Nov. 1, 1966 J. LIEBERMANN ET AL 3,283,099

HEAT RESPONSIVE SNAP ACTING SWITCH

Filed Jan. 15, 1965 5 Sheets-Sheet 1

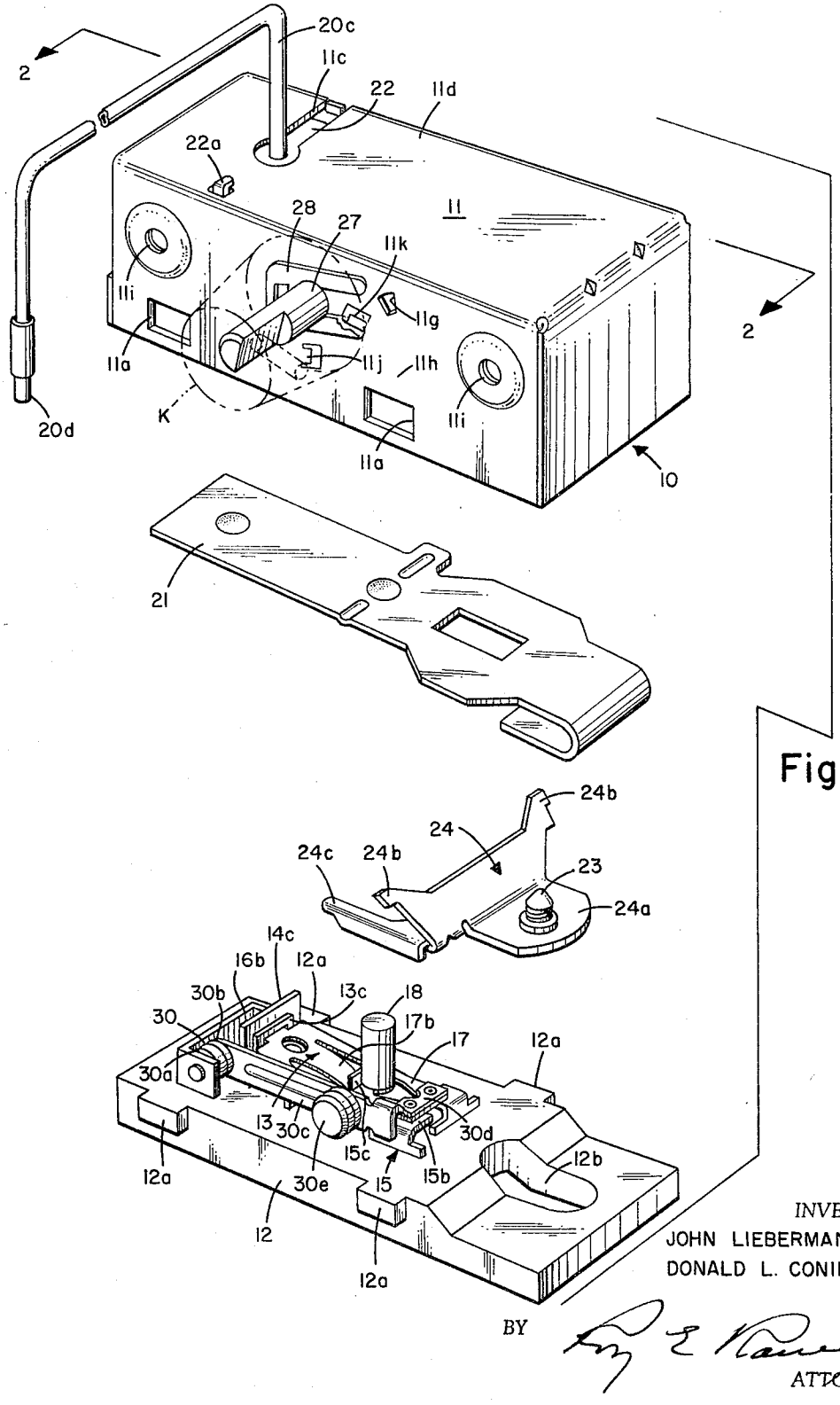


Fig. 1

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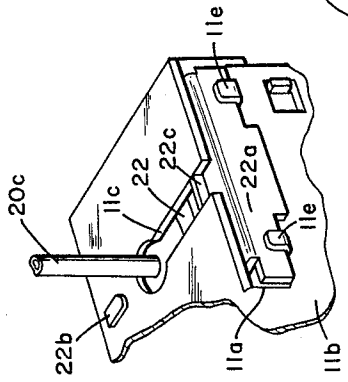


