May 11, 1943. I. E. McCABE 2,318,699

TEMPERATURE RESPONSIVE ELECTRIC SWITCH

Filed April 14, 1941 2 Sheets-Sheet 1

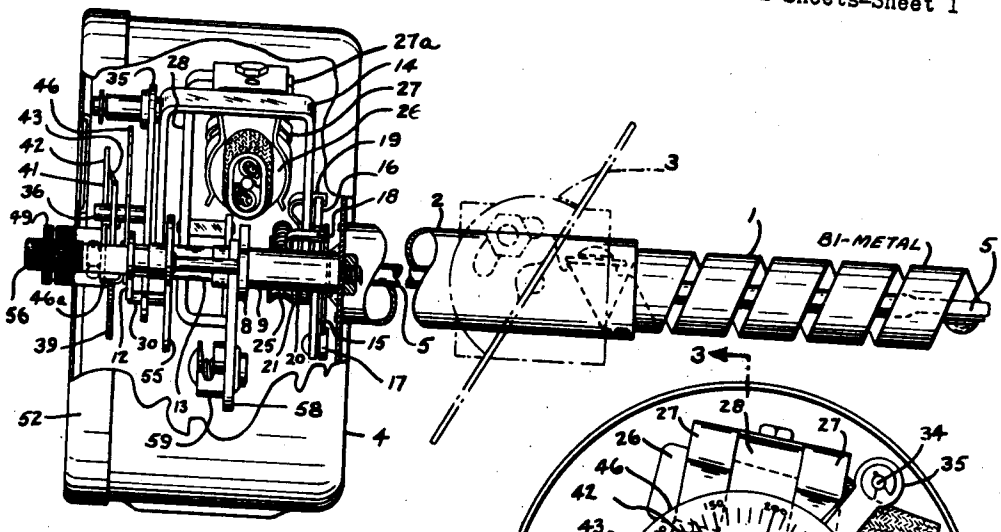


Fig. 1

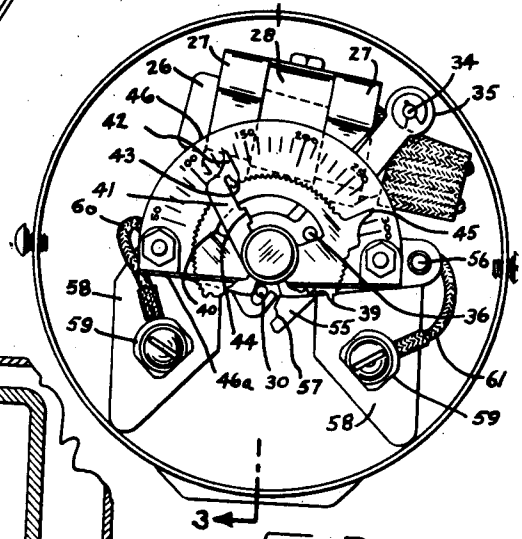


Fig. 2

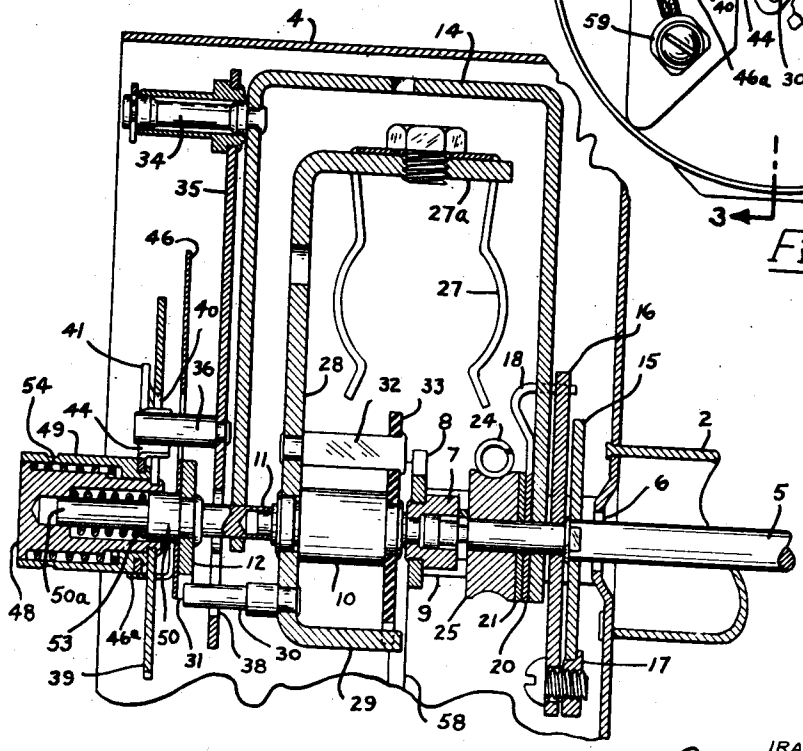


Fig. 3

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TEMPERATURE RESPONSIVE ELECTRIC SWITCH

Filed April 14, 1941 2 Sheets-Sheet 2

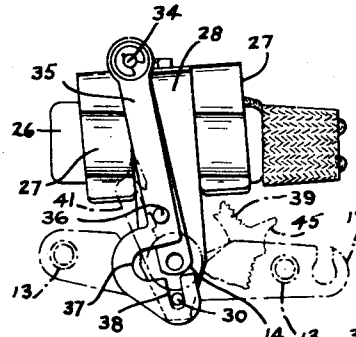


Fig. 8

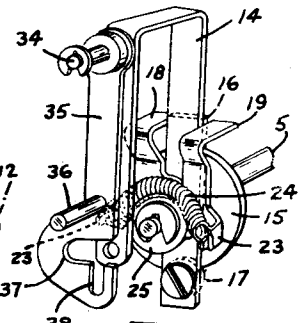


