

July 22, 1941.

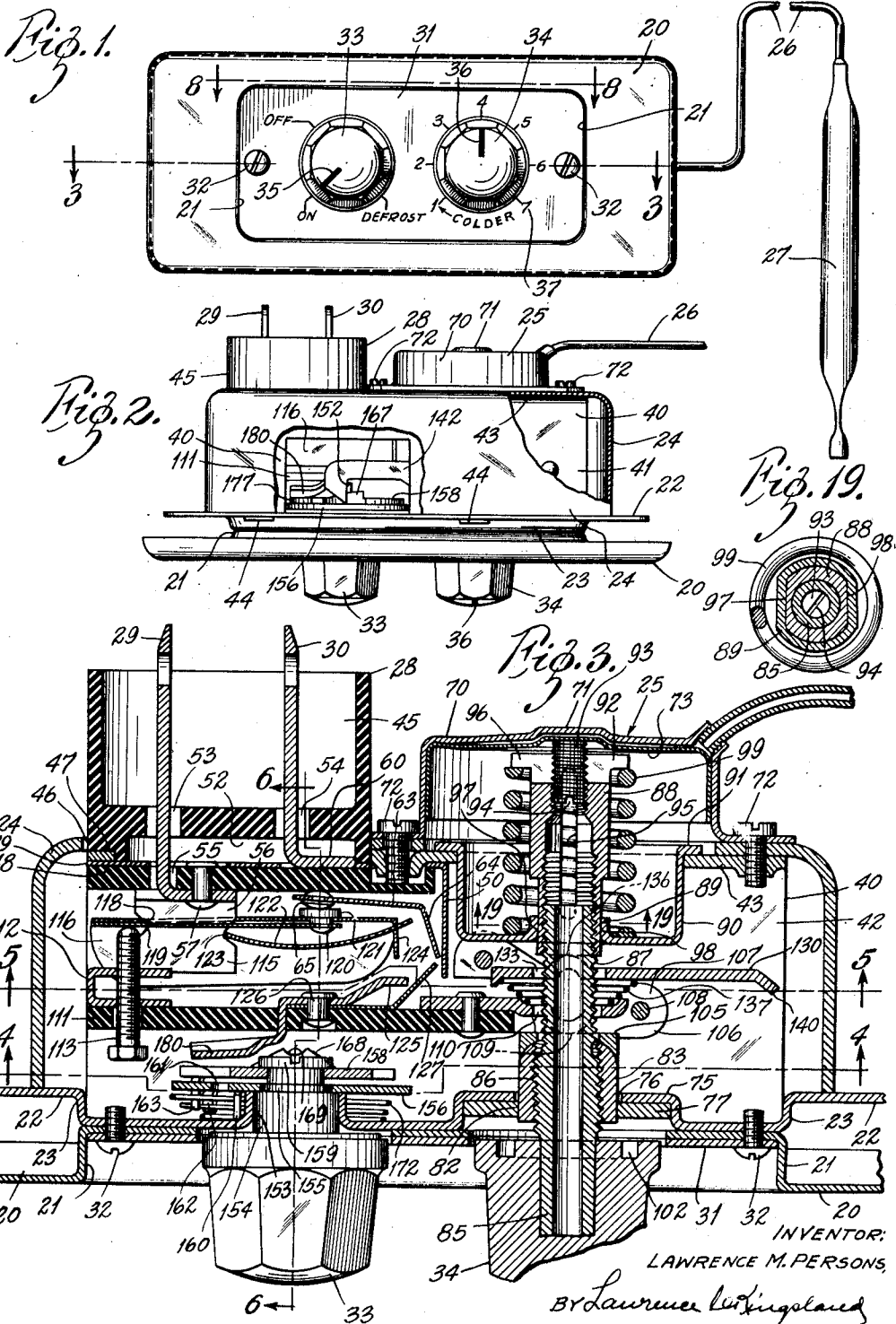
L. M. PERSONS

2,250,437

REFRIGERATOR CONTROL SWITCH

Filed Feb. 8, 1937

4 Sheets-Sheet 1



July 22, 1941.

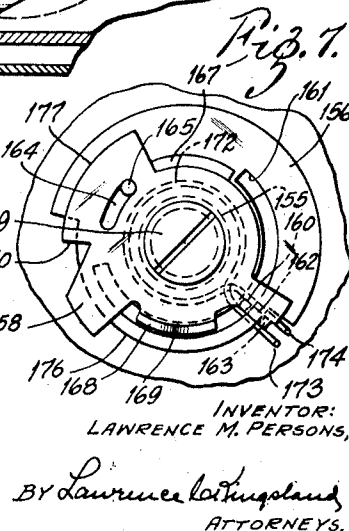
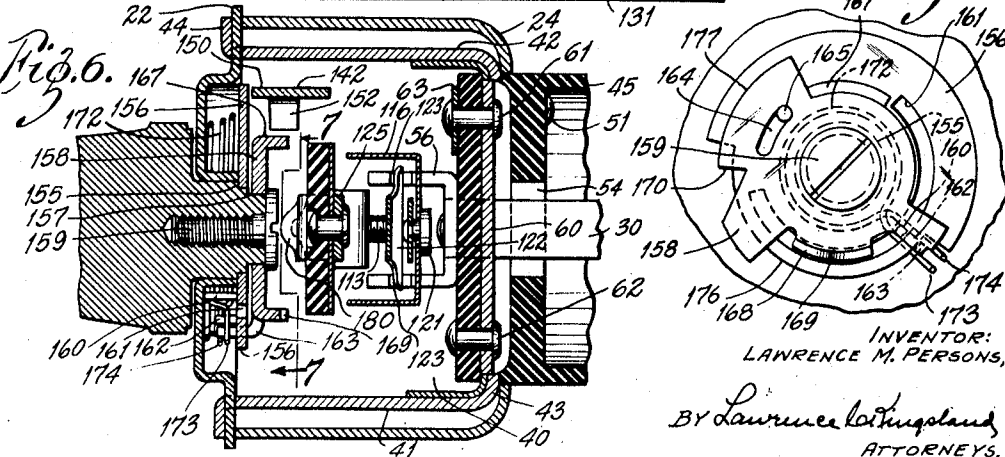
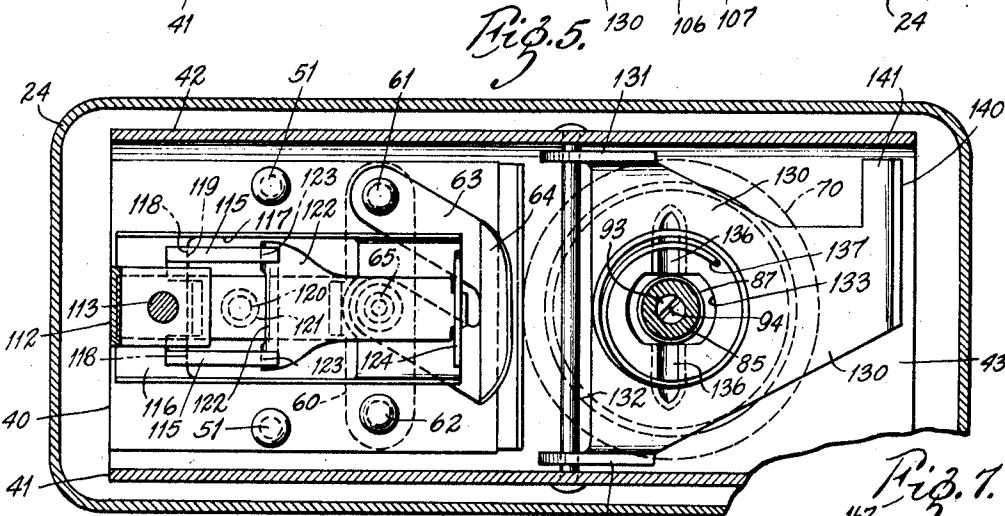
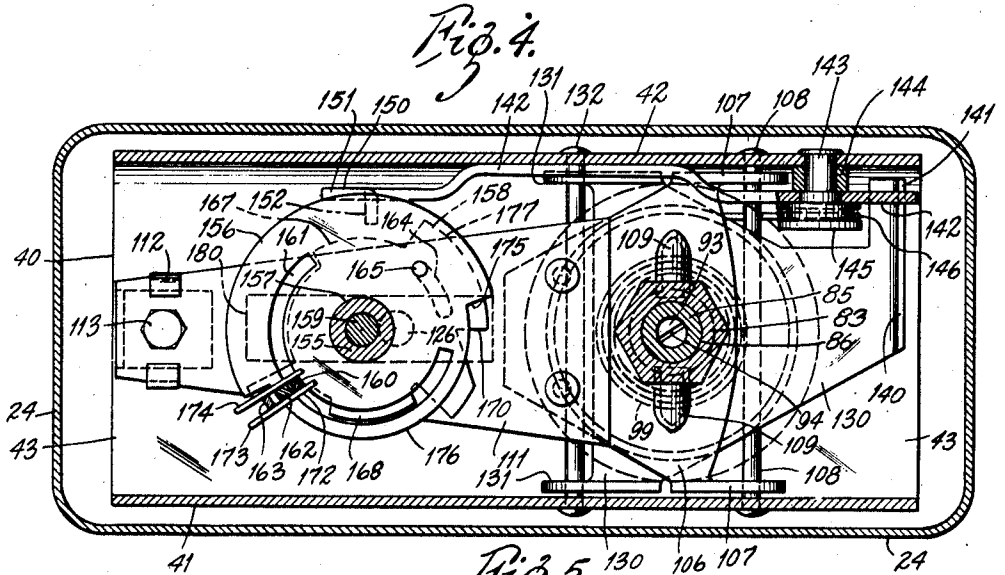
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REFRIGERATOR CONTROL SWITCH

