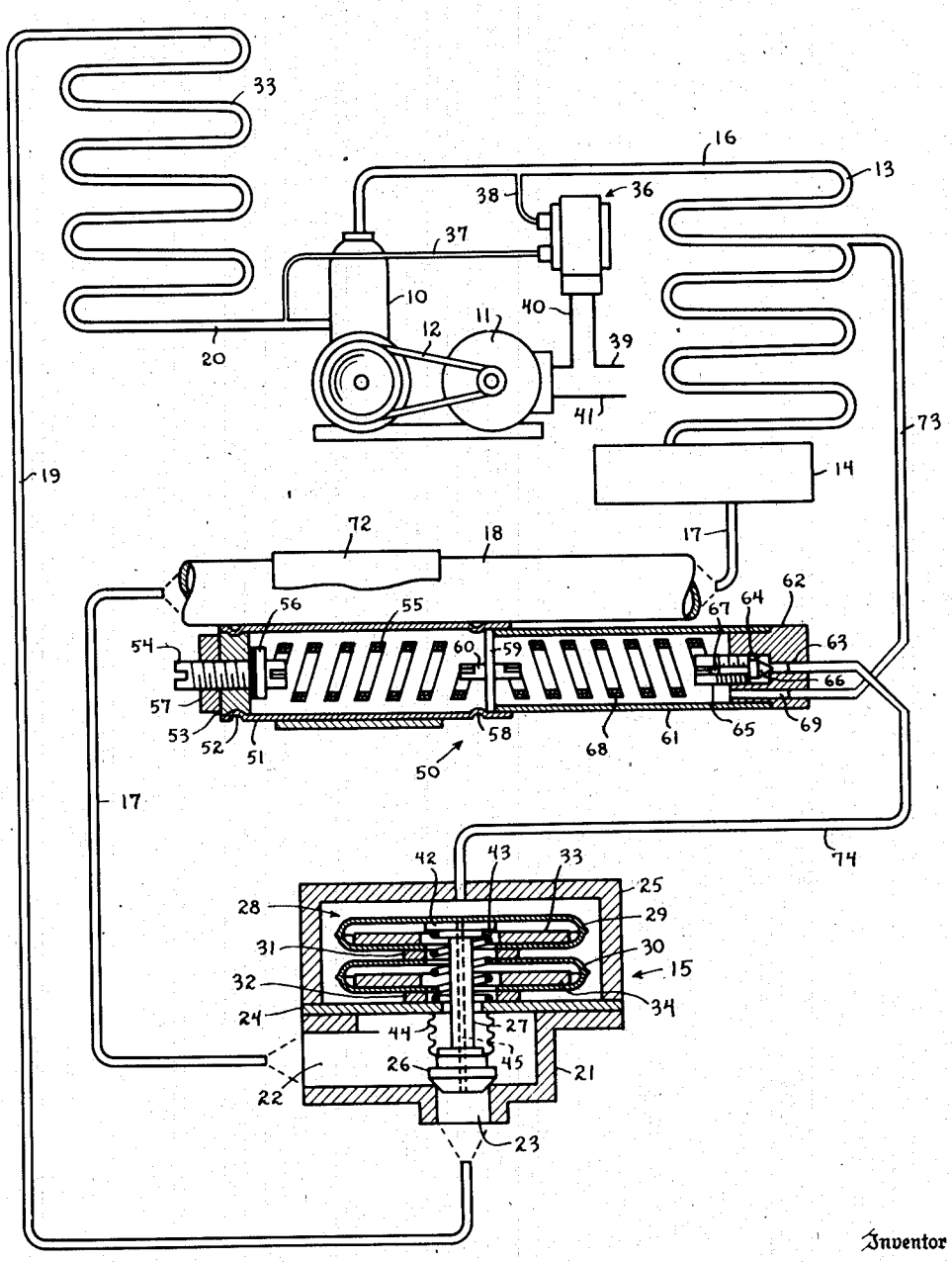
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REFRIGERATING SYSTEM

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REFRIGERATING SYSTEM

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My invention relates to refrigerting systems, particularly those of the type wherein gas is liquefied in a condenser and then expanded in an evaporator. It has been common practice in the past to control the supply of refrigerant to the evaporator in accordance with the accumulation of liquid in the condenser by the use of a so-called high side float valve. My invention is concerned with improved methods and means of controlling the supply of refrigerant to the evaporator in effect in accordance with the accumulation of liquid in the condenser.