Fig. 4

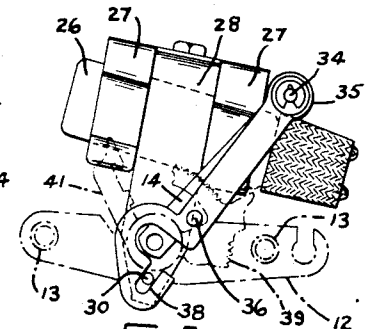


Fig. 9

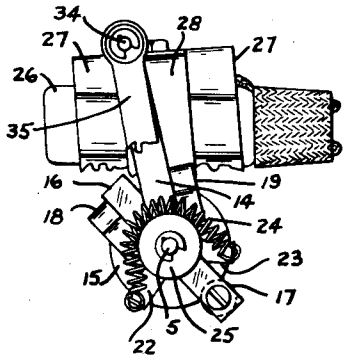


Fig. 6

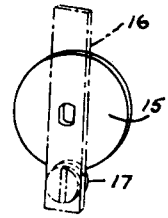


Fig. 5

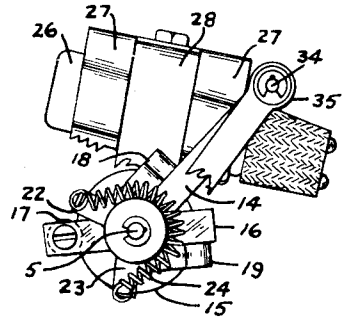


Fig. 7



Fig. 10

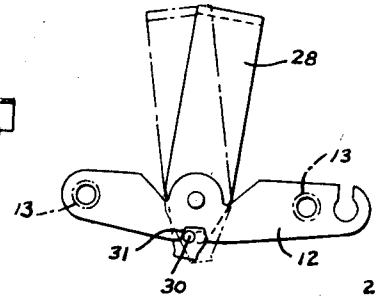


Fig. 11

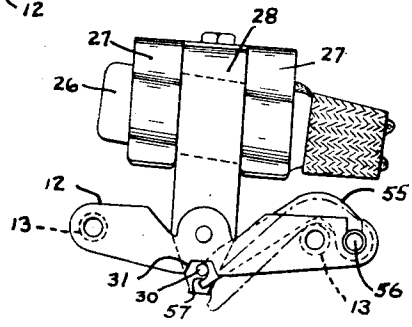


Fig. 12

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UNITED STATES PATENT OFFICE

2,318,699

TEMPERATURE RESPONSIVE ELECTRIC SWITCH

Ira E. McCabe, Chicago, Ill.

