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3,103,568

THERMALLY RESPONSIVE SWITCH DEVICES

Filed May 5, 1961

6 Sheets-Sheet 1

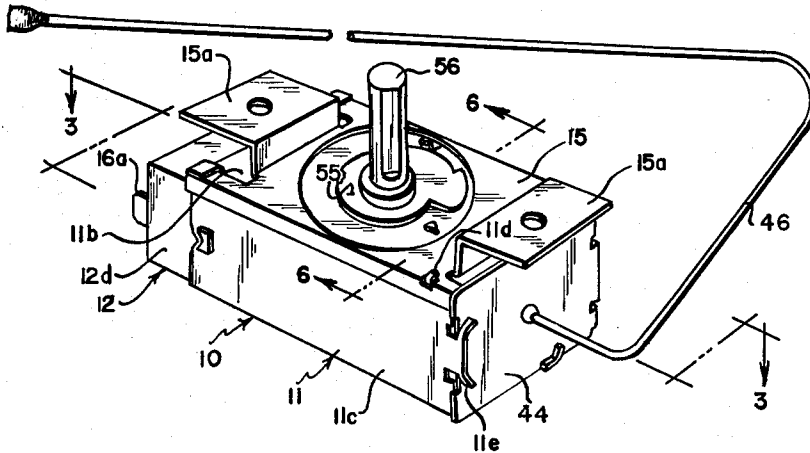


FIG. 1

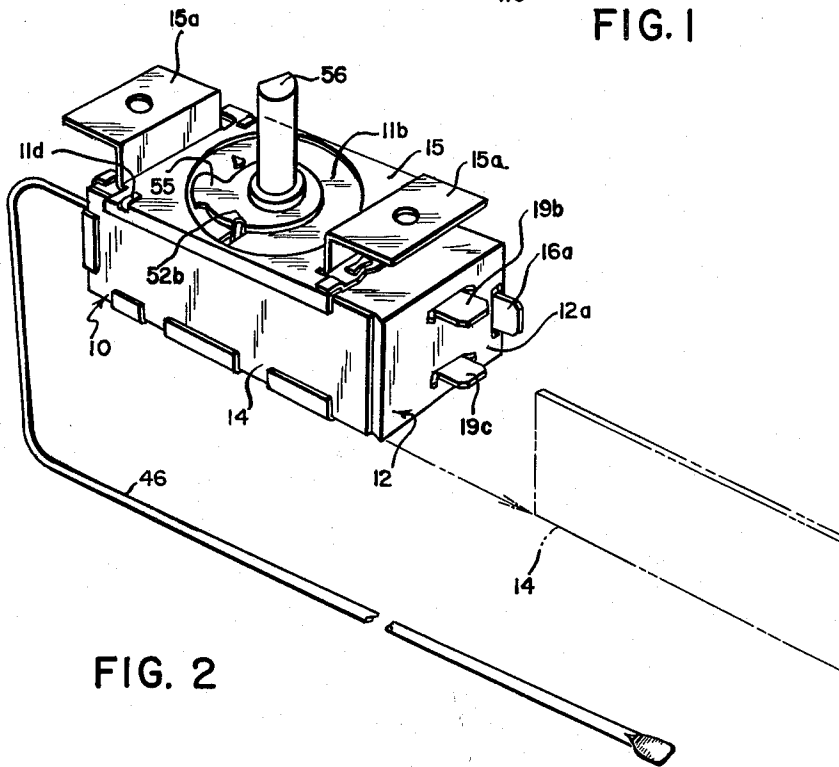


FIG. 2

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6 Sheets-Sheet 3

