Dec. 24, 1946.

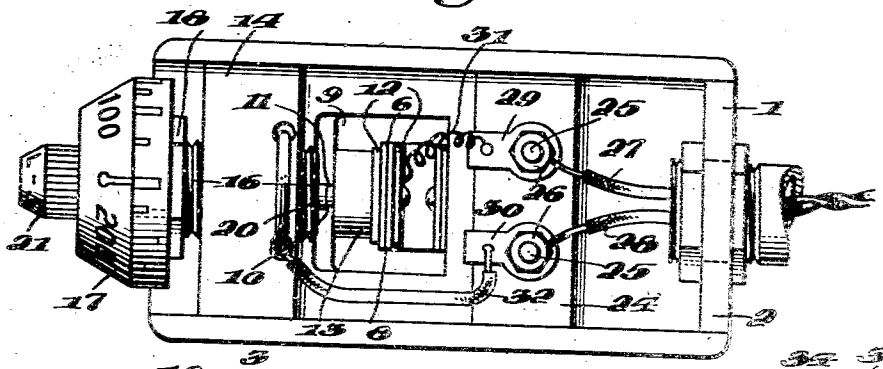
G. W. CRISE

2,413,100

THERMOSTATIC SWITCH

Filed May 27, 1943

Fig. 1.



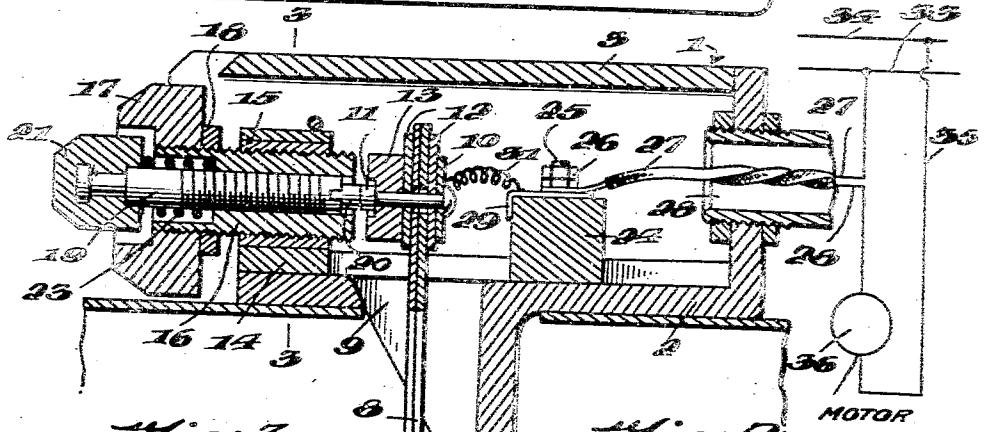


Fig. 3.

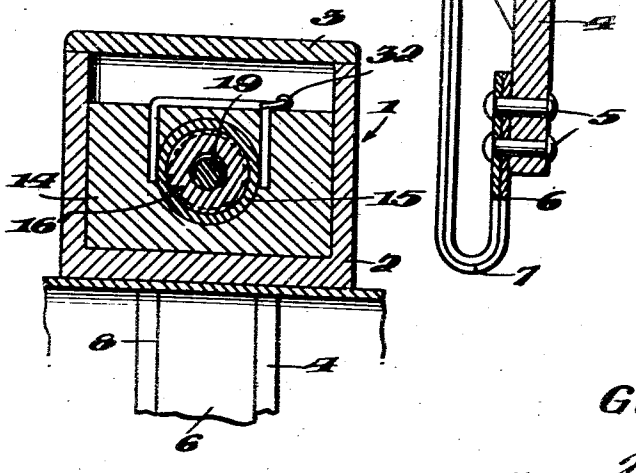


Fig. 2.

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THERMOSTATIC SWITCH

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7 Claims. (Cl. 200—138)

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This invention relates to thermostatic switches, having particular reference to switches of the type causing automatic opening and closing of electrical circuits in response to temperature variations.

