Sept. 8, 1953 C. W. COBLENTZ 2,651,691

CONTROL DEVICE FOR REFRIGERATION SYSTEM

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Fig. 1.

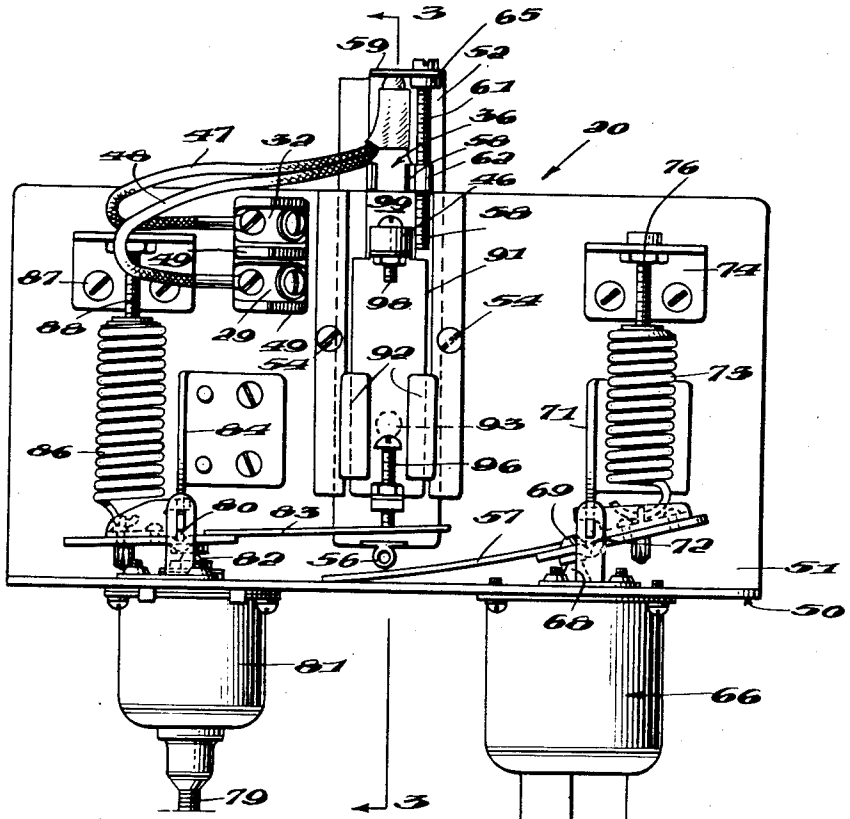
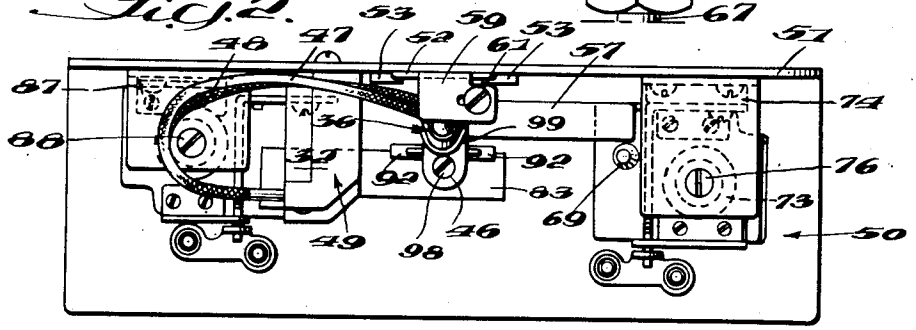


Fig. 2.



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Fig. 3.

