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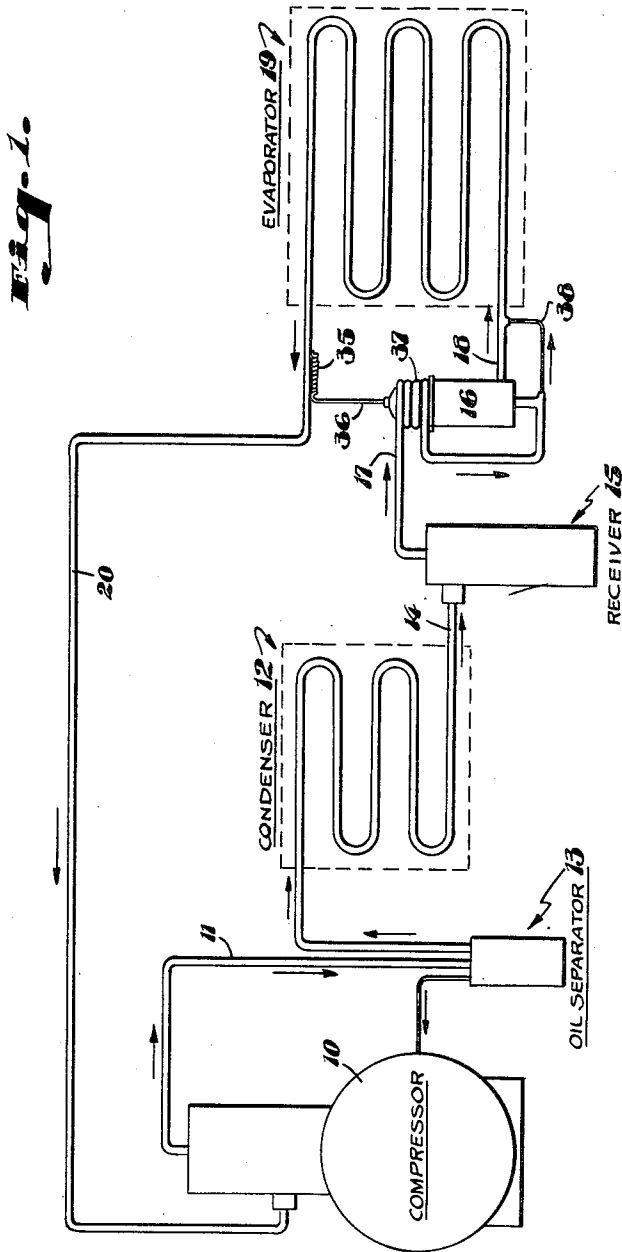
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REFRIGERATING SYSTEM WITH LOW TEMPERATURE STABILIZATION

Filed Oct. 13, 1953

2 Sheets-Sheet 1



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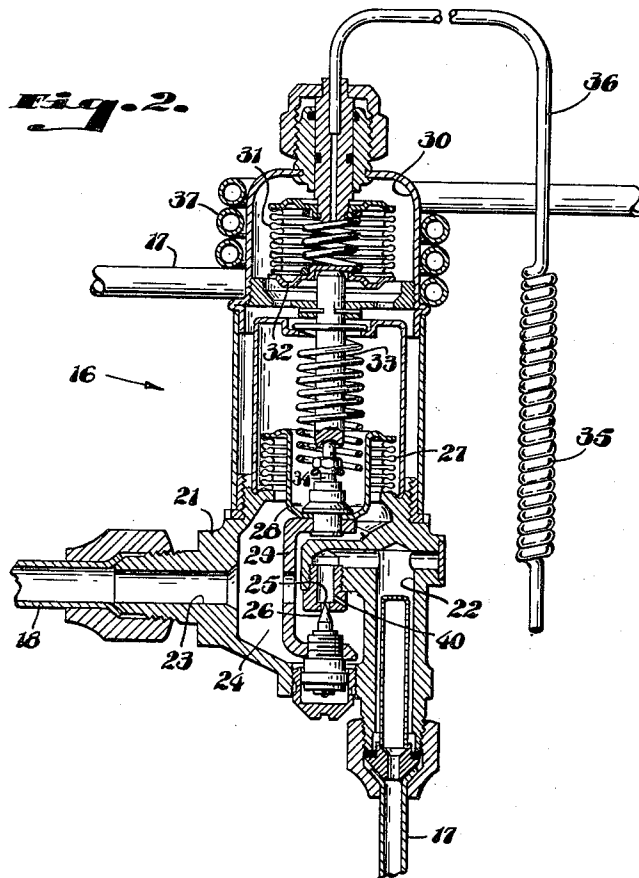
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1

