March 18, 1924. 1,487,515

C. I. HALL

THERMAL RESPONSIVE SWITCH

Filed May 2, 1921

Fig. 1.

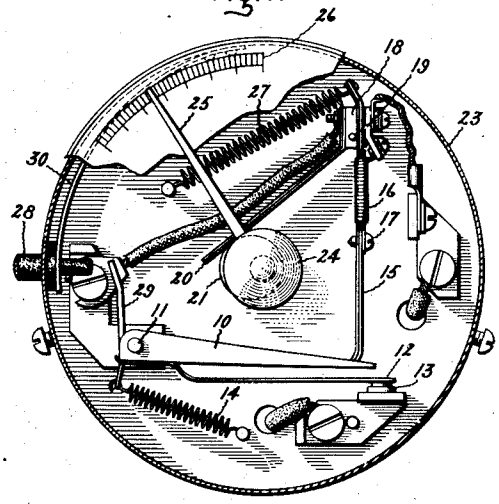


Fig. 2.

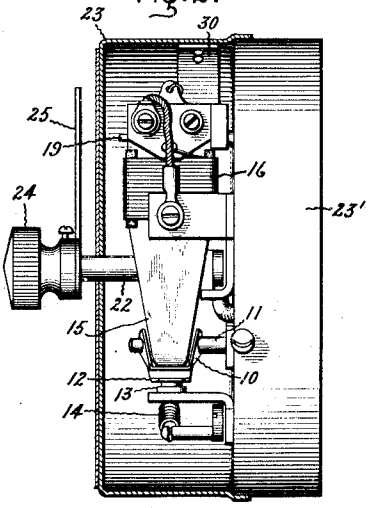
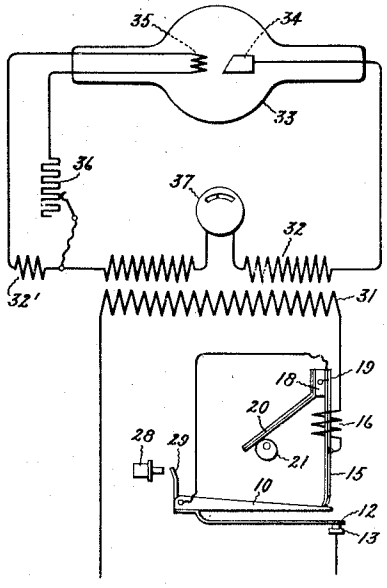


Fig. 3.



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UNITED STATES PATENT OFFICE.

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THERMAL RESPONSIVE SWITCH.

Application filed May 2, 1921. Serial No. 466,335.

To all whom it may concern:

Be it known, that I, CHESTER I. HALL, a citizen of the United States, residing at Fort Wayne, in the county of Allen, State of Indiana, have invented certain new and useful Improvements in Thermal Responsive Switches, of which the following is a specification.

My invention relates to improvements in thermal responsive switches and in particular to improvements in thermal responsive time switches.

One of the objects of the invention is the provision of a switch which will operate in a definite and predetermined time due to a flow of current of a definite value.

Another object of the invention is the provision of a switch of the character indicated which will operate quickly by a snap action.

Another object is the provision of a switch of the character indicated which will be operated substantially independently of variations of ambient or room temperature.

The invention has a particular utility in the control of the timing of X-ray exposures with relation to either the current taken by the tube or the applied potential. However, the invention is by no means limited to its use in the control of X-ray exposures, but is applicable generally to give a thermal time element control of an electric circuit.

In carrying the invention into effect in one form, a thermostatic latch is provided which is flexed responsively to the heating effect of a predetermined value of current to release a switch member to quickly return to its normal position after an interval of time. The time interval may be very nicely varied by varying the relative positions of the switch member and the thermostatic latch. A heating element preferably either a coil mounted on the thermostatic latch or in close proximity thereto, is provided for heating the latch in accordance with the current through the switch. A thermal responsive member is connected to the latch for the purpose of compensating for changes of ambient temperature and a cam cooperates with the member for varying the time taken to open the switch. The switch parts are enclosed in a casing which provides a thermal storage volume so that the same length of time will always be required for the same deflection of the thermostatic latch. A button extending through the casing is provided for resetting the switch after it has opened.

For a better understanding of my invention, reference is had to the accompanying drawings, wherein Fig. 1 is a front view of one form of my improved thermal time switch with a portion of the cover of the case in which the switch mechanism is mounted broken away for the purpose of showing the various details of construction and arrangement; Fig. 2 is a side view of the same with the cover of the case in section; and Fig. 3 is a very simplified diagram of a control arrangement for an X-ray tube with my improved thermal time switch shown in simplified diagram controlling the time of the X-ray exposure for a given value of current.