An object of my invention is to provide a pressure operated expansion valve for use in systems of the above mentioned type, the pressure for operating the valve being controlled by a pilot valve responsive in effect to the accumulation of liquid in the condenser.

Another object of my invention is to control the release of liquid from a condenser in effect in accordance with the accumulation of liquid therein by adjusting a release valve dependently upon the difference between the temperature of condensing refrigerant and the temperature of liquid collected in the lower part of the condenser. The liquid collected in the lower part of the condenser is subcooled below the temperature of the refrigerant condensing in the upper part of the condenser and as the liquid collects in the condenser the difference between the temperature of the liquid at the lower part and the temperature of condensing refrigerant higher up in the condenser becomes greater. Thus by controlling the release of liquid from the condenser in accordance with this temperature difference, the use of a high side float may be dispensed with even though equivalent results are produced.

Another object is to provide a pressure operated expansion valve for a refrigerating system of the type mentioned controlled by a pilot valve responsive to the difference between the temperature of liquid collected in the condenser and the temperature of condensing refrigerant whereby the expansion valve is controlled in effect in accordance with the accumulation of liquid in the condenser without the use of a high side float. In carrying out this object, it is a further object of my invention to convey gas from the condenser for operating the expansion valve and pass it in heat exchange relationship with a temperature responsive element controlling the pilot valve.

Further objects and advantages of the invention will become apparent from the following detailed description and annexed drawing wherein the single figure of the drawing represents a compression type refrigerating system embodying my invention.

Referring to the drawing, I have shown a refrigerating system comprising a compressor 10 driven by an electric motor 11 by means of a belt 12. The discharge of the compressor is connected to a condenser 13 of the coil type by a pipe 16. The condenser has a receiver 14 in which liquid refrigerant collects, the receiver being connected to an expansion valve 15 by a pipe 17, a portion 18 of the pipe connecting the receiver and expansion valve being shown enlarged. The outlet of the expansion valve 15 is connected to an evaporator 33 by a pipe 19 and the outlet of the evaporator 33 is connected to the suction side of the compressor by a pipe 20.

The compressor motor 11 is controlled by a controller 36. The controller 36 is the same as that disclosed in detail in the application of Albert L. Judson and Carl G. Kronmiller Serial No. 196,447, filed March 17, 1938. The controller 36 includes elements responsive to the compressor suction and discharge pressures, the elements being connected to the suction pipe 20 and discharge pipe 16 by tubes 37 and 38, respectively. The controller embodies switching mechanism operated by the pressure responsive elements whereby the motor 11 is controlled through the wires 39, 40 and 41. The operation of the system in response to the controller 36 is to start the compressor at a relatively high suction pressure and to stop it at a relatively low suction pressure. The compressor may also be stopped at any time in the event that the discharge pressure rises to an unduly high value.

Numeral 21 designates the body of the expansion valve 15 it having an inlet 22 and an outlet 23. The upper part of the valve body is closed by a plate member 24 and superimposed upon the plate member 24 is a casing 25, the valve body, plate 24 and casing 25 being secured together in any suitable manner so as to make the engaging parts fluid tight. The outlet 23 forms a valve seat which is adapted to be engaged by a valve head 26 to which is attached a stem 27 which extends through an opening in the plate 24 and into the interior of the casing 25. Disposed within the casing 25 is a pressure responsive device 28 comprising two expansible and contractible cells 29 and 30 each of which is made up of two complementary diaphragms sealed together at their edges. The cells 29 and 30 are spaced by a spacing ring 31 and the device 28 is spaced from the plate 24 by a similar ring 32. Within the cell 29 is a

