 12 forms part of one of the controlling elements. Contacts 11 and 12 are normally open but may be closed as hereinafter described. Lead 13 connects the contact 12 with electro-magnet 14 forming part of the switch operating mechanism hereinafter described, and lead 15 connects said magnet with contact 16 which with contact 17 forms part of another controlling element. Contacts 16 and 17 are normally closed but may be opened as hereinafter described. Contact 17 is connected by the lead 18 to contact 4. This circuit may be called the controlling circuit and is connected, as will be apparent, to the main circuit at points in one and the same side of said main circuit, and preferably on opposite sides of said switch.

If the parts are in the normal position shown in Figure 13, it will be observed that the main circuit 1, 2, 3, 5 is open and the controlling circuit 10, 13, 14, 15, 18 is also open, contacts 11 and 12 being separated. If, under these conditions, contacts 11 and 12 are closed, the magnet 14 is energized to rotate the switch member 7, in a manner hereinafter described, to bridge the contacts 4 and 6, thereby closing the main circuit so that electrical energy is supplied to the consumer element 2. As will be understood, the resistance interposed by the consumer element materially reduces the voltage of the current passing through the controlling circuit before the switch member 7 closes, but after the switch 7 is closed, current ceases to pass through the controlling circuit, so that no arcing occurs between the contacts 11 and 12, even though these may be separated very gradually. Thus the current supplied to the controlling circuit is in the nature of a mere impulse which is started when contacts 11 and 12 are closed and which is terminated as soon as switch 7 is closed in response to the impulse.

Contacts 11 and 12 form part of a thermostatic control element best shown in Figures 2, 8 and 9, employing in the apparatus illustrated the tem-

perature sensitive diaphragm 21 which, as shown in Figure 8, is attached to the partition 22 of the casing by means of the bolt 23. The diaphragm may be filled with a readily expansible gas such as ether, and the free side of the diaphragm may be attached to the rod 24 pivoted to the partition 22 at 25. The lower end of the rod 24 carries a block of insulating material 26 into which the contact 12 is fitted. Positioned opposite to contact 12 is contact 11 which is carried on the rod 27 which is rotatably mounted in the insulators 28 and 29, the insulator 29 being threaded to cooperate with the threaded end 30 of the rod in order that the contacts 11 and 12 may be adjusted, by turning the knurled head 31, to close at any desired temperature. Closing of the contacts 11 and 12 energizes the electromagnet 14 to actuate the armature 35 and the arm 36 to permit rotation of the switch member 7 to close the main circuit in a manner hereinafter described.

Carried in the partition 22 and the outer wall of the casing is a shaft 40 (see Figures 4 and 8) to which is attached one end of the coil spring 41, the other end of which is attached to a spring housing 42 loosely mounted on the shaft 40. Secured to the housing 42 by means of the screws 43 is a plate 44, the outer periphery of which (as shown in Figure 5) is provided with a series of projections 45, 45*a*, 45*b* and 45*c* to cooperate with the detents 46 and 47 of the lever 48 secured to a rod 49 mounted in the partition 22 and the casing. Fixed to the shaft 40 (see Figures 4 and 8) is a ratchet wheel 50 which cooperates with the pawl 51 to hold the spring 41 under tension. The shaft 40 is provided with a squared end 52 so that by means of a key, the shaft 40 may be rotated to initially tension the spring 41.

Referring again to Figure 5, it will be apparent that if the electro-magnet 14 is energized the armature 35 will be drawn to the right and the arm 36 will be actuated to rotate the shaft 49 and lever 48 to release the engagement of the detent 46 with the projection 45, but at the same time to cause the detent 47 to be interposed into the path of the opposite projection 45*b* which is caused to rotate toward it by the tensioned spring 41.

Reverting to Figure 4 and 8, there are also secured to the spring housing 42 disks of insulating material 55 and 56, between which is secured, by means of the screws 57, the rotary switch member 7 before referred to. Thus, as the housing 42 and disk 44 rotate when the detent 46 is released, the switch member 7 is also rotated to bridge the contacts 4 and 6 to close the main circuit.

As soon as the main circuit is closed the heating element begins to generate steam in the radiator, and continues to do so until the main circuit is broken. In order to break the circuit the steam pressure created within the radiator may be conveniently used. For this purpose (see Figures 5 and 10) the pipe 60 may be provided having a threaded end for connection to the outer wall of the radiator. This pipe is connected to the interior of a sylphon bellows 61, having a floating face 61*a* which is connected to the shaft 62. The other end of the shaft 62 is provided with rack teeth 63 which cooperate with the pinion 64 which carries a pawl 65 to engage the ratchet wheel 66 which is rigidly secured to the shaft 40. Between the floating end of the sylphon bellows 61 and the casing is mounted a spring 67 which normally compresses the bellows to collapse the same. As soon as sufficient pressure is built up in the radiator to overcome the tension of the spring 67, however, the shaft 62 is thrust toward the left thus rotating the pinion 64 and the shaft 40 to rewind the spring 41.

