March 19, 1929. I. G. THOMAS 1,705,690

THERMOSTAT

Filed April 12, 1926 3 Sheets-Sheet 1

Fig. 1.

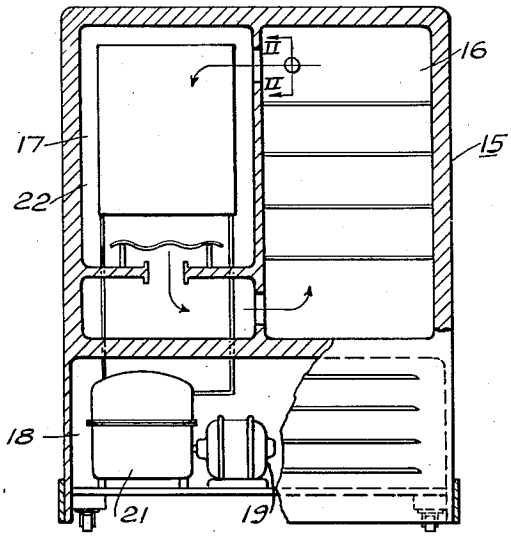


Fig. 2.

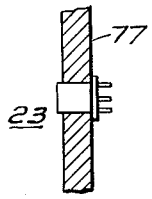


Fig. 3.

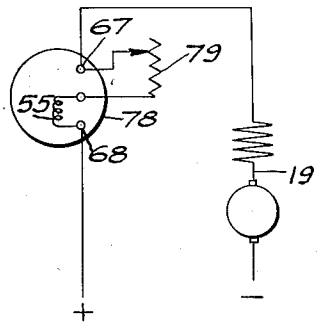
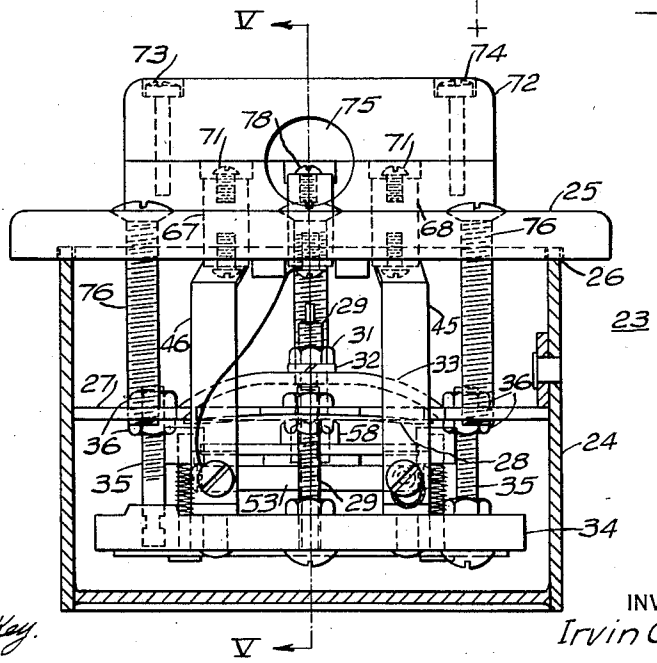


Fig. 4.



WITNESSES:
E. A. McGlaskay.
H. M. Biebel

INVENTOR
Irvin G. Thomas.

BY
Wesley G. Carr
ATTORNEY

March 19, 1929. I. G. THOMAS 1,705,690

THERMOSTAT

Filed April 12, 1926 3 Sheets-Sheet 2

Fig. 5.