Filed Feb. 8, 1937

4 Sheets-Sheet 2



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July 22, 1941.

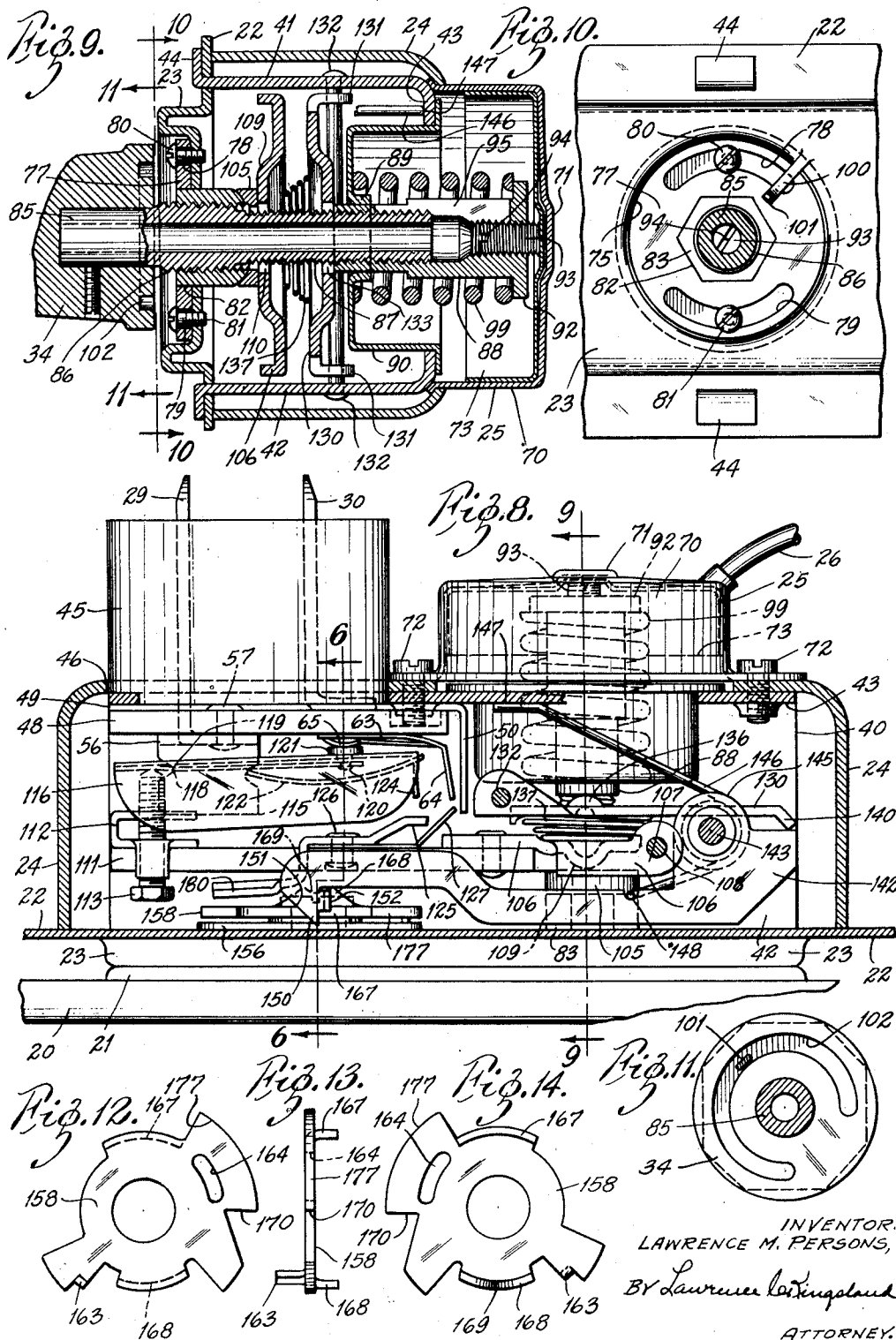
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REFRIGERATOR CONTROL SWITCH

Filed Feb. 8, 1937

4 Sheets-Sheet 3



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2,250,437

REFRIGERATOR CONTROL SWITCH

Filed Feb. 8, 1937

4 Sheets-Sheet 4

Fig. 15.

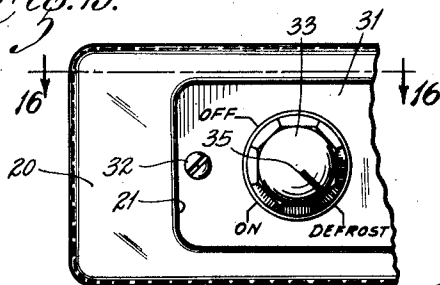


Fig. 17.

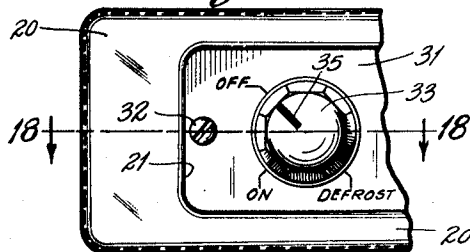


Fig. 16.