The shaft 62 also carries a dog 68 having a bevelled face 69 adapted to engage the pin 70 carried by the lever 48 to lift the same to disengage the detent 47 from projection 45*b* to permit rotation of the spring housing and switch member 7 to open the main circuit, and to cause re-engagement of the detent 46 with the next successive projection 45 to hold the switch member 7 in open position. Also attached to the shaft 62 is the contact 17 which moves with the shaft away from contact 16, with which it is normally in engagement, to break the controlling circuit for purposes hereinafter described.

In order that the pressure static mechanism just described may be adjusted to permit the breaking of the main circuit at any desired pressure, the rod 71 is connected to shaft 62 in any suitable manner and projects through the casing. Surrounding the rod 71 is a sleeve 72 having a knurled head and exterior threads Also surrounding the rod 71 and located between the sleeve 72 and shaft 62 is a coil spring 73. As will be apparent by turning the sleeve 72 the compression on the spring 73 may be increased or decreased, thus increasing or decreasing the pressure necessary to expand the sylphon bellows 61 to break the main circuit.

Thus it will be observed that the normal condition of the apparatus with the room temperature at or above normal is as illustrated. Referring now to Figure 8, if the room temperature falls below that for which the thermostatic control element is set, the diaphragm 21 collapses until the contacts 11 and 12 close, whereupon the electromagnet 14 is energized and the switch mechanism is rotated to bridge the terminals 4 and 6. Energy is then supplied to the consumer element until the steam pressure created in the radiator is sufficient to operate the bellows 61, in which case the switch mechanism is again operated to break the circuit and at the same time the spring 42 is rewound.

If the room temperature has been raised sufficiently to break the contacts 11 and 12, the main circuit remains broken until the room temperature is again lowered. On the other hand, if the room temperature is still below normal, the contacts 11 and 12 would remain closed. In order to prevent closing of the main circuit under these conditions, therefore, the contacts 16 and 17 are provided (see Figures 5 and 13) the contact 16 being mounted on the insulating block 74 and the contact 17 being mounted on the shaft 62. When the bellows 61 is collapsed, the contacts 16 and 17 are closed, but when the bellows 61 is expanded contacts 16 and 17 are open, and even though contacts 11 and 12 may be closed, the controlling circuit cannot be closed to close the main circuit until the pressure within the radiator decreases sufficiently to permit contacts 16 and 17 to close.

Under certain conditions, it may be desirable that the application of the electric energy to the consumer element be controlled entirely by temperature, and that the main circuit be broken by operation of the temperature sensitive element either as a substitute for the pressure means previously described, or as an auxiliary thereto. Accordingly, the arm 75 (see Figure 8) is connected to the rod 24 and is pivoted at 76 to the partition 22 and extends therethrough to engage the cam 77 (see Figure 14) mounted on the shaft

78. Formed integrally with the cam 77 is a finger 79 (see Figures 5 and 14) adapted to cooperate with pin 70 to trip the lever 48. As will be apparent, whenever the diaphragm 21 is expanded sufficiently, the arm 75 is moved to depress the cam 77 to cause the finger 79 to engage the pin 70 to trip the lever 48 thus breaking the main circuit.

In the preferred embodiment of the invention disclosed and described herein the means just described serves as an auxiliary means in the nature of a safety device. Thus, if for any reason the sylphon bellows 61 should fail to operate, as soon as the room temperature is raised above a predetermined degree the main circuit is broken and current ceases to be supplied to the consumer element. It will be apparent, however, that under certain conditions it might be desirable to dispense with the pressure element entirely, and to control the making and breaking of the main circuit simply by means of the temperature sensitive element. Thus if the temperature should drop below a predetermined minimum, the circuit would be made, while if the temperature is increased beyond a predetermined maximum the circuit would be broken.

It is to be understood that the invention may be variously modified and embodied within the scope of the subjoined claims.

I claim as my invention:

1. In a controlling apparatus, in combination, a switch, a mechanical motor for operating said switch, escapement mechanism interposed between said motor and said switch, means including a temperature-responsive element for controlling said escapement mechanism, and means including a pressure-responsive element for controlling said escapement mechanism.

2. In a controlling apparatus, in combination, a switch, a mechanical motor for operating said switch, escapement mechanism interposed between said motor and said switch, means including a temperature-responsive element for controlling said escapement mechanism, means including a pressure-responsive element for controlling said escapement mechanism, and means responsive to the actuation of one of said responsive elements for storing energy in said mechanical motor.