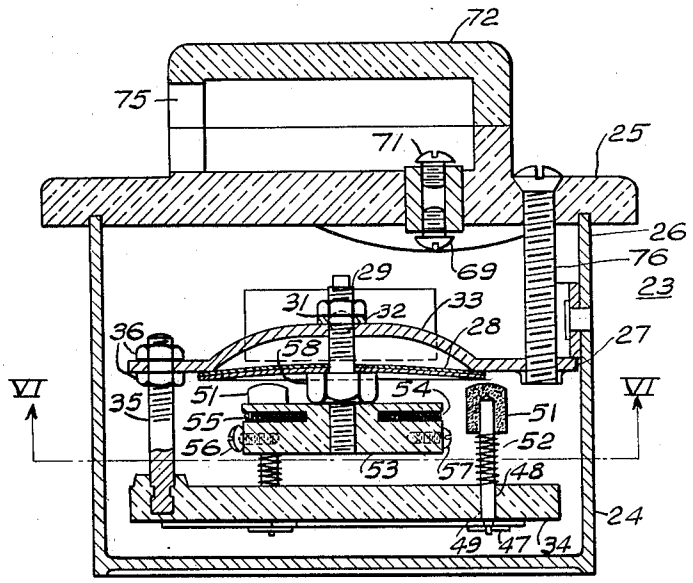
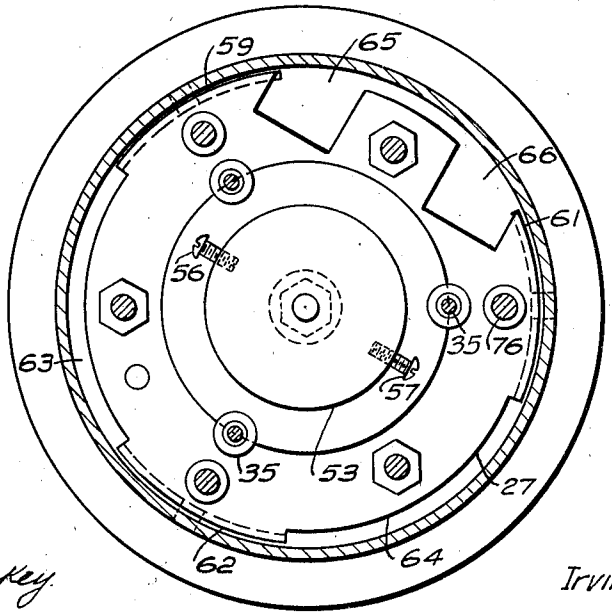


Fig. 6.



WITNESSES:
E. A. McCloskey.
W. M. Bielel

INVENTOR
Irvin G. Thomas.

BY
Wesley G. Carr
ATTORNEY

March 19, 1929. I. G. THOMAS 1,705,690

THERMOSTAT

Filed April 12, 1926 3 Sheets-Sheet 3

Fig. 7.

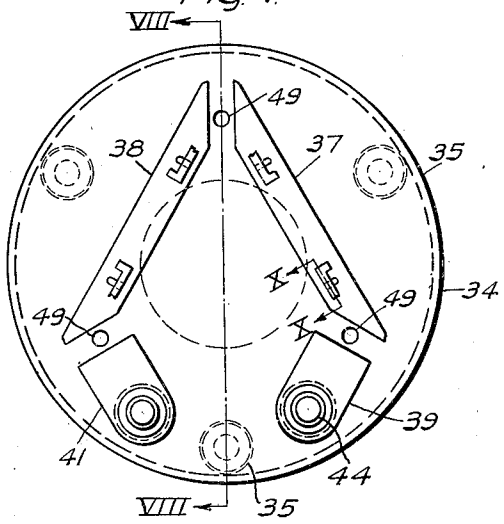


Fig. 8.

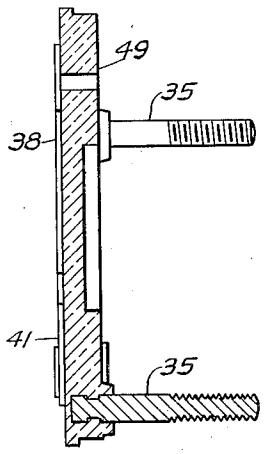


Fig. 9

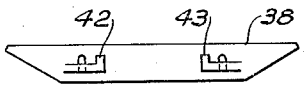
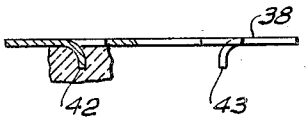


Fig. 10



WITNESSES:
E. A. McCloskey.
N. M. Bichel

INVENTOR
Irvin G. Thomas.
BY
Wesley Sloan
ATTORNEY

Patented Mar. 19, 1929. 1,705,690

UNITED STATES PATENT OFFICE.

