May 14, 1957 E. C. RANEY 2,792,466

CONTROL APPARATUS

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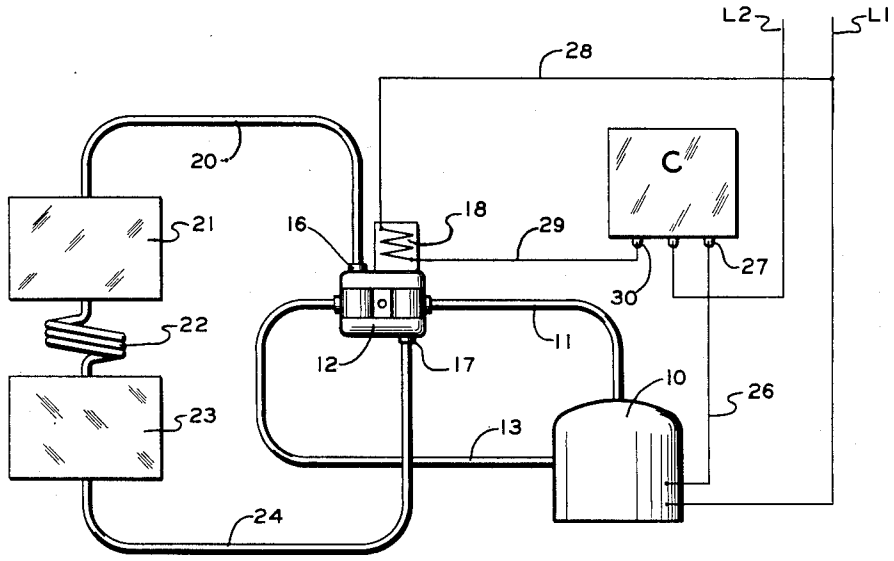