Application April 14, 1941, Serial No. 388,424

9 Claims. (Cl. 200—138)

This invention relates to improvements in electric switch mechanisms and more particularly to the structure of temperature responsive electric switches.

It is an object of this invention to provide a switch of the character described and illustrated in this applicant's prior Patent No. 1,834,288, dated December 1, 1931, wherein the parts are so constructed that compensating adjustments may be made at the factory to insure consistent manual adjustments in the field. Electric switches of this type are designed to control the operation of domestic heating systems, as well as for industrial purposes with some of the more common uses being to limit temperature within furnaces, bake ovens, stack pipes and ducts and for the control of dampers and circulating fans employed in warm air heating systems. Devices of this character when installed in connection with electrically operated and controlled heating systems have the thermally responsive element extending into the stack or pipe leading from the furnace or heater to the chimney or into the bonnet if the heater is a warm air furnace or in warm air ducts running from the furnace, with the instrument or switch casing supported on the exterior thereof.

Because of the various temperatures at which the device may be desired to operate due to the variety of uses to which it may be put and its location when installed, it is desirable for such a device to be made operable over a wide temperature range and adjustable over that range in such a manner as will permit the adjustment of the high and low operating points independently of each other. Furthermore when such devices are applied to domestic heating apparatus, the compact and improved appearance of the heating plants being made today necessitate or make desirable the use of controlling devices, attached thereto, to be small and compact to fit into limited space and to harmonize with the general design of the new type of boilers and furnaces. It is also desirable that when these devices are of the adjustable type that the adjustments be made upon the exterior of the enclosure for the operating instrumentality.

It is thus an object of this invention to provide a small and compact temperature actuated switch of the character and for the uses described in which a simple form of adjusting means permits the adjustment of the operating points to be made upon the exterior of the switch enclosure. It is a further object to provide a switch operating structure permitting unlimited movement of the temperature responsive actuating means beyond the predetermined adjusted temperatures which limit the operation of the switch thus protecting the temperature responsive means and preserving the calibration of the device. It is still a further object to provide means to compensate for variations in the manufacture of helical bi-metallic coils employed as the temperature responsive actuating means, when calibrating the device for service. Still another object resides in the provision of a manually operated locking means for locking the switch in closed position, in those forms of devices which open the switch on falling temperature, and to automatically release the locking means when the temperature has risen above the low setting of the device sufficiently to maintain the switch closed while temperature remains above the low setting.

With these and other objects in view reference is made to the accompanying sheets of drawings illustrating a preferred form of this invention with the understanding that minor changes may be made without departing from the scope thereof.

In the drawings:

Figure 1 is a view in side elevation of a preferred form of this invention with parts broken away illustrating the adjusting and operating mechanism in elevation.

Figure 2 is a front view of Figure 1 with the front cover removed.

Figure 3 is an enlarged fragmentary detail view in vertical section taken on the line 3—3, Figure 2, illustrating some parts in elevation.

Figure 4 is a detail view in perspective of parts of the switch operating mechanism as connected to the operating shaft.

Figure 5 is a detail view in perspective illustrating the means of adjustment between the operating shaft and parts actuated thereby.

Figure 6 is a detail view in elevation, with parts broken away, illustrating the position assumed by the parts when the thermal element in response to temperature changes has oscillated the operating shaft beyond the amount necessary to tilt the mercury tube switch to open the circuit.

Figure 7 is a view similar to Figure 6 illustrating the position assumed by the parts when the operating shaft has been oscillated beyond that necessary to tilt the switch to close the circuit.

Figure 8 is a detail view in elevation illustrating the position of the parts assumed when the switch mechanism has been actuated to open the

switch and the latch post in engagement with one stop shown in dot and dash lines.

Figure 9 is a view similar to Figure 8 illustrating the position of the parts assumed when the switch mechanism has been actuated to close the switch and the latch post in engagement with the other stop shown in dot and dash lines.

