

July 31, 1962

J. H. HEIDORN

3,047,696

SUPERHEAT CONTROL

Filed Dec. 11, 1959

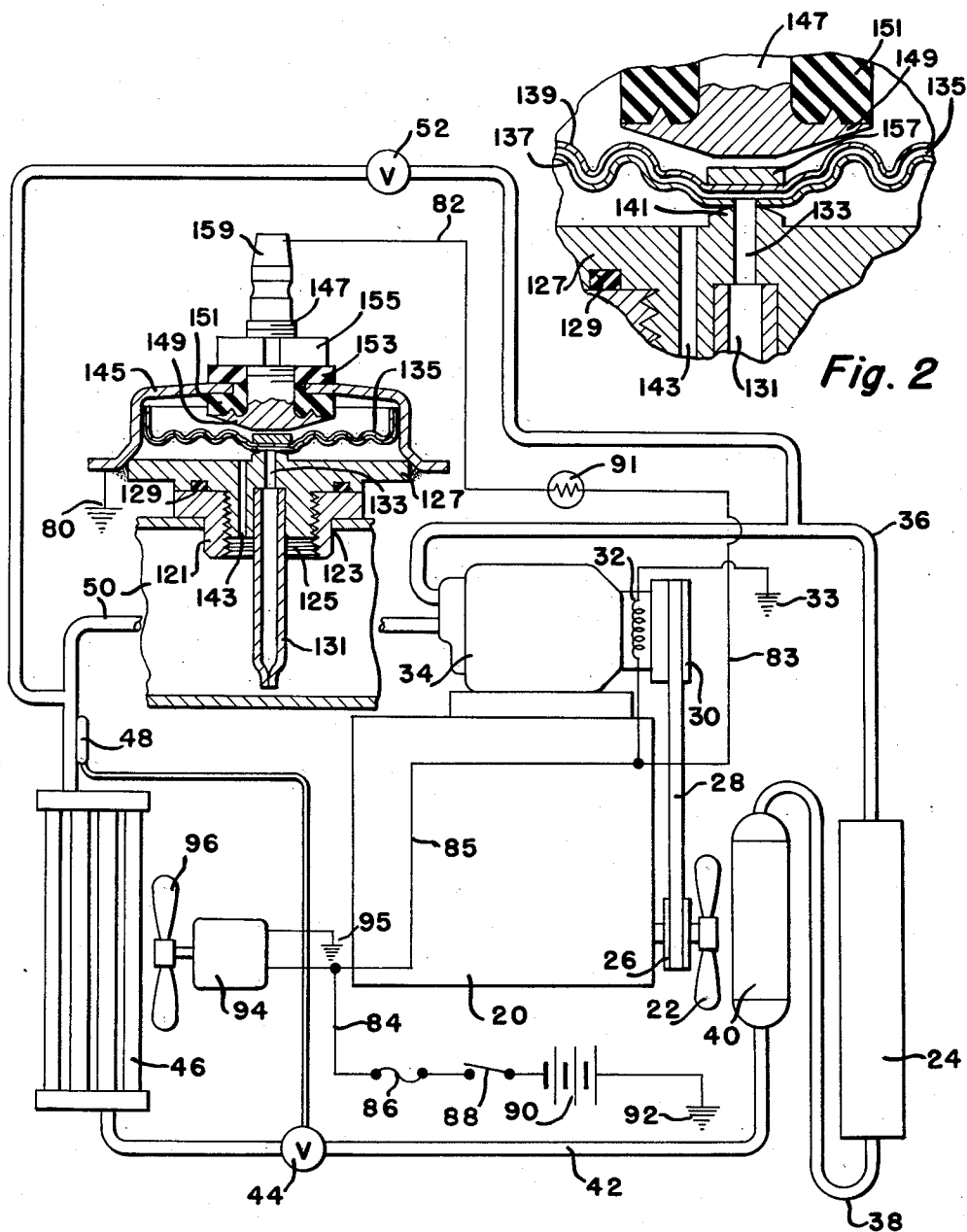


Fig. 1

INVENTOR.
John H. Heidorn
BY *Carl A. Sticker*
His Attorney

1

3,047,696

SUPERHEAT CONTROL

John H. Heidorn, Dayton, Ohio, assignor to General Motors Corporation, Detroit, Mich., a corporation of Delaware

Filed Dec. 11, 1959, Ser. No. 858,895

3 Claims. (Cl. 200-140)

This invention pertains to refrigerating apparatus and especially to control devices responsive to excessive superheat.