Referring to the figures, the switch member 10 is pivoted at 11 and has connected therewith a resiliently mounted switch contact 12 which is adapted to make engagement with the stationary contact 13 to complete an electric circuit through the switch. The switch member 10 and the resiliently mounted contact 12 are biased to the open position by means of the spring 14 and are held in the closed position against the bias of the spring 14 by means of the thermostatic latch 15. This thermostatic latch is adapted to be heated in accordance with the current through the switch contacts 12 and 13 by means of a heating coil 16 insulated in any suitable manner from the thermostatic latch and connected at one end 17 to the latch. This thermostatic latch is supported in an insulating block 18 which is pivotally mounted on the pin 19, and a thermal responsive member 20 is connected to the latch 15 so as to compensate for changes of ambient temperature. The free end of the thermostatic latch is adapted to make an abutting engagement with the switch member 10 so that this free end may slide freely with respect to the switch member.

A rotatable cam 21 cooperates with the thermal responsive member 20 so as to vary the relative positions of the member 20 and the latch 15 with respect to the switch member 10 so as to adjust the point of abutment of the free end of the latch and predetermine the length of time taken by the latch in bending or flexing so as to slide out of

engagement with the switch member 10 and thereby release this switch member to open the switch contacts 12 and 13. The cam 21 is mounted on a shaft 22 which extends through the cover of the casing 23, and a knob 24 is provided on the end of the shaft 22 for turning the cam 21 from the outside of the casing. A pointer 25 is also mounted on the shaft 22 and cooperates with the scale 26 on the cover of the casing to indicate the time taken by the switch in opening for a given value of current. A spring 27 is provided for biasing the thermal responsive member 20 into engagement with the cam 21. A button 28 of insulating material extends through the casing and is adapted to engage the extension 29 on the end of the switch member 10 so as to return the switch member to the closed position after it has been opened in response to the bending or flexing of the thermostatic latch 15. This button is biased out of engagement with the casing of the switch by means of the spring 30. The switch parts are suitably mounted on the base 23' of insulating material. By reason of the fact that the switch parts are enclosed within the casing 23, a thermal storage volume is provided, so that substantially the same length of time will always be required for the same deflection of the thermostatic latch. The thermal responsive member 20 will compensate for changes of ambient temperature by reason of the fact that this member and the thermostatic latch will always bend or flex in the same direction due to a change of ambient temperature, and the flexing of the member 20 will thus counteract the flexing of the latch.

Referring to Fig. 3, the thermal responsive switch previously described is adapted to control the primary 31 of a transformer, the secondary 32 of which is connected to the terminals of the X-ray tube 33. The right hand terminal of the secondary 32 is connected to an anode or target 34 of the X-ray tube, and the hot cathode 35 of the tube is connected across a portion 32' of the secondary of the transformed. An adjustable resistor 36 is provided for varying the potential applied to the hot cathodes 35. The ammeter 37 is connected in the circuit of the secondary of the transformer for indicating the current in the secondary circuit.

The operation of my invention as thus constructed and arranged is as follows:— Assume that the switch is in the closed position as indicated in the figures and that the pointer 25 has been turned to the proper position to indicate the time of X-ray exposure desired. The heating coil 16 will heat the thermostatic latch 15 substantially in accordance with the current through the switch contacts 12 and 13, and this latch will flex or bend so that finally the free end of the latch will be moved out of engagement with the switch member 10. The switch member 10 has a channel section so that the abutting free end of the thermostatic latch 15 will slide along the switch member 10 and finally leave the right hand end of the switch member. The switch member is then permitted to return to the open position by reason of the bias of the spring 14 and carry the resiliently mounted contact 12 quickly out of engagement with the stationary contact 13 by a snap action. The time interval taken by the switch in opening will be substantially identical with the time as indicated on the scale 26 for a given value of current, by reason of the fact that the various parts of the switch are enclosed within the casing 23, and also by reason of the fact that variations of ambient temperature are compensated for by the cooperation of the thermal responsive member 20 with the thermostatic latch 15. When the switch opens, the X-ray bulb 33 is simultaneously deenergized and the exposure of the X-rays ceases.

In order to reset or close the switch, the button 28 will be pressed so as to return the switch member 10 and the resiliently mounted contact 12 to the closed position, thereby permitting the thermostatic latch 15 to slip past the end of the switch member and return to its original position. It will be understood that the thermostatic latch will resume its initial shape shortly after the heating coil 16 is deenergized by the opening of the switch contacts.

In order to obtain a greater or less time interval for a given value of current, the knob 24 will be turned to the desired time interval as indicated on the scale 26, thereby moving the cam 21, the thermal responsive member 20 and the thermostatic latch 15 so that they are moved to different relative positions with respect to the switch member 10 and the point of abutment of the free end of the latch is varied. The shape of the cam 21 is such that a substantially uniform scale 26 may be provided. Obviously, if the value of the current is varied, the time limit for a given setting will be correspondingly varied, so that the switch may be used to protect a translation device from overheating.