Fig. 4

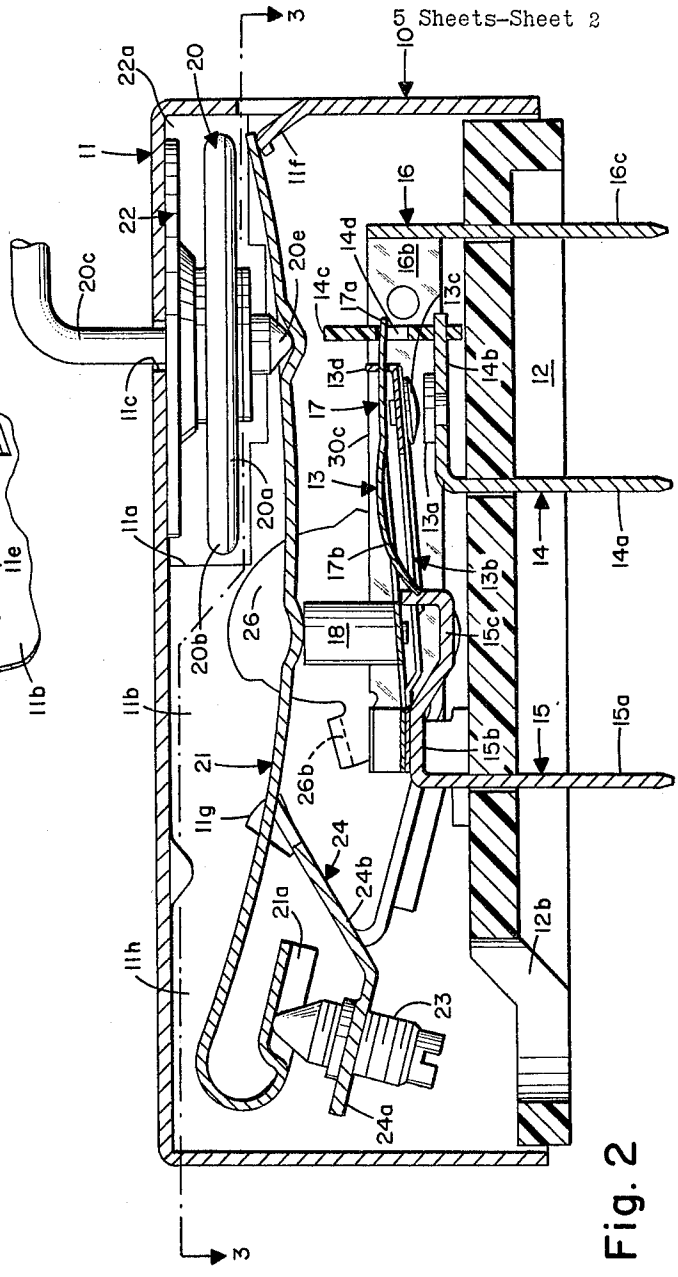


Fig. 2

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HEAT RESPONSIVE SNAP ACTING SWITCH

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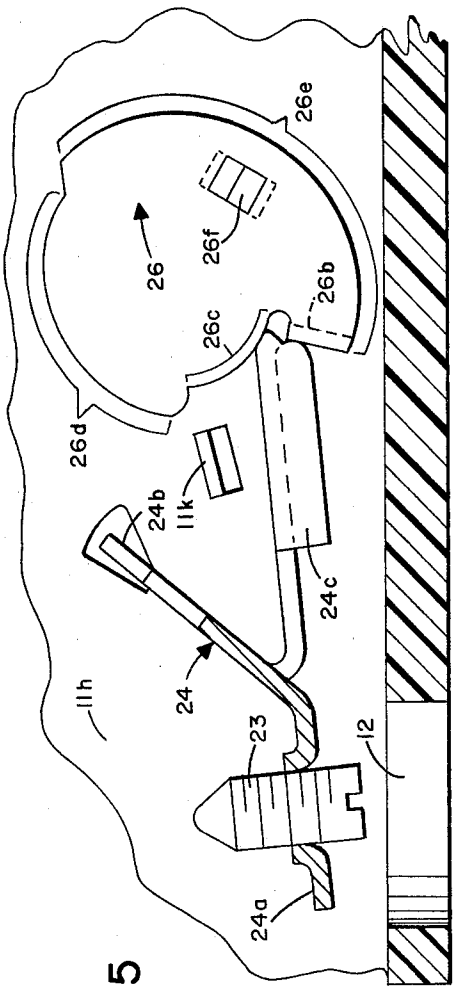