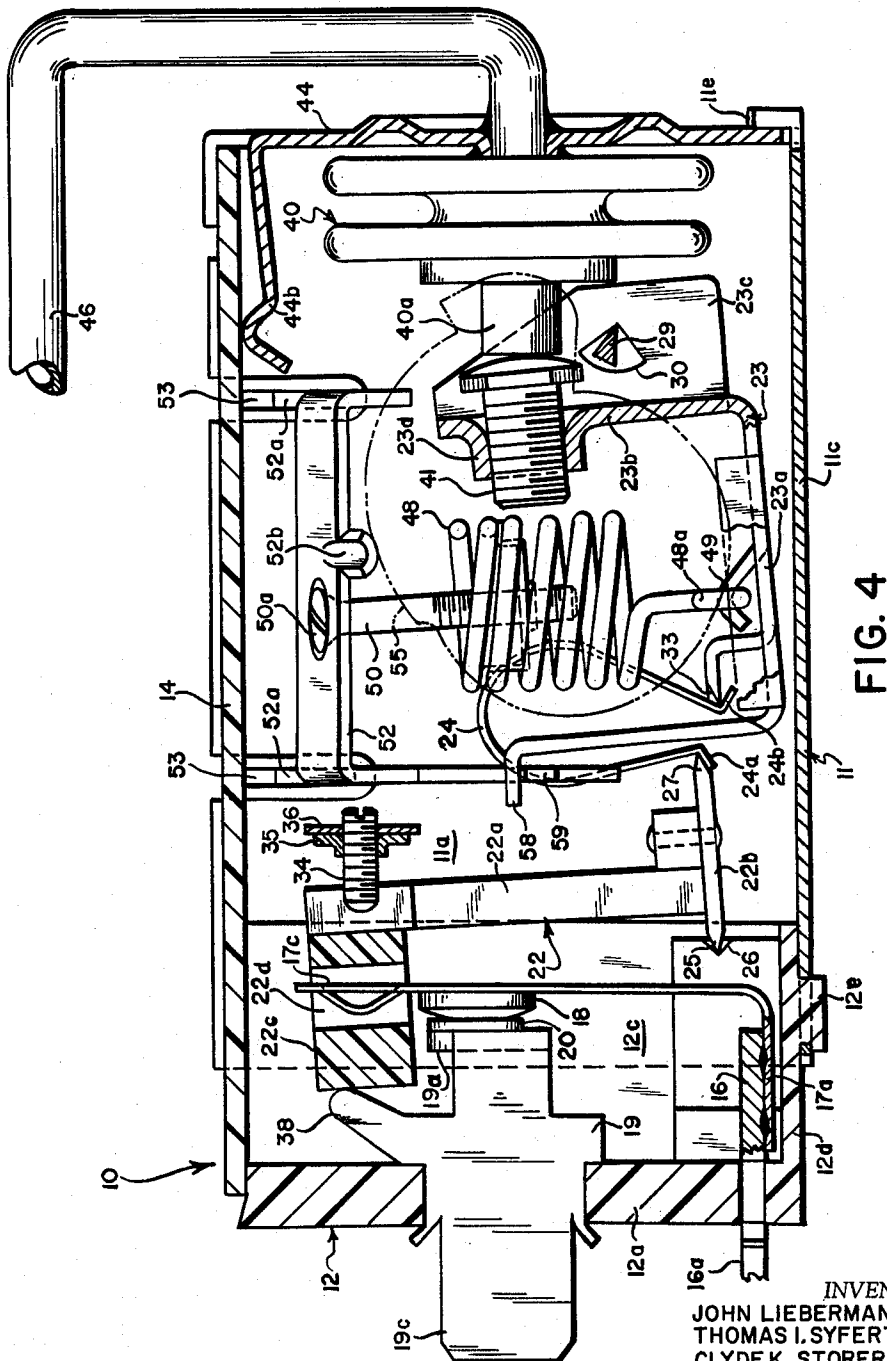


FIG. 4

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6 Sheets-Sheet 4

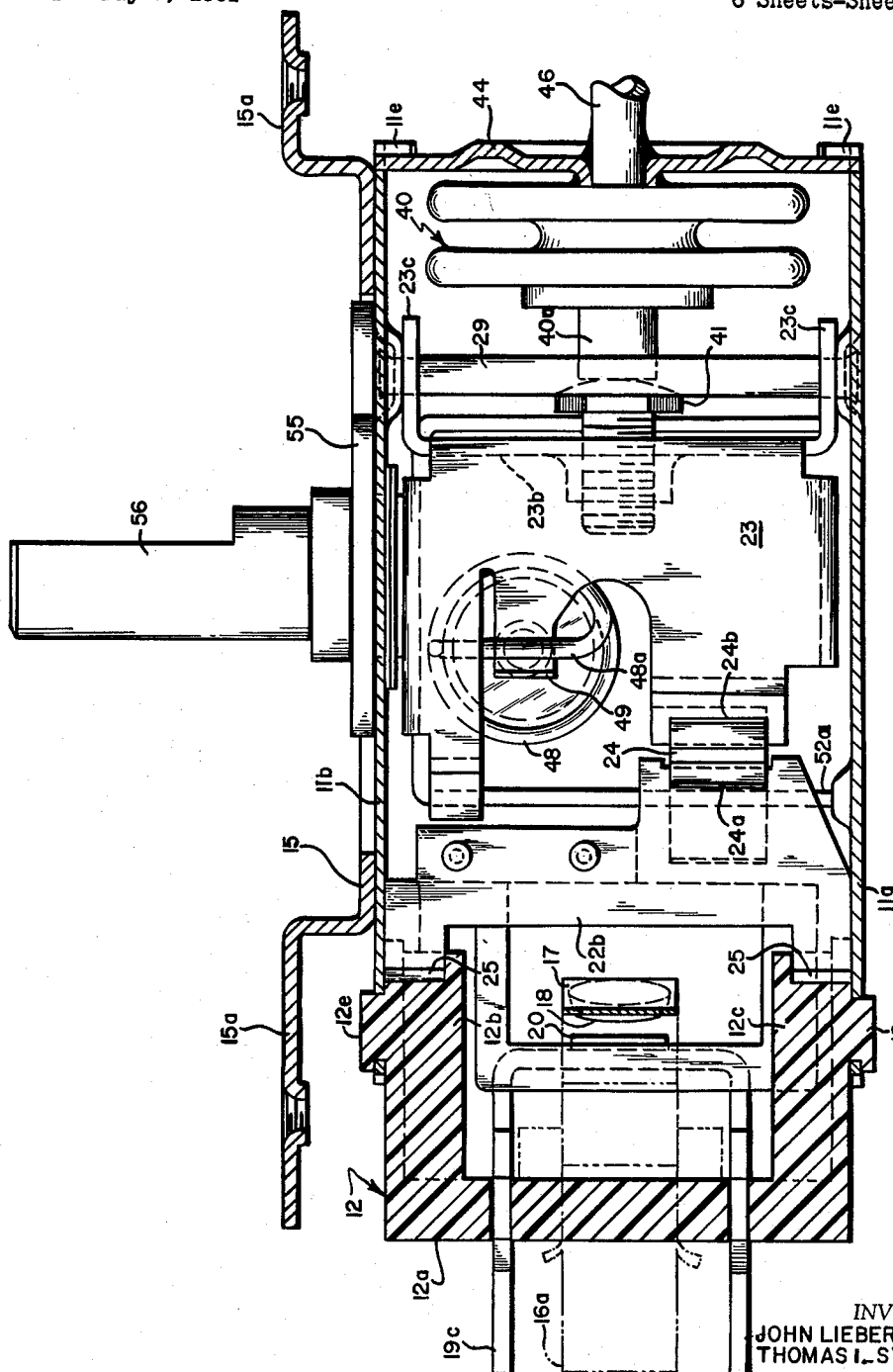


FIG. 5

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6 Sheets-Sheet 5

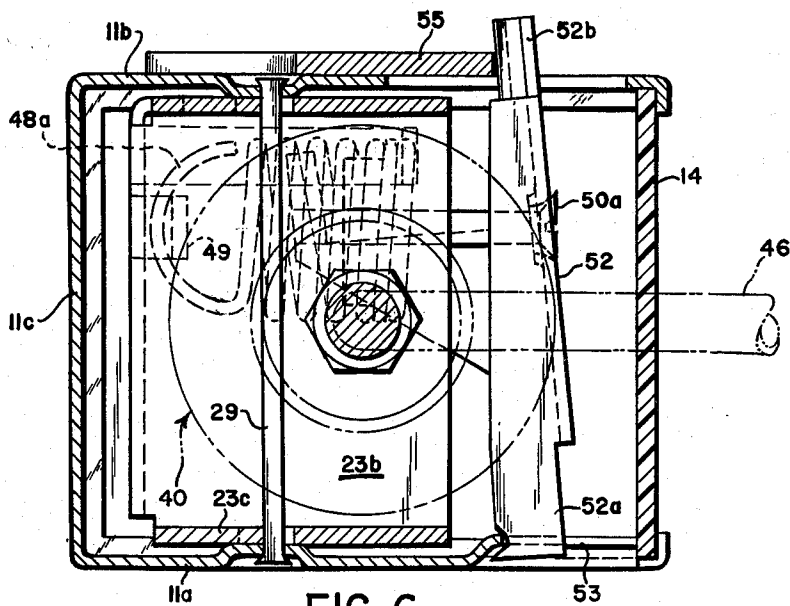


FIG. 6

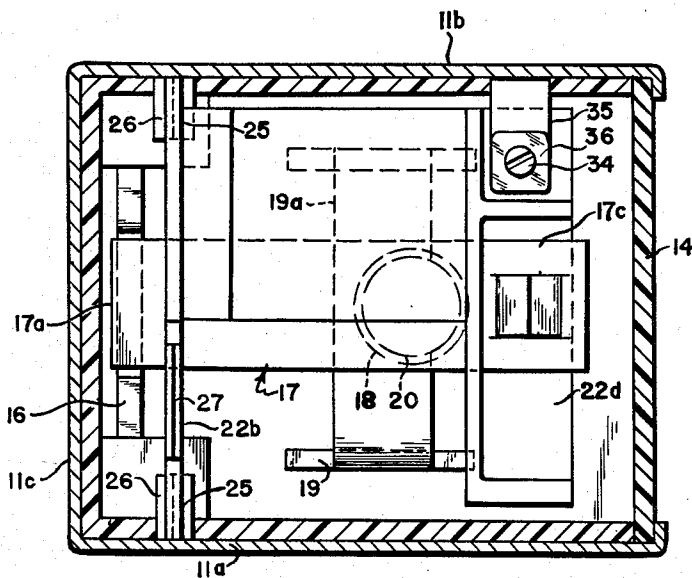