Figure 10 is a detail top plane view of the toothed adjusting disk restraining member, showing the positions of the toothed wheel adjacent the disk in dot and dash lines.

Figure 11 is a detail view in elevation illustrating the stop on the switch carrier arm and notch on the underside of the front plate to limit the travel of the said arm, showing the position assumed at one end of travel in full lines and at the other end of travel in dot and dash lines.

Figure 12 is a view similar to Figure 11 illustrating the lock latch in engagement with the stop on the switch carrying arm in full lines and the position of the lock latch when disengaged in dot and dash lines.

In the embodiment of this invention illustrated upon the accompanying sheets of drawings, the thermally responsive element is shown in Figure 1, as a helical coil 1 of bi-metallic metal, one end of which is secured to a cylindrical tube 2 adapted to be inserted through the stack or casing of a furnace or heater employing an electrically operated and controlled fuel burning mechanism. The tube 2 is preferably held in position in the stack or casing by an adjustable clamp member 3. The exterior end of the tube 2 is rigidly secured to the rear wall and supports the casing 4 enclosing the switch mechanism. The outer or free end of the thermal coil 1 is rigidly secured to the end of an operating shaft 5 which passes through the tube 2 and an opening 6 provided therefor in the rear wall of the casing 4 and is terminated adjacent thereto. As shown in Figure 3, the inner end of the operating shaft 5 is rotatably received in a bearing 7 therefor mounted on a supporting plate 8 extending transversely of the casing 4 and held in spaced apart relation by posts 9 in engagement with the rear wall thereof. The bearing 7 beyond the end of the operating shaft 5 provides a bearing for a reduced axial stub of a switch arm carrier member 10 having a similar reduced axial stub on its other end rotatably received in a recessed bearing stud 11 extending in line with the axis of the operating shaft 5 from a front plate 12 spaced apart in parallel relation to the supporting plate 8 by extensions 13 of the posts 9.

An inverted U-shaped switch operating bracket 14 is perforated adjacent the free ends of each arm so that the bracket may be mounted to oscillate about the bearing 11 on the front plate 12 and the operating shaft 5. The switch operating bracket is oscillated by the movement of the operating shaft in response to the contraction and expansion of the thermal element in response to temperature changes. To transmit the motion of the operating shaft 5 to the operating bracket, a disk 15 is keyed on the shaft. An actuating arm 16, rotatably mounted on the shaft 5, of greater length than the diameter of the disk so that each end projects beyond the periphery of the disk, is provided at its lower end, with an adjustable clamping member 17 which is adapted to engage the disk to cause the arm to rotate with the disk, as shown in detail in Figure 5. As shown in Figure 4, the upper free end of the arm 16 projects between two arms 18 and 19 extending upwardly from separate disks 20 and 21 mounted to rotate on the shaft 5 on the side of the arm of the bracket 14 opposite the actuator arm 16. The free ends of these arms are bent rearwardly so that they will engage opposite sides of the bracket 14 and extend in the path of the free end of the actuating arm 16. The disks 20 and 21 are each provided with angular extensions 22 and 23 the ends of which are bent in the direction of the front of the casing 4 and act as anchors for the opposite ends of a coil spring 24 which is passed over a grooved hub 25 rotatably mounted on the shaft 5 so as to exert tension on the arms 18 and 19 to normally keep them in engagement with the opposite sides of the bracket 14 and arm 16.

The switch operated by the oscillation of the bracket 14 is a mercury tube switch, preferably of the type disclosed in this applicant's prior Patent No. 1,757,436, dated May 6, 1930, which closes the circuit when tilted above its transverse axis in one direction and which opens the circuit when tilted in the opposite direction. The mercury tube switch 26 is secured between clamps 27 mounted upon the upper right angular extension 27^a of the switch carrier arm 28 mounted upon the switch arm carrier 10. The arm 28 extends therebelow and is terminated in a right angular extension 29. An actuator stud 30 is mounted on the arm 28 below the carrier member 10 and extends below the front plate 12 to be received in a notch 31 formed in the lower surface thereof so that the ends of the notch being engaged by the stud 30 limit the amount of oscillation imparted to the carrier arm 28. The carrier arm 28 is also provided with an oppositely extending stud 32 above the carrier member 10 which is engaged with a plate 33 mounted on the carrier member 10 the lower end of which is engaged by the free end of the extension 29 of the arm 28.