Fig. 5

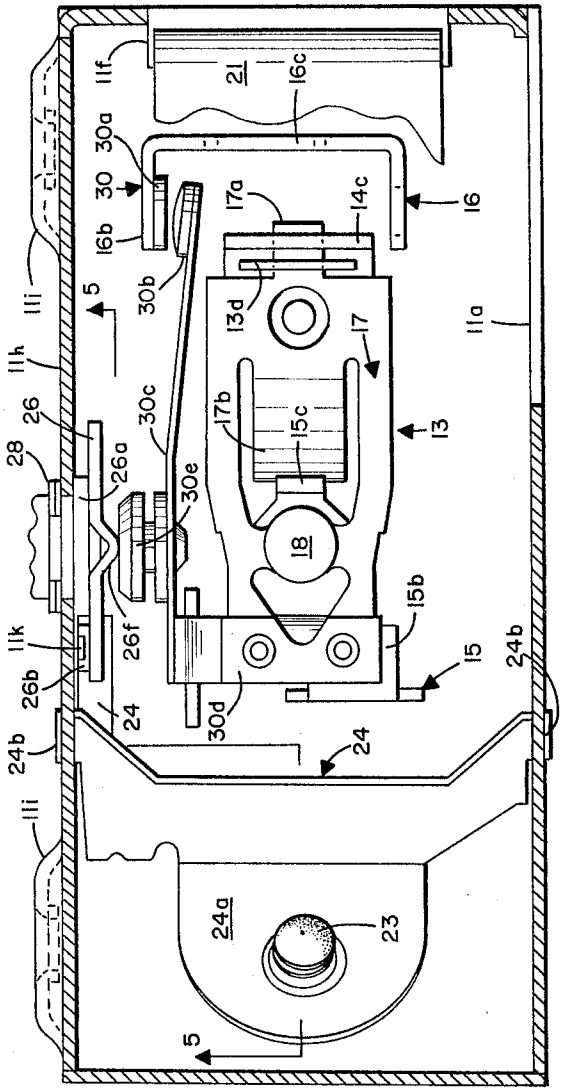


Fig. 3

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HEAT RESPONSIVE SNAP ACTING SWITCH

Filed Jan. 15, 1965 5 Sheets-Sheet 4

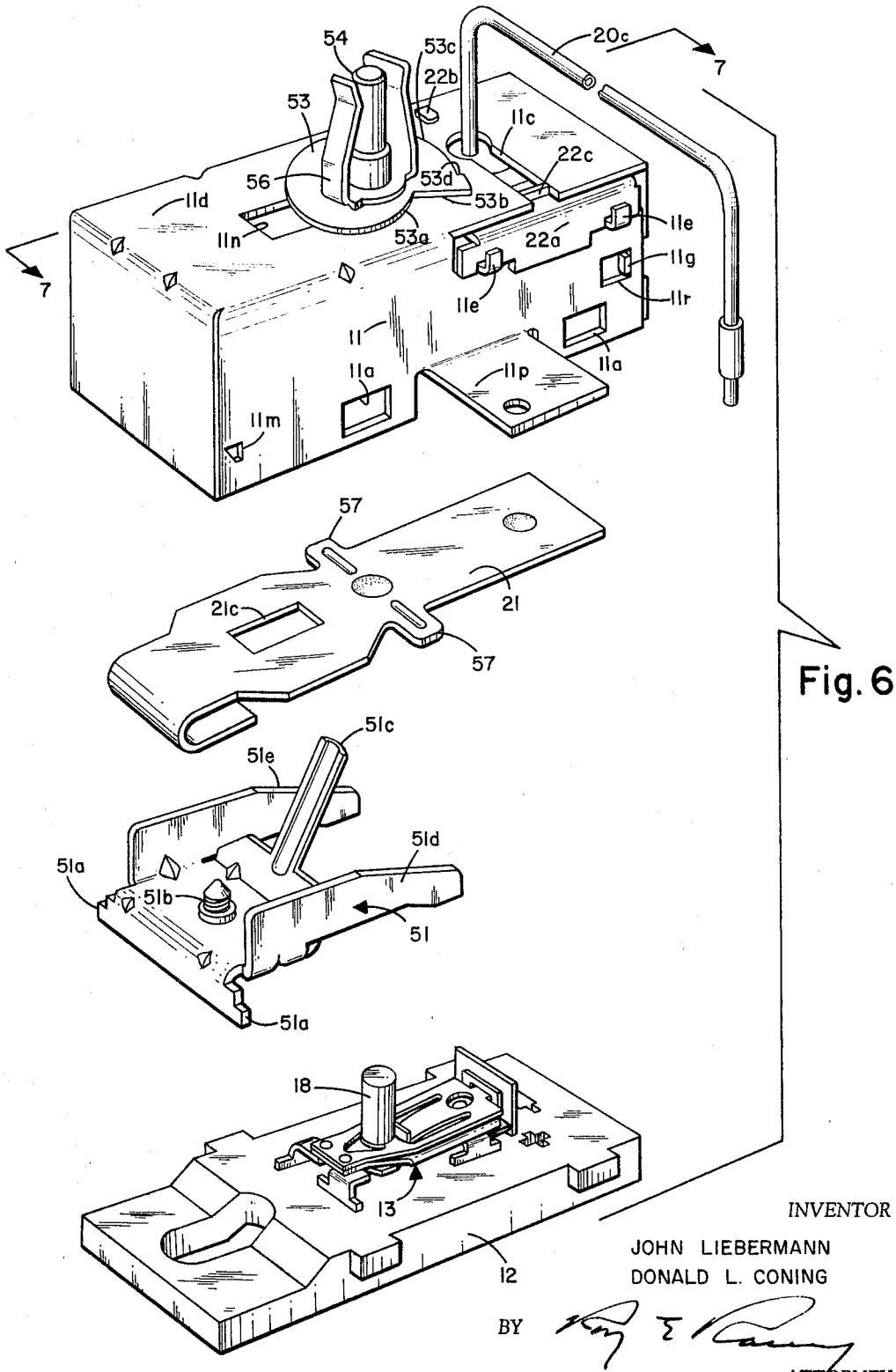


Fig. 6

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HEAT RESPONSIVE SNAP ACTING SWITCH