FIG. 7

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6 Sheets-Sheet 6

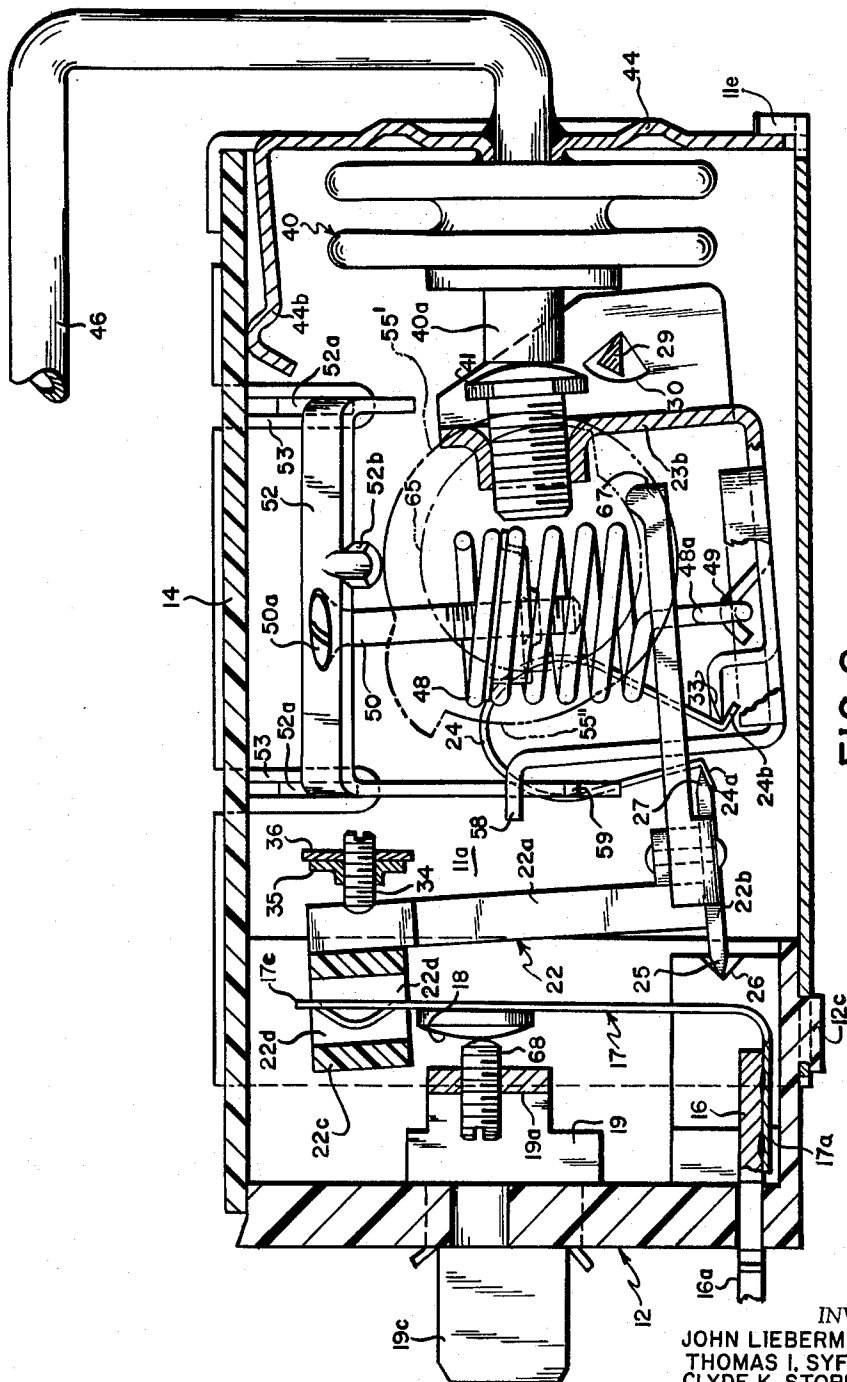


FIG. 8

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THERMALLY RESPONSIVE SWITCH DEVICES

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5 Claims. (Cl. 200—140)

This invention relates to thermally actuated electric switch devices and more specifically to a novel and improved construction in that type of switch device which embodies a snap acting switch mechanism, a thermally responsive power element for operation thereof, and adjustable means for varying the operating characteristics of the switch device.