The outer arm of the oscillating operating bracket 14 adjacent its top is provided with an outstanding pin 34 which acts as a pivot for the upper end of an operating latch 35 which extends downwardly therefrom to a point adjacent the upper surface of the front plate 12 and then is provided with a hooked lower end, as shown in Figure 4. The operating latch 35 mounts an outstanding post 36 extending beyond the upper surface of the front plate 12. The hooked shaped lower end of the operating latch 35 is so formed that it includes a horizontal slot 37 opening therefrom and a vertical slot 38 which provides means for slidably receiving the actuator stud 30 upon the switch operating bracket 14. The horizontal slot 37 allows the end of the latch 35 to swing, without engagement, about the bearing post 11 on the front plate 12. From the structure thus described it is apparent that with the actuating arm 16 properly clamped to the disk 15, movement imparted to the disk 15 by the shaft 5 will in turn cause the rotation of the bracket 14. As the bracket is caused to move from left to right the operating latch 35 is oscillated, with its lower hooked extremity rotating around the switch actuator stud 30, extending through the slot 38, without moving the stud.

To cause movement of the operating latch 35 to actuate the switch 26, and to determine the temperature at which point operation of the switch occurs, two adjustable stops are provided, hereinafter described, which, when engaged by the latch post 36, serve as a fulcrum for imparting an oscillating movement to the hooked end. When the post is brought into engagement with a stop, movement thereafter imparted to the

operating latch 35 will oscillate the hooked end thereof which, through its slotted engagement with stud 30, will actuate the switch from one position to another. As shown in Figure 8, the operating shaft has rotated in one direction to rotate the switch operating bracket 14 carrying the latch 35 with it until the post 36 thereon engages the left hand stop, so that further rotation in the same direction causes the mercury switch to be tilted to the left. When the switch is moved past center it continues in its movement, by its own weight, until the stud 30 engages the end of the notch 31 in the underside of the front plate 12 which acts as a stop to limit the travel of the bracket 14 and arm 28 in that direction, as shown in dot and dash line in Figure 11. Thus a positive action is obtained in opening or closing the switch circuit. Upon oscillation of the operating shaft 5 in the opposite direction the movement of the parts are reversed.

The coil spring 24, as shown in Figure 4, maintains the arms 18 and 19 normally in engagement with the actuator arms 16 and the bracket 14 to impart the oscillating movements of the operating shaft 5 in response to temperature changes to the bracket 14 as hereinbefore described. When the mercury switch has been actuated and the bracket 14 and arm 28 is restrained from further movement by the stud 30 engaging one of the stops, should the temperature continue to change to cause the thermal coil 1 to expand or contract beyond that which actuated the switch, the spring 24 allows further continued movement of the shaft 5 in one direction, as shown in Figure 6, or in the opposite direction, as shown in Figure 7, without placing undue strain upon the thermal coil or any of the parts.

The actuating arm 16 is adjustably mounted upon the disk 15 secured to the shaft 5, so that when calibrating the device compensation can be made for variations in the relationship between the mounting holes in the thermal coil 1. As an alternative arrangement the disk 15, Figure 5, may be omitted and the arm 16 keyed to the shaft and a suitable adjustable clamp provided upon the exterior end of shaft 5 for securing thereto the outer end of the thermal coil no matter what its position.

One of the two stops for post 36 is in the form of a toothed disk 39, having an annular slot 40 therein through which the post 36 projects, mounted for rotation upon an extension of the bearing member 11 on the front side of the front plate 12. The other is an arm 41 projecting beyond the periphery of the disk 39 extended from a disk mounted for rotation about the same bearing member 11 in front of the annular slotted disk 39. The arm 41 terminates in a pointed indicator 42 and is provided with a depressed tooth 43 adapted to extend over the periphery of the toothed disk 39 and being adapted for engagement between two adjacent teeth thereon. The arm 41 is also provided with a bent over stop 44 extending through the annular slot 40 in the disk 39 to be in line with and act as a stop for the post 36 on the latch 35. The disk 39 is also provided with a radial pointed indicator 45 adjacent the right end of the annular slot 40. Both pointed indicators are mounted to be positioned over an annular segment 46 secured at its ends upon the front plate 12 and provided with a calibrated temperature scale over which the pointed indicators 42 and 45 may be adjusted.