FIG. 1

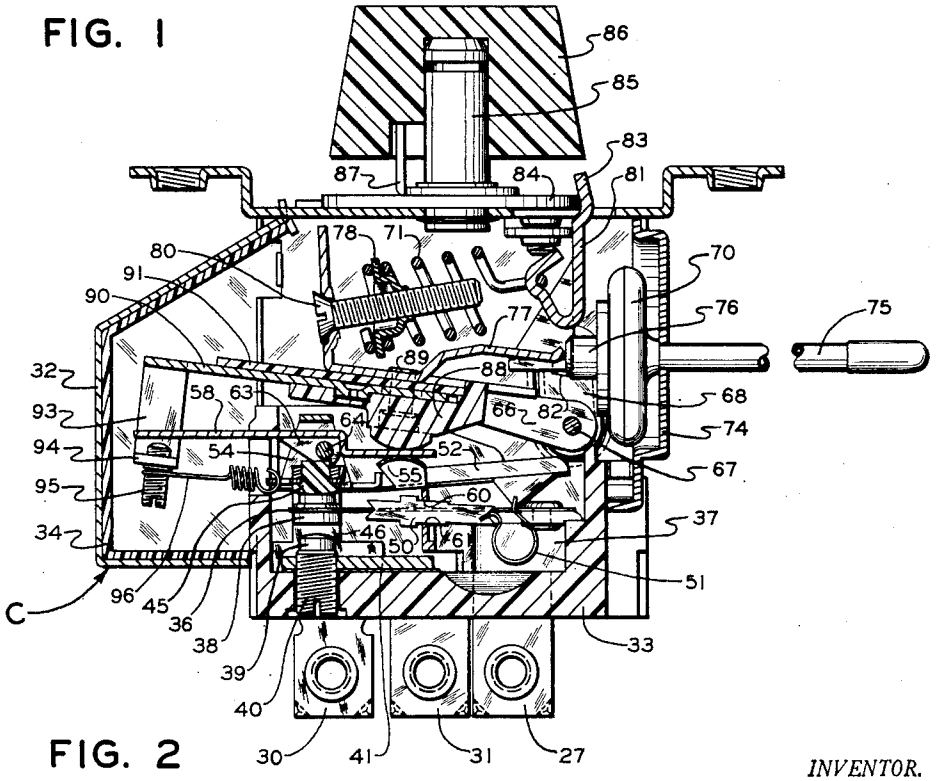


FIG. 2

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FIG. 3

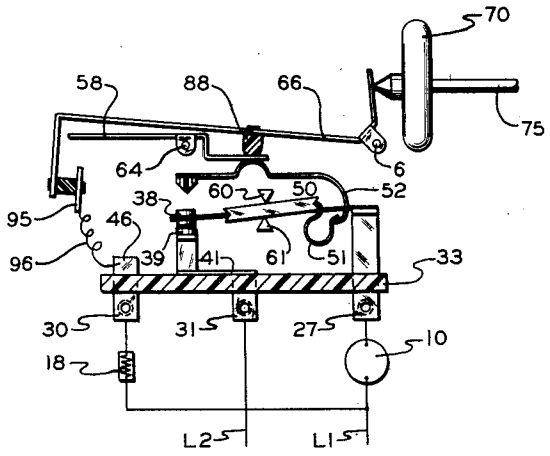


FIG. 4

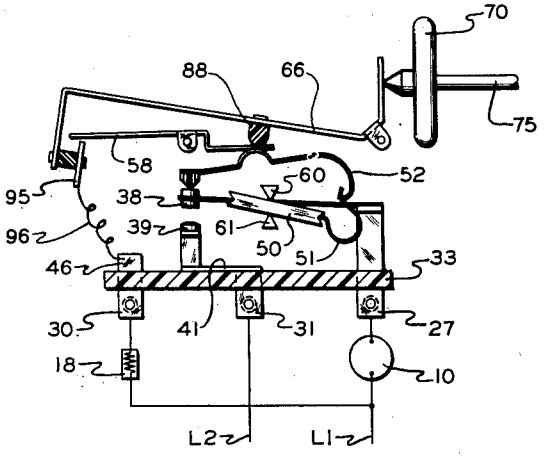
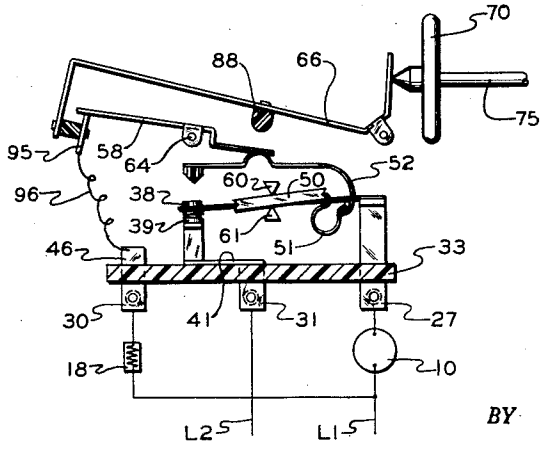


FIG. 5



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CONTROL APPARATUS

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4 Claims. (Cl. 200—67)

It has been proposed to selectively heat or cool a space by operation of an electrically driven compressor-condenser-expander type refrigerating system having electrically actuated means, such as a solenoid operated reversing valve, to reverse the order of flow of refrigerant through two heat exchangers both capable of operating as an evaporator so that during one phase of operation of the system one of the heat exchangers serves as an evaporator to chill air in the space to be tempered, and during the other phase of operation of the system the exchanger then serves as a condenser to heat air in the space. The present invention relates to an improved thermostatic control apparatus for automatically controlling the operation of both the electrically driven compressor and the refrigerant flow reversing means so that during the time predetermined relatively high temperatures prevail in the space the compressor is operated and the refrigerant is circulated in one direction through the exchangers to provide cooling, and during relatively cool periods when the temperature of the space is below a predetermined temperature the compressor is operated and the refrigerant circulated in the opposite direction through the exchangers to provide heat for the space.

The present invention is directed to a control mechanism comprising a single thermal responsive device which operates a switch mechanism to provide automatic operation of the system for either heating or cooling, as required to maintain predetermined temperatures.

An object of the present invention is to provide an improved control apparatus for heating and cooling systems of the type mentioned comprising an electric switch adapted to control operation of the compressor, a temperature responsive switch actuator movable in opposite directions through a given range in response to increases and decreases in the temperature to be controlled, and when oscillated adjacent to one end of its range being operable to directly actuate the switch between open and closed positions and operable through a reverse acting lever when oscillated adjacent to the other end of its range of movement to likewise actuate the switch, the actuator also being operative to actuate a second switch in moving toward one extremity of its range of movement, which second switch is adapted to control operation of the refrigerant flow directing means. The improved control apparatus thus provides a relatively simple, inexpensive, automatic, yet highly reliable control for systems of the type referred to.