IRVIN G. THOMAS, OF MANSFIELD, OHIO, ASSIGNOR TO WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY, A CORPORATION OF PENNSYLVANIA.

THERMOSTAT.

Application filed April 12, 1926. Serial No. 101,313.

My invention relates to thermostats and particularly to refrigerator temperature controlling devices.

An object of my invention is to provide a refrigerator thermostat of relatively simple and efficient construction.

Another object of my invention is to provide an encased thermally actuable switch that shall follow closely the temperature variations in a refrigerator.

Another object of my invention is to provide a thermally actuable impact switch of relatively simple, compact and efficient construction.

Another object is to provide a snap-acting thermostatic member having an inherently large temperature differential between its upper and lower operating temperatures, with means for reducing the temperature differential.

In practicing my invention I provide a metal casing, a supporting table for a bimetallic disc having a snap action and adjustably mounted thereon, a contact-member-supporting plate supported by the table, the movable contact members being actuable by impact of the snap-acting disc. An electric heating element is located in closely spaced relation to the disc. The supporting table is interlocked with projections on the inside of the casing, a cover member being provided for the casing cooperating with the table to hold all of the switch assembly in the casing.

The problems of temperature regulation encountered in a refrigerator which is to be cooled by means of a fluid medium compressed by a motor and permitted to expand in an expansion chamber in a portion of the refrigerator, are many, and the design of a thermally-actuable motor controlling element presents many difficulties. It is necessary that the thermally actuable means be entirely encased, and that it be highly sensitive to the relatively slow temperature changes occurring in a refrigerator of the usual type.

In the drawings,

Fig. 1 is a view in vertical section through a refrigerator, in which is mounted a device embodying my invention,

Fig. 2 is a fragmentary sectional view therethrough, taken on the line II—II of Fig. 1,

Fig. 3 is a diagram of a circuit employed with the device embodying my invention,

Fig. 4 is a view in longitudinal section through a thermally-actuable device embodying my invention,

Fig. 5 is a view in longitudinal section therethrough, taken on the line V—V of Fig. 4,

Fig. 6 is a view in lateral section taken on the line VI—VI of Fig. 5,

Fig. 7 is a bottom plan view of a contact supporting member,

Fig. 8 is a view in lateral section therethrough taken on the line VIII—VIII of Fig. 7,

Fig. 9 is a top plan view of a contact member, and,

Fig. 10 is a fragmentary view, mainly in section, taken on the line X—X of Fig. 7.

Referring more particularly to Fig. 1 of the drawings, I have there illustrated a domestic refrigerator 15 comprising a food compartment 16, a refrigerating compartment 17 and a bottom compartment 18. While I have illustrated a specific embodiment of refrigerator, this is done for illustrative purposes only.

Means for cooling the food compartment of the refrigerator comprise an electric motor 19, a compressor 21 actuated thereby, and an expansion or brine tank 22 connected to the compressor by suitable conduits. The devices illustrated are shown schematically only, and are intended to cover any one of the devices which may be used for the purposes of cooling a refrigerator. The general operation of the refrigerating devices is to cool the air in the refrigerating chamber 17 and to thereby cause a circulation of the air from the bottom of the refrigerating chamber into the bottom of the food chamber and out at the top thereof, as is illustrated by the arrows. It is understood that suitable openings are provided in the walls separating the respective chambers to permit of such circulation of air.

Means for controlling the motor 19 in accordance with the temperature of the air in a predetermined portion of the interior of the refrigerator, comprises a thermally-actuable switch 23 which is the particular device embodying my invention. This device is located in the upper part of the food chamber 16, as

is shown more particularly in Fig. 1 of the drawing.

The thermally-actuable switch 23 comprises a metal casing 24 having one end thereof closed and the other end thereof open, the open end of which may be provided with a cover plate 25 which may be of a suitable electric-insulating material. The plate 25 is provided with a circular groove 26 in its bottom face to receive and interfit with the edge portion of the tubular casing 24 so that the members located within the casing will be protected.