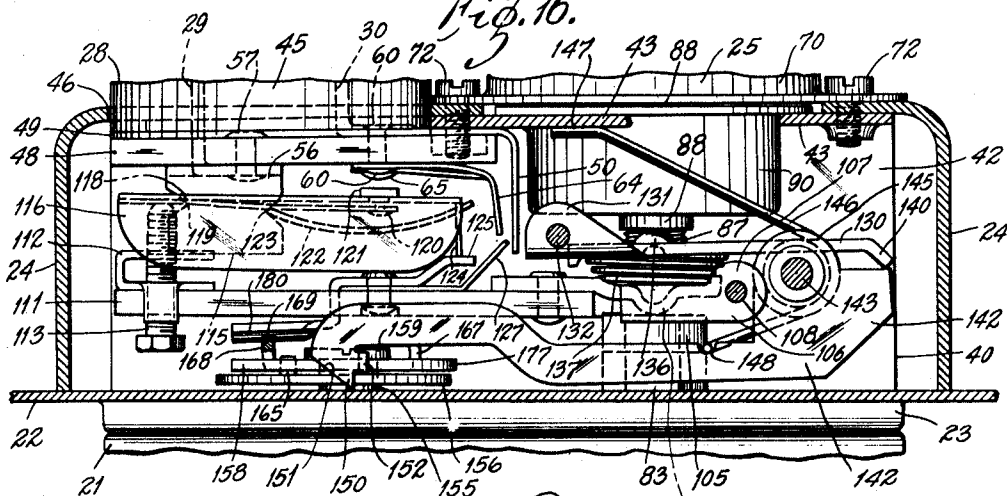
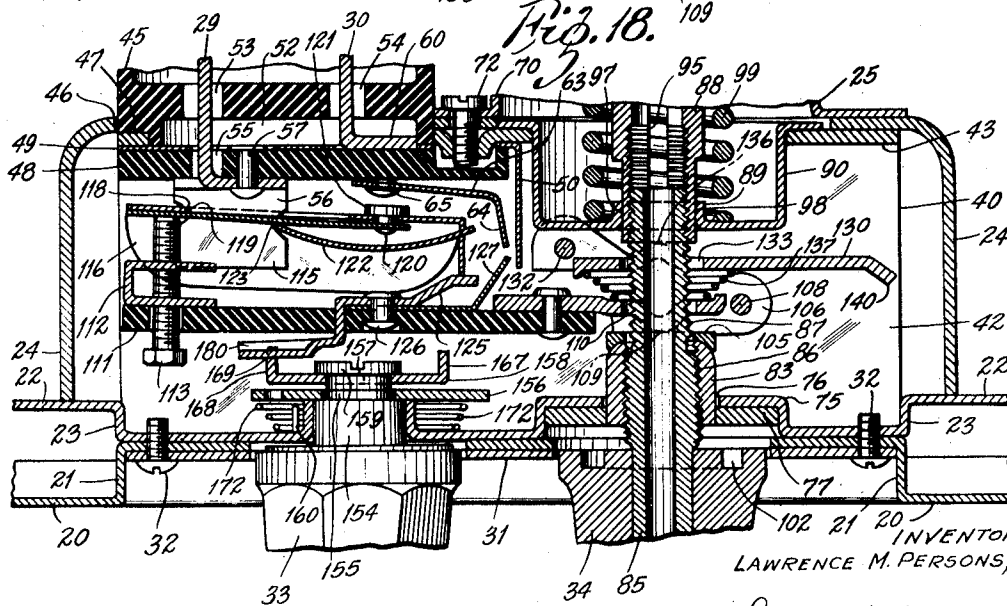


Fig. 18.



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UNITED STATES PATENT OFFICE

2,250,437

REFRIGERATOR CONTROL SWITCH

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Application February 8, 1937, Serial No. 124,661

38 Claims. (Cl. 200—83)

The present invention relates to heat-responsive switches in general, and in particular to switches for use on refrigerator controls.

This present switch includes a minutely adjustable heat-responsive device of the diaphragm, solid-charge type. The heat-responsive mechanism operates a switch that is designed to control a cooling unit. Interrelated with the mechanism just recited is a further control which has several stages in which it operates. It operates to an "off" position wherein it acts as a complete cut-off maintaining the main switch open; it operates to an intermediate or "on" position wherein the main switch is responsive only to the heat-responsive device; and it operates to a "defrost" position wherein the main switch is maintained open until a predetermined condition of the heat-responsive mechanism exists, at which time the switch is automatically changed from the defrost position to the "on" position. In connection with the defrost operation of the switch, means are provided for the manual change of the switch from the defrost position, if it may be desired.

In the present invention, all of these mechanisms together with their several adjustments are combined into a single small and compact housing made possible by their particular construction.

It is an object of the invention to provide in a single instrument a switch normally controlled by a heat-responsive device with supplemental means selectively to maintain the switch at inoperative position, to permit it to operate or to maintain it subject to an additional operation of the heat-responsive means, after which additional operation, it is automatically released.

It is a further object of the invention to provide a switch of the type described having a diaphragm type solid-charge heat-responsive mechanism.

It is a further object of the invention to provide a switch of this type with the diaphragm heat-responsive mechanism, together with a means disconnected from said diaphragm, but adapted to be actuated thereby, and an adjustment therefor.

It is a further object of the invention to provide a mechanism of this kind having two levers, both actuated by the heat-responsive means, with means to adjust both together so that both operate at temperatures varied by the same amount, or to adjust one of them relative to the other, so that the temperature of operation of one of them

may be held constant but that of the other varied.

It is a further object to provide means to attain the last-named adjustment by large increments, and also by a fine degree of change, whereby the instrument may be set quickly and accurately.

It is a further object to combine in a mechanism of this kind a switch providing inherently a temperature differential between its point of opening and point of closing.

It is a further object of the invention to provide a differential screw adjustment in connection with the solid-charge diaphragm by heat-responsive mechanism.

It is a further object of the invention to provide a mechanism maintaining the switch in one position of its operation, together with mechanism interrelated with said heat-responsive means automatically to release said first-named mechanism upon a predetermined temperature condition.

Other objects will appear in the description to ensue.

Fig. 1 is a front elevation of the switch.

Fig. 2 is a view from the top, with a casing partly broken away.

Fig. 3 is a horizontal section on the line 3—3 of Fig. 1.

Fig. 4 is a vertical section on the line 4—4 of Fig. 3.

Fig. 5 is another vertical section on the line 5—5 of Fig. 3.

Fig. 6 is a transverse vertical section on the line 6—6 of Fig. 3.

Fig. 7 is a view of the cams taken on the line 7—7 of Fig. 6.

Fig. 8 is a plan view with the casings in section.

Fig. 9 is a transverse, vertical section taken on the line 9—9 of Fig. 8.

Fig. 10 is a section on the line 10—10 of Fig. 9.

Fig. 11 is a section on the line 11—11 of Fig. 9.

Fig. 12 is a view of one of the cams taken from the front side.

Fig. 13 is an edge view of said cam.

Fig. 14 is a view of the cam taken from the back side of the device.

Fig. 15 is a view of the defrost switch in defrosting position.

Fig. 16 is a view of the switch similar to Fig. 8 but in defrost position with the switch locked open, as indicated by the line 16—16 of Fig. 15.

Fig. 17 is a front view of the switch knob in the off position.

Fig. 18 is a view similar to Fig. 3 but with the switch locked in "off" position.

Fig. 19 is a section on the line 19—19 of Fig. 3.

The device embodies a front panel 20 having an inset 21 therein projecting behind it. To this panel is secured the front plate 22 of the switch proper, which front plate has an inset 23 adapted to lie against the inset 21 of the panel 20. To this front plate 22 is secured a main housing 24 of the switch in a manner to be described. A diaphragm heat-responsive means 25, to be described in detail, is secured to the back of the housing 24. A fluid-containing tube 26 extends from the diaphragm means 25 and has a bulb 27 at the outer end thereof. An electric circuit plug 28 is likewise secured to the back of the housing 24 and has two terminals 29 and 30 that run through a switch inside the device, as will be described.

The inset 21 has therein a dial 31, this dial, the panel 20, and the front plate 21 all being held together by screws 32. This dial plate has operating therefrom two knobs 33 and 34 that have pointers or indicators 35 and 36, respectively, on them. The indicator 35 on the switch knob 33 operates to the positions designated "off," "on," and "defrost," as shown. The indicator 36 on the adjusting knob 34 operates over a cooling speed scale 37. These operations will be explained more in detail hereafter.

Within the outer housing 24 there is located a bridge 40 consisting of side panels 41 and 42, and a back panel 43. This bridge is open at its ends and the side panels are secured to the front plate 22 by turned-over lugs 44 that project through the plate. A plug socket 45 is secured at one end of the back panel 43. The plug socket 45 fits through a cut-away portion 46 in the outer casing 24. The bridge 40 has an opening therethrough slightly smaller than the outer dimensions of the socket 45. The socket 45 has a cut-away portion providing a shoulder 47 that engages against the end of the bridge 40 bordering the opening therethrough. Reference to Fig. 6 will show that the socket 45 extends laterally beyond the limits of the opening in the bridge 40 so as to rest on the bridge.