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

Fig. 1 is a schematic view of a reverse cycle heating and cooling system embodying the invention for affecting the temperature in a room;

Fig. 2 is a sectional view of a control apparatus embodying the invention for controlling the heating and cooling system shown in Fig. 1;

Figs. 3, 4 and 5 are schematic views of the control apparatus showing certain members thereof in different control positions.

In the form shown, the invention is employed to control the operation of a well known type of reverse cycle heating and cooling system for a space, such as a room, comprising an electric motor driven refrigerant compressor 10, having its high pressure refrigerant discharge connected by a tube 11 to the inlet of a reversing valve mechanism 12 and its low pressure inlet connected by a tube 13 with the outlet of the reversing valve. The reversing valve 12 may be of any suitable construction such that the direction of flow through ports 16, 17 thereof is reversed by energization of a solenoid 18. The port 16 is connected by a tube 20 to a heat exchanger 21, which may serve either as a refrigerant condenser or as an evaporator. The exchanger 21 is connected by a capillary tube 22 to a similar type heat exchanger 23 so that liquid refrigerant condensed in either exchanger may flow into the other exchanger and evaporate therein, as is well known in the art. The exchanger 23 is connected by tube 24 to the port 17 of the valve. In practice, the exchanger 23 is arranged to have air blown in heat exchange relation therewith and into the room to be temperature conditioned, and the exchanger 21 is arranged to have a heat exchange medium passed in heat exchange therewith to carry away heat of condensation of refrigerant or to supply heat for evaporation of refrigerant according to the particular function of the exchanger at any given time. Since reverse-cycle systems for room air conditioning are well known in the art, the details are not shown.

The power for operating the compressor 10 and solenoid 16 is furnished by lines L1, L2, which may be usually commercial 115 v. A. C. lines. One side of the compressor motor 19 is connected to L1 and the other side is connected by wire 26 to a terminal 27 of a control apparatus C, the details of which are described hereinafter.

One side of the solenoid 18 is connected to L1 by wire 28 and the other side is connected by wire 29 to a second terminal 30 of the control apparatus. Line L2 is connected to a third terminal 31 of the control apparatus. The control apparatus is responsive to air temperature corresponding to that of the room to be conditioned, and is operative to automatically energize the solenoid 18 and the compressor 10 when heating is required, but energizes the compressor only when cooling is required, as is explained in detail hereinafter.

Referring to Fig. 2, the control apparatus C is shown in detail, and it comprises a suitable sheet metal housing 32, including a mounting bracket, to attach the control to a panel, not shown, and having an open side, box-like switch base 33, which is preferably formed of a molded plastic, such as Bakelite, attached in an opening in the wall 34 of the housing. A single pole, single throw, snap acting switch is located in the base 33, and while the switch may be of any suitable construction, to illustrate the invention it is shown comprising a U-shape, flat spring arm 36 having its open ends secured to a terminal bracket 37 embedded or otherwise attached in the bottom wall of the base and which includes the terminal 27. The opposite end of the arm 36 has a contact 38 thereon which is arranged to engage a contact 39 when the arm is deflected downwardly, as viewed in the drawings. The contact 39 is fixed to the end of a screw 40 threaded in a terminal bracket 41 having a portion lying flat on the bottom wall of the base 33 and including the terminal post 31 which extends through and beyond the bottom wall of the base, as shown. The upward movement of the arm 36 is limited by a stop 45 formed by an insulator attached to a terminal bracket 46 which has the terminal

post 30 formed thereon which extends below the base wall, as shown, and a laterally projecting upper end portion which overhangs the end of the arm 36 and to which portion the insulator stop is attached.

The arm 36 is adapted to be snap moved between stop 45 and contact 39 by a link 50 and C-shape spring 51 which are actuated by an operating lever 52. The link is pivoted at one end to the yoke portion of the arm 36 and the other end thereof is pivotally connected to one end of the spring 51. The other end of the spring is pivoted to the operating lever 52, as shown. The operating lever 52 comprises an A-shape flat spring member having its open end attached to brackets 54 at opposite sides of the base, only one of which is shown. The cross bar 55 of the operating lever has a raised part which forms an abutment against which a power lever 58 engages to deflect the operating lever. The operating lever 52 has an inherent upward bias so that it moves to the switch opening position as shown in Figs. 2, 4 when the power lever 58 moves upwardly. The toggle link 50 is positioned between spaced stops 60, 61 and alternately pivots about the stops as the operating lever 52 moves the spring 51 from one side to the other of a line through the pivots of the spring and toggle link whereby the spring force acts through the link to snap the arm 36 to the contact closed and open positions.