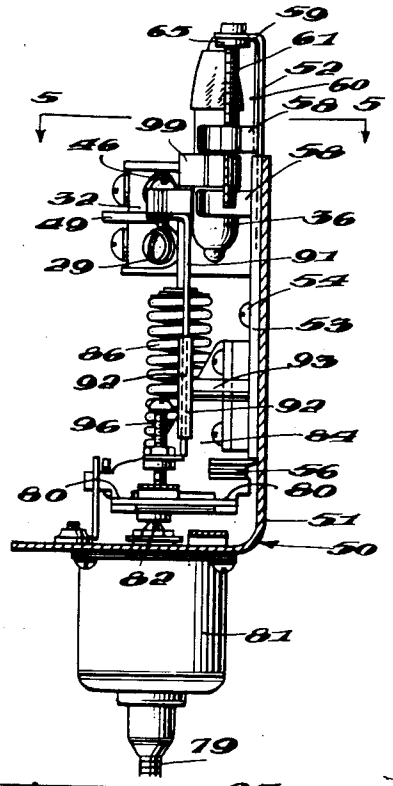


Fig. 4.

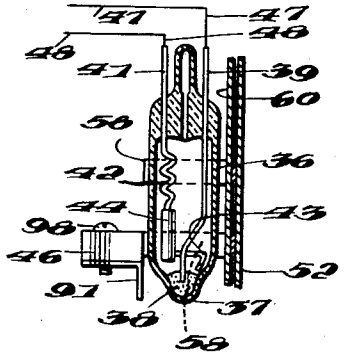


Fig. 5.

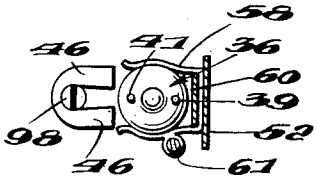
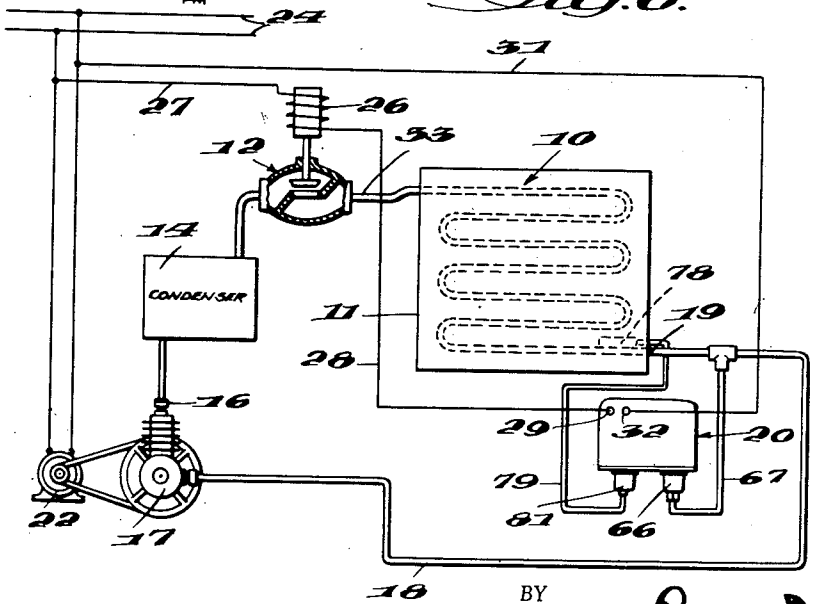


Fig. 6.



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CONTROL DEVICE FOR REFRIGERATION SYSTEM

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8 Claims. (Cl. 200—83)

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The present invention relates to means for controlling the operation of a refrigeration system and more particularly pertains to a relay assembly responsive to changes in temperature and pressure for controlling the supply of the refrigerant in the liquid state to the evaporator of such a system.

In a mechanical refrigeration system, the absorption of heat attendant upon a change of state of the refrigerant from liquid to gaseous is utilized for removing heat from a space or room to be cooled. The vaporization of the liquid refrigerant is accomplished by conducting it to a space where the pressure is low. This low pressure reduces the boiling point temperature of the refrigerant and the liquid is vaporized and heat is absorbed in the process. After evaporation, the vapor or gas is guided to a compressor where the gaseous refrigerant is placed under pressure. The compressed gaseous refrigerant is then conducted to a condenser where the gas is cooled below its condensation point and reverts to a liquid. The liquid refrigerant is fed from the condenser to the evaporator at intermittent intervals as required.