It is to be understood that while I have indicated a use for my invention in the control of the time for X-ray exposure, my invention is not necessarily limited thereto, but is applicable generally to give a thermal time element control of any electric circuit.

In accordance with the provisions of the patent statutes I have described the principle of operation of my invention, together with the apparatus which I now consider to represent the best embodiment therof, but I desire to have it understood that the appa-

ratus shown is only illustrative and that the invention can be carried out by other means.

What I claim as new and desire to secure by Letters Patent of the United States is:—

1. The combination in an electric switch of a switch member biased to a normal position, a pivotally supported flexible thermostatic latch adapted to engage the switch member for holding the switch member in another position, the said latch adapted to be flexed responsively to the heating effect of a predetermined value of current to thereby disengage the switch member and release the same to return to the normal position after an interval of time, and means for adjusting the position of the latch about its pivotal support for varying the said time interval.

2. The combination in an electric switch of a switch member biased to the open position, a pivotally supported flexible thermostatic latch having a free end adapted to abut against the switch member for holding the same in the closed position, a heating coil disposed on the latch for heating the latch in accordance with the current through the switch to thereby flex the latch and cause the free end thereof to slide out of abutting engagement with the switch member and release the switch member after an interval of time, and means for adjusting the position of the said latch about its pivotal support for varying the said time interval.

3. The combination in an electric switch of a movable switch member biased to the open position, a resiliently mounted switch contact carried thereby, a flexible thermostatic latch adapted to engage the switch member for holding the switch member and contact in the closed position, an electric heating element for the said thermostatic latch, the said latch adapted to be flexed responsively to the heating effect of the said heating element to disengage the switch member and release the same to return to the open position, and means for imparting a relative movement to the said latch and the said switch member for adjusting the time taken by the latch to release the switch member for a given value of current in the heating element.

4. The combination in an electric switch of a pivotally mounted switch member biased to the open position, a resiliently mounted switch contact carried thereby, a flexible thermostatic latch one end of which is supported and the free end of which is adapted to abut against the switch member for holding the switch member and the said contact in the closed position, an electric heating element for the said thermostatic latch, the said latch adapted to be flexed responsively to the heating effect of the said heating element to cause the free end of the latch to slide out of abutting engagement with the said switch member and release the switch member to return to the open position, and means for imparting a relative movement to the said latch and the said switch member for adjusting the point of abutment between the said free end of the latch and the switch member to adjust the time taken by the latch to release the switch member for a given value of current in the heating element.

5. The combination in an electric switch of a switch member biased to a normal position, a flexible thermostatic latch for holding the switch member in another position and arranged to flex responsively to the heating effect of a predetermined value of current to release the switch member after an interval of time, and a thermoresponsive member connected to the latch for compensating for changes of ambient temperature.

6. The combination in an electric switch of a switch member biased to a normal position, a flexible thermostatic latch for holding the switch member in another position and arranged to flex responsively to the heating effect of a predetermined value of current to release the switch member after an interval of time, a thermoresponsive member connected to the latch for compensating for changes of ambient temperature, and means for varying the relative positions of the latch and the thermoresponsive member with respect to the switch member for varying the time taken by the latch to release the switch member for a given value of current.

7. The combination in an electric switch of a switch member biased to the open position, a flexible thermostatic latch one end of which is adapted to engage the switch to hold the same in the closed position, a thermostatic strip having one end connected to the other end of the latch and adapted to be held in position for compensating for changes of ambient temperature, and a pivotal support for the connected ends of the strip and latch.

8. The combination in an electric switch of a switch member biased to the open position, a flexible thermostatic latch one end of which is adapted to engage the switch member to hold the same in the closed position, a thermostatic strip having one end connected to the other end of the latch, and means for rotating the latch and strip about their connected ends as a pivot for varying the time taken by the latch to release the switch member for a given value of current.

9. The combination in an electric switch of a switch member biased to the open position, a flexible thermostatic latch one end of which is adapted to engage the switch to hold the same in the closed position, a thermostatic strip having one end connected

to the other end of the latch, and a cam cooperating with the strip for holding the same in a given position and for rotating the strip and latch about their connected ends as a pivot for varying the time taken by the latch to release the switch member for a given value of current.

10. The combination in an electric switch of a pivoted switch member, a resilient switch contact connected therewith and having relative movement with respect to the switch member, a flexible thermostatic latch one end of which is adapted to engage the switch member to hold the switch contacts closed, a thermostatic strip having one end connected to the other end of the latch, a pivotal support for the connected ends of the latch and strip, a cam cooperating with the strip for varying the position of the latch with respect to the switch member, and means for biasing the strip into engagement with the cam.

In witness whereof I have hereunto set my hand this 28 day of April, 1921.

CHESTER I. HALL.