An insulating plate 48 is located inside the back plate 43 of the bridge 40. Between this plate and the bridge is an insulating shield or liner 49 having a depending projection 50 thereon, for a purpose to be described. A pair of rivets 51 extend through the socket 45, the insulating plate 48, and the liner 49, clamping them together and holding them all rigidly against the bridge 40.

The underside of the socket 45 is cut out, as at 52. It likewise has holes 53 and 54 extending through it. The terminal 29 extends through the hole 53 and through a corresponding opening 55 in the switch plate 48 where it merges with the switch member 56 from which it is stamped and of which it is an integral part. This switch member 56 is U-shaped in cross-section (Fig. 6) and is secured rigidly to the plate 48 by a rivet 57, this rivet obviously supporting the terminal 29.

The other terminal 30 has a laterally extending base 60 into which it merges as an integral part. This base is mounted on the outer face of the switch plate 48 by means of rivets 61 and 62. The cut-out portion 52 in the socket 45 provides room for the base 60 of the terminal 30 and the several rivets described. On the inner face of the switch plate 48 and maintained thereagainst by the rivet 61 passing through one of the legs

thereof, is a U-shaped switch contact element 63. The connecting portion of the U-shaped contact element is shown turned at a sharp angle to the legs thereof, as at 64. On the free leg of the element 63 is a contact point 65 giving a limited movement against the inherent resilience of the element 63. The rivet 61 establishes electrical contact between the terminal 30 and the switch contact element 63.

Thus it may be seen that the terminal 29 is in electric circuit with the U-shaped switch element 56; and the contact 30 is in electric circuit with the contact point 65. It is also clear that each of the contacts and its several attached members, as so far described, is out of contact with the other. The means for bringing the terminals in circuit will be described hereinafter.

The heat-responsive member 25 comprises a relatively inflexible flanged cup 70 having preferably a somewhat conical end surface that may be domed as at 71, and corrugated. Screws 72 extend through the flanges of the member 70 through suitable holes in the outer casing 24 and are threaded into back panel 43 of the bridge 40. Closely fitted within the member 70 is a flexible cup-like member 73, the lateral walls of which are welded to the lateral walls of the cup-shaped member 70 so that the top part forms a flexible diaphragm. The tube 26 extends in through a corner of the cup-shaped member 70 and thereby communicates with the space between the member 70 and the flexible diaphragm element 73. As will be understood, the bulb 27, the tube 26 and this space between the member 70 and the diaphragm are completely filled with fluid, preferably liquid. Normally the diaphragm 73 is contiguous throughout with the cup-shaped member 70 except when forced away by increase in the volume of the liquid.

Opposite the power means 25, there is an inset portion 75 formed on the front plate 22. This inset portion has an opening 76 therethrough. Seated within the inset 75 is a plate 77 having arcuate slots 78 and 79 therein. Screws 80 and 81 are threaded into the portion 75 and hold the plate 77 in position, it being adjustably rotatable by virtue of the arcuate slots. The plate 77 has a central non-circular opening 82 therein, here shown as hexagonal. A hexagonal internally threaded sleeve 83 fits snugly within the opening 82 and is thereby prevented from rotating. This sleeve fits freely and rotatably through the opening 76 in the inset portion 75 of the front plate 22.

An externally threaded hollow differential screw 85 has threads 86 engageable with the internal threads on the sleeve 83. The screw projects beyond the sleeve 83 and on this projecting portion has external threads 87 that have slightly less pitch than the threads 86. The threads 87 engage on corresponding internal threads on a sleeve 88. The said sleeve 88 passes through a flanged hole 89 in a cup-shaped member 90 that has a pressed fit in the back panel 43 of the bridge 40, it overhanging the portion 43 by a flange 91.

The sleeve 88 has a flanged head 92 threaded to receive a correspondingly threaded plug 93 having a kerf 94, by means of which it may be adjusted. The screw 85 and sleeve 88 being hollow, access to the kerf 94 is had through them after removal of the knob 34 which is fastened to the outer end of the screw 85 by means of a set screw. The sleeve 88 is slotted as at 95. It likewise is slotted as at 96 whereby a tool may

be inserted for its removal. Adjacent its inner end the sleeve 88 has opposed flat portions 97 and 98 that slip within the correspondingly shaped flanged opening 89 on the cup 90 thereby being prevented from rotary motion relative thereto although not precluded from axial motion. Between the flanged head 96 of the sleeve 88 and the cup 90 is a compression spring 99 acting to force the sleeve 88 outward, and, as will be shown, to cause the screw 93 to contact with the flexible member 73.

From the foregoing it will be seen that the relation between the flexible member 73 and the assembly, including the plug 93, the sleeve 88 and the screw 87, is controlled by set screw 93 and the handle 34.

As shown in Fig. 10 the inset 75 on the front plate 22 has extending therefrom a prong 100. This prong has an upstanding end 101 that is engageable within an arcuate groove 102 (Fig. 11) within the handle 34. This groove is somewhat less than 360° in extent and permits the handle to turn within the range and compass by the grooves 1-7 of the dial 37, but stops the adjustment at these two extremes.

The sleeve 83 has a rounded end over which fits a correspondingly rounded washer 105. The washer thus may be seated against the sleeve at various positions. A main lever 106 has upturned ears 107 through which extends a pivot shaft 108 secured to the side walls of the bridge 40. This lever 106 has upstanding abutments 109 pressed therein, they extending upwardly from opposite sides of a hole 110 that fits around the screw 87 whereby the lever 106 crosses the screw. The abutments 109 on the lever 106 rest against the washer 105 and are held there by means to be described. Thus, as the screw 85 moves downwardly, in Fig. 3, the washer 105 is withdrawn and, by means to be described, the lever 106 is caused to follow this washer. In the showing of Fig. 3, the lever is in its downward position.

Extending from the lever 106 and forming a part thereof is an insulating plate 111. This plate 111 has at the outer end thereof a U-shaped bracket 112 threaded to receive a set screw 113. The bracket 112 is secured to the lever by the bent over prongs shown in Fig. 4.

The previously mentioned switch plate 56, being U-shaped, has thereon upstanding ears 115. A switch blade member 116 of U-shaped cross-section (Fig. 6) has an opening 117 therein whereby the member fits over the switch plate 56. A blade is secured to the member 116 and forms part thereof. The opening 117 provides an internal edge 118 engageable in opposed notches 119 in the flanges 115 of the switch plate 56. The blade of the member 116 extends between the two flanges 115 and carries at its outer end a contact point 120 that is movable through an opening in the top of the member 116. The contact point 120 has a head 121 that limits the movement of the blade away from the member 116. A bow spring 122 engages at one end in opposed notches 123 in the flanges 115 opposite the notches 119, and at its other end by a tongue and slot connection, fits in a turned up end 124 on the member 116. The member 124 is of such length that it will strike a stop element 125 secured to and extending from the insulating plate 111, the securing means comprising a rivet 126. An insulating element 127 is secured also by the rivet 126 and has a projecting portion extending upwardly adjacent the insulating member 50. It may be seen from the foregoing that when the

lever 106 pivots in a clockwise direction in the drawings the screw 113 presses on the member 116 at a point very close to the pivot edges within the notches 119. This action tends to lift the contact point 121 away from the contact point 65, the action being opposed by the bow spring 122. When the contacts are freed a suitable amount, the extension 124 will strike the stop 125 and stop the movement. The details of this operation will be given subsequently.

The foregoing description relates to the main switch operation in response to increase of fluid volume back of the diaphragm 73. The additional control, including the defrost switch mechanism will now be described.