One of the factors determining the degree of refrigeration is the rate at which the liquid refrigerant is passed to the evaporator. The control of the movement of the refrigerant to the evaporator is often accomplished by an expansion valve operated automatically in accordance with the pressure differentials on opposite sides of the expansion valve. The automatic control of the valve is made responsive to predetermined conditions such as the temperature of the space being cooled and the pressure or temperature of the refrigerant at a particular part of the refrigerating system, or a combination of such factors. The known arrangements for automatic control of such an expansion valve are complex, and accordingly subject to unreliable operation.

In carrying out the invention, an electromagnetically actuated valve is employed to control the movement of the liquid refrigerant to the evaporator, and the present invention provides improvements in the means for controlling the energization of the coil of such a valve in response to changes in superheat of the vaporized refrigerant leaving the evaporator.

A more specific object of the invention resides in providing a switch mechanism for controlling the operation of a refrigerating system wherein changes in temperature of the refrigerant leaving the evaporator are transmitted through a pivoted beam to adjust one part of the switch

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mechanism and changes in pressure of the gaseous refrigerant are transmitted through a second pivoted beam to adjust another part of the switch mechanism so that the point at which the switch opens or closes its contacts depends upon the combined movements of the two beams.

Other objects and features of the invention will be more apparent to those skilled in the art as the present disclosure proceeds and upon consideration of the accompanying drawings and the following detailed description wherein an exemplary embodiment of the invention is disclosed.

In the drawings:

Fig. 1 is a front elevational view of a switch assembly exhibiting the invention for controlling the actuation of an electromagnetic valve in a refrigerating system with the protecting casing removed.

Fig. 2 is a plan view of the mechanism shown in Fig. 1.

Fig. 3 is a sectional view taken on the line 3—3 of Fig. 1.

Fig. 4 is a fragmentary sectional view of parts of the mechanism and the mercury switch embodied in the relay assembly.

Fig. 5 is a fragmentary sectional view taken on the line 5—5 of Fig. 3 with the abutment removed.

Fig. 6 is a diagrammatic illustration of a refrigeration system incorporating the invention.

A refrigeration system as illustrated in Fig. 6 includes an evaporator or vaporizer 10 which may be in the form of convoluted tubing. The evaporator 10 is disposed in a space to be cooled such as that formed by a container 11. The liquid refrigerant is moved intermittently into the evaporator 10 under the control of an electrically actuated valve 12. This valve has its inlet side connected to a condenser 14. The condenser is in turn connected to the outlet 16 of a compressor 17. The inlet of the compressor is connected by a conduit line 18 to an outlet 19 of the evaporator. The cycle of refrigeration includes the control of movement of the liquid refrigerant through the valve 12 into the vaporizer 10 where the pressure is sufficiently low to cause the refrigerant to evaporate or vaporize. The gaseous refrigerant after it has absorbed heat passes through the outlet 19 of the evaporator and through the conduit line 18 and is compressed by the compressor 17. The refrigerant under increased pressure reverts to a liquid state in the condenser 14.

The recycling of the refrigerant through a closed system of the character described is well-known, and the present invention pertains to the switch assembly shown at 20 in Fig. 6 and illustrated in detail in Figs. 1 to 5 for controlling the energization of a coil 26 of the valve 12 to thereby control the movement of the liquid refrigerant to the evaporator 10. The valve 12 moves to the closed position when the coil 26 is de-energized. The compressor 17 may be operated in any suitable manner, such as by means of an electric motor 22. The motor is arranged to be supplied with electrical energy from mains 24. The coil 26 for the valve 12 is connected to one side of the line 24 by a conductor 27. A lead 28 extends from the other side of the coil 26 to a terminal 29 of the relay 20. The other side of the line 24 is connected by a conductor 31 to another terminal 32 of the relay 20. The circuit to the coil 26 is completed when the terminals 29 and 32 are bridged as hereinafter described to open the valve 12 and permit the liquid refrigerant to move in the conduit line 33 and pass into the evaporator 10.

