March 5, 1929. L. A. M. PHELAN 1,704,370

THERMOSTAT

Filed Sept. 22, 1924 3 Sheets-Sheet 1

Fig. 1.

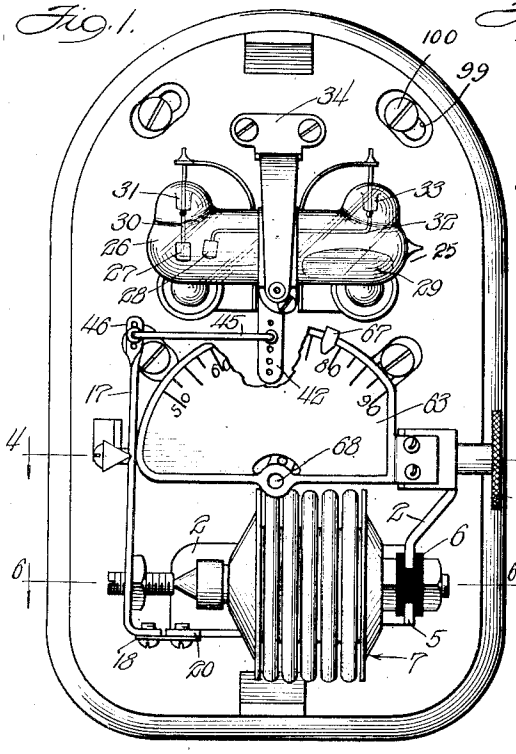


Fig. 2.

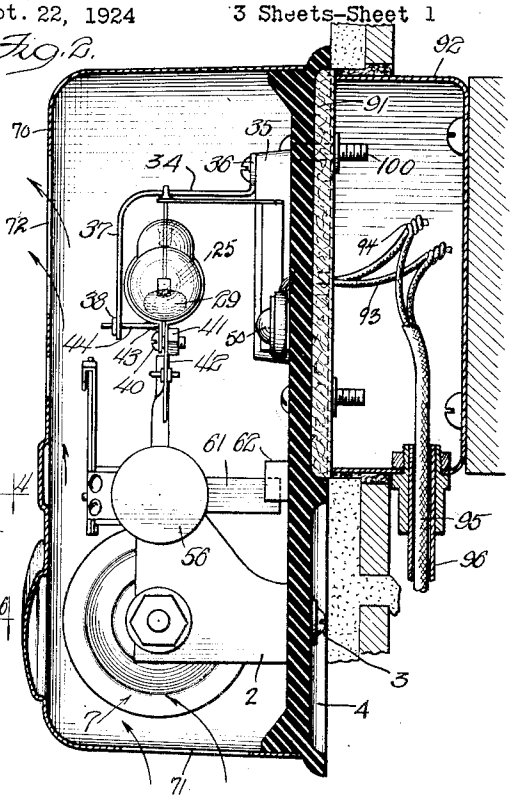


Fig. 3.

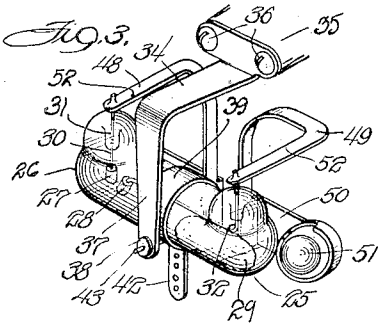


Fig. 4.

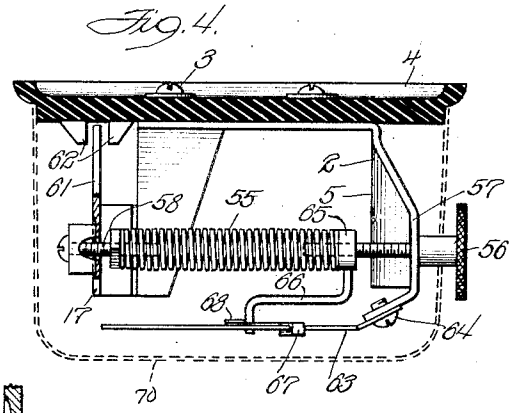


Fig. 7.

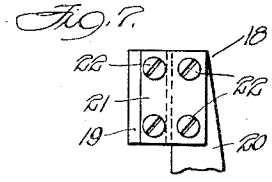
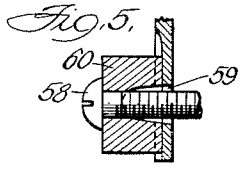


Fig. 5.



Witness:
W. R. Olson

Inventor:
LOUIS A. M. PHELAN
By Jones, Addington, Ames & Seibold
Attys.

March 5, 1929. L. A. M. PHELAN 1,704,370

THERMOSTAT

Filed Sept. 22, 1924 3 Sheets-Sheet 2

Fig. 9.

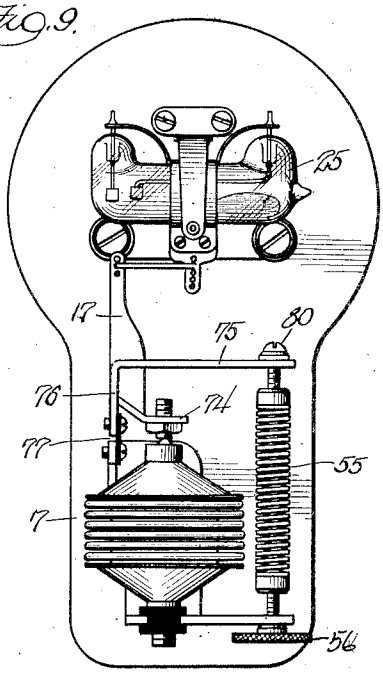


Fig. 10.