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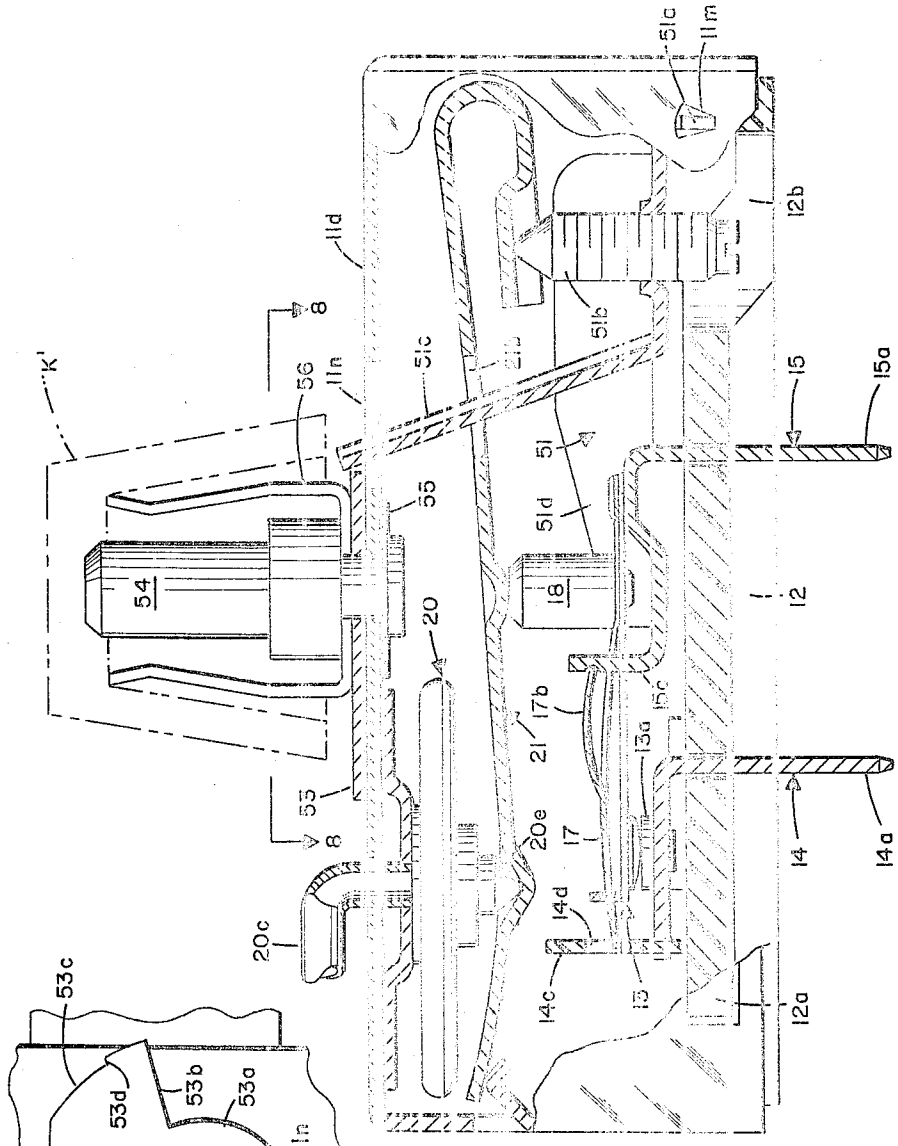


Fig. 7

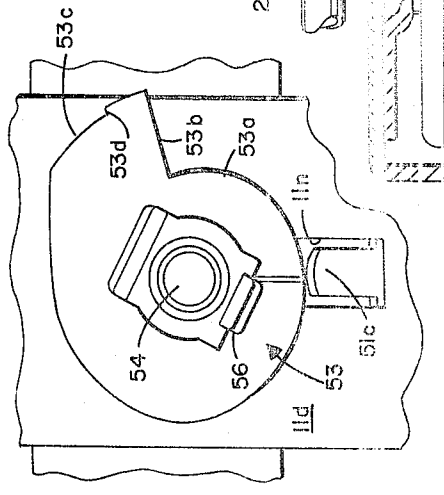


Fig. 8

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United States Patent Office

3,283,099

Patented Nov. 1, 1966

3,283,099

HEAT RESPONSIVE SNAP ACTING SWITCH

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Filed Jan. 15, 1965, Ser. No. 425,883

5 Claims. (Cl. 200—140)

The present invention relates to pressure responsive electric switching mechanisms particularly suitable for use as adjustable thermostatic control devices for air conditioning equipment and the like.