As shown in Figures 2 and 10, the toothed disk 39 is normally restrained from rotation by a plate or strip 46a having a notch 47 stepped at both ends to receive a toothed disk 39 below its horizontal diameter and allow for rotation of the disk when the latter is moved out between the wider portions of the notch but when moved forward the bottom steps of the notch 47 enter between adjacent teeth on the disk to hold it in fixed position. This strip 46a is held with the notched portions at right angles and adjacent to the flat face of the disk 39 by right angular extensions at each end and perforated to be secured to the ends of the annular scale 46 by the same means which secures the scale to the front plate 12. Provision is made to adjust the disk 39 so that the right end of the annular slot 40 will act as a stop for the latch stud 35 to actuate the switch at the desired temperature indicated on the scale by the pointer 45. Also provision is made to adjust the arm 41 so that its stop 44 will be engaged by the latch stud 35 to reverse the position of the switch at the desired temperature indicated on the scale by the position of the pointed indicator 42.

The means provided for setting the pointers 42 and 45 at the desired temperature includes a recessed hub 48 mounting a superimposed recessed hub 49 with the hub 48 mounted upon the portions 50 and 50a of the bearing member 11 extending from the front side of the front plate 12. Both hubs 48 and 49 extend through an aperture 51 provided therefor in the cover 52 covering the front of the casing 4, as shown in Figure 1. As shown in Figure 3 the inner end of the hub 48 mounts and is secured to the toothed disk 39. A coil spring 53 is mounted about the reduced portion 50a of the bearing member 11 with one end in engagement with the shoulder 50 on the bearing member and the other in engagement with the shoulder within the opposite end of the recess in the hub 48. This spring normally urges the toothed wheel to engage the lower steps in the notch 47 in the strip 46a. The superimposed hub 49 is also recessed and its inner end mounts and is secured to the disk carrying the arm 41. The outer circumference of the hub 48 is stepped to form a support adjacent its outer end and adjacent its inner end for the hub 49 with a space between them for a coil spring 54 received within the recess of the hub 49 with one end bearing upon the outer step of the hub 48 and another against the bottom of the enlarged recess in the hub 49, to be normally urging the hub 49 and arm 41 to maintain the tooth 43 on the arm 41 in engagement between adjacent teeth on the toothed disk 39. The lower step on hub 48 acts as a stop to limit the outward movement of the hub 49 against the tension of the spring 54.

By means of the hubs 48 and 49 projecting through the front cover 52 of the instrument casing 4, desirable adjustments of the stops for the operating latch post 36 may be made after installation without removing the cover of the instrument casing. By depressing the hubs 48 and 49, they normally travel in unison, the toothed disk 39 is moved out of engagement with its retaining plate 46a to allow the pointed indicator 45 to be rotated to the temperature on the scale on plate 46 desired. By pulling out hub 49 the coil spring 54 will be compressed and allow hub 49 to slide over hub 48 to withdraw the tooth 43 on the arm 41 from engagement with the tooth wheel 39 so that the arm 41 may be rotated to the desired temperature as indicated on the scale on plate 46. The cover is provided

with a glass covered section for viewing the calibrated plate over which the settings of the two pointers are made.

As shown in the drawings and described, the mercury switch 26 is mounted to close its circuit when actuated upon an increase in temperature. Such an arrangement is utilized in a device of this character for closing a circuit to a circulating fan used in conjunction with automatically controlled and fired warm air heating systems. As in the case of such installations it may be desired to operate the fan during summer seasons for cooling and ventilating purposes. To utilize this improved device for that purpose this invention contemplates to provide manually operated means for moving the switch to closed position, when desired during the summer, and to lock it in that position to cause a continuous operation of the fan until released manually or, in the event of an operation of the firing mechanism, to release the lock upon a temperature rise after which the device again becomes automatic in operation in response to temperature changes.