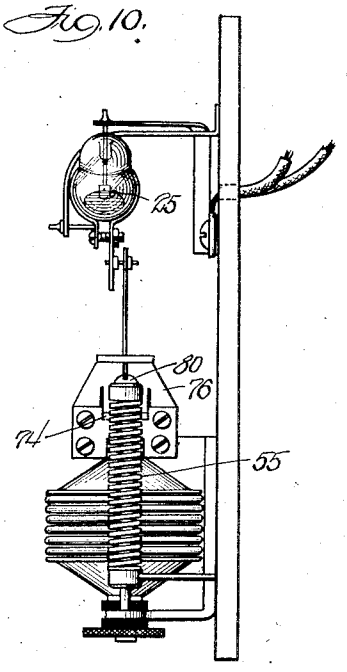


Fig. 11.

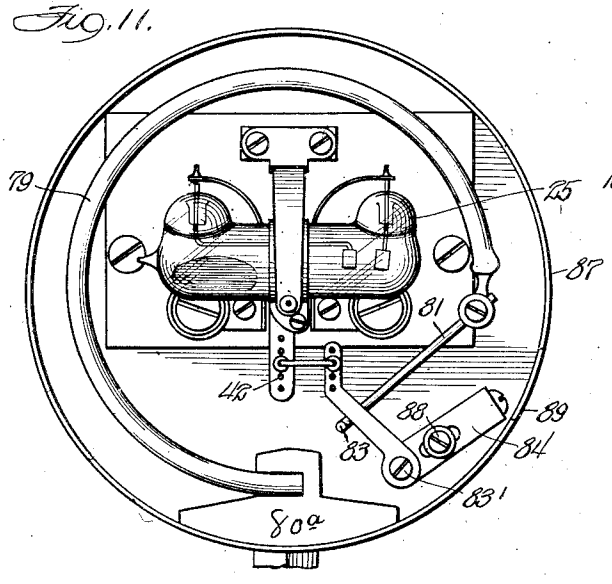
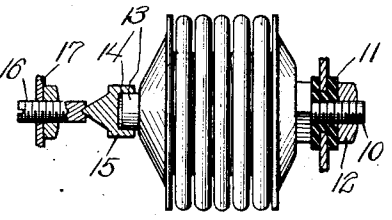


Fig. 6.



Witness:
W. K. Olson

Inventor:
LOUIS A. M. PHELAN
By Jones, Addington, Ames & Bibby
Attys.

March 5, 1929. L. A. M. PHELAN 1,704,370

THERMOSTAT

Filed Sept. 22, 1924 3 Sheets-Sheet 3

Fig. 8.

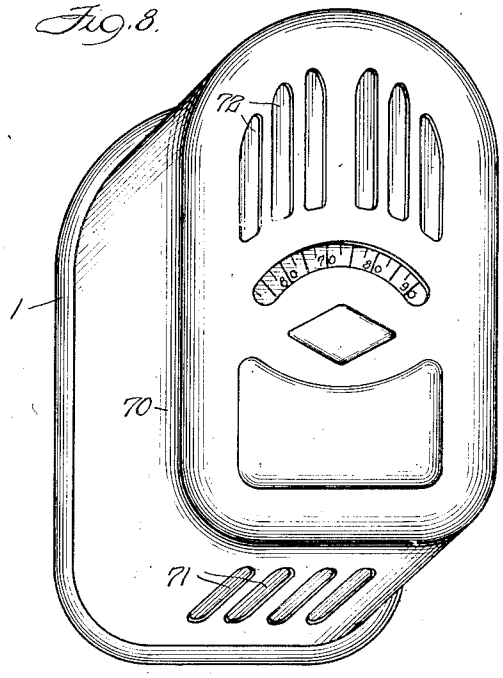
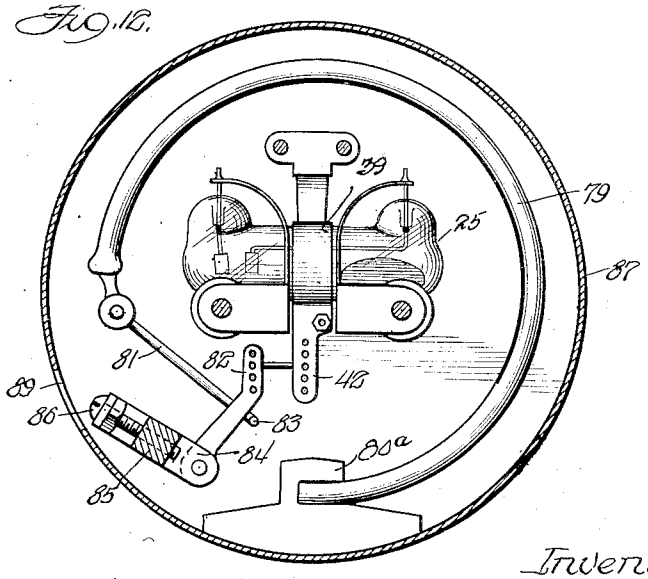


Fig. 12.



Witness:
W. K. Olson

Inventor:
Louis A. M. Phelan
By Jones, Addington, Ames & Seibold
Attys.

Patented Mar. 5, 1929. 1,704,370

UNITED STATES PATENT OFFICE.