3. In a controlling apparatus, in combination, a main circuit, means for making and breaking said circuit, a controlling circuit, means in said controlling circuit for controlling said circuit making means, said circuits being so arranged that the closing of said main circuit entirely short circuits said controlling circuit.

4. In a controlling apparatus, in combination, a main circuit having a switch therein, and a controlling circuit having means therein to control said switch, said controlling circuit being connected to said main circuit at points directly on each side of said switch.

5. In a controlling apparatus, in combination, a switch, a mechanical motor for operating said switch, escapement mechanism interposed between said motor and said switch, a coil shunted about the contacts of said switch for controlling said escapement mechanism, and a temperature-responsive switch for controlling said coil.

6. In a controlling apparatus, in combination, a switch, a mechanical motor for operating said switch, escapement mechanism interposed between said motor and said switch, a coil shunted about the contacts of said switch for controlling said escapement mechanism, a temperature-responsive switch for controlling said coil, and pressure-responsive means for controlling said escapement mechanism.

7. In a controlling apparatus, in combination, a switch, a mechanical motor for operating said switch, escapement mechanism interposed between said motor and said switch, a coil shunted about the contacts of said switch for controlling said escapement mechanism, a temperature-responsive switch for controlling said coil, and pressure-responsive means for preventing said temperature-responsive means from causing actuation of said switch in circuit-closing direction.

8. In a controlling apparatus, in combination, a switch, a mechanical motor for operating said switch, escapement mechanism interposed between said motor and said switch, a coil shunted about the contacts of said switch for controlling said escapement mechanism, a temperature-responsive switch for controlling said coil, pressure-responsive means for controlling said escapement mechanism, and means under the control of said pressure-responsive means for controlling the circuit of said coil.

9. In a controlling apparatus, in combination, a main circuit having a control switch therein, a controlling circuit connected directly to opposite sides of said switch, a switch in said controlling circuit, and temperature sensitive means for operating said controlling circuit switch.

10. In a controlling apparatus, in combination, a main circuit having a control switch therein, a controlling circuit having a plurality of switches and an electro-magnet therein, means including a temperature sensitive element for operating one of said controlling circuit switches, means operated by said electro-magnet to close said main circuit switch when said temperature sensitive element closes said controlling circuit, means including a pressure sensitive element to open said main circuit switch, and means operated by said last named means to operate another of said controlling circuit switches.

11. In a controlling apparatus, in combination, a main circuit having a switch therein, a controlling circuit connected to said main circuit at points in one and the same side of said main circuit and on opposite sides of said switch, a plurality of switches in said controlling circuit, an electro-magnet in said controlling circuit, means including a temperature sensitive element for operating one of said controlling circuit switches, means operated by said electro-magnet to close said main circuit switch when said temperature sensitive element closes said controlling circuit, means including a pressure sensitive element to open said main circuit switch, and means operated by said last named means to operate another of said controlling circuit switches.

12. In a controlling apparatus, a rotatable switch, means including a spring to rotate said switch to open and close the same, an escapement mechanism to control the rotation of said switch, and means including temperature and pressure sensitive elements to operate said escapement mechanism.

13. In a controlling apparatus, a rotatable switch, means including a spring to rotate said switch to open and close the same, means to initially tension said spring, and means including a pressure sensitive element to rewind the same.

14. In a controlling apparatus, a rotatable switch, means including a spring to rotate said switch to open and close the same, an escapement mechanism to control the rotation of said

switch, means to operate said escapement mechanism, and means including a pressure sensitive element to rewind said spring after operation of said escapement mechanism.

15. In a controlling apparatus, a rotatable switch, means including a spring to rotate said switch to open and close the same, an escapement mechanism to control the rotation of said switch, means including a temperature sensitive element to actuate said escapement mechanism, and means including a pressure sensitive element to actuate said escapement mechanism.

16. In a controlling apparatus, in combination, a main circuit having a control switch therein, a controlling circuit having a switch therein, temperature sensitive means for opening and closing said controlling circuit switch, means whereby closing of said controlling circuit switch causes said main circuit switch to be closed, and means operating independently of said controlling circuit whereby movement of said temperature sensitive means in one direction beyond a predetermined limit causes said main circuit switch to be opened.

17. In a controlling apparatus, in combination, a main circuit having a switch therein, a controlling circuit connected to said main circuit at points in one and the same side of said main circuit and on opposite sides of said switch, a switch in said controlling circuit, temperature sensitive means for operating said controlling circuit switch, means whereby closing of said controlling circuit switch causes said main circuit switch to be closed, and means operating independently of said controlling circuit whereby movement of said temperature sensitive means in one direction beyond a predetermined limit causes said main circuit switch to be opened.