A supporting table 27, of substantially circular form and of sheet metal, is located within the casing 24 and is adapted to support a bimetallic disc 28 by means of a single central stud 29 which is screw-threaded to the table 27 at its central portion and is held in any predetermined position relatively thereto by a nut 31 and lock washer 32. The central portion of the table 27 is bowed upwardly as shown at 33, in order not to engage the central portion of the bimetallic disc 28.

A contact-member-supporting plate 34 is made of electric-insulating material and is supported from the table 27 by a plurality of symmetrically spaced studs 35, one end of each of which is moulded to the member 34 as is shown more particularly in Figs. 5 and 8 of the drawings. The upper end of each of the studs 35 is screw-threaded and provided with co-operating nuts 36 located one at each side of the supporting table 27. This construction permits of supporting the member 34 and any elements mounted thereon from the table 27, it being possible to adjust the distance therebetween by means of the co-operating nuts 36 which are tightened against the plate to securely hold the member 34.

A plurality of spaced contact members 37 and 38 and a plurality of contact-terminal members 39 and 41 are mounted on the lower or bottom surface of the member 34 as is shown more particularly in Fig. 7 of the drawings. The members 37 and 38 are identical and respectively comprise a bar of metal having two portions 42 and 43 punched out to extend laterally of the plane of the members. As the plate 34 is molded, it is possible to secure the contact members 37 and 38 against the surface of the member 34 by means of the projections 42 and 43 extending into the member 34. The terminal members 39 and 41 may be secured on the plate 34, either by rivets or preferably by studs 44 which extend through the plate 34 and permit of securing thereagainst the ends of strip conductors 45 and 46, respectively.

The ends of the contact plates and terminal members are spaced apart, as is shown more particularly in Fig. 7 of the drawing, and their outer end surfaces are engaged by contact bridging members 47 which are secured to one end of rod members 48 which extend through openings 49 in the member 34. Impact heads 51 are secured on the other end of rod members 48 and spring members 52 are located between the heads 51 and the upper surface of the plate 34 to normally yieldingly hold the bridging members 47 against the adjacent spaced ends of the contact plates and the ends of the contact plates and terminal members. It may be noted that the construction illustrated in Fig. 7 of the drawings provides six breaks for interrupting the circuit controlled by the device.

A member 53, of substantially circular shape and of electric-insulating material is mounted on the lower end of the stud 29 having screw-threaded engagement therewith and an annular groove 54 is provided therein adjacent to the upper surface thereof, substantially as shown in Fig. 5 of the drawings, and a relatively high resistance heating coil 55 (see Fig. 3) is located in this groove for a purpose to be hereinafter set forth in detail. Two machine screws 56 and 57 are located in the peripheral surface of the member 53 to permit of connecting electric conductors to the ends of the heating coil wound in the groove 54. The stud 29 is provided with an intermediate flange or a nut 58 mounted thereon to provide an abutment for the disc 28 and to permit of adjusting the position thereof, and the member 53 is screwed on the stud 29 until it abuts against the nut 58.

A plurality of lugs 59, 61 and 62 are mounted against the inner surface of the casing 24 in symmetrically-spaced relation peripherally thereof. The table 27 is adapted to have peripheral edge portions thereof located below these members, as shown more particularly in Fig. 4 of the drawings, recesses 63 and 64 being provided in the rim portion of the table to permit of inserting the table in the casing, moving it to a position below the members 59, 61 and 62 and then giving it an angular turning movement on its axis to cause the projecting portions of the table to be located below the members 59, 61, 62, respectively. Relatively larger recesses 65, and 66 are provided at one part of the periphery of the table 27 to permit of the conductor strips 45 and 46 extending upwardly from the member 34 to co-operating terminal members 67 and 68 which are molded in the cover member 25 and which comprise short lengths of metal tubes having screw-threads on the interior thereof and having short machine screws 69 located at the lower surface of the member 25 and similar short machine screws 71 located at the upper surface of the member 25.

An auxiliary cover member 72, also of molded material, is provided to cover the upper terminal members mounted in the member 25 and is held against the cover member 25 by machine screws 73 and 74. A substantially circular opening 75 is provided at one

side of the cover members to permit of extending a conduit into the auxiliary cover member within which suitable control circuit conductors may be located in a manner well known in the art.