More particularly the present invention relates to an improvement in a control device for air cooling apparatus or the like comprising a housing supporting an electric switch to be connected in the circuit of the refrigerant compressor motor of the apparatus and which is actuated by an expandable power element having a temperature sensing tube connected therewith and filled with a vapor which changes in pressure according to changes in temperature. The housing is supported on a panel or the like of the air cooling apparatus and a control knob projects therefrom which the user may conventiently manipulate to set the control device to cause continual operation of the apparatus, or to adjust temperatures at which the apparatus is cyclically operated, or to turn the apparatus off, or to control the circuit of an electric fan for circulating air to be cooled through the apparatus. The invention provides a construction by which a relatively few parts, easily fabricated, are utilized to provide the control device, and by use of many common parts, different modifications of the control may be manufactured. For example, one form may have the control knob shaft projecting from the same wall of the housing as does the temperature sensing tube and in another form the control knob shaft may project from a wall of the housing which is at right angles to the wall from which the tube extends, the different forms being available for use on differently arranged air cooling apparatus.

In carrying out the invention, it is an object to provide an electric switch operated by a pressure responsive element through a single elongated resilient beam which serves to variably load the element and also to amplify movements thereof to actuate the switch, one end of the beam being pivoted adjacent the power element and the opposite end being supported on a lever which is shiftable about its pivot by a cam attached to a rotatable adjusting shaft supported in an opening in one wall of the housing and which cam is engaged by a portion of the lever extending parallel to the beam, the cam having a contour such that when it is rotated to one position the lever is shifted to alter the loading of the beam on the power element in excess of the pressures normally developed by the power element to hold the switch in one control position irrespective of normal temperatures sensed by the power element and to relieve the beam when the cam is in another position whereby the beam is prevented from moving the switch to another switch operating position, irrespective of the reduction in pressure of the power element so as to provide constant running of the apparatus. In one form of control device the beam engaging lever includes an arm arranged to engage the beam during one portion of the travel of the lever to positively actuate the switch mechanism independently of the pressures in the power element.

Other objects and advantages of the invention will be apparent from the following description of a preferred form thereof, reference being made to the accompanying drawings wherein:

FIG. 1 is an exploded view of one form of control device embodying the invention and which is particularly

suited to control operation of an air conditioning apparatus;

FIG. 2 is a sectional view of the switch shown in FIG. 1 taken substantially along lines 2—2 of FIGS. 1 and 3, certain parts being broken away;

FIG. 3 is a sectional view of the control device taken substantially along line 3—3 of FIG. 2;

FIG. 4 is a fragmentary view of the device shown in FIG. 1;

FIG. 5 is a fragmentary sectional view taken substantially along line 5—5 of FIG. 2;

FIG. 6 is an exploded view of a second form of the invention;

FIG. 7 is a sectional view taken substantially along line 7—7 of FIG. 6; and

FIG. 8 is a sectional view taken along line 8—8 of FIG. 7.

Referring to FIGS. 1 through 5, a temperature control device embodying one form of the invention is shown at 10 which is particularly suitable for controlling the operation of a conventional air conditioning or cooling apparatus, not shown, comprising an electric motor driven refrigerant compressor, a refrigerant condenser and an evaporator all connected in the usual circuit to cool air circulated over the evaporator and into the space to be cooled by an electric motor driven fan. The control device comprises a rectangular box-like housing 11 formed of sheet metal and which is open at the bottom side, as viewed in the drawings. The bottom side of the housing is closed by a base 12 formed of a panel of suitable relatively rigid molded plastic material and which is secured in place by four rectangular lugs 12*a* formed thereon which fit into corresponding openings 11*a* in the front and rear walls of housing 11, only two of which appear in the drawings, the lugs being secured in the openings by crimping the wall portions along the lower edges of the openings against the lugs as is indicated at 11*b* in FIG. 2.

A snap acting switch mechanism 13 is supported on base 12 and it may be of any suitable form; that disclosed, however, comprises three terminal members 14, 15 and 16 having blade type terminal portions 14*a*, 15*a* and 16*a* which extend through and are suitably secured in openings through the base. Terminal 14 has a bridge like section 14*b* on the inside surface of the base to which a fixed switch contact 13*a* is secured. An upstanding insulating plate 14*c* is attached to terminal portion 14*a* and has a rectangular window 14*d* therethrough forming upper and lower limiting stops for the arm of a snap mechanism described more fully hereinafter.

A flat spring type contact arm 13*b* is riveted at one end to a bridge portion 15*b* of terminal member 15, and a switch contact 13*c* is attached to the opposite end of the contact arm, which arm is inherently biased to urge contact 13*c* to engage contact 13*a*.

Contact arm 13*b* is actuated and controlled in movement by an actuator arm 17 which is formed of a flat spring strip having one end riveted to bridge portion 15*b* and overlapping the fixed end of contact arm 13*b* and the opposite end of which has a tongue 17*a* which extends loosely through an opening in an upturned tab 13*d* of contact arm 13*b* and through window 14*d*. The opening through tab 13*d* provides a lost motion connection between arms 17 and 13*b*.