LOUIS A. M. PHELAN, OF BELOIT, WISCONSIN, ASSIGNOR TO ABSOLUTE CON-TAC-TOR CORPORATION, OF BELOIT, WISCONSIN, A CORPORATION OF ILLINOIS.

THERMOSTAT.

Application filed September 22, 1924. Serial No. 739,006.

My invention relates to automatically operated electric switches and more particularly to those having enclosed contacts which make and break the circuit and which are capable of handling substantial quantities of current at commercial voltages.

While I shall describe my invention as having particular application to a type of switch provided with enclosed contacts, it will nevertheless be understood that any type of switch may be used, which is automatic in operation and may be actuated by an actuating force imparted by a device provided for the purpose, notwithstanding that the former type of switch may be preferable on account of its durability and simplicity of design.

The present invention, however, refers more particularly to a thermostatically operated switch which comprises a heat responsive element or thermostat that provides an actuating force for the electric switching mechanism for opening and closing the electric circuit as the thermostat expands and contracts by reason of temperature changes that may influence it.

The switch, which I employ, is preferably of the tiltable mercury contactor type wherein the co-operating contact members or electrodes between which the circuit is made and broken, are fixed in position and are adapted to be bridged by a conducting body, such as mercury, that is moved to and fro by an actuating thermostat at the expense of very little energy, such as may be available when a temperature change of a few degrees only, or even a degree, may occur. The co-operating contact members of my switching device are spaced a suitable distance from one another to preclude premature electric discharges between them, and they are completely enclosed in a sealed container, thereby insuring them against corrosion, contamination and deterioration.

An object of my invention resides in the provision of an improved form of thermostatically operated switch of the tiltable mercury contactor type, wherein novel means are provided for resiliently supporting the mercury contactor and for absorbing the kinetic energy of the movable body of mercury contained in the contactor upon operation of the switch. A pivotal mounting which is connected to the thermostatic element, is provided for the mercury contactor, allowing the contactor to be tiltably carried so that it is sensitive to the slightest movement by the thermostat.

A further object of my invention is to provide the resilient supporting means for the mercury contactor in the form of current conductors coextensive with the lead-in-wires whereby a dual function is provided: viz, that of absorbing the kinetic energy of the movable body of mercury within the contactor, which places the opposite side of this supporting means under tension to assist in the return of the contactor to its normal position, and secondly, that of carrying the electric current to the lead-in-wires which eliminates the usual wires heretofore employed.

A still further object of my invention is to provide an improved form of mounting for the thermostatic or heat responsive element whereby it will be thermally insulated from its support, and so positioned that the natural flow of air currents will contact with its maximum surface.

In accomplishing these and other objects and advantages of my invention, I am able to provide an exceedingly simple and compact arrangement of the parts in a device which is durable, reliable and efficient. When controlling motor circuits, I have found it unnecessary to employ relays or like devices, as the switching mechanism which I use has a large current carrying capacity and is capable of quick and accurate operation by the expenditure of very little energy.

In the drawings:

Figure 1 is a front elevational view of a device embodying my invention with the cover omitted so that the various operating parts of the structure will be more clearly illustrated;

Fig. 2 is a side elevational view thereof with the cover illustrated in section showing the manner of mounting the device upon a wall in thermally insulated relation;

Fig. 3 is a perspective view of the mercury contactor and the mounting provided therefor;

Fig. 4 is a section taken on line 4—4 of Fig. 1, illustrating the means for adjusting the tilting position of the mercury contactor;

Fig. 5 is a horizontal sectional view illus-

trating the knife blade engagement of the aforesaid means illustrated in Fig. 4 with the actuating member serving as the interconnection between the mercury contactor and the thermostatic element;

Fig. 6 is a sectional view through the thermally insulated mounting of the thermostatic element;

Fig. 7 is a bottom view of a novel form of resilient mounting for said actuating member.

Fig. 8 is a perspective view of the device, illustrating the cover having venting holes therein which permit a natural flow of air currents about the thermostatic element;

Fig. 9 is a view similar to Fig. 1 illustrating a modified form of my invention which is provided with the thermostatic element in vertical position;

Fig. 10 is a side elevational view thereof;

Fig. 11 is a front view of another modified form of my invention; and

Fig. 12 is a view of the same device looking from the rear thereof.

The device illustrated in Figures 1 and 2 preferably comprises a mounting base 1 of bakelite, or other suitable insulation material, to which is secured a bracket 2 by means of screws 3 entering from the rear of the base 1 and having their heads seated within a recess 4 in the rear face of this base. Bracket 2 is provided with a forwardly extending portion 5 having a slot 6 cut therein along the front edge. A thermostatic element 7 is adapted to be supported upon insulating base 1. Thermostatic element 7 is of the expansible and contractible bellows type, the interior of which may be provided with a highly volatile fluid which renders the bellows sensitive to the slightest temperature change. In order that the operation of the bellows will be efficient and accurate and will not be influenced by the temperature of the adjacent parts of the device, I provide a thermally insulated support which prevents the conduction of heat to the bellows 7. This thermally insulated support, as illustrated in the Figure 6, comprises a projecting shank 10 at the right-hand end of the bellows and a heat insulated collar 11 adapted to seat in slot 6 of bracket 2. Nuts 12 on each side of the collar 11 serve to hold the shank 10 seated in the slot 6 of bracket 2. The left-hand side of the bellows 7 terminates in a stud 13 adapted to seat in a recess 14 provided in a bearing 15. This bearing 15 is furnished with a point contact with one end of a screw 16 projecting from an actuating member 17.