A second lever 130 has turned up ears 131 through which extends a pivot shaft 132 secured to the side walls 41 and 42 of the bridge member. This lever 130 has an enlarged opening 133 therein permitting the lever to pass across the sleeve 85. This lever has upstanding abutments 136 pressed therefrom on opposite sides of the opening 133. The abutments 136 extend oppositely to the abutments 109 on the main lever 106 and contact the lower end of the sleeve 88. A coil spring 137 surrounds the sleeve 85 and is disposed between the levers 106 and 130 to hold them apart. This arrangement maintains the abutments 109 against the washer 105, as previously intimated, and causes the lever 106 to follow outward movement of the sleeve 83 produced by expansion of the diaphragm 73. Outward movement of the sleeve 88, that is to say, toward the front of the device, by virtue of its contact with the abutments 136, forces the lever 130 in a clockwise direction. Movement in the reverse direction of the sleeve 88 permits the lever 130 to move in a counterclockwise direction under influence of the spring 137.

The lever 130 has a turned down end 140, this end appearing on a projection 141 extending laterally from the end of the lever. A third lever 142 is pivoted to the side walls 42 of the bridge by means of a pivot 143. A spacer element 144 maintains the lever outwardly from the wall. The pivot 143 has a headed extension 145 thereon around which are disposed convolutions of a coil spring 146. One end of this spring rests against the back 43 of the bridge as at 147. The opposite end of the spring engages in a notch 148 of the lever 142. The spring is so tensioned as to urge the lever 142 in a counterclockwise direction, referring to Fig. 16. Or, in other words, it is urged so that its free end is at all times as far toward the front plate 22 as possible. The lever is bent and offset, as shown in Figs. 4 and 16, so as to clear the other mechanisms. At its free end the lever has a down-turned point 150 having a sloping edge 151 and opposite thereto an intumed prong 152.

A flanged opening 153 is formed in the front plate 52. The knob 33 has a projection 154 thereon that extends into the opening 153. This projection is provided with a first shoulder 155 onto which is fitted a cam 156. There is a second shoulder 157 about which fits a second cam 158. This latter cam is shown in detail in Figs. 12-14. A headed screw 159 is threaded into the projection 154 and holds the several members in place on the knob. The cam 156 is fixed to the knob 33 to rotate therewith, whereas the cam 158 is rotatable relative to the knob. A lug 160 is struck up from the front plate 22 and engages in a slot 161 within the cam 156, thus limiting the rotation thereof. The cam 156 has

at one point of the periphery thereof a depending ear or dog 162, for a purpose to be described.

The cam 158 that is rotatably mounted relative to the knob 33 is shown in detail in Figs. 12-14. This cam has a depending ear or dog 163 adapted, at certain positions, to lie adjacent the ear 162 of the cam 156. The cam 158 likewise is provided with an arcuate slot 164 of limited length through which a pin 165 fixed to the cam 156 extends. Thus the cam 158 is caused to rotate with the cam 156 save for a limited motion relative thereto-permitted by the slot 164 and the pin 165.

The cam 158 is likewise provided with two oppositely upstanding cam edges 167 and 168. The cam face 167 has an increasing height as shown in Fig. 2. The cam face 168 slopes as shown particularly in Fig. 3 and has a notch 169 at the apex thereof. This cam likewise has a radial edge 170 that, upon rotation of the knob, is adapted to pass ahead of the intumed end 152 on the lever 142 to permit the lever to drop, as shown in Fig. 16. A coil spring 172 surrounds the flanged opening 153. As shown in Fig. 7 this coil spring has opposite ends 173 and 174, the ends being overlapped so that there is always a tendency for them to come together. In the neutral or "on" position, shown in Fig. 7, the two ends are on opposite sides of the lug 160 on the front plate 22. These ends, however, project out far enough so that they may engage the lugs 162 and 163 on the two cams in a manner to be described.

By reference to Fig. 4 it may be seen that the front cam 156 is somewhat larger than the back cam 158. The cam 156 is provided with an edge 175 substantially radial which provides an arcuate section shown at 176 and terminating approximately at the down-turned lug 162, which section 176 is of lesser radial extent than the remainder of the cam. This provides a space into which the point 150 of the lever 142 may drop in one position of operation, as shown in Fig. 16. The other end of the cut-away portion 176 likewise permits relative movement between the two cams since the downturned lug 163 of the cam 158 may move within the space thus provided.

Referring to Fig. 4 and remembering that the rotation of the cam 158 is limited by the action of the fixed lug 160 within the slot 161, it will be observed that the slot and lug are so related as to permit slightly over 90° movement of the cam 156 in either direction from the position of Fig. 4. Rotating the knob 33 counterclockwise in Fig. 4 first will carry the cams 156 and 158 to such a point that the edge 175 of the cam 156 is behind the sloping portion 151 and the point 150 of the lever 142. It will be observed that at this position the periphery at 177 of the inside cam 158 is inside the periphery of the cam 156. Consequently, the cam 158 will not affect the point 150 of the lever. Upon continued counterclockwise rotation of the knob 33, the edge 170 of the cam 158 will pass behind the projection 152 of the lever 142. When this occurs the action of the spring 137 will cause the lever to drop, whence it will act as a lock to hold the cams in this position upon release of the knob.

On the main lever 111 the stop 125 is provided with an extension 180, preferably bowed, as shown in Fig. 6, which extension is adapted to be engaged by the cam faces 167 and 168 of the cam 158. When the knob 33 is rotated counterclockwise, as just previously described, at the

time the point 150 and the extension 152 will have fallen ahead of the cam edges 170 and 175, the sloping cam element 167 will have ridden under the projection 180 causing the projection and the lever 111 to be raised whereby the switch is opened, and the same will be held open as long as the end 152 of the locking lever 142 remains behind the cam edge 170.

Reverting to the neutral position shown in Fig. 4, if the knob 33 is turned clockwise therefrom the cam 156 will be moved approximately 90° and will carry with it the cam 158. When the cam face 168 of the cam 158 comes into contact with the projection 180 of the lever 111 the cam 158 will temporarily be stopped. The cam 156 will continue until the pin 165 engages the other end of the slot 164 after which further motion of the knob 33 will force the cam 158 to follow. By this means the cam edge 168 will be moved under the projection 180 until the projection engages within the notch 169. It will be held in this position until released by rotating the knob 33 counterclockwise. During this last-named operation the cam 156 will constantly be beneath the point 150 of the lever 142 so that the said lever is maintained in its upper position.

As has been stated, the spring 172 urges the cams to the neutral position shown in Fig. 7. One of the two ends of this spring is always hooked over the lug 160. When the knob 33 is rotated clockwise, referring to Fig. 4 (counterclockwise in Fig. 7), the lug 162 on the cam 156 draws the end 174 clockwise while the end 173 is maintained against the fixed lug 160. Consequently, there is a constant urge by this spring to return the knob to its neutral position. If this clockwise rotation is continued until the notch 169 is engaged over the projection 180 the switch will remain in the position thus attained, since the strength of the coil spring 172 is insufficient to withdraw the notch from the projection. When the knob is turned counterclockwise in Fig. 4, the lug 162 on the cam 156 will carry the end 173 with it while the end 174 is maintained against the lug 160 so that the spring again urges the cams to the neutral position. However, when this action is carried to the point that the extension 152 on the lever 142 engages over the edge 170 of the cam 158, the spring will be held inactive, since it is of insufficient strength to overcome this lock. When the lever 142 is released, the spring immediately returns the knob to the neutral position. The operation of the entire mechanism is as follows:

If the switch is mounted on a refrigerator the bulb 27 will be located at a point, the temperature of which is to be controlled. The switch may be mounted at a convenient, accessible point in the refrigerator. A circuit to a compressor motor or other suitable part of the refrigerating mechanism is connected to the terminals 29 and 30 so that these terminals and the switch are in series with such circuit.

It will be understood that this switch is operated within a certain fixed temperature range. The various adjustments provided, including the knob 34, do not widen or narrow this range, but shift it bodily up or down, as the case may be. The particular point within the range at which the switch will operate is determined by the setting of the knob 34.