Arm 17 is snap actuated between the limits formed by the upper and lower edges of window 14*d* by a toggle tongue 17*b* formed integral with the arm and the projecting end of which is pivoted in a V groove extending across the face of a cantilever abutment 15*c* projecting from the bridge portion 15*b*, the tongue being bowed to exert a spring force in the direction of the movable end of arm 17. Arm 17 is inherently biased upwardly for

overcoming the closing bias of arm 13*b* and moving that arm to separate contacts 13*a* and 13*c* to open the switch, and is moved downwardly to permit contact arm 13 to close the contacts by the depression of an insulator button 18 which is riveted to a cross member of the actuator arm. Snap movements are imparted to arm 17 by tongue 17*b* shifting its line of force from above and below a plane through the centerline of the arm as the arm moves above or below the plane of the pivot points at the end of the tongue. This snap movement is transmitted to contact arm 13 by a hammer blow action by reason of the lost motion connection between the two arms. Thus, the contacts 13*a* and 13*c* are opened and closed with a rapid, decisive movement to minimize arcing and prevent sticking of the contacts.

It will be seen that by depressing button 18, switch contacts 13*a* and 13*c* are closed and a circuit can be established through terminal 14, contacts 13*a*, 13*c*, contact arm 13*b* and terminal 15. When button 18 is released arm 17 moves upwardly with a snap action causing contacts 13*a* and 13*c* to break the aforementioned circuit with a snap movement.

Switch actuator button 18 is depressed to switch closing position by expansion of a pressure responsive power element 20 acting through a resilient beam 21. Power element 20 comprises a wafer type bellows formed of two dish shaped flexible metal discs or diaphragms 20*a* and 20*b* suitably sealed together at their edges to form an expansible chamber. Diaphragm 20*b* is brazed to a rigid base plate 22 to which one end of a capillary tube 20*c* is brazed to communicate with the interior of the bellows, and the outer end of which tube is sealed as at 20*d*. Bellows 20 secured to plate 22 is inserted into housing 11 through a rectangular opening 11*a* in the rear wall 11*b* thereof, as viewed in FIG. 1, and a slot 11*c* in the top wall 11*d* of the housing receives tube 20*c*. The opening 11*a* is closed by a flange 22*a* formed on plate 22 and which is secured to the housing by two lugs 11*e* extending from the rear wall of the housing and engaging in notches in flange 22*a*, and a tab 22*b* projecting through an opening in top wall 11*d*. A positioning lug 22*c* formed on plate 22 projects into slot 11*c*.

The bellows 20 and tube 20*c* contain a suitable vapor, such as a refrigerant well known as Freon, which expands and contracts with changes in temperature, thereby causing expansion and contraction of the bellows in accordance with temperatures at the tube. Preferably, the tube is located in a position which is normally cooler than the temperature at the bellows so that the pressure inside the bellows corresponds to the temperature of the tube. The vapor content of the power element is limited so that it will be completely vaporized at a temperature slightly above the desired range of operation of the control device so that excessive pressures will never develop in the bellows.

Expansion and contraction of bellows 20 is transmitted to switch actuator arm 17 through a resilient beam 21 against which button 18 rests, the movable wall 20*a* of the bellows having a rigid pointed stud 20*e* thereon which engages in the apex of a dimple formed in the beam to minimize friction between the engaging parts. Beam 21 comprises a strip of flat spring metal, one end of which rests on a abutment 11*f* formed by striking inwardly a portion of an end wall of housing 11 and the opposite end of the beam rests on a positionable support, described more fully hereinafter so that the spring beam urges the bellows toward a collapsed position whereby movement of button 18 to operate switch 13 occurs when pressures inside the bellows correspond to the temperatures desired to be maintained by the air conditioner controlled by the switch, which is well understood by those familiar with the art.

Beam 21 has a rectangular opening 21*a* therethrough which is provided in the event the lever is to be used in a modified form of control apparatus described hereinafter and has a lug 57 formed thereon for a like purpose, as appears hereinafter. The left hand end of beam 21 has a reverse curve formed therein and the under surface of the turned end portion has a V groove 21*a* formed therein which receives the pointed end of a screw 23 threaded through an opening in the yoke 24*a* of a U shaped lever 24. The ends of the two legs 24*b* of lever 24 are pivoted in bearings formed by edges of wedge shaped openings 11*g* in the opposite side walls of housing 11 so that the lever can be rotated about these pivots to shift the end of the beam 21 and either increase or decrease the load on bellows 20 as the case may be. The control mechanism can be calibrated by adjustment of screw 23 by a tool inserted through an opening 12*b* through base 12.

Lever 24 is positioned about its pivot by a cam 26 which is engaged by an arm 24*c* formed on the lever and which is maintained against the cam by the reaction of beam 21 of the lever.