The cover member 25 is held in its proper operative position against the otherwise open end of the casing 24 by a plurality of symmetrically-spaced long machine screws 76 which extend through the cover member 25 and into the supporting plate 27 as is shown more particularly in Figs. 4 and 5 of the drawings. Upon turning the screws 76 it is possible to cause the plate 27 to tightly fit against the bottom surface of the members 59, 61 and 62, respectively, by means of which the switch structure is held in proper operative position within the casing 24, and the cover member is held tightly against the casing 24.

The device designated generally by the numeral 23 may be located in a back wall 77 of the refrigerator structure, (see Figs. 1 and 2), so that it will project into the food chamber 16 and so that the terminal members thereof will be located outside of the refrigerator box. The motor 19 is adapted to be connected in series circuit relation with the thermally actuable switch hereinbefore described substantially as shown diagrammatically in Fig. 3 of the drawing.

An auxiliary terminal 78 is provided in the device 23, one end of the heating element 55 being connected thereto and an adjustable resistor 79 is provided in order to permit of varying the amount of energy which is translated into heat in the heating element 55. The rheostat 79 may be located in any suitable or desired place.

The disc thermostat 28 is of the type disclosed and claimed in Patent No. 1,448,240 to J. A. Spencer that is subjected, ordinarily, to a relatively large ambient temperature differential between the operating temperatures thereof and which, because of its shape operates with a snap action. While this relatively large temperature differential is not objectionable when the operating temperatures are high, and the temperature changes are effected quickly, it is of importance in refrigerator control where the operating temperatures are relatively low, and the temperature changes are relatively small and are effected very slowly.

The bimetallic disc 28 is so located relatively to the supporting table 27 that its periphery will move away from engagement with the table 27 upon a reduction in temperature below a predetermined value. This reduction in temperature is, of course, effected by the operation of the motor causing a circulation of the cooling medium through the expansion chamber 22 whereby the temperature of the chamber 17 is lowered, which finally results in a lowering of the temperature in the food chamber 16 to or below the desired value, for which the disc 28 has been adjusted. This adjustment is made by giving a turning movement to the stud 29 to cause the central portion of the disc to be bowed upwardly toward or against the plate 27 which has been given a bowed shape as hereinbefore described, to permit of such adjustment.

As changes in the temperature of the food chamber are effected very slowly, it may be possible that the initial movement of the disc 28 will be relatively slow also until it reaches the critical position, after which the peripheral portion will move at a relatively high speed. It has been found by actual test that the time of movement from one position to another of a bimetallic disc of this type is on the order of three ten-thousandths seconds. The member 34 is so adjusted that the distance between the impact head 51 and the disc 28 is small. Hence, the impact heads 51 will be struck a blow by the quick-moving peripheral portion of the disc 28, whereby disengagement of the bridging members 47 from the contact plates and terminal members and a compression of the springs 52 will be effected by the kinetic energy of the moving disc in a very short period of time, so that substantially no arcing will take place at the co-operating contact members.

Since the springs 52 are in compression, when the disc has been actuated into engagement with impact heads 51, the pressure thereof against the disc 28 tends to cause the disc to be returned to the position shown in the drawings before the disc has reached the temperature at which it would return without the aid of the springs. The rapidity of return may be regulated by employing springs having the proper stiffness. Thus, it is seen that the springs 52 tend to influence, modify, or to reduce the ambient operating temperature differential to which disc 28 would ordinarily have to be subjected in order to cause it to deflect from one position to another.

As shown more particularly in Fig. 3 of the drawings, the heating coil 55 is connected across the terminals of the thermally-actuable switch 23. It is evident, therefore, that the heating coil is short-circuited so long as the switch is closed and in the position shown in the drawings. Upon the operation of the device to cause disengagement of the bridging members from the contact members, current traverses the heating element 55, the adjustable resistor 79 and the motor 19.