Electric switch devices of the type with which the invention is concerned are particularly suited for use in the thermostatic control of refrigerators, air-conditioners and the like apparatus, wherein an electric compressor motor is cyclically operated in response to temperature variations in the apparatus or in the medium being heated or cooled. The temperature variations to which the switch devices must respond differ with each apparatus and often with each application of the same type of apparatus. Moreover, with the trend toward less bulky appliances and apparatus being accomplished by better insulation methods and materials as well as miniaturization of parts, the space which may be occupied by a switch device is at a premium. Accordingly, it is desirable to provide such switch devices which are compact in size and wherein the operating characteristics, such as the "cut-in" or closing operation and the "cut-out" or opening operation can be independently adjusted or set to vary the spread or "differential" therebetween, and wherein these characteristics can be simultaneously adjusted or set by manual control means without substantial change in the differential, so as to permit selection of a desired temperature level to be maintained by a refrigerator, air conditioner, or the like under the control of the switch device.

As one object, this invention aims to provide an improved thermally responsive switch device of the above mentioned character in which certain novel constructions and arrangements of parts provide the aforementioned desirable features, the device comprising a generally rectangular housing formed at least in part by an insulator member located at one end thereof and which carries a movable switch contact and a fixed contact, the movable contact being actuated for cooperation with the fixed contact by a toggle member in the form of a lever arm pivoted to the insulator member and extending alongside thereof and being connected with the movable contact to effect shifting thereof with a snap action, the toggle member forming part of a snap acting mechanism in the housing for actuating the movable contact in response to movements of a power element, preferably a thermally responsive bellows means located at the end of the housing opposite the insulator member.

It is another object of this invention to provide a switch device having the above described arrangement of parts and wherein the snap acting mechanism may be conveniently and accurately adjusted to select the temperatures at which the switch contacts will be operated between open and closed positions, the mechanism including a bellows engaging lever pivoted in the housing for movement about one axis and connected by over-center spring means to the toggle member for effecting the snap action thereof, and an adjusting lever pivoted to one housing wall for movement about an axis transverse to the axis of the bellows engaging lever, the adjusting lever being connected by a range spring to the bellows engaging lever and being adjustably positioned by cam means for varying the biasing

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effect of the range spring on the bellows engaging lever whereby the temperature responsive characteristics of the switch may be selectively changed.

Still another object of this invention is the provision of the toggle member and the bellows engaging lever in the form of bell cranks arranged so as to define a space therebetween for accommodating the adjusting lever and range spring, the bell cranks being pivoted about parallel axes and arranged with one leg of each extending toward but terminating short of one leg of the other bell crank with the over-center spring means disposed therebetween, and the other leg of each bell crank extending substantially parallel to and in the same direction as that of the other bell crank so as to define the mentioned space between the parallel legs thereof.

Another object of the present invention is the provision of improved switch means embodying the foregoing constructions and in one form of which the cut-out and cut-in temperature characteristics may be simultaneously varied by a single control, and in another form of which one of those temperature characteristics is maintained constant although the other is varied.

As another object the invention aims to provide other constructions and arrangements of parts, the objects and advantages of which will become apparent from the following description of the preferred embodiments of the invention and from the accompanying sheets of drawings forming a part of this specification, and in which:

FIG. 1 is a perspective view of a thermally responsive switch device embodying this invention;

FIG. 2 is another perspective view of the device of FIG. 1;

FIG. 3 is a sectional view of the switch device taken substantially along line 3—3 of FIG. 1 and on an enlarged scale;

FIG. 4 is a view similar to FIG. 3 but with some parts in different positions;

FIG. 5 is a sectional view taken substantially along line 5—5 of FIG. 3;

FIG. 6 is a sectional view taken along line 6—6 of FIG. 1;

FIG. 7 is a sectional view taken along line 7—7 of FIG. 3; and

FIG. 8 is a sectional view similar to FIG. 3 but illustrating a modified switch device embodying this invention.

In the form of the invention illustrated and described in FIGS. 1 through 7, there is provided a thermally actuated electric switch device, generally indicated at 10, which is particularly useful in controlling the cyclic operation of refrigerant compressors in refrigerators, air conditioners and the like, in response to temperature fluctuations. The switch device 10 includes a housing comprising a channel shaped member 11, preferably formed of sheet metal, and comprising side walls 11a, 11b joined by a wall 11c. An insulator member 12, formed of molded "Bakelite" or other suitable insulating plastic material extends from between the walls 11a, 11b of channel member 11 so as to form one end portion of the housing.