In the construction of such switches, it is a common expedient to employ flexible bimetallic strips as the temperature-responsive motivating element for moving the associated circuit closing or opening contact devices into and out of physical engagement with each other. Due to the relatively slow movement of such bimetallic elements, difficulty has been encountered in providing desired rapidity (snap action) in bringing the contact devices into and out of engagement, in order to avoid or minimize destructive arcing effects produced as a result of electric current discharges in the air space between the devices when the same are but slightly spaced. Another disadvantage present in conventional switches employing bimetallic elements is the difficulty in varying or controlling definitely the duration of the periods in which the contact devices associated with such elements remain in circuit-completing or interrupting relation.

Accordingly, it is an object of the present invention to provide a switch utilizing a bimetallic operating element for operating separable contact devices having embodied therein improved means for effecting rapidly executed relative movement between said devices when the spacing of the latter is such as to be likely to produce damaging electrical arcing therebetween.

It is another object of the invention to provide a switch of the character set forth with improved adjustable means for controlling the duration of the periods in which the contact devices are caused to remain in circuit-closing engagement. For example, the period measured by the time required to effect separation between the contact devices when the switch responds to a decrease in the temperature of the atmosphere surrounding the bimetallic element with respect to that required to effect closure of said devices, whereby to enable the switch to maintain an associated electrical circuit in a complete condition for definite intervals of time.

A further object of the invention is to provide a switch utilizing a bimetallic temperature-responsive element having the free or movable end thereof provided with a permanent magnet normally spaced from a longitudinally adjustable armature, the latter being so disposed that when the bimetallic element is flexed to bring the magnet into relatively close proximity to the end of the armature, magnetic attraction is created between the magnet and the armature to such a degree as to provide flexing of the bimetallic element beyond that which said element normally assumes at the temperature when the attraction occurs, such attraction being utilized to accelerate the movement of the bimetallic element in effecting its circuit-completing and breaking operations.

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Still, a further object of the invention resides in providing a switch of the character aforesaid in which the bimetallic element is formed with one of the contact devices of the switch and the magnet armature is provided with a second contact device, the latter being adjustably carried by the armature for effecting desired spacing of said contact device and regulate the temperature differential required to effect the separation of said devices. By temperature differential, I refer to the decrease in temperature from that required to bring the contact devices into relative engagement with regard to that temperature at which said devices are separated.

Another object is to provide a thermostatic switch characterized by its simplicity and ruggedness in construction, its high contact efficiency, ease of adjustment and the fact that all the available differential is utilized to produce the maximum speed in causing the contact devices to make and break an associated circuit.

For a further understanding of the invention, reference is to be had to the following description and the accompanying drawing, wherein:

Fig. 1 is a vertical sectional view taken through a thermostatic switch constructed in accordance with the present invention;

Fig. 2 is a top plan view thereof with the cover plate of the switch casing removed;

Fig. 3 is a transverse cross sectional view taken on the line III—III of Fig. 2.

Referring more particularly to the drawing, the numeral 1 designates the casing of my improved switch, said casing embodying a base section 2 and a removable cover or lid section 3. In the particular form of the casing illustrated, the base section is formed with a depending bracket extension 4, to the lower portion of which is secured, as by means of rivets 5, the fixed end of a flexible bimetallic element 6. This element, as usual, is composed of a pair of metallic strips with one strip having a higher coefficient of expansion than the other, the strips being so mounted and relatively united as to produce flexing movement of the free end thereof in response to variations in temperature of the surrounding atmosphere. As shown, the element 6 is provided with a U-bend

7 intermediately of its length in order to provide an upwardly extending arm 8 which terminates within the interior of the casing after passing through an opening 9 provided in the bottom of the base section 2.