The relay mechanism 20 for controlling the actuation of the valve 12 includes a mercury switch having an envelope or glass tube 36 closed at its lower end as shown in Fig. 4 to form a depending pocket 37 adapted to receive and retain a small body of mercury 38. The upper end of the tube 36 is closed in a conventional manner and includes two lead-in wires 39 and 41. The lead-in wire 39 is in the form of an electrode which extends downwardly into the mercury pool 38. The other lead-in 41 is provided with a flexible portion 42 which carries a depending tip 43 which is normally out of engagement with the mercury pool 38. An armature or magnetizable element 44 is affixed to the flexible portion 42. A magnet 46 of U-shape is provided for biasing the armature to the left in Fig. 4 when the tube 36 and the armature 44 is horizontally opposite the free ends of the magnet or within the field produced by the magnet 46 to thereby move the tip 43 into the mercury body 38 and complete a circuit between the lead-in wires 39 and 41. A flexible conductor 47 extends from the electrode 39 to the terminal 32 as shown in Fig. 1. A similar flexible conductor 48 connects the electrode 41 with the terminal 29. These terminals are mounted on an insulating body or terminal block 49 carried by a vertical flange 51 of a frame 50 for the relay assembly. Thus, when the armature 44 is in a position to be attracted by the magnet 46, the terminals 32 and 29 are bridged to complete a circuit to the coil 26 to thereby open the valve 12.

The tube 36 is adapted to be moved relative to the magnet 46 in accordance with the changes in the pressure of the gaseous refrigerant adjacent the outlet 19 of the evaporator 10. Means is provided for raising the tube 36 when this pressure increases and the tube and its support may move downwardly by gravity when the pressure in the suction line 18 decreases. The tube 36 is secured to a plate 52 which is formed of non-magnetic material such as brass. This plate 52 is adapted to be moved vertically in a pair of guide members 53 which are formed of non-magnetic material such as brass, and secured to the vertical flange 51 of the frame by means of screws 54. A projection 56 extends laterally from the lower end of the plate 52, and this projection is preferably arcuate shaped, as shown in Fig. 1, for the purpose of being engaged by a pivotally mounted beam 57.

The tube 36 is mounted on the upper end of the plate 52 so as to move therewith but the tube is adjustable on the plate 52. A plurality of generally U-shaped resilient clips 58 are provided which partly embrace the tube 36 and embrace a plate 60, as shown in Fig. 5. The upper end of the plate 60 is secured to a horizontal flange 59 carried by the plate 52. A screw 61 extends through the flange 59 and depends along the side of the tube 36. The screw 61 is provided with threads which engage internal threads within a member 62 carried by one of the clips 58. Rotation of the screw 61 will provide for vertical adjustments of the position of the tube 36 relative to the plate 52 by moving both clips 58 along the plate 60. A collar 65 is secured to the screw 61 below the flange 59.

A change in the pressure in the line 18 alters the position of the beam 57 which in turn controls the position of the plate 52 and the tube 36. It is for this purpose that a pressure-responsive member 66 is mounted on the horizontal flange of the frame 50. This pressure-responsive device includes therein a bellows (not shown) which is influenced by changes in pressure. A conduit line 67 extends from the pressure-responsive member 66 and is in open communication with the suction line 18 as shown in Fig. 6. The bellows (not shown) expands in response to increased pressure and moves a pointed lug 68 upwardly to engage the beam 57. A socket member 69 is mounted on the beam 57 to receive the pointed upper end of the lug 68. The beam 57 is mounted for pivoting movement on a bracket 71 carried by the vertical flange of the frame 51. The beam 57 turns about aligned fulcrums 72. A spring 73 is provided for moving the beam 57 to inactive positions. The spring 73 is connected at its lower end to a portion of the pivoted beam structure to the right of the fulcrum points 72 as shown in Fig. 1. The upper end of the spring 73 is connected to a bracket 74 mounted on the vertical flange of the frame 51. The tension of the spring 73 may be varied by adjusting the position of the threaded screw 76.