Tests disclose that the likelihood of compressor damage is present whenever excessive superheat occurs in the suction line of compressors. This may occur whenever sufficient refrigerant and lubricant leak from the refrigerating system. This occurs infrequently, yet when it does happen, the cost of repair is high.

It is an object of this invention to provide a simple inexpensive reliable control which is operative whenever it is subjected to excessive superheat.

It is another object of this invention to provide a compact reliable control having few parts which is applied directly to the suction line of the compressor and which operates whenever there is an excess of superheat in the suction line.

These and other objects are attained in the form shown in the drawings in which a fitting extends through an opening in the suction line and has a tube with a closed end extending therefrom into the suction line. Outside the suction line it is provided with a fluid motor connected to the interior of the tube which contains a thermally expansive fluid. The fluid motor is enclosed in a housing sealed to the fitting. The fitting is provided with a passage connecting the interior of the housing with the interior of the suction line so as to subject the fluid motor externally to the pressure within the suction line while internally it is subjected to the pressure of the thermally expansive fluid. The thermally expansive fluid has a sufficiently higher temperature boiling point than the refrigerant in the suction line that when a predetermined amount of superheat is present in the refrigerant flowing through the suction line, the fluid motor will expand and move its contact into engagement with an insulated electrode extending through the housing to close a circuit which will blow a fuse to prevent further operation of the compressor.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings wherein a preferred embodiment of the present invention is clearly shown.

In the drawing:

FIGURE 1 is a diagrammatic view of an automotive refrigerating system provided with an enlarged sectional view of a control embodying one form of my invention together with the adjacent portion of the suction conduit; and

FIGURE 2 is an enlarged sectional view of the central portion of the fluid motor or diaphragm and adjacent areas.

Referring now more particularly to FIGURE 1, there is shown an automobile driving engine 20 having a fan 22 for circulating air through the condenser 24. The fan shaft also carries a pulley 26 which through a belt 28, a driving pulley 30 and an electromagnetic clutch 32 drives a compressor 34. This compressor 34 is preferably mounted on the engine 20. The compressor 34 delivers compressed refrigerant through the discharge conduit 36 to the condenser 24 from which the condensed refrigerant flows through a drain conduit 38 to a receiver 40.

The receiver 40 is connected by a supply conduit 42 with the thermostatic expansion valve 44 which controls

2

the flow of liquid refrigerant to the inlet of the air cooling evaporator 46. The thermostatic expansion valve 44 has a thermal operating bulb 48 in heat transfer relation with the suction line 50 connecting the outlet of the evaporator 46 with the inlet of the compressor 34. The thermostatic expansion valve 44 has a diaphragm operating system which is responsive to the differential between a pressure corresponding to the temperature of the bulb 48 and the pressure within the evaporator 46. The thermostatic expansion valve 44 controls the superheat of the refrigerant leaving the evaporator 46 under normal conditions. A by-pass valve 52 is provided in a by-pass connection connecting the suction line 50 and the discharge conduit 36 which opens in accordance with reduced refrigeration requirements to reduce the capacity of the refrigerating system. If desired, the electromagnetic clutch 32 may be thermostatically controlled and the by-pass connection and valve 52 may be omitted.

The system is charged with a fluoride refrigerant, such as difluorodichloromethane, and mineral oil lubricant. Since the compressor 34 is externally driven, a shaft seal is required for a drive shaft connecting with the driven pulley 30 through the magnetic clutch 32. Because of the nature of the installation of the refrigerating system in an automobile, it is desirable that the parts be readily removable. It is therefore practical to provide removable connections throughout the system so that the parts may be removed whenever necessary. Road shocks and vibrations are apt to affect such connections. As a result, systems of this type are subject to leakage and occasionally serious leaks occur. In extreme cases of neglect where the refrigerant charge is almost completely depleted, excessive amounts of oil lubricant accumulate in the evaporator causing insufficient lubrication within the compressor. Under such circumstances, the reduced flow of refrigerant is insufficient to cool the compressor so that the compressor overheats and is damaged both from the insufficient lubrication and the insufficient flow of refrigerant. Very often the compressor is damaged beyond economical repair.

I have found that when the valve 44 is properly set the superheat in the suction line 50 is about 23° F. However, this superheat rises as the refrigerant charge is depleted. This rise in superheat is particularly rapid when about half the refrigerant charge has been lost. When the superheat exceeds about 60° F., more than half of the refrigerant charge has been lost.