The power lever 58 has two lugs 63 formed at opposite sides thereof, only one of which appears in the drawings, and these lugs are pivoted on a pin 64 supported in the brackets 54 to provide the fulcrum for the lever.

The power lever 58 is moved clockwise by a bellows lever 66 which is pivoted on a pin 67 supported in openings through embossed portions 68 formed in opposite side walls of the housing (only one embossed portion appearing in the drawings) and which is rocked in opposite directions about its pivot by the expansion of a bellows or diaphragm 70 and a range spring 71 which is attached to the bellows lever to oppose the expansion of the bellows.

The bellows or diaphragm 70 comprises a conventional type thermally responsive element comprised of two dish-shape flexible metal walls hermetically joined about the edges to form an expansible chamber and having a suitable fluid contained therein which causes expansion and contraction of the flexible walls thereof upon increases and decreases in temperature, as is well known in the art. The diaphragm 70 is supported in a casing 74 which is attached to an end wall of the housing 32, and includes a tube 75, which may be coiled and located in an air stream representative of the room temperature, as is well understood in the art. A post 76 is attached to the outer flexible wall of the diaphragm and engages the end of a leg 77 formed on the bellows lever.

One end portion of the range spring 71 is threaded on a plate 78 which is in turn threaded on an adjusting screw 80 rotatably supported in an opening in the outer end portion of the bellows lever, which portion is turned upwardly as shown in Fig. 2. The opposite end of the spring 71 is attached to a hook formed on a sheet metal adjusting lever 81 which has reinforcing sides, only one of which can be seen, and two laterally projecting lugs which engage in openings 82 in the embossed portions 68. The pivoting lugs are not shown since such pivoting arrangements are well known. The movable end of the adjusting lever has a finger 83 which projects through an opening in the top wall of the housing 32 and rides on an adjusting cam 84 rotatably supported on the housing wall by a spindle 85. The cam is attached to an adjusting knob 86 through a key 87 formed thereon which projects into a recess in the knob. The cam 84 is shaped to swing the adjusting lever 81 as it is rotated by the knob 86 and thereby vary the tension of the range spring 71 on the bellows lever 66. Thus, the temperatures at which the diaphragm 70 is operative to actuate the bellows lever and operate the switch mechanism, as described more fully hereinafter, can be adjusted by the knob. Any other suitable alternative means for adjusting the operation of the thermally responsive element can be employed.

The bellows lever 66 has a button member 88 formed of molded electrical insulation attached thereto by two rivets 89, only one of which appears in the drawing, and the button engages the power lever 58 directly opposite the raised part 55 of the switch operating lever 52 and moves the latter to actuate the switch mechanism to its closed position when the bellows lever is moved counterclockwise to a predetermined position by expansion of the bellows, as is illustrated in Fig. 3.

The bellows lever 66 is adapted to also actuate the switch mechanism to its closed position by clockwise movement, due to collapse of the diaphragm 70, through the lever 58 which is rotated clockwise by the lever 66 picking up the left-hand end of lever 58. This is effected by providing a bracket 90 on the outer end of the bellows lever 66 which is supported between insulator members 88 and 91. The rivets 89 project through bosses on the member 88 which, in turn, extend through openings in the bracket 90 so that the bracket is held firmly to the lever 86 and is electrically isolated therefrom.

The bracket 90 has an L-shaped outer end 93 including a foot 94 which has a screw 95 threaded therein which engages the underside of the lever 58 when the lever 86 is moved clockwise to a predetermined position. The screw 95 provides an adjustable engagement between the levers 86 and 58 and also provides an electrical contact in a circuit which includes terminal bracket 46, a pig-tail connector wire 96 attached at one end to screw 95 and having the other end attached to the terminal bracket, as shown.