Actuating member 17 is vertically positioned and is adapted to be furnished with a leaf spring mounting 18 at its lower end. As illustrated in Figure 7, which is a bottom plan view of this leaf spring mounting, the actuating member 17 is provided with a horizontal projection 19 lying in substantially the same plane as the projecting portion 20 of bracket 2. A leaf spring 21 overlaps both portions 19 and 20 and is secured to each by a plurality of screws 22. This serves as the fulcrum point of the actuating lever 17, and further serves to impart greater resiliency, so that the slightest change in the contraction or expansion of the bellows 7 may be transmitted, to allow the upper end of the actuating member to readily flex for operating a mercury contactor 25, suitably supported at the upper end of insulating base 1.

Mercury contactor 25, in this instance, comprises a sealed container 26, preferably a glass tube, in which cooperating electrodes 27 and 28 are sealed. The container 23 is evacuated and contains a body of mercury 29, as well as an inert gas. The container 26 is of tubular form having its longitudinal axis placed approximately horizontal. The electrodes or contact members 27 and 28 are made of pure metal and are disposed on one side of the axis of rotation of the mounting for the mercury contactor. A tiltable mounting is provided for the mercury contactor, which allows mercury 29 to ride on a lower annular surface of container 26, and, when tilted to the left of Figure 1, it serves to establish an electric circuit between the electrodes 27 and 28. When the contactor 25 is tilted in the direction illustrated in Figure 1, the mercury 29 flows to the other end of the container 26 and thereby opens the electric circuit between the cooperating contact members or electrodes 27 and 28. Electrode 27 is connected in electrical circuit through a leading-in-wire 30, which is embodied in the glass shank 31, thereby providing a substantial support for the leading-in wire 30. Similarly the electrode 28 is connected to a leading-in wire 32 which is likewise embedded in a glass shank 33. Thus it will be seen that the electrodes 27 and 28 are fixed and stationary with respect to each other.

I provide a novel form of tiltable mounting and resilient support for the mercury contactor 25. This tiltable mounting and resilient support comprises a rigidly fixed bracket 34 secured to an insulating projection 35, by means of screws 36, which projection 35 is preferably integrally formed with the insulating base 1. Bracket 34 projects forwardly and then downwardly, having a portion 37 which is apertured at its lower end as indicated at 38. An annular clamping ring 39 securely grips the mercury contactor 25 at a point substantially midway of its ends. The clamp 39 is brought tightly against the glass container 26 by means of a screw 40 and a cooperating nut 41. One of the lower ends, designated 42, of clamp 39 forms a downwardly

projecting apertured extension, while the other end 43 of said clamp 39 is adapted to have fixed thereto one end of a rod 44. The opposite end of this rod 44 is pivoted in the lower apertured end 38 of the portion 37 of bracket 34. From the description thus far, it will be seen that I provide a pivotal mounting for the mercury contactor 25, which is located substantially at a point between the ends of the contactor. The arrangement reduces frictional losses to a minimum because friction at the pivot point of contactor 25 is practically negligible. Apertured extension 42 of clamp 39 is adapted to connect to the upper end of the actuating member 17 by means of a rod 45. Actuating member 17 has its upper end 46 also apertured which permits rod 45 to be accurately adjusted with respect to the actuating arm and position of the contactor 25, to compensate for any mechanical or manufacturing inaccuracies.

To provide a balanced support for the mercury contactor 25, I provide means for resiliently supporting the contactor at its ends. In addition to accomplishing this purpose, said means further functions to absorb the kinetic energy of the movable body of mercury 29 in the container 26 when the switch is actuated. This means comprises a pair of leaf spring members 48 and 49, best illustrated in Fig. 3. Each leaf spring is provided with an extension 50, which is adapted to connect with the terminals 51 of the electric circuit. The leaf spring extends upwardly and then outwardly, resulting in forwardly projecting arms 52. The end of each arm 52 is apertured for the purpose of receiving, in fixed relation, the projecting tips of the lead-in wires 30 and 32. The spring members 48 and 49 are in electrical conducting relation between the lead-in wires 30 and 32 and the terminals 51 of the circuit. This arrangement eliminates flexible leads and further eliminates the influence which tension in flexible leads would have on the movement of the contactor 24 when operated. Furthermore, these resilient members tend to restore the contactor to normal position when tilted irrespective of whether normal position is in closed circuit position or open circuit position.

I provide means for adjusting the tiltable position of the contactor 25 in order to obtain a proper setting or adjustment of the bellows 7, so that it will be adapted to operate the contactor at a desired temperature change. This means comprises a horizontal tension spring 55 having its axis substantially parallel to the axis of the bellows 7 and adjustable by a knurled thumb screw 56 which is journaled in a portion 57 of bracket 2. Spring 55 tends to place a tension on the actuating member 17, and, due to the fact that its axis is parallel to that of the bellows, this tension will be maintained more uniform for all temperature adjustments. The knurled thumb screw 56 enters the tension spring 55 at one end, while the opposite end of the tension spring is carried by a second screw 58. As illustrated in Figure 5, an aperture 59 of a diameter greater than the diameter of screw 58 is furnished in actuating member 17, and through this aperture 59 screw 58 is adapted to project, the screw being held out of contact with the periphery of the aperture. At the outer end, a member 60, through which screw 58 passes, furnishes a knife blade contact between the actuating member and the screw 58. The tension on the actuating member 17 may be varied by turning the knurled screw 58 in either direction. It will be noted in Fig. 4 that the actuating member 17 has a lateral extension 61 extending between spaced parallel lugs 62. Lateral extension 61 of the actuating member 17 has, therefore, limited movement between these spaced parallel lugs 62. When reaching the end of its movement, the projection 61 still allows further tension to be applied to the actuating member 17. Minimum frictional losses are obtained where the tension spring 55 connects to the actuating member 17, and consequently, a finer adjustment of the position of contactor 25 at its pivotal mounting may be obtained. An indicator plate 63 may be secured to the portion 57 of bracket 2, as indicated at 64. One end of tension spring 55 is soldered or otherwise secured to a collar 65, from which a member 66 projects. An indicator arm 67 is pivoted at 68 to indicator plate 63. The upper portion of indicator arm 67 embraces the periphery of indicator plate 63 along which temperature calibrations are provided for indicating the temperature at which the bellows may be set to operate the switch.