The adjustments or calibrations of the instrument are arranged as follows. If it be desired

to have the main switch close at 30° and the defroster to release at 40°, the knob 33 is then moved to the defrost position, locking the switch open. The bulb 27 is then brought to 40°, the temperature at which the defroster should release. With the knob 34 removed, a screw driver is inserted through the screw 85 and the sleeve 88, and the set screw 93 is turned in or out until the lever 130, acting upon the lever 142, just trips the latter, relieving the cam 156 so that the knob 33 returns to the "on" position, allowing the switch to be free. Following this, the bulb is reduced to 30°, the temperature of operation of the main switch for a given setting of the knob 34. Then the plate 77 is turned to rotate the sleeve 83 in or out until the washer 105, against which the lever 106 is urged by the spring 137, just permits the lever 106 to open the switch. The screws 80 are then tightened to maintain this adjustment. The knob 34 is secured to the screw 85 with its index 36 at the proper graduation.

Should subsequent adjustments be necessary the switch setting may be changed by moving the plate 77, this not changing the temperature at which the defrost release operates. As soon as the plate 77 is fixed, and save for the operation of the knob 34, the temperature difference between the switch and the defrost is fixed. If the screw 93 is then moved both the defrost and switch temperatures of operation are changed together, by the same amount, their difference not altering. If the defrost is to be changed and the switch be held at the same value, the screw 93 is adjusted, and then the plate 77 turned to offset the change produced on the switch by adjusting the screw 93.

After these adjustments are made to set the device it is evident that the temperature at which the switch operates may be changed by turning the knob 34. This operation, however, does not change the defrost setting. It is also evident that the adjustment of the switch alone may be effected by removing the knob 34, and turning the screw 85 until the washer 105 attains the proper position, after which the knob is replaced. This operation is the same as that of the plate 77, in that it produces relative rotation between the sleeve 83 and the screw 85. This manner of adjustment is more micrometric than merely moving the plate, since it works through the differential screw and may be used to obtain a fine setting supplemental to that produced by adjusting the plate 77.

The set screw 113 on the switch is preferably adjusted as the device is originally assembled. If subsequent adjustment is necessary the outer housing 24 can be removed by removal of the several screws 72 and a wrench or ratchet screw driver may be applied to the set screw.

Let it be assumed that the device is cold and the switch open. Then, if the liquid heats, expanding the diaphragm frontward, the washer 105 will be withdrawn from the lever 106, so that the spring 137 moves the lever. This correspondingly withdraws the screw 113, whereupon the bow spring 122 moves the switch blade 116 toward closing the contact 121 with the contact 65. As the blade closes the moment produced by the spring 122 increases, whereby the switch seeks to close more rapidly. The moment tends to act backwardly against the lever 106 and with great magnitude, owing to the large mechanical advantage in reversing the levers 116 and 106. As it is an increasing force, it produces more move-

ment than is permitted by the movement of the washer 105, and this movement is absorbed by the inherent resilience of the lever 106—111, so that this lever is deformed by a certain amount. This capacity of the lever 106—111 to absorb the movement of the blade 116 permits the switch to close with a snap action. After the switch closes further movement of the washer 105 relieves the internal stresses in the lever 106—111. As the switch closes the contact 121 is forced against the top of blade 116, displacing the end of the blade 116 deforming the same against its resiliency.

With the switch closed the refrigerator unit will operate, it being in series with the switch. As soon as the mechanism is cooled to its desired limit, as determined by the setting of the knob 34, the switch will again open. In this action the diaphragm 73 moves backward, as does the screw 85 and the washer 105. The lever 106 will be moved, forcing the screw 113 against the switch blade 116 and tending to open the contacts. This action is resisted by the movement of the bow spring 122, now at its maximum value. As the washer 105 acts upon the lever 106—111 against this resistance the resilience of the lever permits it to absorb some of this movement, until the inherent righting force of the lever, times its lever arm, equals the moment of the spring 122 at this, its maximum, value. Further movement of the lever 106 will then displace the blade 116 and remove the contact 121 from the contact 65. As the lever 116 moves away the moment of the spring 122 decreases by virtue of a reducing lever area, whereupon the stored energy in the lever 106—111 releases to open the switch with a snap action, until the depending end 124 strikes the stop 125, this being prior to dead center. Hence the spring 122 always applies some closing moment to the switch.

If the points 65 and 121 are welded, the opening action will part them. In this action the initial movement of the blade 116 does not move the contact 121, since the latter is mounted on the blade 118, and lost motion is provided between them. The blade 116 is then permitted to get a running start, whereby the increased energy of motion is applied to break the contacts. Additionally, the mounting of the contact 65 on the free leg of the U-shaped member 63 permits it to follow the contact 121 a short distance. In so doing, however, the member 63 is deformed so as to set up torsional and shearing forces in addition to tension, that readily break the weld. Since the weld causes greater resistance to opening, added energy will be stored in the lever 106—111, so that, when the break does occur, the opening will occur with a very rapid action.

It is necessary in a switch of this type to have a differential between the temperature of opening and that of closing. In the present device, the switch inherently provides this differential. As this switch is acted on by frontward pressure on the lever 106, it will not open until energy is stored in the lever equal to this maximum moment of the spring 122. When, however, the switch closes, movement of the blade 116 starts upon withdrawal of the screw 113 therefrom, and proceeds more rapidly as the lever 106 continues to withdraw, owing to the increasing moment of the spring 122. Hence, at the point of closure, the forces acting on the contact 121 are dynamic rather than static. Furthermore, the principally applied force from the diaphragm, in opening the switch is constantly decreasing the amount

of energy that can be absorbed by the lever 106—111, whereas, in opening, the applied force is constantly withdrawing and hence the amount of energy that can be absorbed by the lever is constantly being increased by virtue of the fact that it is constantly relieved.

It may then be seen that it requires more energy to open the switch than to close it. Hence, the lever 106 will move further before the switch opens than it will to close the same.

This being true, let it be assumed that the switch is open, and is to close at 30°. As the diaphragm 73 expands, the screw 85 will move forward to a certain point representative of 30°. At this point sufficient energy is available to close the switch, which event will occur. Then, neglecting override, let it be assumed that the temperature is progressively lowered. Since it requires more energy to open the switch than to close it, the screw 85 will have to move backward beyond the opening point before sufficient energy is stored to break the contacts. Hence, the switch will not open until some lower temperature, such as 28° is reached.

When the knob 33 is turned to the defrost position the cam 156 drops from beneath the point 150, and the extension 152 on the lever 142 drops behind the edge 170 on the cam 153. Thus the lever 142 rotates in a counterclockwise direction, referring to Fig. 16, and to the position shown in this figure, under the influence of the spring 146. This turning of the knob 33 simultaneously causes the cam edge 167 to act upon the abutment 180 on the lever 111 to open and hold open the switch. Consequently, the compressor is held inoperative. However, when the diaphragm 73 is moved to a certain high point, the sleeve 88 acting upon the abutments 136 of the lever 130 will move this lever about its pivot. After this motion reaches a certain amount the edge 140 of the lever will act upon the contact end of the lever 142 to rotate the same clockwise, as seen in Fig. 16. This lifts the extension 152 and the point 156 free of the cams, whereupon the end 173 of the spring 172 immediately causes the knob 33 to return to neutral position or the position designated "on." This rotation of the knob frees the cam edge 167 from the abutment 180 and permits the switch to close immediately, which it will do, since the temperature is above the normal temperature at which the switch is closed. In this operation the mechanism is permitted to override the normal operating temperature of the switch without damage because the connection between the diaphragm and the lever 106 is ultimately effected through the spring 137 which merely compresses to a greater degree when the defrost switch is set. By this means the operator may set the switch to defrost position and then, when the unit reaches a certain high temperature at which defrosting may be completed automatically, it will be shifted back to normal operating conditions.