ring member 33 and within the cell 30 is a similar ring member 34, these ring members having sufficient thickness to prevent complete collapse of the cells whereby the diaphragms might be damaged. The valve stem 27 extends within the cells 29 and 30 and at its upper end carries a disc 42 which is suitably secured to the upper diaphragm of the upper cell. Numeral 43 designates a coil spring which encircles the valve stem 27, one end of the spring bearing against the plate 24 and the other end bearing against disc 42 adjacent the upper diaphragm of cell 29 so that the spring tends to expand the device 28 urging the valve in opening direction. Numeral 44 designates a seal-off bellows connected to the valve member 26 and the plate 24 to seal the interior of the valve body from the interior of the expansible cells. There is a longitudinal orifice 45 in the valve stem 27 and valve member 26, this orifice being coaxial with a similar orifice in disc 42 and in the upper diaphragm of cell 29 whereby communication is provided between the space within the casing 25 exterior of the device 28 and the outlet side of the valve. The casing 25 is adapted to contain a pressure and the device 28 expands and contracts depending upon the magnitude of this pressure and adjusts the position of the valve member 26 with respect to its seat accordingly.

Numeral 50 designates generally a temperature responsive pilot valve mechanism which controls the pressure applied to the pressure operated valve 15. The mechanism 50 comprises a tube 51 having an annular detent 52 near one end which retains in its proper place an end plug 53. An adjustable screw 54 extends through the end plug 53, the inner end of the screw 54 being slotted so as to receive the end of a coiled bimetal element 55. The screw 54 has a shoulder 56 and between this shoulder and the plug 53 is a fibre washer or disc to prevent the escape of pressure around the screw 54. The screw 54 may be locked in any adjusted position by means of a lock nut 57. The other end of the tube 51 has a similar annular detent 58 in engagement with which is a disc 59. The opposite end of the bimetal element 55 is engaged in a slot in a pin 60 which extends through the disc 59. Numeral 61 designates a second tube similar to the tube 51 but of slightly smaller diameter, the tube 61 being telescoped within the tube 51 and having its end bearing against the disc 59. The opposite end of the tube 61 is closed by a plug 62 which has a bore 63 and a screw threaded counter bore 64. The counter bore 64 receives a screw plug 65 which carries a valve head 66 adapted to seat on the seat formed by the counter bore. The screw plug 65 has a groove 67 along its side so that fluid leaving the interior of the tube 61 through the bore 63 may pass the valve and the screw plug. The left end of the screw plug 65 is slotted and receives the end of a coiled bimetal element 68 similar to the element 55, the other end of the element 68 being received in a slot in the opposite end of the pin 60. The end plug 62 has another bore 69 whereby fluid may be admitted to the tube 61.

The tube 51 which is of larger diameter is in intimate thermal contact with the portion 18 of the pipe connecting the condenser and expansion valve as will be seen, the device 50 being held in place by a clamp or strap 72 passing around the tube 51 and pipe 17. The bimetal element 55 is therefore responsive to the temperature of the refrigerant in the pipe connecting the condenser and the expansion valve. The tube 61 being spaced from the pipe portion 18, the bimetal element 68 is not responsive to the temperature of the refrigerant passing from the condenser to the expansion valve but it is responsive to the temperature of fluid within the tube 61.

The bore 69 may be connected to one of the condenser coils, that is, a point on the condenser near the upper part thereof by a tube 73. The bore 63 is connected to the casing 25 by a tube 74. The tube 73 is connected to a point on the condenser 13 wherein the refrigerant has not yet condensed such that gas may be conveyed through the tube 73 to the interior of the tube 61 where the gas condenses and thence through the tube 74 to the casing 25. The bimetal element 68 is therefore responsive to the temperature of the condensing refrigerant while the bimetal element 55 is responsive to the temperature of the condensed refrigerant, that is, liquified refrigerant which collects in the receiver 14. The bimetal elements 55 and 68 are arranged to act in opposition, that is, if both are affected by an increase in temperature one of them will tend to move the valve member 66 away from its seat and the other will tend to move it towards its seat, the valve member 66 of course being moved toward or away from its seat by reason of the screw plug 65 being turned when the bimetal elements expand or contract.