In the form of the control shown in FIGS. 1–5, cam 26 is mounted on a shaft 27 which is rotatably supported in the front wall 11*h* of housing 11 and is adapted to have an adjusting knob attached thereto in a position on the air conditioner apparatus convenient to the user. The housing can be attached to a panel on the air conditioner by screws, not shown, extended through the panel and threaded into openings in embossments 11*i*. Cam 26 includes a hub 26*a* to which shaft 27 is attached, and the shaft projects through an opening in wall 11*h* which is smaller than the hub, and a flat U shaped spring 28 received in a groove about the shaft at the outside of wall 11*h* holds the hub to the wall of the housing and retains the shaft in the openings.

Cam 26 is limited in counterclockwise movement, as viewed in FIG. 1, by a stop lug 26*b* formed thereon and which engages a tab 11*j* struck inwardly from the front wall of the housing, and rotation of the cam in the opposite direction is limited by lug 26*b* striking a tab 11*k* struck inwardly from the front wall of the housing.

Cam 26 has three distinct peripheral sections at different distances from the axis thereof which rock lever 24 about its pivots to vary the deflection of beam 21. When lever 26*c* of cam 26 is positioned to be engaged by arm 24*c* of lever 24 the lever is positioned to cause the greatest relaxation of pressure on beam 21 and switch 12 will be closed at relatively low temperatures, generally below that capable of attainment by the air conditioner controlled so that in effect, this position of the cam effects constant running of the air conditioner. The segment 26*d* of the cam has a gradually sloping radius and when engaged by arm 24*c* lever 24 is pivoted to produce variations in flexure of beam 21 so as to provide a control range of normal operating temperatures of the air conditioner.

When section 26*e* of cam 26 is engaged by arm 24*c* of lever 24, the lever is tilted to apply sufficient force against beam 21 and element 20 to prevent the element from expanding to close switch 13 and, in effect, provides an off control position of the control switch. It will be seen that by transmitting the movement of the power element 20 to switch 13 through loading beam 21 and controlling the beam through lever 24 as described, an exceedingly simple structure is effective to provide in a single control knob the capability of setting the air conditioner for constant running, a cycling temperature control range, and an off position.

By forming the reverse bend in beam 21 for engaging screw 23, the effective length of the lever is greater than the longitudinal dimension of the control to provide a proper spring rate for loading the bellows to produce the range of operations desired.

Control device 10 also provides an auxiliary switch 30 for controlling a fan circuit, not shown, for circulating air through the air conditioner, and the operation of the auxiliary switch is also controlled by cam 26.

Fan switch **30** comprises a fixed contact **30***a* attached to one leg **16***b* of a U-shaped bracket **16***c* formed on the upper end of terminal member **16** and which extends across base **11** spaced from the switch mechanism **13**. Contact **30***a* is engaged by a movable contact **30***b* attached to the end of a flat spring contact arm **30***c* lying in a plane parallel to the side walls of housing **11** and having an integral laterally extending base strip **30***d* riveted to bridge portion **15***b* and overlying actuator arm **17**. Arm **30***c* is normally biased to close contacts **30***a* and **30***b* and is moved laterally to open the contacts by a raised portion **26***f* on cam **26** engaging an insulator button **30***e* secured to contact arm **30***c* and positioned to be engaged by the cam rise when the cam is rotated to the switch "off" end of its limit. Rise **26***f* and button **30***e* are located and dimensioned so that contact arm **30***c* remains in the switch closed position when arm **24***c* of lever **24** initially engages segment **26***c* of the cam, which effects opening of switch **13** and in this position of the knob K and cam **26** the fan is operated although the air conditioner compressor motor circuit is open through switch **13**. Both the air conditioner and fan circuits can be opened by movement of the cam to bring rise **26***f* against button **30***e*.

Another form of air conditioner control embodying the invention is shown at **50** in FIGS. 6 to 8 in which the axis of the control knob K' is normal to the top wall of the housing, yet the principal parts of the control are like or basically like those described with reference to control **10** and such parts bear the same reference characters.

Control **50** comprises a housing **11** including a base **12** supporting a snap switch **13** which is actuated by a power element **20** through a beam **21**, all as described with reference to control **10**. The principal differences in the control structures lies in the arrangement by which beam **21** is deflected to provide various control functions and in the mounting means, which in control **50** includes a laterally projecting tab **11***p* having an opening therethrough, through which a mounting bolt may be located. Furthermore, the view of control **50** discloses a tab **11***q* which is formed on an end wall of the housing and locks the end wall to the side wall by extending into an opening **11***r*.

The reversed end portion of beam **21** of control **50** is deflected by a lever **51** which is U shaped and has laterally extending pivot tabs **51***a* projecting from opposite sides of the yoke thereof and which are pivoted in wedge shaped bearing openings **11***m* in the side wall of housing **11**. Screw **51***b* is threaded through the yoke and engages beam **21** in the same manner as described relative to control device **10**. Lever **51** is positioned about its pivot by a cam **53** which is located on the top side of wall **11***d* and is attached to a shaft **54** having an end extending through an opening in the top wall of housing **13** and secured in place by a flat U spring **55** having the legs thereof received in a groove around the shaft adjacent the end on the inner side of upper wall **11***d*. Cam **53** is attached to the shaft on the outside of the top wall **11***d* and is secured in place by a clip **56** which is adapted to receive a knob K'.