With the switch in defrost position, if it is desired to revert it to normal, prior to its automatic return, such may be done by merely turning the knob 33. In this action the cam 156 moves relative to the cam 153, which latter is held from motion by the engagement of the extension 152 over the edge 170. As this movement of the cam 156 proceeds the edge 175 strikes the slope 151 of the lever 142 and by riding on this slope lifts the lever until the extension 152 is free of the cam 153. As soon as this is

done the knob 33 may be released and the spring 172 will return it to the "on" position.

When it is desired manually to open the switch and hold it open it is necessary only to turn the knob 33 to the "off" position which brings the cam edge 168 into position so that the projection 180 is engaged in the notch 169. In this position the mechanism is rendered entirely inoperative until it is manually changed from this "off" position.

From the above it may be seen that the switch device includes many advantages within a compact structure, being complete in desired functions, simple to operate, and fully adjustable. Although it has been described for use on a refrigerator, such is merely one of its applications. Also, while the structure is particularly valuable when used in a diaphragm-type temperature responsive mechanism, it is readily adapted to other similar uses. It is not limited to use an electric switch and, where the term "switch" is used in the claims, such is understood to be merely representative of mechanisms operable by this type of movement.

What is claimed is:

1. In a device of the kind described, a switch, means responsive to physical conditions, means adapted to operate said switch at a predetermined condition of said responsive means including a lockable member, separate means shiftable to lock the lockable member and maintain the switch against operating movement and means movable independently of said lockable member interconnecting said separate means and said responsive means to release said separate means when said responsive means attains a predetermined condition.

2. In a device of the kind described, a switch, means responsive to changes in physical conditions, means adapted to operate said switch at a predetermined condition of said responsive means including a lockable member, means to lock the lockable member to maintain the switch against operation, means movable independently of said lockable member interconnecting the last-named means and the responsive means to release the former upon the responsive means attaining a predetermined condition, and means to adjust one of said predetermined conditions without affecting the other.

3. In a device of the kind described, a switch, power means to operate said switch at a predetermined condition including a lockable member, releasable means to lock said member and maintain said switch against operation, means separate from said lockable member and connected with said power means to release said releasable means when said power means attains a predetermined condition, means to adjust both said predetermined conditions while maintaining the difference between them, and means for adjusting one of said predetermined conditions relative to the other.

4. In a device of the kind described, a frame, a power means mounted on the frame, mechanism adapted to be moved by said power means, said mechanism including two separate members movable relative to each other and to the frame, two abutments on said mechanism, means urging said members against said abutments to move together upon movement of said mechanism, one of said abutments being adjustable relative to the mechanism whereby to vary the movement of one of said members relative to said power means,

5. In a device of the kind described, a power means, a mechanism adapted to be moved by said power means, said mechanism including two abutments on said mechanism, a pair of separate movable members, one engageable with each abutment for movement therewith upon movement of the mechanism by the power means, means for adjusting both said abutments relative to the power means, and means for adjusting one of said abutments relative to the other.

6. In a device of the kind described, a frame, a power means, a first element adapted to be moved by said power means, a second element, and means connecting said second element to said first element for movement therewith, said connecting means adjustably engaging both elements and adapted in said adjustment to produce a movement of said elements relative to each other equal to a fractional part of the movement of said connecting means relative to each of them, and said connecting means extending through the frame to be accessible from the outside thereof for effecting said adjustment.

7. In a device of the kind described, a frame, a power means, a first element adapted to be moved by said power means, a screw threadedly engaging said first element on one side of the frame, a second element differentially threadedly engaging said screw, and a member adapted to be moved with said second element upon movement thereof in response to movement of said first element by said power means, and said screw projecting through the frame to be accessible on the other side thereof for effecting said adjustment.

8. In a device of the kind described, a solid-charge actuated diaphragm, a first element adapted to be moved by said diaphragm, a second element, a differential screw adjustably connecting said elements for movement together, said screw, upon being turned, producing micrometric movement of said second element relative to the first, and means for turning said screw, said screw extending beyond the same side of both elements to be accessible for effecting its rotation.

9. In a device of the kind described, a power means including an element to be displaced upon changes of physical conditions, a first threaded element adapted to be moved by said means, a second threaded element, differential screw means adjustably connecting said elements, a first member adapted to be moved by said first threaded element, and a second member adapted to be moved with said second threaded element, rotation of said screw adjusting the point of movement of said second member relative to said power means, but not altering said first member.

10. In a device of the kind described, a frame, a power means mounted on said frame, a first element, an adjustable abutment between said first element and said power means, a second element, differential screw means connecting said elements for adjustment relative to each other and for movement together by said power means, and two movable members mounted on the frame, one adapted to be moved with each of said elements.

11. In a device of the kind described, a power means mounted thereon, a hollow, internally threaded sleeve, a hollow screw engageable with the threads on said sleeve, an abutment adapted to be adjusted by said screw, a member adapted to be moved by said abutment, and a set-screw means between said power means and said sleeve, adjustable through the hollow screw and sleeve.

12. In a device of the kind described, a frame, a power means on said frame, a first sleeve maintained on said frame for axial movement but against rotary movement, spring means urging said first sleeve toward said power means, a screw means threadedly engaging said first sleeve, a second sleeve engaging said screw means, two levers between said sleeves, spring means acting oppositely on said levers to urge one against said first sleeve and the other against said second sleeve, and a switch adapted to be actuated by said lever of said second sleeve.

13. In a device of the kind described, a frame, a power means on said frame, a first sleeve adapted to be moved by said power means, means on said frame preventing rotation of said sleeve but permitting axial movement thereof, a screw engaging said sleeve, a second sleeve threadedly engaging said screw, means on said frame preventing rotation of said second sleeve but permitting axial movement thereof, a lever, resilient means urging said lever against said second sleeve, and a switch adapted to be actuated by said lever.

14. In a device of the kind described, a frame, a power means on said frame, a first sleeve adapted to be moved by said power means, means on said frame preventing rotation of said sleeve but permitting axial movement thereof, a screw engaging said sleeve, a second sleeve threadedly engaging said screw, means on said frame preventing rotation of said second sleeve but permitting axial movement thereof, a lever, resilient means urging said lever against said second sleeve, a switch adapted to be actuated by said lever, a second lever adapted to be actuated by said first sleeve, lock means releasably maintaining said switch against operation, and means actuated by said second lever to release said lock means upon movement of said power means and said first sleeve a predetermined distance.

15. In a device of the kind described, a power means, a pair of members adapted to be moved by said power means, a switch adapted to be actuated by one of said members after movement of said power means as much as a predetermined distance, releasable lock means preventing actuation of said switch by its member, and means operated by said second member to release said lock means upon movement of said power means a predetermined greater distance, whereby said first member may then actuate said switch.

16. In a device of the kind described, a power means, a pair of members adapted to be moved by said power means, one of them being resiliently connected to said power means, a switch adapted to be actuated by said resiliently connected member upon movement of said power means as far as a predetermined distance, means locking said switch against such actuation whereby the force of said power means is stored in said resilient connection, means operated by said second member to release said lock means upon movement of said power means a predetermined greater distance, whereby the force stored in said resilient means may then actuate said switch.

17. A device as set forth in claim 15, with means to adjust the position of said power means relative to the switch at which said switch normally operates.

18. A device as set forth in claim 15, with means to adjust the position of said power means

relative to the switch at which said release means operates.

19. A device as set forth in claim 15, with a single means to adjust the position of said power means relative to the switch at which both said members normally operate.

20. A device as set forth in claim 15, with means to adjust the position of said power means relative to the switch at which each member is moved, whereby the position of each may be determined separately.

21. In a device of the kind described, a frame, a power means thereon, a first threaded sleeve, resilient means urging said sleeve toward said power means whereby the same is moved by said means, an adjustable abutment between said power means and sleeve, a screw engageable with said sleeve, a second threaded sleeve engageable over said screw, means preventing rotation of said second sleeve but permitting axial movement thereof, said last-named means being mounted on said frame for adjustment relative thereto, a first movable member engageable with said first sleeve for movement thereby, a second movable member engageable with said second sleeve for movement thereby, said adjustable abutment being adapted to alter the relation of both sleeves relative to the power means, and said means preventing rotation of said second sleeve being adjustable to alter the relation of said second sleeve relative to the power means and said first sleeve.