The control mechanism includes means for varying the position of the magnet 46 in response to changes in temperature of the gases leaving the evaporator. A temperature-responsive bulb 78 (Fig. 6) is mounted in the container 11 in contact with the tube of the vaporizer adjacent the outlet of the evaporator coil. The temperature-responsive bulb 78 is of a well-known structure and is provided with a tube 79 which extends in the communication with a bellows (not shown) within a temperature-responsive fitting 81. The bellows (not shown) expands on an increase in temperature and a lug 82 extends through the horizontal flange of the frame 50 and engages a pivoted beam 83. This beam 83 is mounted for pivoting movement about fulcrum points 89 carried by a bracket 84. A spring 86 is connected at its lower end to the beam 83 to the left of the fulcrum points 89, as shown in Fig. 1. The upper end of the spring 86 is connected to a bracket 87. A threaded screw 88 forms a part of the upper connection to permit adjustment of the tension of the spring 86.

The magnet 46 is mounted on the upper end of a plate member 91 which is formed of non-magnetic material such as brass or the like. The

plate 91 is arranged for guided vertical movements and it is for this purpose that a guide member 92 is arranged to embrace the opposite edges of the plate 91. This guide member 92 is supported by a stud 93 carried by the plate 52. The lower end of the plate 91 carries a screw 96 which provides an abutment adapted to be engaged by the beam 83. The position of the screw 96 may be altered to provide for proper adjustment of the magnet 46 in relation to the position of the beam 83. The magnet 46 is mounted on the upper end of the plate 91 by means of a screw 98. The magnet 46 is thereby mounted so as to move along the mercury tube 36 and influence the position of the armature 44. A non-magnetic lug 99 is mounted on the tube 36 between the clips 58 so as to project forwardly from the face thereof and to be engaged by the free ends of the legs of the magnet 46.

The temperature-responsive bulb 78 assumes the temperature of the suction gas adjacent the outlet of the evaporator 10. If the refrigeration system has been at rest for a prolonged period the temperature of the evaporator coil will accordingly be quite high so that the bellows within the fitting 81 will expand to move the free end of the beam 83 upwardly. The plate 91 will accordingly move upwardly in the guide member 92. The free ends of the legs of the U-shaped magnet 46 will engage the lug 99 to move the tube 36 and the plate 52 upwardly since there will be very little pressure in the line 18. When the magnet 46 engages the lug 99, the magnet field is then in a position to attract the armature 44 and move the tip 43 into the mercury pool 38. The terminals 29 and 32 of the relay are thereby bridged to close the circuit to the coil 26. The valve 12 is thereby opened so that the liquid refrigerant moves to the evaporator.

If too much liquid is fed to the evaporator coil all of it does not boil off and some of the liquid approaches the outlet end 19 of the evaporator. Accordingly the temperature is lowered at the bulb 78. This decrease in temperature causes the bellows within the temperature responsive fitting 81 to partially collapse. The free end of the beam 83 accordingly moves downwardly, and the magnet 46 moves to a position where the armature 44 is no longer attracted and the circuit to the coil 26 is opened so that the valve 12 closes.

In the meantime, the pressure in the suction line 18 assumes normal conditions and the bellows within the fitting 66 expands to move the free end of the beam 57 upwardly to support the plate 52 and the tube 36 in a position corresponding to changes in pressure in the vaporized gaseous refrigerant. It will be appreciated that as the pressure increases in the suction line 18 the point at which the armature 44 escapes from the influence of the field of the magnet 46 will be altered. If the pressure in the conduit line 67 is lowered, a further downward movement of the magnet 46 will be required before the supply of liquid refrigerant to the evaporator is interrupted. Thus the valve 12 is controlled by superheat.

While the invention has been described with reference to specific structural features and with regard to particular organization of the pivoted beams for controlling the operation of the flow of the refrigerant to the evaporator by changes in superheat, it will be apparent that modifications may be made in the details as well as the combination of the elements. Such changes and others may be made without departing from the spirit and scope of the invention as set forth in the appended claims.

What I claim and desire to secure by Letters Patent is:

1. In a switch mechanism, a switch device including two contacts one responsive to a magnetic field and movable relative to the other, a vertically movable member carrying said switch device adapted to move downwardly by gravity action, means for engaging and moving said member upwardly and maintaining the switch device in elevated positions against the action of gravity, magnetic actuating means for said switch device for moving one contact relative to the other, a second member movable vertically and downwardly by gravity action carrying said magnetic actuating means along the path of movement of the switch device, and means for engaging and moving the second member upwardly and maintaining the magnetic actuating means in elevated positions against the action of gravity in operative and inoperative positions relative to said switch device.