The temperature of the refrigerant which passes into the tube 61 will of course correspond to the condensing pressure existing in the condenser. If tube 73 is made long enough it may be connected to the top of condenser 13 so as to take off superheated rather than saturated gas, the length of the tube insuring that the gas condenses upon reaching tube 61 so that the temperature therein will correspond to condensing pressure in the condenser. The pressure in the receiver 14 will of course be substantially the same as the condensing pressure higher up in the coil. However the temperature of the liquid refrigerant in the receiver 14 will not correspond to the pressure existing in the condenser, that is, the condensing pressure, because after the refrigerant condenses and flows downwardly through the coil it is subcooled by the air passing over the condenser coil and inasmuch as after having been condensed there is no further heat of condensation, the temperature of the liquid refrigerant is lower than the temperature of the gas in tube 73. Thus the more liquid there is in the receiver and the condenser the greater difference there may be between the temperature of the liquid in the receiver and the temperature of the condensing gas. Inasmuch as the bimetal elements 55 and 68 act in opposition as described above when they are subjected to differing temperatures the pilot valve mechanism will be actuated dependently upon the amount of the difference. When no refrigerant has been condensed in the condenser and only high pressure gas is present therein, the pilot valve will be wide open and high pressure gas will be communicated from the upper part of the condenser through the tube 73, the pilot valve and the tube 74 to the casing 25 and this pressure acting on the pressure operated device 28 will maintain the expansion valve 15 in closed position. As liquid collects in the receiver 14 due to condensation, the temperatures affecting the bimetal elements 55 and 68 will diverge as described above. In

accordance with this divergence in temperatures the pilot valve, that is, the member 66 will gradually move toward its seat tending to throttle the gas flow from the upper part of the condenser to the interior of the casing 25. As this flow of gas is throttled the pressure within the casing 25 is reduced, it being understood that the orifice 45 which is restricted permits the accumulated gas within the casing 25 to bleed off to the outlet side of valve 15. As the pressure within the casing 25 is thus reduced the device 28 expands tending to move member 26 away from its seat thus opening the valve. Thus the pressure in casing 25 and the position of the expansion valve 15 is controlled in accordance with the difference between the temperatures affecting the bimetal elements 55 and 68. The supply of refrigerant to the evaporator, that is, the release of liquid refrigerant from the condenser is therefore controlled in effect in accordance with the accumulation of liquid refrigerant in the condenser and receiver.

The position of the valve member 66 may be conveniently manually adjusted by adjusting screw 54 whereby the amount of liquid maintained in the condenser can be adjusted.

From the foregoing those skilled in the art will appreciate that my invention makes possible the attainment of results equivalent to those attained when a high side float type expansion valve is used. With my particular arrangement the expansion valve itself can be placed in any desired location, it not being necessary as in the case of a float to place it where the liquid refrigerant accumulates. The pilot valve mechanism may be made very small and may be produced very inexpensively and by reason of the particular bleed circuit arrangement only a single connection to the main expansion valve is required.

The embodiment of my invention which I have disclosed is exemplary of forms which it may take and of modifications which may be made in it. My disclosure is intended to be illustrative only and the boundaries of my invention are to be determined therefore, not in accordance with the disclosure but only in accordance with the scope of the appended claims.

I claim as my invention:

1. In a refrigerating system of the type having a condenser for liquefying gas, and an evaporator, in combination, means comprising a main valve for controlling the supply of refrigerant to the evaporator, pressure responsive means for adjusting said main valve, means for communicating refrigerant from said condenser to said pressure responsive means for operating the main valve, a pilot valve controlling the pressure in said pressure responsive means, and control means responsive in effect to the accumulation of liquid in said condenser controlling said pilot valve whereby said main valve is controlled in effect in accordance with the accumulation of liquid in the condenser, said control means comprising an element responsive to the temperature of liquid refrigerant at the lower part of the condenser and an element responsive to the temperature of condensing refrigerant, said elements being so related as to position said pilot valve dependently upon the difference between said temperatures.