18. In a controlling apparatus, a heating element, means including a main circuit to connect said element to a source of electric energy, a switch in said circuit, means including a temperature sensitive element and an electro-magnetic element to close said switch and circuit to heat said element, means including a latch to hold said switch in closed position, and means including a pressure sensitive element responsive to pressures created by operation of said heating element to release said latch to open said switch and circuit.

19. In a controlling apparatus, in combination, a control switch, means including a temperature element and an electro-magnet for controlling said switch, means distinct from the first mentioned means including a pressure sensitive element for additionally controlling said switch, and means including the temperature sensitive element supplementing said second mentioned means for additionally controlling said switch.

20. In a controlling apparatus, in combination, a switch, a supply of releasable energy adapted when released to move said switch, means for controlling the release of the energy from said supply, pressure-responsive means for controlling said controlling means, and means for storing energy in said supply upon actuation of said pressure-responsive means.

21. In a controlling apparatus, in combination, a switch, a supply of releasable energy adapted when released to move said switch, means for controlling the release of the energy from said supply, and means responsive to a condition resulting from the closure of said switch for controlling said controlling means.

22. In a controlling apparatus, in combination, a switch, a supply of releasable energy adapted when released to move said switch, means for controlling the release of the energy from said supply, means responsive to a condition resulting from the closure of said switch for controlling said controlling means, and means for storing energy in said supply and under the control of said responsive means.

23. In a controlling apparatus, in combination, a switch, a supply of releasable energy adapted when released to move said switch, means for controlling the release of the energy from said supply, a coil for controlling said controlling means, a switch for controlling said coil, a temperature-responsive element, and a pressure-responsive element, one of said elements controlling said coil-controlling switch and the other of said elements controlling said first-mentioned controlling means.

24. In a controlling apparatus, in combination, a switch, a supply of releasable energy adapted when released to move said switch, means for controlling the release of the energy from said supply, a coil bridged across the contacts of said switch for controlling said controlling means, an element responsive to one extreme of a condition under the control of said switch for actuating said controlling means to cause released energy from said supply to open said switch, and a switch in the circuit of said coil, said element closing said last-mentioned switch in response to the other extreme of said condition.

25. In a controlling apparatus, in combination, a switch, a spring motor for operating said switch, an escapement mechanism for controlling the operation of said motor, temperature-responsive means for controlling said escapement mechanism, and means responsive to a condition resulting from operation of said switch for winding said spring motor.

26. In a controlling apparatus, in combination, a switch, a spring motor for operating said switch, an escapement mechanism for controlling the operation of said motor, and means responsive to conditions controlled by said switch for controlling said escapement mechanism.

27. In a controlling apparatus, in combination, a switch, a spring motor for operating said switch, an escapement mechanism for controlling the operation of said motor, means responsive to conditions controlled by said switch for controlling said escapement mechanism, and means under the control of said main switch for rewinding said spring motor.

28. In a controlling apparatus, in combination, a switch, a spring motor for operating said switch, an escapement mechanism for controlling the operation of said motor, a temperature-responsive element, means responsive to actuation of said element in one direction for actuating said escapement mechanism, and means responsive to actuation of said element in the other direction for actuating said escapement mechanism.

29. In a controlling apparatus, in combination, a switch, a spring motor for operating said switch, an escapement mechanism for controlling the operation of said motor, a coil and a controlling switch therefore shunted about the contacts of said switch, temperature-responsive means adapted upon actuation in one direction to close said coil-controlling switch, means responsive to energization of said coil for actuating said es-

capement mechanism, and means responsive to actuation of said temperature-responsive element in its other direction for actuating said escapement mechanism.

30. In a controlling apparatus, in combination, a switch, a spring motor for operating said switch, an escapement mechanism for controlling the operation of said motor, a coil and a controlling switch therefore shunted about the contacts of said switch, temperature-responsive means adapted upon actuation in one direction to close said coil-controlling switch, means responsive to energization of said coil for actuating said escapement mechanism, means responsive to actuation of said temperature-responsive element in its other direction for actuating said escapement mechanism, and pressure-responsive means adapted in response to predetermined pressure conditions to prevent energization of said coil.

31. In a controlling apparatus, in combination, a heating element, a switch for controlling the flow of electrical energy to said heating element, operating means for said switch, a coil bridged across the contacts of said switch, a switch controlling the circuit of said coil, a temperature-responsive element upon a predetermined fall in temperature to close said coil-controlling switch and adapted upon a predetermined rise in temperature to affect said operating means to cause the latter to open said first-mentioned switch, and pressure-responsive means adapted upon a predetermined rise in pressure to prevent closure of the circuit of said coil.

32. In a switch of the type described, the combination comprising an electromagnet, a switch arm actuated by said magnet, means for holding the switch arm in actuated position, and pressure responsive means for actuating said means to release the switch arm.

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