A very fine and accurate temperature setting may be obtained by having the fulcrum point of actuating arm 17 substantially at its lower end. By having its point of contact with the bellows substantially adjacent to this fulcrum, the actuating arm 17 multiplies the motion of the bellows in a large ratio, and consequently, secures operation of the contactor 25 with a very slight motion of the bellows. The thermally insulated support for the bellows secures maximum efficiency in the operation of the latter, and the temperature of the surrounding parts will have practically no effect thereon.

In Figure 8, I have illustrated a cover 70 adapted to be placed over the front of the device and suitably secured to the insulating mounting base 1. A plurality of elongated ventilation openings 71 are provided in the cover 70 on the under side, and at the

upper end of the front face, a second set of elongated ventilation openings 72 may be furnished. Bellows 7 is horizontally disposed adjacent to the ventilation opening 71, so as to have a maximum surface thereof exposed to the natural air currents entering openings 71 and leaving the interior of the cover through openings 72. The arrangement of openings 71 and 72 obtain a natural flow or circulation of air within the cover, and moreover, the disposition of the bellows so that a maximum surface thereof is exposed to the air currents within the cover permits the device to be very sensitive to any change of temperature in the room.

In Figure 2, a novel form of wall mounting for the insulating base 1 is illustrated. A recess 90 similar to the recess 4 in the lower end is provided in the upper end of the insulating base 1. Thermal insulating material 91, such as felt, or the like, is adapted to be inserted in recess 90. Attached to the wall at this point is an outlet box 92, in which proper connecting of the wiring may be made. Wires 93 leading from the front side of insulating base 1 at the terminals 50 are connected at 94 to circuit wires 95 leading upwardly through the conduit 96. This arrangement serves to thermally insulate the insulating base 1 from the outlet box 92 which is usually sunk in the wall and subject to currents of air therein, which currents of air are generally of varied temperatures and different from the room temperature, and are apt to affect the operation of a sensitive thermostat. The pad of felt 91 covers the portion of the base 1 exposed to the outlet box 92 and prevents conduction of heat to or from the base 1, thereby thermally insulating it from all temperature effects as the result of its contact with the wall. It is thereby impossible for the temperature controlled bellows 7 to expand or contract except by the temperature effects of the currents of air circulated through the cover, to which currents of air the bellows presents a maximum surface. The bellows 7 is, therefore, sensitive and dependable, and exceedingly accurate in its operation of the contactor 25, the latter being capable of tilting at the slightest movement of the bellows 7.

Insulating base 1 may be provided with a plurality of elongated slots 99 which are adapted to receive screws 100 for mounting the base to the wall. Screws 100 pass through the felt 91, but the felt serves to cover the slots, and due to their elongation (which permits adjustment of the screws) the felt prevents an opening adjacent the shanks of these screws which would otherwise appear.

On Figures 9 and 10, I have illustrated the device provided with the bellows 7 and coil spring 55 disposed vertically. The actuating member 17 is provided with a lateral extension 74 engaged by a point contact with bellows 7. An arm 75 is connected adjacent to its outer end, as indicated at 80, to one end of a coil spring 55, as indicated at 80. Actuating arm 17 then extends downwardly at 76 to provide a leaf spring mounting 77, which is similar to the mounting 18. The upper end of actuating arm 17 interconnects with contactor 25, which is provided with a mounting substantially the same as in the form previously prescribed. While I have not shown an indicator plate in connection with this embodiment, it is to be understood that the same may be provided and connected to the tension spring 55 in any suitable manner, so that the movement of the knurled thumb screw 56 will adjust the tilting position of the contactor 25 with respect to the bellows 7.

In Figures 11 and 12, I have illustrated a device embodying several of the essential features of my invention which is, however, operated by a pressure element instead of a thermostatic element. By referring to Figures 11 and 12, it will be noted that one end of the Bourdon pressure gauge 79 is connected to a nipple 80^a while the opposite end has a rod 81 fixed thereto. A link 82 is pivotally connected at 83′ to a bracket 84. In this device, contactor 25 is also pivotally mounted and resiliently supported at its ends, the same as was previously described for the embodiment illustrated in Figures 1 to 8 inclusive. Link 82 connects with the depending arm 42 of the clamping ring 39 carrying the contactor 25. Upon movement of the Bourdon gauge 79, the rod 81 with its right-angular projections 83 will tend to engage the under side of link 82 for tilting the mercury switch to open and close the circuit.