Lever **51** has an arm **51***c* which projects through an opening **21***b* in beam **21** and through a rectangular opening **11***n* in the top wall **11***d* of the housing and engages and follows the periphery of cam **53** by reason of the reaction of beam **21** against the lever. Rotation of cam **53** causes lever **51** to rotate about is pivots **51***a*, **51***b* one way or the other and to deflect beam **21** to vary the loading on power element **20**. Lever **51** also has parallel side arms **51***d*, **51***e* which rise and engage the underside of beam **21** as the lever is rotated to its extreme clockwise position, as is explained more fully hereinafter.

Cam **53** is shaped generally in the form of a helix, having a relatively short radius at **53***a* adjacent a radially extending shoulder **53***b*, and a high plateau **53***c* terminating in a radially extending shoulder **53***d*. The rotation of cam **53** is limited by shoulders **53***b* and **53***d* abutting opposite sides of arm **51***c* when the cam is rotated in opposite directions. When cam **53** is rotated to engage shoulder **53***d* against arm **51***c*, lever **51** is moved clockwise about pivots **51***a*, as viewed in FIG. 7, which applies a maximum of force through beam **21** countering the expansion of bellows **20**, and arms **51***d* and **51***e* engage the undersides of laterally projecting side lugs **57** on the central portion of the beam and on opposite sides of stud **20***e* of power element **20**, which arms force the beam and bellows to a position in which switch **13** is held open irrespective of pressures developed in the power element, which pressure will not become excessive due to the limited fill of the power element.

As cam **53** is rotated to move stop shoulder **53***b* toward arm **51***c* lever **51** is rotated counterclockwise and acting through screw **51***b* on beam **21** decreases the loading effect of the beam on the power element, thereby lowering the temperatures at which switch **13** is operated. When portion **53***a* of the cam is engaged by arm **51***c* the pressures required in the power element or bellows **20** to close the switch are well below temperatures which would normally occur at tube **20***c*, and therefore the switch is effectively set in its off position.

Control device **50** does not have an auxiliary fan control switch.

It will be seen that by my invention, control devices may be provided formed of a relatively few simple parts, easily assembled and which provide a wide range of adjustment and setting for controlling the operation of an air conditioning system or the like to provide both manual and thermostatic operations. It will be understood that other modifications, and adaptations may be made, all falling within the scope of the claims which follow.

We claim:

1. A pressure responsive control device comprising:
(a) a housing;
(b) an electric switch in said housing including a movable actuating member;
(c) a vapor filled expansible power element;
(d) means interconnecting said power element and said switch actuator comprising a generally flat spring strip having one end supported by said housing at one end of said housing and adjacent to said power element and the intermediate portion thereof engaging said actuator, the other end of said spring having a reversely curved portion adjacent the end of said housing opposite said one end thereof;
(e) a lever pivoted to an intermediate portion of said housing and having a swingable end extending adjacent to said reversely curved end of said spring;
(f) a thrust member carried by said swingable end of said lever and engaging the reversed portion of said spring;
(g) an arm connected to said lever; and
(h) manually operable means rotatably supported by said housing and engaging said arm for swinging said arm to shift said spring.

2. A pressure responsive control device comprising:
(a) a rectangular box-like housing, one wall of said housing being formed by an insulating block;
(b) an electric switch supported on said block, said switch including a movable switch operating member centrally disposed in said housing;
(c) an expansible power element supported on the wall of said housing opposite said insulating block and adjacent one end thereof;
(d) a generally flat spring member extending from one end of said housing to the other and engaging said power element adjacent one end thereof and said switch operating member adjacent the central portion thereof, the other end of said spring having a reversely extended portion;

(e) means on an end wall of said housing adjacent said power element forming an abutment for supporting an end of said spring in engagement in the said power element;

(f) a U shape lever in said housing having the ends of the legs thereof pivotally supported in opposite side walls of said housing and having the yoke portion thereof extending in a direction transversely of said spring;

(g) a screw threaded through said yoke portion and engaging said reversely extended portion of said spring;

(h) an arm extending rigidly from said lever; and

(i) a cam rotatably supported on a wall of said housing and engaged by said arm and operative to move said lever about its pivot and cause said lever to flex said spring.

3. A pressure responsive control device as defined in claim 2 in which said cam comprises a flat disc supported parallel to and adjacent an inside wall of said housing and said periphery is engaged by said arm extending from said yoke.

4. A pressure responsive control device as defined in claim 2 in which said cam comprises a flat disc supported on the outside of the top wall of said housing and parallel to and adjacent said top wall, said arm projecting from the central portion of said yoke of said lever through aligned openings through said spring and said top wall.

5. A pressure responsive control device as defined in claim 4 in which said lever has a second arm rigidly attached thereto extending generally parallel to said spring when said cam is in one position and positions to engage and move said spring to a given switch operating position when said cam is set in another position.

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