As shown in Figures 1 and 12, a lock latch 55 is mounted at one end upon an operating shaft 56 rotatably mounted between the supporting plates 8 and 12 with one end extending beyond front plate 12 with its outer end knurled and of such length as to pass through an aperture provided therefor in the cover 52 for the casing 4. The latch 55 is so arranged that its free end may be brought into the path of travel of the actuator stud 30 and the free end is notched at 57 so that when the switch carrying arm 28 has been oscillated to open the switch 26 the latch 55 may be manually rotated to bring the notched end 57 into engagement with the actuator stud 30 and oscillate the switch carrying arm 28 in the opposite direction to close the switch, against the force of the thermal coil tending to open the switch. As a result only a part of the full movement normally made by the switch to full on position is utilized and the latch is locked into engagement with the stud 30. When in this position, the establishment of heat which will raise the temperature of the thermal coil to remove its force against the locking means, the switch will automatically move to the limit of its on position whereupon the latch lock 55 by its own weight falls free and the device becomes automatic in operation in response to temperature changes.

When this device is employed to limit temperature conditions the position of the switch is reversed in the support clips 27.

Plates of insulating material 58 are preferably attached to the front side of the supporting plate 8 for supporting binding posts 59 to which the ends of the flexible leads 60 and 61 from the switch terminals are attached, as shown in Figure 2, for connection into the controlled circuits.

What I claim is:

1. A temperature responsive device including a tiltable mercury tube switch, an operating shaft, a thermal member for operating the shaft, a tiltable bracket, means transmitting movement imparted to the shaft to the bracket, a switch actuator operated by the tiltable bracket, adjustable means for determining the time of switch operation and means upon the switch actuator adapted to abut said adjustable means when the actuator is operated by the tiltable bracket and upon continued movement of the bracket thereafter to cause the actuator to tilt the switch including means to limit the tilt of the switch and the movement of the bracket after operating the switch, and yielding means incorporated in said transmitting means allowing continued movement of the shaft beyond the limited movement of the bracket.

2. A temperature responsive device including a tiltable mercury tube switch, an operating shaft, a coil of thermal metal for operating the shaft having means on one end thereof to immovably secure that end and means on the other end for connection upon the shaft, a tiltable bracket, an operative connection between the operating shaft and bracket including means secured upon the operating shaft, means to adjust the relation between the means secured upon the shaft and the bracket in accordance with the position, at ambient temperature, of the end of the coil connected to the shaft, a switch actuator operated by the tiltable bracket, adjustable means for determining the time of switch operation, means upon the switch actuator adapted to abut said adjustable means when the actuator is operated by the tiltable bracket and upon continued movement of the bracket thereafter to cause the actuator to tilt the switch.

3. The structure of claim 2 including means to limit the tilt of the switch and movement of the bracket after operating the switch, and yielding means incorporated in said transmitting means allowing continued movement of the shaft beyond the limited movement of the bracket.

4. In a temperature responsive device having a casing, a tiltable mercury tube switch and actuating means for tilting the switch within the casing, the combination with thermally responsive means for operating the actuating means and a calibrated temperature scale, of adjustable means cooperating with the actuating means for determining the temperature points of switch operation including two hubs one super-imposed upon the other, the inner hub mounting a toothed disk having a pointer projecting beyond the periphery of the disk, retaining means to position the disk adjacent the dial and to engage the teeth of the disk to prevent rotation of the disk, the outer hub mounting a pointer arm having a pawl adapted to engage the teeth on the disk, and means yielding to the depression of the hubs to release the toothed whel from its retaining means to be rotated to the desired position and by an outward pull of the outer hub to detach the pointer arm pawl from the toothed disk to rotate the pointer arm to the desired position.