In order to adjust or set the device to operate at a predetermined pressure, a slotted bracket 84, to which the link 82 is pivoted, is fastened by means of a screw 86 to a lug 85 fixed to the casing 87. Bracket 84 is guided in its movement by a screw 88 riding in its slot and entering the lug 85. Casing 87, however, is provided with an opening 89 into which a tool may be inserted for adjusting screw 86. When it is desired for the device to operate at a desired pressure, the tilting position of contactor 25 is varied, this in turn changing the position of the arm 82 with respect to the right angular projection 83, so that a greater or a smaller movement of the link 81 will be required, it depending on the pressure at which the device is to operate.

The mercury contactor 25, which I have disclosed herein, may be of any type, if so desired. However, as I have disclosed it, it is of the type of contactor more particularly described and claimed in my copending application, Serial Number 530,243, filed

January 19, 1922 and the joint copending application of myself and Clifford Hotchkiss, Serial Number 630,027, filed November 24, 1922, both of which applications are entitled "Electrical apparatus."

While I have shown and described several embodiments of my invention, it is to be understood that many modifications may be made therein without departing from the scope and spirit of the appended claims, and furthermore I desire that only such limitations shall be imposed as are specifically pointed out in the claims and such as are required by the prior art.

I claim:

1. An electric switch comprising a tiltable mercury contactor, a bracket upon which said contactor is pivotally mounted, and a spring member having one end fixed and stationary and resiliently supporting said contactor at an electrode lead-in wire for absorbing the kinetic energy of the movable body of mercury contained in said contactor.

2. An electric switch comprising a tiltable mercury contactor, a bracket upon which said contactor is pivotally mounted, and leaf-spring members having one of their ends fixed and stationary and their other ends resiliently supporting said contactor at the electrode lead-in wires for absorbing the kinetic energy of the movable body of mercury contained in said contactor.

3. An electric switch comprising a tiltable mercury contactor, a bracket upon which said contactor is pivotally mounted, and leaf-spring members having one of their ends fixed and stationary and their other ends resiliently supporting said contactor and serving as current conductors to said contactor.

4. An electric switch comprising a tiltably mounted contactor, a mounting base therefor, spring members secured at one of their ends to said mounting base and attached at the other of their ends to the electrodes of said contactor thereby permitting said contactor to be tilted.

5. An electric switch comprising a mounting base, a mercury contactor pivotally mounted thereupon, and spaced leaf-spring members severally attached at one of their ends to said mounting base and secured at the other of their ends to the electrode lead-in wires of said contactor, said leaf-spring members serving as conductors for said contactor and as shock-absorbing means for absorbing the kinetic energy of the movable body of mercury in said contactor.

6. An electric switch comprising a tiltable mercury contactor, a bracket for pivotally mounting said contactor, and leaf-spring members disposed on both sides of said bracket and having one of their ends attached to the electrode lead-in wires of said contactor and the other of their ends fixed and stationary.

7. An electric switch comprising a tiltable mercury contactor, a member upon which said contactor is pivotally mounted, and resilient means disposed on each side of said mounting member and having one of their ends connected to the electrode lead-in wires of said contactor and the other of their ends fixed and stationary, said resilient means serving as current conductors and as shock-absorbing means for said contactor.

8. An electric switch comprising a tiltable mercury contactor, a bracket for pivotally mounting said contactor adjacent to its center, and leaf-spring members disposed on both sides of said bracket and having one of their ends engaging said contactor adjacent to its ends and the other ends of said leaf-spring members being fixed and stationary.

9. An electric switch comprising a pivotally mounted mercury contactor, and L-shaped leaf-spring members resiliently supporting said contactor upon its pivotal mounting and serving as current conductors to the electrodes of said contactor, said spring members having one of their ends attached to a mounting member and their other ends attached to said electrodes.

10. An electric switch comprising a tiltable mercury contactor, a mounting base therefor, a member serving as a pivotal mounting for said contactor, resilient means supporting said contactor upon said mounting base that serve as shock-absorbing means and current conductors to the electrodes of said contactor, and means for adjusting the tiltable position of said contactor.

11. An electric switch comprising a mounting base, a bracket, a mercury contactor pivotally mounted on said bracket, spaced leaf-spring members having one of their ends connected to the electrodes of said contactor and the other of their ends secured to said base member for resiliently supporting said mercury contactor, means for adjusting the tiltable position of said contactor, and expansible and contractible means for tilting said contactor upon said bracket.

12. An electric switch comprising a mounting base, and a mercury contactor pivotally mounted thereupon, resilient supporting means for balancing said contactor about its pivoted mounting and serving as current-conductors to said contactor, and expansible and contractible means for tilting said contactor about its pivot, said resilient supporting means being stationary and fixed to said mounting base and serving to absorb the kinetic energy of the movable body of mercury contained in said contactor.

13. An electric switch comprising a mounting base, a mercury contactor pivoted

thereupon, L-shaped leaf-spring members supporting said contactor about its pivot at its leading-in wires upon one of their ends, electric terminals connected to the other ends of said leaf-spring members, and means for tilting said contactor about its pivotal mounting, said leaf-spring members being stationary and supported upon said mounting base and serving to absorb the kinetic energy of the movable body of mercury contained in said contactor.

14. An electric switch comprising a mounting base, a mercury contactor, a pivotal mounting for said contactor, L-shaped leaf-spring members supporting said contactor at its leading-in wires upon one of their ends and balancing said contactor upon said pivotal mounting, electric terminals connected to the other ends of said leaf-spring members, means for tilting said contactor about its pivotal mounting, said leaf-spring members serving to absorb the kinetic energy of the movable body of mercury contained in said contactor, and means for varying the position of said contactor about its pivot.