It will be seen that the switching mechanism is actuated to its closed position when the diaphragm 70 is expanded, as shown in Fig. 3, due to an increase to a predetermined temperature at the bulb 75, and is opened as the diaphragm commences to collapse due to a decrease in room temperature, as shown in Figs. 2 and 4, and is then reclosed as the temperature at the bulb decreases to a predetermined low, as shown in Fig. 5. Furthermore, it is to be noted that electrical contact is made between the lever 58 and the screw 95 just prior to closing of the switch contacts 38, 39 during the collapse of the diaphragm so that the circuit through the screw is made and broken by the snap switch.

The operation of the control apparatus is as follows: Assuming that the weather is warm, as the temperature at the bulb 75 approaches 80° F., for example, the expansion of the diaphragm or bellows 70 moves the lever 66 counterclockwise which lowers the operating lever 52 until at 80° F. the switch arm 36 is snapped downwardly by the spring 51 and toggle 50 passing dead center, as described previously, thereby completing the compressor circuit from L1, compressor motor, wire 26, terminal 37, switch arm 36, contacts 38, 39, terminal 41, to L2. The position of the various parts of the control apparatus at this point is illustrated in Fig. 3. The system is then operative to furnish cool air to the room, and as the temperature decreases, the diaphragm 70 tends to collapse and permit lever 66 to move clockwise until the contacts 38, 39 are opened by reverse movement of the switch arm 36 as described previously.

As the room temperature falls to say 73° F., the diaphragm 70 collapses to the point at which clockwise movement of lever 66 causes screw 95 to engage the left hand end of lever 58 and tilt the latter clockwise, thereby depressing the switch actuator 52 to cause contacts 38, 39 to be closed, as seen in Fig. 5. This action not only energizes the compressor 10 by closing contacts 38, 39 as described with reference to the cooling cycle of the system, but also energizes the solenoid 18 to cause the valve 12 to reverse the order of flow of refrigerant through the heat exchangers 21, 23 to produce a heating cycle. The circuit for the solenoid 18 is established from

line L1, through wire 28 to one terminal of the solenoid, wire 29 to terminal member 46, wire 96 to screw 95, lever 58, lever 52, spring 51, toggle link 50, switch arm 36, contacts 38, 39, terminal member 41, to L2. As the room temperature increases, the diaphragm 70 expands and moves the lever 66 counterclockwise which permits similar rotation of the lever 58 so that the switch mechanism will open contacts 38, 39 and terminate operation of the system.

As is well understood in the art, by increasing or decreasing the tension of the spring 71 by turning the knob 56, the pressures of the fluid within the diaphragm 70 required to operate the switch mechanism, and consequently the temperatures of operation, can be adjusted as desired.

It will be seen that the diaphragm 70 acting through lever 66 has a range of movement corresponding to the temperature range desired to be maintained in the room and that the invention provides a relatively simple switch mechanism operated by reversing movements of the diaphragm adjacent to opposite ends of its range of movement to open and close the switch to energize and deenergize the compressor to provide heating or cooling cycles. Thus, the control apparatus for the reverse cycle system is relatively inexpensive and yet reliable and accurate in operation.

While but one form of the invention has been disclosed, it is to be understood that other forms, adapations and modifications may be adopted without departing from the invention defined in the claims which follow.

I claim:

1. Control apparatus comprising an electric switch mechanism including a contact member movable between two circuit controlling positions, a lever, a pivot for said lever, said lever being rotatable about its pivot in one direction to actuate said switch mechanism to cause said contact member to be moved from one controlling position to the other, and an actuator movable through a given range in opposite directions and operative when moved adjacent to one extremity of its range of movement to actuate said switch mechanism to cause said contact member to be moved from said one controlling position to the other and operative when moved adjacent to the other extremity of its range of movement to rotate said lever about its pivot in the first mentioned direction to actuate said switch mechanism to cause said contact member to be moved from said one controlling position to the other.

2. Control apparatus as defined in claim 1 including second electric switch mechanism operated by the movement of said actuator to rotate said lever in said one direction.

3. Control apparatus as defined in claim 1 in which said pivot is positioned intermediate the ends of said lever and a portion of said lever at one side of said pivot engages said switch mechanism for actuation thereof, as set forth, and a portion of said lever at the opposite side of said pivot is engaged by said actuator when said actuator moves in said opposite direction to actuate said switch mechanism.

4. Control apparatus as defined in claim 3 comprising a switch contact carried by said actuator and engaging said lever to form an electrical connection therewith when said actautor moves said lever in said one direction about said pivot.

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