2. In a switch mechanism for controlling the flow of a liquid refrigerant in a refrigeration system, a normally open mercury switch including an armature, a member carrying said mercury switch guided for vertical movements and movable downwardly by gravity, a beam pivoted about a horizontal axis for raising said member and the mercury switch, a magnet for biasing said armature to a switch closing position, a second member carrying said magnet mounted for vertical movements along the mercury switch to operative and inoperative positions relative to the armature and movable downwardly by gravity, and a beam mounted for pivoting movement about a horizontal axis for raising said second member.

3. In a switch mechanism for controlling the movement of a liquid refrigerant to the evaporator in a refrigeration system, a member mounted for guided vertical movements and movable downwardly by gravity, a mercury switch including an armature carried by said member, means adapted to engage said member and move it upwardly to lift the mercury switch, a second member mounted for guided vertical movement along the path of movement of the first member and movable downwardly by gravity, magnetic means carried by said second member positioned to move along the path of movement of the mercury switch to operative and inoperative positions relative to the armature, and means for engaging said second member and moving it upwardly to raise the magnetic means.

4. In a switch mechanism, a mercury switch including an armature, a member carrying said mercury switch mounted for guided vertical movements and movable downwardly by gravity, means for engaging and moving said member upwardly, magnetic means, a second member mounted for guided vertical movements carrying said magnetic means along the path of movement of the mercury switch to operative and inoperative positions relative to the armature and movable downwardly by gravity, means for engaging and raising the second member, and an abutment fixed in relation to the mercury switch adapted to be engaged by said magnetic means.

5. In a switch mechanism, a switch device including two contacts one movable relative to the other, a vertically movable member carrying said switch device adapted to move downwardly by gravity action, means for engaging and moving said member upwardly and maintaining the switch device in elevated positions against the

action of gravity, actuating means for said switch device for moving one contact relative to the other, a second member movable vertically and downwardly by gravity action carrying said actuating means along the path of movement of the switch device, means for engaging and moving the second member upwardly and maintaining the actuating means in elevated positions against the action of gravity in operative and inoperative positions relative to said switch device, and means for moving the switch device upwardly with the second member after the actuating means has moved upwardly a predetermined distance relative to the first member and is in an operative position with respect to the switch device.

6. In a switch mechanism, a plate member, means guiding said plate member for vertical movements, means adapted to engage said plate member and move it upwardly whereby the plate member may move downwardly by gravity action as the means retreats therefrom, a switch device mounted on said plate member, a second plate member, means carried by the first plate member guiding said second plate member for vertical movements, means for operating the switch device carried by the second plate member so as to be movable vertically along the path of movements of the switch device, movable means for raising said second plate member which may move downwardly by gravity action as the movable means moves downwardly, and abutment means adjustable to fixed positions relative to the second plate member for engagement by said movable means.

7. In a switch mechanism, a switch device, a vertically movable member carrying said switch device adapted to move downwardly by gravity action, means for moving said member upwardly for maintaining the switch device in elevated positions against the action of gravity, actuating means for said switch device, a second member movable vertically and downwardly by gravity

action carrying said actuating means along the path of movements of the switch device, means for moving the second member upwardly and maintaining the actuating means in positions against the action of gravity in operative and inoperative positions relative to the switch device, and a lug carried by the switch device in the path of upward movement of the actuating means adapted to be engaged thereby before the actuating means moves upwardly beyond an operative position with respect to the switch device.

8. In a switch mechanism, a switch device, a vertically movable member carrying said switch device adapted to move downwardly by gravity action, means for moving said member upwardly and maintaining the switch device in different elevated positions against the action of gravity, actuating means for operating said switch device when in a position adjacent the switch device, a second member movable vertically and downwardly by gravity action carrying said actuating means along the path of movements of said switch device, means for moving the second member upwardly and maintaining the actuating means in different elevated positions against the action of gravity and in operative and inoperative positions with respect to the switch device, and means for adjusting the switch device to different vertically fixed positions relative to the first member.

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