15. An electric switch comprising a mounting base, a mercury contactor, a pivotal mounting for said contactor, L-shaped leaf-spring members supporting said contactor upon one of their ends to balance said contactor upon said pivotal mounting and the other ends of said leaf-spring members being secured to said mounting base, heat responsive means for tilting said contactor about its pivtol mounting, said leaf-spring members serving to absorb the kinetic energy of the movable body of mercury contained in said contactor, and means for varying the position of said contactor about its pivot.

16. A balanced mounting for a mercury contactor having a centrally located pivot comprising a clamping member secured at a substantially central point on said contactor, a bracket for carrying said clamping member, and resilient members adapted to be attached to the ends of said contactor and tending to return the contactor to normal position when tilted.

17. A balanced mounting for a mercury contactor comprising means providing a centrally located pivot for the contactor, in combination with resilient members connected directly to the leading-in wires of said contactor adjacent to both of its ends and tending to balance the contactor about said pivot while tilted, said resilient members serving as current conductors to said leading-in wires.

18. An electric switch comprising a pivotally mounted mercury contactor, a base for said pivotal mounting, resilient means connected adjacent to the ends of said contactor and balancing said contactor about said pivotal mounting, said resilient means being attached to said base, a thermally insulated heat responsive device on said base, and interconnecting means between said contactor and said heat responsive device, said resilient means serving as current conductors to electrodes in said contactor.

19. An electric switch comprising a pivotally mounted mercury contactor, a base for said pivotal mounting, resilient means connected adjacent to the ends of said contactor and balancing said contactor about said pivotal mounting, said resilient means being attached to said base, a heat responsive means for actuating said contactor, means for horizontally mounting said heat responsive device on said base in thermally insulated relation, and means for interconnecting said contactor and said heat responsive device, said resilient means serving as current conductors to electrodes in said contactor.

20. An electric switch comprising a tiltable mercury contactor, a pivotal mounting therefor, a base for said pivotal mounting, resilient electrical conductors connected to the leading-in wires of said contactor adjacent to the ends thereof, said electrical conductors tending to balance said contactor about said pivotal mounting and having their corresponding ends attached to said base, a heat responsive device for actuating said contactor, means for horizontally mounting said heat responsive device on said base in thermally insulated relation, a vertical actuating arm having its fulcrum in close proximity to the point of contact with said heat responsive device for multiplying the movement of said heat responsive device, and adjustable means interconnecting said actuating arm with said contactor for transmitting thereto the adjustably multiplied movement of said heat responsive device.

21. An electric switch comprising a tiltable mercury contactor, a pivotal mounting therefor, a base for said pivotal mounting, resilient electrical conductors connected to the leading-in wires of said contactor adjacent to the ends thereof, said electrical conductors tending to balance said contactor about said pivotal mounting and having their corresponding ends attached to said base, a heat responsive device on said base for actuating said contactor, an actuating arm for transmitting the movement of said heat responsive device to said mercury contactor, said actuating arm being disposed at right angles to the axes of said contactor and said heat responsive device, and adjustable means for varying the degree of movement of said contactor in response to said heat responsive means.

22. An electric switch comprising a tilt-

able mercury contactor, a pivotal mounting therefor, a base for said pivotal mounting, resilient electrical conductors connected to the leading-in wires of said contactor adjacent to the ends thereof, said electrical conductors tending to balance said contactor about said pivotal mounting and having their corresponding ends attached to said base, an overhanging bracket arm secured to the upper end of said mounting base for providing a pivotal mounting for said contactor, a heat responsive device mounted on said base, an actuating arm interconnecting said contactor and heat responsive device for transmitting the motion of the latter to the former, said actuating arm being mounted for movement substantially in the same direction of movement as said heat responsive device, and adjustable means for varying the degree of movement of said contactor in response to said heat responsive means.

23. An electric switch comprising a tiltable mercury contactor, a pivotal mounting therefor, a base for said pivotal mounting, resilient electrical conductors connected to the leading-in wires of said contactor adjacent to the ends thereof, said electrical conductors tending to balance said contactor about said pivotal mounting and having their corresponding ends attached to said base, a heat responsive device mounted on said base in thermally insulated relation, an actuating arm for transmitting the motion of said heat responsive device to said contactor, said thermally insulated mounting comprising a bracket, a shank at one end of said heat responsive device adapted to seat in said bracket, thermal insulating material between said shank and said bracket, and a single sharp point contact between the opposite end of said heat responsive device and said actuating arm whereby the heat flow between said arm and said heat responsive device will be minimized.

24. An electric switch comprising a tiltable mercury contactor, a mounting base therefor, a heat responsive device mounted on said base in thermally insulated relation, an actuating arm for transmitting the motion of said heat responsive device to said contactor, said thermally insulated mounting comprising a bracket, a shank at one end of said heat responsive device adapted to seat in said bracket thermal insulating material between said shank and said bracket, a single point contact member affixed to the opposite end of said heat responsive device and engaging said actuating arm, and means including an adjusting screw carried by said actuating arm for engaging said single point contact member.

25. An electric switch comprising a tiltable mercury contactor through which an external electric circuit is controlled, a mounting base for said contactor, an expansible and contractible bellows serving as a heat responsive device for actuating said contactor, an actuating arm engageable by the movable end of said bellows for transmitting the motion of said bellows to said contactor, and an adjustable element interposed between said actuating arm and the movable end of said bellows for permitting initial calibration of the latter when mounted on said base.