5. In a temperature responsive device having a casing, a tiltable mercury tube switch and actuating means for tilting the switch within the casing, the combination with thermally responsive means for operating the actuating means and a calibrated temperature scale, of adjustable means cooperating with the actuating means for determining the temperature points of switch operation including two hubs, one super-imposed upon the other, the inner hub mounting a toothed disk having a pointer projecting beyond the periphery of the disk, retaining means to position the disk adjacent the dial and to engage the teeth of the disk to prevent the rotation of the disk, the outer hub mounting a pointer arm having a pawl adapted to engage the teeth on the disk, a spring normally acting on the outer hub to maintain the pawl in engagement with the disk teeth and yieldable to movement of the hub to free the pawl and permit rotation of the hub, a spring normally acting on the inner hub to maintain the disk thereon in engagement with

the retaining means and yieldable upon movement of the hub to free the disk for rotation of the hub.

6. A temperature responsive electric switch including a casing, a mercury tube switch and switch operating mechanism mounted within the casing, a temperature responsive coil of thermal metal mounted exteriorly of the casing having one end secured thereto and the free end secured to the end of an axially mounted operating shaft the other end of which enters within the casing, an operative connection between the operating shaft and switch operating mechanism to open and close the switch, said mechanism including a pivoted switch operating latch adapted to be actuated upon movement of the operating shaft, a post projecting from the free end of the operating latch, spaced apart stops on each side of the latch post adapted to be engaged by the post to throw the switch from one position to another, adjustable means to position the stops upon a calibrated temperature scale to throw the switch at the desired degree of temperature to which the temperature responsive coil is subjected, said adjusting means including a post projecting through the front of the casing for manually adjusting the position of both stops.

7. The structure of claim 6 wherein said adjusting post is in the form of two hubs one superimposed upon the other, with the outer hub mounting within the casing a pointer arm having a stop, the inner hub extending therebeyond and mounting a toothed disk having an annular slot through which the latch post and the stop on the pointer arm pass, the radial edge of the slot acting as the other stop for the latch post, a pointer projecting beyond the periphery of the disk adjacent the radial edge stop, a spring pressed pawl normally engaging the toothed disk and a tooth struck from the pointer arm to normally engage between the teeth on said disk, and means yielding to the depression of the hubs to release the toothed wheel from the pawl to be rotated to the desired position and by an outward pull of the outer hub to detach the pointer arm tooth from the disk wheel to rotate the pointer arm to the desired position.

8. A temperature responsive electric switch including a casing, a mercury tube switch and switch operating mechanism mounted within the casing, a temperature responsive coil of thermal metal mounted exteriorly of the casing having one end secured thereto and the free end secured to the end of an axially mounted operating shaft the other end of which enters within the casing, a supporting plate and a front plate spaced apart from each other and from the front and back of the casing and parallel thereto, bearing members mounted upon said plates in alignment with the operating shaft with the inner end of the operating shaft received in one of the bearings in the supporting plate, a U-shaped operating bracket having its free ends perforated, one to receive and oscillate about the bearing on the front plate and the other to receive and oscillate about the end of the operating shaft, a mercury tube switch supported on the upper end of a carrier arm extending from a switch carrier mounted for oscillation between the adjacent perforated ends of the bracket, an operative connection between the operating shaft and an arm of the operating bracket, an operating latch pivotally mounted adjacent the top of the other arm of the operating bracket, and an operative connection between the operating latch and switch carrying arm whereby expansion and contraction of the thermal coil imparts oscillation to the operating shaft to operate the switch.

9. A temperature responsive device including a tiltable mercury tube switch, an operating shaft, a thermal member for operating the shaft, a tiltable bracket, means transmitting movement imparted to the shaft to the bracket, a switch actuator operated by the tiltable bracket, adjustable means for determining the time of switch operation and means upon the switch actuator adapted to abut said adjustable means when the actuator is operated by the tiltable bracket and upon continued movement of the bracket thereafter to cause the actuator to tilt the switch, including a manually operated latch operable to tilt the switch to one position and hold the same in its manually tilted position against the effort of the thermal member to tilt the switch to the reverse position until in response to a temperature condition wherein the thermal member no longer opposes the actuation of the switch, whereupon the latch falls free of engagement with the tiltable switch.

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