Adjacent to its free flexible upper end, the arm 8 of the bimetallic element is apertured for the reception of a contact device 10. Said device, in this instance, partakes of the form of a rivet, having a shank which is semicircularly headed at one end and cylindrically headed as at 11 at its opposite end. Desirably, the contact device 10 is formed from copper, silver or other good conducting material for electric current. The device 10 is carried by mica or other dielectric disks 12 disposed on opposite sides of the arm 8, in order that the contact 10 may be electrically spaced or insulated from the bimetallic element. Also, supported on the shank of the contact device 10 is a permanent magnet 13, preferably of disk-like form and having north and south polarity regions. The magnet, the insulating disk, and the contact device 10 are unitarily carried by and secured to the free end of the bimetallic element by the heads formed at the opposite ends of said contact device.

Arranged within the casing 1 is a stationary bearing block 14, preferably of an insulating material. This block is bored to receive a stationary metallic bushing 15, which is internally threaded for the reception of the external threads provided on a tubular steel armature 16. By the rotation of the armature, it will be seen that the same may be advanced or retracted longitudinally with respect to the magnet 13 in order to control the spacing therebetween and render the switch responsive in a circuit opening or closing sense to varying temperatures affecting the bimetallic element 6. A manipulating wheel 17 is threadedly mounted on the outer end of the armature and is held in secured engagement therewith by a lock nut 18. The wheel 17 may be formed from a molded plastic, if desired, having dielectric properties. Preferably, the wheel has its outer surface suitably graduated to indicate temperature in degrees Fahrenheit and this surface may be adjusted relatively to a suitable indexing point to provide exterior indication of the temperature adjustment of the armature.

The armature is provided with an internally threaded bore which is adapted to receive the external threads of a temperature differential controlling screw 19. The inner end of this screw carries in fixed engagement therewith a contact device 20 which, through the longitudinal adjustment of the screw 19, may be brought into desired relationship with the first-named contact device 10. To facilitate adjustment of the screw 19, the outer end of the latter is equipped with a knob 21 having its outer surface suitably calibrated, as at 22, for disclosing, exteriorly of the casing, the adjustment of said screw. A coil spring 23 may be used to exert pressure on the knob 21 for the purpose of maintaining the screw 19 in set positions of adjustment.

Many different devices may be provided for conducting electrical current to the contact devices 10 and 20. By way of illustration, the casing, in this instance, has been shown as provided with a block 24 of an insulating material. This block carries a pair of spaced upstanding threaded posts 25 carrying nuts 26. Conductors 27 and 28 are shown as electrically connected with these posts and with copper strips 29 and 30 carried thereby. A wire 31 extends from the strip 29 to

the semicircularly headed end of the contact device 10, and a complemental wire 32 extends from the strip 30 to the metallic bushing 15 of the bearing block 14. The conductors 27 and 28 lead to trunk conductors 33 and 34, a lead 35 may extend to an electric motor 36 employed for any suitable purpose, such as driving the fan or blower of the furnace of a forced air heating system, a lead 37 extending from the return side of the motor to the conductor 28, the circuit for the motor thus being opened or closed by the operation of the contact devices and their associated parts. When the switch is used in connection with the forced air heating system, the switch casing 1 may be mounted on the bonnet or plenum housing of the furnace of such a system, so that the bimetallic element will extend into the plenum chamber of the furnace, being thereby responsive to the temperature of the air passing through said chamber.

From the foregoing, it will be evident that when the armature 16 is adjusted longitudinally toward the magnet and the bimetallic strip to reduce the spacing between these parts, the switch will respond to a lower environmental temperature to bring the contacts 10 and 20 into circuit-completing engagement than when the armature is retracted to increase the spacing. When so retracted, a higher environmental temperature is, of course, necessitated to cause the switch to complete the associated circuit. In this manner, the response of the switch to temperature is governed solely by the spacing or relationship between the armature and the magnet.

The time period produced by a decrease in temperature for breaking a completed circuit is controlled by the positions of the differential screw 19 and its associated contact 20. With the armature in a given position of adjustment, it will be seen that by retracting the screw 19 and its contact 20 relative to the end of the armature facing the magnet 13, a longer period of time or a greater drop in temperature will be required to produce sufficient tension of the free end of the bimetallic strip to cause it to overcome the close attraction between the magnet and the armature than when the screw 19 and its contact is advanced to a more forward position. It will be appreciated that the degree of attraction between the magnet 13 and the opposing end of the armature increases or decreases with the distance therebetween. Since the contact 20 is nonmagnetic, it does not influence the magnet, this latter function being assigned to the armature. Hence, the armature is used for temperature control and the screw 19 for differential regulation. By differential regulation, I refer to the duration of the operating cycle of the electrical apparatus in the circuit governed by the switch. The magnet and armature are in all their operative positions spaced from each other, and their positions of relative approach are limited by the engagement of the contacts 11 and 20.