26. An electric switch comprising a tiltable mercury contactor through which an external electric circuit is controlled, a mounting base for said contactor, an expansible and contractible bellows serving as a heat responsive device for actuating said contactor, an actuating arm engageable by the movable end of said bellows for transmitting the motion of said bellows to said contactor, and an adjustable element interposed between said actuating arm and the movable end of said bellows for permitting initial calibration of the latter when mounted on said base, said element providing a point contact for the movable end of said bellows for minimizing friction and heat conduction thereat.

27. An electric switch comprising a tiltable mercury contactor, a mounting base therefor, an expansible and contractible element horizontally disposed thereon, an actuating arm for connecting said contactor and said element in operative relation, a casing housing the aforesaid elements, and means for varying the tilting position of said contactor whereby said element may be adjusted so that its movement to operate said contactor may be predetermined, said means acting parallel to the axis of said element and being exteriorly accessible of said casing.

28. An electric switch comprising a tiltable mercury contactor, a mounting base therefor, an expansible and contractible element horizontally disposed thereon, an actuating arm for connecting said contactor and said element in operative relation, a tension spring acting in a direction parallel to the axis of said element for varying the tilting position of said contactor, a casing housing the aforesaid elements, and means exteriorly accessible of said casing for adjusting said tension spring.

29. An electric switch comprising a tiltable mercury contactor, a mounting base therefor, an expansible and contractible element disposed thereon, an actuating arm adapted to connect said contactor and said element in operative relation and spring means associated with said actuating arm at a point intermediate said contactor and element for varying the tilting position of said contactor, said spring means including a tension spring provided with a knife blade en-

gagement with said actuating arm and an adjusting means for varying the tension of said spring against said actuating arm.

30. An electric switch comprising a mounting base, a heat responsive bellows located at the lowermost portion thereof and having its axis placed horizontally, a vertically arranged lever pivotally mounted adjacent to said bellows and extending upwardly therefrom, a tiltable electric contactor pivotally mounted adjacent to the upper end of said lever and near the upper portion of said mounting base, and means for connecting said lever and said contactor whereby movements of the said bellows may be imparted to tilt said contactor, said contactor comprising a container, electrodes sealed therein and a body of mercury adapted to control an external electric circuit through said electrodes when said contactor is tilted.

31. An electric switch comprising a mounting base, a horizontally disposed heat responsive element located at the lowermost portion thereof, an electric tiltable contactor located on said base above said heat responsive element, means for connecting said contactor and said element in operative relation, and a container for said heat responsive element having vents therein whereby the maximum surface of heat responsive elements is presented to the natural flow of air currents that influence said heat responsive elements, said contactor comprising a container, electrodes sealed therein and a body of mercury adapted to control an external electric circuit through said electrodes when said contactor is tilted.

32. An electric switch comprising a tiltable mercury contactor, a mounting base therefor, a bellows element located at the lower portion of said base and having its axis horizontally disposed, an actuating arm for connecting said contactor and said bellows in operative relation whereby tilting action is imparted to said contactor, and an enclosing casing having vent holes therein located only above and below said bellows in order that the bellows may receive maximum exposure to the natural flow of air currents having egress through the openings below said bellows and exit through the openings above said bellows.

33. An electric switch comprising a tiltable mercury contactor, a pivotal mounting for said contactor including an apertured depending arm, an expansible and contractible bellows serving as a heat responsive device, an actuating arm between said contactor and said bellows, the end of said actuating arm adjacent to said contactor having one or more apertures provided therein, and an interconnecting member between the apertured end of said actuating arm and said apertured depending arm permitting accurate adjustment of the parts to compensate for inaccuracies in the manufacture thereof.

34. An electric switch comprising a tiltable mercury contactor, a mounting base therefor, means for pivoting said contactor upon said base, and resilient conductors having one of their ends attached to said base and their other ends attached to the leading-in wires of said contactor at the end portions thereof for balancing said contactor upon its pivoting means.

35. An electric switch comprising a tiltable contactor, a mounting base, pivotal means engaging said contactor intermediate its ends, and spring members constituting leading-in wires for said contactor and being connected to the end portions of said contactor for balancing the same upon its pivotal means.

36. An electric switch comprising a contactor, a mounting base therefor, means for pivoting said contactor adjacent to its center upon said base, spring means constituting leading-in wires to said contactor for balancing said contactor in normal position upon its pivoting means, and actuating means for tilting said contactor in opposition to the force exerted thereupon by said spring means.

37. An electric switch comprising a contactor, a mounting base therefor, means for pivoting said contactor upon said base, spring means constituting leading-in wires to said contactor for balancing said contactor in normal position upon its pivoting means, and heat responsive means for tilting said contactor upon its pivoting means in opposition to said spring means.

38. An electric switch comprising a tiltable mercury contactor, a mounting base therefor, resilient supporting means providing current conductors for said contactor, and a pressure element for tilting said contactor about its pivot, said resilient supporting means serving to absorb the kinetic energy of the movable body of mercury contained in said contactor.

39. An electric switch comprising a tiltable mercury contactor, resilient supporting means for said contactor adapted to serve as current conductors therefor and tending to minimize the energy required to tilt said contactor as well as balance the same when tilted, a pressure element for tilting said contactor about its pivot for opening and closing the circuit, and an adjustable connection between said contactor and said pressure element for predetermining the effective operating pressure of said pressure element.

In witness whereof, I have hereunto subscribed my name.

LOUIS A. M. PHELAN.