Insulator member 12 comprises an end wall 12a, side walls 12b and 12c, and a bottom wall 12d, and is conveniently secured in place by lugs 12e extending through corresponding openings in the walls of channel member 11. A temperature responsive snap switch mechanism, described hereinafter, is located within the housing formed by channel member 11 and insulator member 12. The housing is preferably closed on the side opposite wall 11c by an insulating cover member 14 which is adapted to slide between walls 11a and 11b and to be held by the in-turned edge portions of those walls as is best shown in FIG. 2. A mounting bracket 15, having apertured ears or lugs 15a, overlies wall 11b and is secured thereto by tabs 11d as shown.

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A conductor member 16 extends through, and is secured in, an opening in end wall 12a of insulator member 12 and terminates at its outer end in a blade type terminal connector 16a. A flexible contact arm 17, is formed of flat spring metal such as beryllium copper and has an in-turned end 17a secured to the inner end of conductor 16 by welding or the like. Contact arm 17 carries a movable contact 18 located at the mid portion thereof, as shown. A U-shaped second conductor member 19, having a relatively fixed contact 20 supported on the inner, or yoke portion 19a thereof, is mounted on insulator member 12 with contact 20 in registration with movable contact 18. Conductor member 19 has two leg portions extending through, and secured in, openings in insulator wall 12a and terminating in blade type terminal connectors 19b and 19c.

Snap acting actuator means are provided for operating contact arm 17 to bring contact 20 into and out of engagement with contact 18 for making and breaking an electric circuit therethrough. In this instance the snap acting mechanism comprises a toggle member 22, which is pivoted to insulator member 12, and a bellows operated lever 23 which will later be described in detail, the toggle member and the lever being operatively interconnected by a C-shaped over-center acting toggle spring 24.

One leg 22a of toggle member 22 is molded from "Bakelite" or other suitable rigid insulating material, while another leg thereof comprises a metal plate 22b riveted to one end of leg 22a at right angles thereto so that toggle member 22 takes the form of a bell crank lever. Plate 22b is provided with knife edges 25 engaged in V-shaped notches 26 formed in insulator member 12 to effect the pivotal connection of toggle member 22 therewith, and is provided with knife edge 27 engaging one end 24a of toggle spring 24.

Leg 22a extends across insulator member 12 and terminates in an offset portion 22c which projects between the insulator side walls 12b and 12c and has an opening 22d in which the free end portion 17c of contact arm 17 is loosely caged. Thus, movement of toggle member 22 in a clockwise direction as viewed in FIG. 3 will cause the offset portion 22c to move the caged end 17c of arm 17 and to separate contact 20 from contact 18 against the resilient spring action of arm 17, while counter-clockwise movement of toggle member 22 will permit spring arm 17 to close the contacts as shown in FIG. 4.

Lever 23, which is preferably formed as a sheet metal stamping, comprises leg portions 23a and 23b extending substantially at right angles to one another in the manner of a bell crank, and is pivotally connected to channel member 11 by a triangular fulcrum pin 29 which extends between side walls 11a and 11b and passes through openings 30 in spaced bearing member 23c extending from leg 23b. Leg 23b and toggle member leg 22a extend substantially parallel to one another and in the same direction, while the plate 22b and leg 23a extend toward, but terminate short of, one another. A generally rectangular space is thereby defined between the toggle member 22 and bellows lever 23, which space is utilized to accommodate other parts of the device, as will presently be made apparent.

Bellows lever leg 23a is provided with a knife edge 33 which is pivotally connected with end 24b of toggle spring 24. When lever 23 is in its position illustrated in FIG. 3, spring 24 acts against plate 22b of toggle member 22, urging the latter in a clockwise direction, as viewed in the drawings, about the pivotal axis formed by knife edge 25 and grooves 26 so that offset portion 22c holds contact arm 17 with movable contact 18 separated from fixed contact 20. Movement of toggle member 22 in this direction is limited by engagement of offset portion 22c with a screw 34 which extends through a threaded opening in a lug 35 struck inwardly from housing wall 11a, and acts as an adjustable stop for toggle member 22, thereby determining the spacing between contacts 18

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and 20 when open. A washer 36 of "nylon" or other suitable material surrounds screw 34 and serves to lock that screw in its adjusted position.

Rotation of lever 23 in a counter-clockwise direction about the pivotal axis defined by fulcrum pin 29 will move or bring the pivotal connection between spring end 24b and knife edge 33 through a plane extending through fulcrum pin 29 and the pivotal connection of toggle member 22 with insulator member 12. Upon such passing of knife edge 33 through that plane, spring 24 will act against plate 22b of toggle member 22 causing the latter to rotate in a counter-clockwise direction into the position shown in FIG. 4 with a snap acting movement. As toggle member 22 snaps to its FIG. 4 position, contacts 18 and 20 are quickly closed by the spring action of arm 17 for completing a circuit therethrough. Rotation of toggle member 22 in a counter-clockwise direction is limited by a bendable tang or lug 38 formed as a part of U-shaped conductor member 19 and which is adapted to be engaged by offset portion 22c. Adjustment by bending of lug 38 will serve to change the amount of movement of lever 23 necessary to snap toggle member 22 to open the switch means, while adjustment of screw 34 will serve to change the amount of movement of lever 23 necessary to snap the switch means to its closed position.