The operation of the thermostatic switch when used in a furnace system may be explained as follows: Assuming that the asociated furnace has been cold and is in process of warming up, the increased temperature in the plenum chamber will cause the bimetallic element to flex in order to advance the contact device 10 and the magnet 13 gradually toward the inner end of the armature 16. This movement is continued with temperature increase until the attraction of the magnet 13 with respect to the armature is sufficiently great to overcome normal rigidity of the

bimetallic element 6. At this time, the magnetic attraction is such that the contact devices will snap together and the circuit of the switch will be complete, causing the fan, motor or other apparatus in the circuit to be energized.

When, in the course of time, the furnace has cooled so that the bimetallic element, which for this application has its high expanding metal strip on the inside of its bend, has generated sufficient tension to overcome the magnetic attraction between the magnet and the armature, thus pulling the magnet away from the armature so that engagement between the contact devices will be broken suddenly with spring action on the part of the free end of the bimetallic element. Because of the strong magnetic field across the path of the ensuing arc, the flame will be thrown laterally out of the natural shortest path and rapidly extinguished, with the same effect and result as had the contacts separated at a much faster rate and to a greater distance than their actual mechanical movement.

Since appreciable power is required to separate the contact elements against the attraction of the magnet, a temperature differential results, depending upon the strength of the magnet and its proximity to the armature. As the strength of the magnet is a fixed quantity, the only remaining variable is the resistance between the magnet and the armature when the contact devices 10 and 20 are in physical engagement. Thus, the contact device 20 is mounted on the differential adjusting screw 19, which can be adjusted or retracted with respect to the inner end of the armature 16 by turning the knob 21. Therefore, the closed contact position of the magnet 13 with relation to the armature 16 is under complete manual control. The difference between the circuit-making and interrupting temperatures of the thermostat switch are fully adjustable by the operation of the knob 21.

Inasmuch as the armature, the screw 19 and the contact device 20 rotate as a unit by turning the wheel 17 and thereby approach or recede from the bimetallic element, any working range of temperature to which the switch is responsive may be obtained through the manual adjustment of the wheel 17.

It is important to note that the temperature at which the switch makes circuit-completing contact is determined by the position of the armature 16 and not by the position of the contact 20. This is because of the fact that the attraction of the magnet 13 causes the contacts 10 and 20 to snap together whenever they come within a fixed distance of separation, which on a standard assembly may be $\frac{3}{32}$ of an inch. This is a very practical feature, since a standard Underwriters Code specifies certain limits at which fan switches must contact, a condition with which the present construction complies. Furthermore, the construction permits accurate calibration of the thermostatic switch by means of the locking nut 18 on the armature 16, and this calibration of the armature is unaffected by the adjustment of the differential knob 21. Another feature of importance is that by increasing the magnetic action to absorb all the available power of the allowable differential, maximum advantage is obtained for the contact points and a greater current can be handled than would be possible with prior art designs. A further advantage is that the switch here disclosed admits of large variations in differential in order to regulate the operating cycle of the motor driven equipment which may be associated therewith, such as a furnace fan, fuel-feeding stoker, fuel control valve or the like.

I claim:

1. In a thermostatic switch, a bimetallic strip anchor at one end and adapated to have its free end deflected by temperature variations, a magnet carried by the free end of said strip, a contact movable in unison with the deflectable end of said strip and said magnet, a temperature controlling armature adjustably mounted to vary the spacing between one end thereof and said magnet, a differential varying element movable bodily with said armature and adjustable longitudinally and independently with respect to the armature, and a second contact carried by said element adapted to be brought into and out of engagement with said first contact upon deflection of said strip.