2. In a refrigerating system of the type having refrigerant condensing means and an evaporator, a valve for controlling the supply of refrigerant to the evaporator, means responsive to temperature of liquefied refrigerant at the lower part of the condenser, means responsive to the temperature of condensing refrigerant and operating means for the valve controlled jointly by both of the aforementioned temperature responsive means whereby the valve is positioned dependently upon the difference between said temperatures.

3. In a refrigerating system of the type having refrigerant condensing means and an evaporator, means comprising a valve for controlling the supply of refrigerant to the evaporator, control means for the valve comprising a first device responsive to temperature of liquefied refrigerant at the lower part of the condenser and a second device responsive to temperature of condensing refrigerant, said two devices acting in opposition whereby said valve is positioned dependently upon the difference between said temperatures.

4. In a refrigerating system of the type having refrigerant condensing means and an evaporator, means comprising a valve for controlling the supply of refrigerant to the evaporator, control means for the valve comprising a first device responsive to temperature of liquefied refrigerant at the lower part of the condenser and a second device responsive to temperature of condensing refrigerant, said two devices acting in opposition whereby said valve is positioned dependently upon the difference between said temperatures, said control means including a pressure operated element and means whereby the pressure for actuating said element is controlled by said devices.

5. In a refrigerating system of the type having refrigerant condensing means and an evaporator, a valve for controlling the supply of refrigerant to the evaporator, means responsive to temperature of liquefied refrigerant at the lower part of the condenser, means responsive to the temperature of condensing refrigerant and operating means for the valve controlled jointly by both of the aforementioned temperature responsive means whereby the valve is positioned dependently upon the difference between said temperatures, said temperature responsive means comprising bimetal elements, one being disposed in heat exchange relationship with liquefied refrigerant and the other having means associated therewith whereby refrigerant is conveyed from the condenser and passed in contact with it.

6. In a refrigerating system of the compression type having a compressor, a condenser, and an expander, in combination a pressure operated expansion valve having a pressure chamber, means communicating refrigerant from the high side of the system to said chamber for operating the valve, a pilot valve controlling the pressure in said chamber, and means responsive in effect to the accumulation of refrigerant condensed in the condenser controlling said pilot valve, said last means comprising an element responsive to the temperature of condensed refrigerant and an element responsive to the temperature of condensing refrigerant, said elements being so related as to adjust said pilot valve dependently upon the difference between said temperatures.

7. In a refrigerating system of the compression type having a compressor, a condenser, and an expander, in combination, a pressure operated expansion valve having a pressure chamber, means communicating refrigerant from the high side of the system to said chamber for operating the valve, a pilot valve controlling the pressure in said chamber, and means responsive in effect to the accumulation of refrigerant condensed in the condenser controlling said pilot valve, said

last means comprising a first element responsive to the temperature of condensed refrigerant and a second element responsive to the temperature of condensing refrigerant, said elements being so related as to adjust said pilot valve dependently upon the difference between said temperatures, said refrigerant communicating means including means for passing said refrigerant from the high side in heat exchange relationship with said second temperature responsive element.

8. In a refrigerating system of the type having refrigerant condensing means and an evaporator, a valve for controlling the supply of refrigerant to the evaporator, pressure responsive means for positioning said valve, means conveying gas from the condenser to said pressure responsive means, a first device responsive to the temperature of the liquefied refrigerant at the lower part of the condenser, a second device responsive to the temperature of the condensing refrigerant, said devices being connected in opposition, and means operated by said devices for varying the pressure of the gas delivered to said pressure responsive means whereby said valve is positioned in accordance with the difference between said two temperatures.

9. In a refrigerating system of the type having refrigerant condensing means and an evaporator, means comprising a valve for controlling the supply of refrigerant to the evaporator, control means for the valve comprising a first device responsive to temperature of liquefied refrigerant at the lower part of the condenser and a second device responsive to temperature of condensing refrigerant, said two devices acting in opposition, said control means also including a pressure operated element, means for conveying gas from said condenser to said element for operating said element, and a valve in said conveying means, said devices operating said last mentioned valve for controlling the flow of said gas to said element whereby said first mentioned valve is positioned dependently upon the difference between the temperatures to which the two devices respond.

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