Thermally responsive power means are provided for moving lever 23 about its pivot pin 29 for actuation of the switch mechanism and in this instance comprises an expansible bellows, generally indicated at 40, and having an axially extending post 40a in engagement with an adjusting screw 41 received in a threaded opening 23d in leg 23b of lever 23. Bellows 40 forms part of an assembly comprising an end plate 44 to which the bellows is secured as by brazing and which is in turn secured to side walls 11a, 11b by tabs 11e crimped thereover. A tubular member 46 extends from end plate 44 and communicates therethrough with the interior of the bellows. Tubular member 46 is closed and sealed at its other end, and the bellows 40 and tubular member contain a fluid which expands and contracts with increases and decreases in temperature. Temperature changes experienced by the tubular member 46 result in axial expansion and contraction of bellows 40 which is transmitted via post 40a and screw 41 to leg 23b of lever 23. End plate 44 may be conveniently provided with tongues 44b which serve to grip cover 14.

A tension spring 48 is disposed in the previously mentioned space between toggle member 22 and lever 23 and is connected at one end 48a thereof to a hook 49, which is struck out from leg 23a of lever 23, and this spring serves to resiliently urge lever 23 in a clockwise direction about pivot pin 29 and against the post 40a of bellows 40. Spring 48 is connected at its other end by a screw 50, threadedly engaged in a nut member 51 lodged in the convolutions of spring 48, to an adjusting lever 52, in a recessed opening of which screw head 50a is received. Lever 52 has spaced bearing portions 52a extending through slots 53 in housing side wall 11b and serving to pivotally connect the lever thereto for rotation about an axis extending transversely of the axis of fulcrum pin 29. Lever 52 is also provided with a cam following portion 52b extending therefrom and adapted to engage the periphery of a rotatable cam 55.

Cam 55 is connected to a shaft 56 for rotation therewith, the shaft being suitably journaled in an opening in wall 11b and being adapted to receive a knob, not shown, for conveniently adjusting the position of cam 55. Rotation of cam 55 serves to adjustably position lever 52 for increasing or decreasing the tension of spring 48, and hence for adjusting the load imposed on bellows 40. By this means, which simultaneously shifts the cut in and cut out temperatures without substantially altering the spread or differential therebetween, the temperatures at which the snap acting switch mechanism will be actuated may be conveniently selected. Screw 50 may also be ad-

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justed to vary the tension on spring 48 and serves to shift the range of temperatures which may be selected by use of the cam 55. Screw 50 may therefore be referred to as a range adjusting screw and spring 48 as a range spring.

In some applications, in domestic refrigerators for example, it is desirable to provide an "off" position for the temperature control knob. Switch 10 therefore includes means whereby the contacts 18 and 20 may be maintained in an open condition regardless of increases in temperature. For this purpose cooperable hook members 58 and 59 are provided on lever arms 23a and 52 respectively. When shaft 56 is rotated in a manner to bring the highest portion 55a of cam 55 to bear against cam follower 52b of lever 52, the latter is moved so as to bring hook member 59 into engagement with hook member 58. Lever 23 is thereby restrained against movement by bellows 40 and contacts 18 and 20 will be held open regardless of temperature changes experienced by the tubular element 46.

Referring now to FIG. 8, in which parts corresponding to those already described have corresponding reference characters, there is illustrated therein a modified switch device which may be referred to as a constant cut-in and variable cut-out device. That is to say, rotation of control shaft 56 serves only to adjust the temperature at which the contacts 18 and 20 open. This is accomplished by keeping the tension on range spring 48 constant and varying the amount of movement of bellows 40 necessary to actuate the switch to open the contacts.

The tension on range spring 48 is maintained constant by providing an "off" cam 55' on shaft 56 with a profile which will not shift cam follower 52b except when the follower is engaged by the cam rise indicated at 55" so as to cause hook members 58 and 59 to hold the switch in the "off" position. A cut-out temperature selecting cam 65 is provided on shaft 56 in addition to the "off" cam 55'. Cam 65 is disposed adjacent the inner surface of housing wall 11b and the periphery thereof is engaged by a lever arm 67 extending from toggle member 22 and conveniently formed as a part of plate 22b. Arm 67 and cam 65 cooperate to limit movement of toggle member 22 in a counter-clockwise direction and hence serve to adjustably determine the amount of movement of bellows 40 and lever 23 necessary to snap the toggle member to its switch opening position and therefore to adjustably determine the cut-out temperature of the switch device. While in the FIG. 3 embodiment rotation of shaft 56 and cam 55 serve to simultaneously shift the cut-in and cut-out temperatures, in the present embodiment only the cut-out temperature is varied by rotation of control shaft 56.