2. In a thermostatic switch, a supporting base, a bimetallic strip anchored at one end to said base and having its free end deflectable in response to temperature variations, a contact member carried by the free end of said strip, a permanent magnet surrounding said member and movable in unison therewith upon deflection of the free end of said strip, a temperature regulating and armature-forming screw, mounting means for said screw carried by said base, said means admitting of adjustment of said screw toward and away from said magnet, a differential adjusting screw having engagement with an internally threaded bore provided longitudinally and axially in said temperature-regulating screw, and a second contact member carried by the differential regulating screw in registration with said first contact member.

3. In a thermostatic switch, a supporting base, a bimetallic strip fixed at one end to said base and having its free end disposed for flexing movement in response to temperature variations, a magnet and a contact member carried by and bodily movable with the free end of said strip, a temperature-regulating and armature-forming screw, a threaded bearing carried by said base for the reception of said screw, a manually operated control carried by one end of said screw for effecting its rotation, whereby to govern the spacing between the opposite end of said screw and said magnet, and a manually adjustable differential regulating screw mounted in a threaded bore formed longitudinally and axially in the temperature-regulating screw, one end of said differential regulating screw being formed to provide a second contact member arranged for coaction with said first-named contact member.

4. In a thermostatic switch, a supporting base, a bimetallic strip fixed at one end to said base and having its free end disposed for flexing movement in response to temperature variations, a magnet and a contact member carried by and bodily movable with the free end of said strip, a temperature-regulating and armature-forming screw, a threaded bearing carried by said base for the reception of said screw, a manually operated control carried by one end of said screw for effecting its rotation, whereby to govern the spacing between the opposite end of said screw and said magnet, a manually adjustable differential regulating screw mounted in a threaded bore formed longitudinally and axially in the temperature-regulating screw, one end of said differential regulating screw being formed to provide a second contact member arranged for coaction with said first-named contact member, and circuit-

forming conductors joined in current-transmitting union with said contact members.

5. In a thermostatic switch, a supporting base, a threaded bearing carried by said base, a temperature-regulating armature screw supported by said bearing for longitudinal movement, said screw having an internally threaded bore, a differential-adjusting screw adjustably mounted in the threaded bore of said temperature-regulating screw, independently movable means carried by the outer ends of said screws for manually rotating and adjusting their operating positions, a contact member formed on the inner end of the differential-regulating screw, a bimetallic strip having a fixed end and a free end deflectable in response to temperature variations, and a second contact member and a permanent magnet mounted on and bodily movable in unison with the deflectable end of said strip.

6. In a thermostatic switch, a casing, a bimetallic strip fixed at one end to said casing and having its opposite end free for flexing movement in response to environmental temperature variations, a contact element and a surrounding permanent magnet carried by and movable bodily with the free deflectable end of said strip, a temperature-regulating armature threadedly mounted in said casing for adjusting movement toward and away from said magnet, a differential regulator having a contact at one end thereof, said regulator being carried by said armature and coaxially threaded therein for adjustment of the contact on the end thereof toward and away from the contact element on said bimetallic strip, and concentrically disposed calibrated manipulating devices accessible from the exterior of said casing for effecting adjustment of said armature and regulator.

7. A thermostatic switch comprising a casing having its bottom formed with a depending extension and an adjacent opening, a bimetallic strip having one end fixed to said extension, the body of said strip projecting upwardly through said opening for unrestricted movement therein, the upper deflectable end of said strip being disposed within the confines of said casing, a contact element and a permanent magnet carried by and movable bodily in unison with the upper deflectable end of said strip, a bearing in said casing, a temperature-regulating armature threadedly mounted in said bearing for adjusting movement longitudinally toward and away from said armature, a differential regulator having a contact formed on one end thereof, said regulator being coaxially threaded in said armature for adjusting movement of its contact toward and away from the contact element of said bimetallic strip, and concentrically disposed calibrated manipulating devices accessible exteriorly of said casing for facilitating manual adjustment of said armature and regulator.

GEORGE W. CRISE.