As the resistance of the heating element 55 and of the resistor 79 is very large relatively to the resistance of the motor 19, a very small current only will continue to flow, which is not sufficient to permit operation of the motor, but is sufficient to generate heat to effect operation of the bimetallic disc 28 within a

shorter time than would cause it to operate if permitted to be subjected only to the temperature of the air in the food chamber 16. This time of operation may be varied by adjustment of the rheostat 79, the net result of this being that the bimetallic disc returns to the position shown in the drawings, sooner than would otherwise be the case. This means that the ambient temperature differential to which the disc would ordinarily be subjected in the absence of the heating element has been reduced at both limits thereof. Thus, the temperature of the refrigerator chamber will fluctuate between two values, the differential or difference between which is relatively small as compared with the normal operating differential of the disc.

The lower limit of temperature has been raised because of the adjustment of the disc by means of the stud 29 hereinbefore described, and the upper limit of the ambient temperature has been reduced by use of the heating element 55. This means that a bimetallic disc having an initially large temperature differential is operable to maintain the maximum and minimum temperatures of a body or medium controlled thereby within relatively narrow temperature limits and that this operation can be effected even where the temperature changes to which the control device is subjected are small, and vary very slowly. Thus, an average uniform temperature may be maintained in the refrigerator from which the maximum and minimum values do not widely depart.

I desire to point out particularly how the device embodying my invention meets the many requirements made of thermally-actuable refrigerator controllers: The device follows closely the relatively slow temperature changes in a refrigerator because of the relatively short and direct heat path from the casing wall to the thermal element. The temperature differential or the difference between the maximum and minimum temperatures existing therein may be made any desired small amount, one limiting value being varied by the adjustment of the disc against the support and the other limiting value being varied by use of spring members of greater or less strength, as the case may be, on the stems of the movable bridging members and the heating element. Any variation in the maximum and minimum operating temperatures of the disc will result in corresponding variations in the temperatures of the air in the chamber being controlled.

It is to be noted also that one of the operating temperatures of the bimetallic disc is quite different than the temperature being regulated. The minimum chamber temperature and disc temperature may be approximately 40° F. and the maximum temperature of the disc, effected mainly by heating coil, may be as high as 90° F. The greater the temperature differential between the operating temperatures the greater will be the snap action of the thermostatic disc and hence the greater the blow on the impact head resulting in quicker disengagement of the bridging members from the contact members.

The heating coil is effective also to vary the time between successive individual operations of the disc and therefore between successive cycles of operations thereof. Thus if the amount of energy translated into heat in the coil 55 is relatively small the time required to heat the disc and to cause it to snap back into the position shown in Fig. 3 will be relatively long. This time can be reduced by increasing the amount of heat generated in the coil, as by reducing the active resistance in the auxiliary resistor 79. This means that it is possible to vary the length of time of operation of the motor 19, and corresponding inverse variations in the length of time it is inoperative. It is thus possible to meet any reasonable demands of refrigerator manufacturers as to lengths of time of operation and of shut down of the refrigerating equipment.

As the device 23 can be installed in substantially any position in the refrigerator box 15, it is possible to control the temperature of any desired portion or chamber in the refrigerator 15. Thus instead of locating the casing in an opening in the wall, it may be located entirely within the refrigerator and either at the top of the food compartment or at the bottom thereof, or in the refrigerating compartment 17. This permits of determining the best or most favorable location of the thermostatic switch by a few tests in the refrigerator, so that the same type of device can be used in many different refrigerators and will operate to produce the desired time and temperature cycle within the refrigerator.

It may be noted further that the periphery of the bimetallic disc 28 is normally in close operative engagement with the metal table 27 which is, in turn, in close operative engagement with the metal casing 24 by means of the lugs 59, 61 and 62. The heat flow from the air surrounding the casing 24 to the bimetallic disc 28 is therefore affected easily and quickly so that the disc will follow the temperature changes of the ambient air, even though it is located within a closed casing.

It is obvious that the device embodying my invention can be applied to other devices than to refrigerators. It may be employed in the control of chamber temperatures wherein a heating means is employed to maintain an upper temperature rather than a lower temperature, as is the case in a refrigerator. The bimetallic disc is reversed in its position on the supporting stud so that it will snap over at an increase in temperature instead of at a decrease in temperature.

Various modifications may be made in the

device embodying my invention without departing from the spirit and scope thereof, and I desire that only such limitations shall be placed thereon as are imposed by the prior art.