According to this invention, I provide an arrangement wherein the fuse 86 controlling the clutch 32 is blown whenever the superheat exceeds about 60° F. This is provided by the control shown in the enlarged portion of FIGURE 1. This includes a flanged member 121 extending through an aperture 123 in the suction line 50. The edges of this aperture 123 are soldered or welded to the flanged member 121 to provide a sealed joint. The member 121 is provided with a threaded bore 125 receiving the threaded boss of a fitting 127 having an annular gasket 129 providing a seal between it and the member 121. The threaded boss of the member 127 receives the open end of the tube 131 (about ¾ inches long) which projects into the suction line 50 and is closed at its outer end. This tube is sealed to the fitting 127 by soldering or welding. Its interior is connected by the passage 133 with a fluid motor 135 formed of thin lower and upper flanged, corrugated, stainless steel disks 137 and 139 which are connected together at their flanged edges by gas-tight seam welding. The lower disk 137 is provided with a central aperture which is aligned with the passage 133 connecting with the tube 131. This lower disk 137 is welded or otherwise bonded to the central upper projection 141 upon the fitting 127. This provides direct communication be-

tween the interior of the tube 131 and the interior of the fluid motor 135.

This interior is filled with a thermally expansible fluid, such as dichlorotetrafluoroethane, which boils at a sufficiently high temperature above the boiling point of difluorodichloromethane that its pressure will not exceed the pressure of difluorodichloromethane until the difluorodichloromethane has been superheated about 60° F. To subject the fluid motor 135 to the pressure of the refrigerant in the suction line 50, the fitting 125 is provided with a passage 143. The fitting 127 is also provided with a sealed housing 145 extending over and enclosing the fluid motor 135 so as to confine the refrigerant which may flow through the passage 143 around the fluid motor 135.

The housing 145 is provided with an insulated electrode in the form of a screw 147 having a head 149 within the housing 145. A washer 151 of electrical insulating material is located between the head and the shank of the screw 147 and the housing 145 which is provided with a centrally located aperture for receiving this washer. The shank portion of the screw 147 is also provided with an outer washer 153 on the outer face of the housing 145. Both washers 151 and 153 are clamped together and the electrode 147 is clamped to the housing 145 by the nut 155 which is threaded tightly onto the shank of the screw 147 as shown. The upper diaphragm 139 is provided with a centrally located contact 157 which is adapted to engage the head of the screw 147 when the fluid motor 135 is expanded by excessive pressure within its interior.

The outer portion of the screw 147 is provided with an electrical terminal 159 which is connected through the conductor 82, the thermister 91 and the conductor 83 to one terminal of the electromagnetic clutch 32. The housing 145 is provided with a ground 80 and the electromagnetic clutch 32 also has a ground 33 connected to its other terminal. Conductor 83 and the first terminal of the electromagnetic clutch 32 are connected through the conductor 85, the conductor 84, the fuse 86 and the switch 88 to one terminal of the battery 90. The second terminal of the battery 90 is connected to a ground 92. Air is circulated over the surfaces of the evaporator 46 by a fan 96 driven by an electric motor 94 having one terminal connected to the junction of the conductors 84 and 85 and the second terminal connected to a ground 95.

Under normal conditions, the evaporator may operate at any desired temperature, such as 26° F., with a refrigerant pressure of about forty pounds per square inch absolute prevailing therein when difluorodichloromethane is used as the refrigerant. Normally, a 10° F. superheat (36° F.) is considered desirable at the bulb 48. The temperature of the refrigerant normally rises during its passage through the suction conduit 50, for example, to about 49° F. at the bulb 131, but the pressure (forty pounds per square inch absolute) remains substantially the same throughout. This refrigerant pressure is applied through the passage 143 into the interior of the sealed housing 145 surrounding the fluid motor 135 to exert a collapsing force on this fluid motor for keeping the contact 157 normally separated from the screw or electrode 147. This condition will prevail as long as the pressure of the other refrigerant or thermosensitive liquid tetrafluorodichloroethane in the bulb 131 and the fluid motor 135 is less than the pressure within the sealed housing 145. For example, the pressure of the tetrafluorodichloroethane will not rise above forty pounds until its temperature reaches 92° F. or 66° F. above the evaporating temperature of 26° F. prevailing within the evaporator 46. Therefore, 66° superheat of the refrigerant difluorodichloromethane would be required to reach the temperature of 92° F. at the bulb 131. The refrigerant tetrafluorodichloroethane is selected so that at any temperature its pressure will not be higher than the pressure of the other refrigerant difluorodichloromethane until this other refrigerant has more than 60° superheat.