In addition the fixed contact in the embodiment of FIG. 8 is in the form of screw type contact 68 received in a threaded opening in conductor member 19, and which may be adjustably positioned to select the gap which will be present between contacts 18 and 68 when open.

From the foregoing detailed description of thermally responsive switch devices embodying the present invention, it will be recognized that, by reason of the constructions and arrangements of parts including a toggle member and a bellows engaging lever in the form of two bell crank levers disposed so as to provide space therebetween for adjustable loading or biasing means, and the insulator member which forms the end portion of the housing and pivotally supports the toggle member, the contact means and the differential adjusting means, there have been provided particularly compact yet simple and reliable switch devices. Moreover, it will be appreciated that switch devices embodying this invention are easily regulated and adjusted by means which are readily accessible, so that the devices lend themselves to use in a variety of apparatus and applications.

Although the invention has been described with detailed reference to particular switch devices, it will be under-

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stood that the invention is not limited thereby, but rather the invention includes all such adaptations, modifications, and uses as are reasonably embraced by the scope of the claims hereof.

Having described our invention, we claim:

1. A thermally responsive switch device of the type having one constant and one variable operating characteristic, said device having housing means at least one portion of which comprises an insulator member forming one end of the housing, said insulator member also supporting a relatively fixed contact in said housing for cooperation with said movable contact arm, a snap acting mechanism in said housing including a toggle member pivoted to said insulator member for movement about a first axis between first and second positions for actuating said movable contact arm, a lever pivoted in said housing for movement about a second axis and connected to said toggle member by an over-center acting spring, a temperature responsive power element for moving said lever to effect snap movement of said toggle member between said first and second positions, adjustable biasing means urging said lever in one direction against said power element, said adjustable biasing means including a second lever pivoted to a wall of said housing for movement about an axis transverse to said second axis, spring means connecting said second lever and the first mentioned lever, and control means including a rotary cam engaging said second lever for positioning thereof to select said variable operating characteristic, and means connecting said toggle member and said control means for changing one of said first and second positions in accordance with positioning of said second lever whereby said constant characteristic is unaffected by said selection of said variable operating characteristic.

2. A switch device as defined in claim 1 wherein said control means comprises a second cam rotatable with the first mentioned cam, and said means connecting said toggle member and said control means comprises an arm extending from said toggle member and engaging said second cam.

3. A thermally responsive switch device of the character described having housing means at least one portion of which comprises an insulator member forming one end of the housing, said insulator member supporting a movable contact arm in said housing, said insulator member also supporting a relatively fixed contact in said housing for cooperation with said movable contact arm, a snap acting mechanism in the housing including a toggle member pivoted to said insulator member for movement about a first axis between first and second positions for actuating said movable contact arm, temperature responsive power means in said housing at the other end thereof for operating said snap acting mechanism, said snap acting mechanism comprising a lever pivoted in said housing for movement about a second axis and connected to said toggle member by an over-center acting spring, said lever being movable by said temperature responsive power means for effecting snap movement of said toggle member between said first and second positions, and adjustable biasing means including a second lever pivoted to a wall of said housing for movement about an axis transverse to said second axis and urging the first mentioned lever in one direction against said power element.

4. A switch comprising first and second bell cranks mounted for movement about first and second axes respectively, each bell crank having one leg extending toward and terminating short of one leg of the other bell crank, each bell crank having its other leg extending parallel to and in the same direction as the other leg of the other bell crank to define a space therebetween, first spring means between said one leg of each bell crank for effecting snap acting movement of said first bell crank between first and second positions upon predetermined rotative movement of said second bell crank, electrical contact means operable by the other leg of said first bell

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crank upon said snap acting movements to make and break a circuit therethrough, second spring means acting on said one leg of said second bell crank for biasing thereof in one direction of rotation, thermally responsive power means acting on the other leg of said second bell crank for effecting rotation thereof in said other direction against the action of said second spring means, whereby said second bell crank is rotated and said contact means are operated in accordance with predetermined fluctuations in temperature, a cam and a lever movable by said cam, said second spring means being connected to said lever for adjustment by rotation of said cam, said cam and lever being disposed in the space between said parallel other legs of said bell cranks, and said lever

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being pivoted for rotation about an axis transverse to said second axis.

5 A switch as defined in claim 4 and wherein said second spring means is adjustable whereby said contact means are operable in accordance with different predetermined temperature fluctuations.

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