I claim as my invention:

1. A thermally-actuable switch comprising a supporting table, a bimetallic member supported thereon, a contact-member-supporting plate supported by the supporting table, contact members on the supporting plate, and co-operating contact bridging members normally yieldingly held in operative engagement with the contact members and normally out of operative engagement with the bimetallic member and adapted to be moved by impact from the bimetallic member.

2. A thermally-actuable switch comprising a metal casing, a bimetallic disc member in the casing, a metallic table operatively supporting the bimetallic disc and normally operatively engaging it at its peripheral portion only, said table providing a direct heat path from the casing to the bimetallic disc, and means mounted on the inside of the casing and co-operating with the metallic table to hold it in the casing.

3. A thermally-actuable switch comprising a metal casing having an open end, a metal table therein, a bimetallic element supported by the table, a contact-member-supporting plate supported within the casing by the metal table, contact members on the supporting plate, means on the inside of the casing for interlocking with the metal table, a cover member for the open end of the casing, and means operatively engaging the cover member and the table for effecting close operative engagement of the cover and of the metal table with the casing and for holding the metal table and the elements supported thereby in proper operative positions in the casing.

4. In a thermally-actuable switch, the combination with a casing having an open end and a cover member therefor, of a metal table in the casing, a thermally-actuable element and co-operating contact members operatively supported by the metal table, means on the inside of the casing interfitting with the table, and means co-operating with the table and the cover member for holding the cover member on the casing, for holding the table in proper operative position in the casing, and for ensuring a good heat path between the casing and the thermally-actuable element.

5. A thermally-actuable switch comprising a casing, a metal table therein, a central stud in the table, a bimetallic disc supported by the central stud and having a relatively large temperature differential between its operating temperature values, and means mounted on the central stud for reducing this temperature differential.

6. A thermally-actuable switch comprising a casing, a metal table therein, a central stud in the table, a bimetallic disc supported by the central stud and having a relatively large temperature differential between its operating temperature values, and electric means mounted on the central stud adjacent to the bimetallic disc for reducing the temperature differential.

7. A thermally-actuable switch comprising a casing, a metal table therein, a central stud in the table, a bimetallic disc supported by the central stud and having a relatively large temperature differential between its operating temperature values, and electric heating means energized in accordance with the operation of the bimetallic disc for reducing the temperature differential.

8. A thermally-actuable refrigerator controlling switch comprising a casing, a temperature-controlled actuating element within the casing having a relatively large temperature differential between its operating temperature values, co-operating contact members, certain of which are actuated by the actuating element, and means controlled by the temperature-controlled actuating element for reducing the temperature differential.

9. A thermally-actuable switch comprising a supporting table, a central stud supported thereby, a bimetallic disc supported by the central stud, and an electric heating element supported by the central stud and energized in accordance with the operative positions of the bimetallic disc.

10. In a thermally-actuable switch, the combination with a casing subjected to the temperature of a chamber to be controlled, a plurality of co-operating contact members in the casing, a snap-acting bimetallic element in the casing having a relatively large temperature differential between its maximum and minimum operating temperatures, mechanical means associated with the bimetallic element for changing one of said operating temperatures to reduce the temperature differential, and electric means, energized in accordance with the position of the bimetallic element, for changing the other of said operating temperatures to reduce the temperature differential.

11. In a thermally-actuable switch, the combination with a casing subjected to the temperature of a chamber to be controlled, a plurality of co-operating contact members in the casing, a snap-acting bimetallic element in the casing having a relatively large temperature differential between its maximum and minimum operating temperatures, mechanical means associated with the bimetallic element for changing one of said operating temperatures to reduce the temperature differential, electric means, operated in accordance with the position of the bimetallic element, for changing the other of said operating temperatures to reduce the temperature differen-

tial and means for varying the effect of said electric means.

12. A thermally-actuable switch comprising relatively fixed and movable contact members, a snap-acting bimetallic element for effecting movement of the movable contact member by impact therewith, and resilient and electric means co-operating for accelerating the return of the bimetallic element to its initial position.

In testimony whereof, I have hereunto subscribed my name this twenty fifth day of March, 1926.

IRVIN G. THOMAS.