22. In a device of the kind described, power means, a switch, an actuating member for said switch, means moved by said power means for operating said actuating member, lock means to prevent operation of the switch, having an element engageable with the actuating member to stop the same, means normally urging said element from said actuating member, means holding the same in engagement with said member, and means separate from said actuating member operated by said power means for releasing said last-named holding means.

23. In a device of the kind described, means responsive to changes in physical conditions, a switch, an actuating member for said switch, means for locking said switch against operation including an element engageable with said actuating member, means normally urging said element out of locking position, a lever for holding said element in locking engagement, and means separate from said actuating member causing said first-named means to release said lever upon occurrence of a predetermined physical condition whereby said element removes from locking position.

24. In a device of the kind described, power means, a switch, an actuating member for said switch and adapted to be moved by said power means, a rotatable member having a handle thereon, means normally urging said rotatable member into a normal position, a second rotatable member limitedly oscillatable relative to said first rotatable member, an element on said second rotatable member engageable with said actuating member to stop movement thereof, said element being thus engageable when said rotatable member is displaced from its normal position, a lever, said second rotatable member having an edge engageable with a portion of said lever when said stop element is against said actuating member, said first rotatable member being then adapted, when said handle is turned,

to engage said lever and lift it from said edge of said second rotatable member.

25. In a device of the kind described, a frame, a solid-charge thermal element including a diaphragm, on said frame, a first threaded sleeve, means urging said sleeve toward said diaphragm, an abutment on said sleeve and engageable with said diaphragm, a differentially threaded screw threadedly connected with said sleeve, a second sleeve connected to said screw, whereby rotation of said screw produces micrometric movement of said second sleeve relative to said first sleeve, a first lever, a second lever, a spring between said levers urging the first lever against the first sleeve and the second lever against the second sleeve, a switch adapted to be actuated by said second lever, a rotatable knob on said frame, an element mounted on said knob for rotation therewith, two cams on said element adapted to engage said second lever to hold the same against rotation, and automatic means for releasing one of them, said automatic means including a spring normally urging said rotatable member to rotate so as to remove such cam from said lever, and said element having an edge engageable with said first lever to hold the element against such rotation by the spring, the movement of the diaphragm shifting the first sleeve to lift the first lever from said rotatable element and permit said spring to remove said cam, upon occurrence of a predetermined temperature.

26. In a device of the kind described, a diaphragm adapted to be moved by fluid pressure, a switch including a blade, resilient means urging said blade in one direction with decreasing effect as the blade is moved in the opposite direction, means connecting said diaphragm to said blade including a lever having a short power-receiving arm and a long power take-off arm, which latter is connected with said blade, said lever having inherent resilience to store in itself by deformation certain of the applied forces whereby said blade moves with a snap action, and closes at a different position of said diaphragm from that at which it opens.

27. In a mechanism of the kind described, a power means, an element moved thereby to several positions, a switch, a first member controlling operation of the switch and adapted to be moved by said element, said switch being actuated when said first member is moved by movement of the element to a first position, means to lock said first member against movement, a second member adapted to be moved by said element, and means actuated by the second member to release said lock means when said second member is moved a predetermined distance by the movement of the element to a second position.

28. In a mechanism of the kind described, a power means, an element moved thereby to several positions, a switch, a first member controlling operation of the switch, resilient means interposed between the element and the first member normally to cause the member to be moved upon movement of the element but permitting movement of the element when the member is locked, means to lock the member and thereby to hold the switch, a second member moved by movement of the element, and means operated by the second member to release the lock means after the element has been moved a predetermined distance by the power means.

29. In a mechanism of the kind described, a power means, an element moved by the power

means, a pair of oppositely faced abutments on said element, a pair of members between said abutments, spring means urging the first member against its abutment, a lock means for said member to prevent its movement by said spring when its abutment is withdrawn by movement of the power means and element, the second member being moved by its abutment, and means actuated by said second member when it has been moved a predetermined distance to release said lock means and to permit the spring to urge the first member toward its abutment.

30. In a mechanism of the kind described, a power means, an element moved by the power means, a pair of oppositely faced abutments on the element, a pair of members extending between said abutments, a spring between the members and urging them oppositely against their abutments, whereby both of them are movable with the element, one by direct contact with its abutment, and the other by being urged toward its abutment by the spring, a switch controlled by the one of said members moved through the spring, a lock means preventing movement of said member whereupon movement of said element stores energy in the spring, and means operated by the other member after it moves a predetermined distance, to release said lock means.

31. In a mechanism of the kind described, a power means, a switch, an element moved by the power means, a first member moved by the element and controlling the switch, lock means movable to position to engage the first member and thereby to hold the switch, said lock means including a lever pivotable into one position to hold the lock means and into another position to release the lock means, a second member moved by the element independently of the first member, said second member being adapted to trip the lever and release the lock means when the second member is moved a predetermined distance.

32. In a mechanism of the kind described, a power means, a switch, a first member moved by the power means and controlling the switch, a separately movable abutment means adapted to engage the first member and lock it against movement, means normally urging said abutment away from said member, a latch engageable with the abutment means when the same is moved to locking position, to maintain it in such position, and a second member moved by the power means, said second member being adapted to trip the latch to release the abutment means and enable it to remove from locking position.

33. In a mechanism of the kind described, means movable in response to heat changes, a switch, a first member moved by the heat-responsive means to control the switch, a lock to hold the member and switch in one position, said lock including an abutment device engageable with the member, manual means to move the device, a latch adapted to hold the abutment device in locking position, a second member moved by the power means to trip the latch to permit freeing the abutment device from the first member, and means on said manual means to trip the latch.

34. In a mechanism of the kind described, a

movable member, a locking device therefor, said locking device including a rotatable shaft, a pair of discs on said shaft, one of which is fixed thereon and the other of which is rotatable thereon, means connecting the discs to permit only a limited relative rotation between them, a latch, the movable disc having an edge thereon to be engaged by the latch whereby to be held in a predetermined position, and an abutment on the movable disc carried against the movable member when said disc is rotated to position to engage the latch, the connection between the discs thereafter permitting said limited relative movement whereby the fixed disc may be moved without disturbing the latched movable one, the fixed disc having an edge engageable with the latch upon such limited movement to remove the same from latching engagement and to permit withdrawal of the abutment from the member.

35. In a mechanism of the kind described, a device movable invariably in response to changes in physical conditions, a shaft adapted to be moved thereby, means urging said shaft toward the movable device, a member adapted to be actuated by the shaft, the shaft having an axial opening therethrough, and an unyieldable abutment adjustably secured in said opening and interposed between the shaft and the device, the adjustment of the abutment being effectible through the axial opening.

36. In a device of the kind described, a solid-charge thermal element moving in invariable amounts for given heat changes, a lever adapted to be actuated thereby, means connecting the element and lever to actuate the lever upon movements of the element, and a switch at one end of the lever, and a mechanical means acting on the switch end of the lever to urge it in one direction and to resist movements in the other, the lever between the mechanical means and the point at which the element is connected being inherently resilient, whereby as the power means moves, a part of its movement may be stored as latent energy in the lever, and finally the switch will be actuated with a sudden movement.

37. In a mechanism of the kind described, a power means, a movable member, resilient means connecting the power means to the movable member, a shiftable device movable into two positions to lock the member against movement, and means operable by the power means to release the shiftable device from one of said positions.

38. In a device of the kind described, a cut-off, power means movable to different positions in response to changes in physical conditions, mechanism interconnecting said power means and cut-off to operate said cut-off at predetermined and variable positions of said power means relative to said switch, said mechanism including a member to be moved, a screw, means for displacing the screw relative to the power means upon rotation thereof, an abutment engageable with the moved member but free for independent movement relative to the moved member, and means displacing the abutment a lesser amount upon said rotation of the screw.

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