According to this arrangement, should the refrigerant leak from the system and an excessive amount of lubricant collect in the evaporator 46, the resulting rise in temperature of the refrigerant flowing through the suction line 50 causing an increase in the superheat of the refrigerant to about 60° F. will heat the tube 131 and the dichlorotetrafluoroethane thermally expansible fluid therein sufficiently to expand the fluid motor 135 by the pressure between the diaphragms 137 and 139 until the contact 157 engages the head of the screw 147 to close the circuit portion by-passing the electromagnetic clutch 32 to cause the fuse 86 to blow and prevent further operation of the system until proper attention is given to the replacement of the refrigerant and stopping the leak. The thermister 91 is provided in the by-pass circuit to prevent any momentary closing of the contact 157 with the head 147 from causing the blowing of the fuse 86. This perhaps could be caused by an extremely brief superheat condition. While difluorodichloromethane has been suggested as a refrigerant and dichlorotetrafluoroethane has been suggested as a thermally expansible fluid within the tube 131, it is obvious that other refrigerants may be used and other thermally expansible fluids may be chosen to go with this and other refrigerants to obtain the expansion of the fluid motor 135 at the exact amount of superheat desired.

The control is quite small and can be readily manufactured. It is simple and requires only a few parts.

While the embodiment of the present invention as herein disclosed, constitutes a preferred form, it is to be understood that other forms might be adopted.

What is claimed is as follows:

1. A control for a container having an aperture therein including a removable closure fitting connecting with said container for closing said aperture, a tube having a closed end extending into said container and having an open end mounted upon said fitting, a closed diaphragm means mounted upon said fitting having its interior communicating with the open end of said tube, the interior of said tube and diaphragm means containing a thermosensitive fluid for applying a first pressure to the interior of said diaphragm means, an enclosure mounted upon and hermetically sealed to said fitting enclosing said diaphragm means, said fitting being provided with a passage outside of said tube and diaphragm means connecting the interior of said enclosure with the interior of said container to apply a second pressure to the exterior of the diaphragm means, and a control device operated by the displacement of said diaphragm means.

2. A control for a container having an aperture therein including a removable closure fitting connecting with said container for closing said aperture, a tube having a closed end extending into said container and having an open end mounted upon said fitting, a closed diaphragm means mounted upon said fitting having its interior communicating with the open end of said tube, the interior of said tube and diaphragm means containing a thermosensitive fluid for applying a first pressure to the interior of said diaphragm means, an enclosure mounted upon and hermetically sealed to said fitting enclosing said diaphragm means, said fitting having extending through it a passage outside of said tube and diaphragm means connecting the interior of said enclosure with the interior of said container to apply a second pressure to the exterior of the diaphragm means, and a switch device operated by the displacement of said diaphragm means, said switch device comprising a first contact connected to said diaphragm means and a second contact cooperating with the first contact connected to said enclosure, one of said contacts being electrically insulated and provided with an electrical terminal.

3. A control for a container containing a first refrigerant having a known vapor pressure curve and having an aperture therein including a removable closure fitting, a

5

sealed fluid motor mounted upon said fitting, a tube having a closed end mounted upon the fitting and having its interior connected to a first side of said fluid motor, an enclosure mounted upon and hermetically sealed to said fitting enclosing the second side of said fluid motor, said fitting having a passage outside said tube and fluid motor extending to the interior of said enclosure to apply a pressure to the second side of said fluid motor, said tube and fluid motor containing a second refrigerant having a substantially lower vapor pressure curve than the first refrigerant for applying a second pressure to the first side of said fluid motor, and a control device operated by the displacement of said fluid motor.

5

10

596,601
2,577,450
2,712,579
2,771,248

568,309
700,051
821,760

6

References Cited in the file of this patent

UNITED STATES PATENTS

Knox	Jan. 4, 1898
Carter	Dec. 4, 1951
Raney	July 5, 1955
Ehlke	Nov. 20, 1956

FOREIGN PATENTS

France	Dec. 19, 1923
Great Britain	Nov. 25, 1953
Great Britain	Oct. 14, 1959