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REFRIGERATING SYSTEM WITH LOW TEMPERATURE STABILIZATION

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Application October 13, 1953, Serial No. 385,801

7 Claims. (Cl. 62—3)

This application relates to an improvement over my co-pending application for "Low-Temperature, Stabilized Refrigerating System," Serial No. 297,486, filed July 7, 1952, and is concerned with low-temperature refrigerating systems and particularly with means for stabilizing such systems.

In my prior application, I provided what I believed to be a complete solution to the problem of insuring the contemplated operation of a thermo-responsive expansion valve where the system was being operated to maintain the evaporator at temperatures below the boiling-point of the control fluid in the thermo-responsive valve, such fluid being in heat-exchanging relation with the refrigerant flowing from the evaporator. While my invention disclosed therein has greatly improved the operation of such a system, I have found that during relatively long periods when the compressor is not running, my system for supplying heat to the control fluid is, thereby, inactivated and the fluid will liquefy, resulting in a loss of control over the system—the very thing which the invention of my prior application was designed to guard against.

The primary object of this invention is, therefore, to provide means, for use in cooperation with the invention of my prior application, for insuring against liquefaction of the control fluid in the expansion valve during those periods when the compressor is not running and, to this end, to provide means for supplying some heat to the control fluid during such periods.

Further objects will become apparent as the description proceeds.

To the accomplishment of the above and related objects, my invention may be embodied in the form illustrated in the accompanying drawings, attention being called to the fact, however, that the drawings are illustrative only, and that change may be made in the specific construction illustrated and described, so long as the scope of the appended claims is not violated.

Fig. 1 is a diagrammatic illustration of a refrigeration system embodying my invention; and

Fig. 2 is a vertical sectional view, upon an enlarged scale, through one form of thermo-responsive expansion valve modified for use with the present invention.

Referring more particularly to the drawings, I have shown a compressor 10 connected by a conduit 11 to a condenser 12, preferably through an oil separator 13. A conduit 14 connects the condenser to a receiver 15 in turn connected to an expansion valve 16 by means of a conduit 17. A conduit 18 connects the expansion valve to an evaporator 19 connected to the low-pressure side of the compressor 10 through a conduit 20.

In Fig. 2, I have illustrated one type of expansion valve conventionally used in such a system comprising a body 21 providing a chamber 24 having an inlet passage 22, to which the conduit 17 is connected, and an outlet passage 23, to which the conduit 18 is connected. A valve port 25 guards the entrance of passage 22 into chamber 24 and is controlled by a movable valve needle

2

26. A bellows 27 is open on one end to chamber 24 and carries a bell 28 at the opposite end mechanically connected through yoke 29 to the valve needle 26 whereby the movement of the valve needle is placed partially under the influence of the refrigerant pressure in chamber 24.

Adjacent to, but separated from, chamber 24 is a further chamber 30 in which is supported a further bellows 31 having a movable wall 32. A stem 33, carried by this movable wall, abuts a stem 34, carried by the bell 28 in bellows 27, whereby the valve needle 26 is placed, also, under the control of the movements of the movable wall 32 of bellows 31.

A feeler bulb 35 is placed in heat-exchanging relation with the refrigerant flowing from the evaporator 19 by way of conduit 20, and the interior of said bulb is connected to communicate with the interior of the bellows 31 through a tube 36. The bellows 31, feeler bulb 35, and tube 36 are filled with a suitable low-boiling-point fluid such as one of the Freons or ethane, nitrogen or helium.

The boiling point of Freon 22 is ordinarily considered to be -41° F. and the boiling point of Freon 13 is ordinarily considered to be -115° F., these being the fluids customarily used in the bellows 31 and bulb 35. In the system in which my invention is designed primarily for use, the temperatures desired to be attained range far below the boiling-points of such fluids. Since the fluid in the system, including the bellows 31 and the bulb 35, is intended to be placed in direct heat exchange relation with the refrigerant as it flows from such an extremely cold evaporator, it very often happens that the fluid will be cooled below its boiling-point and become liquefied. When this occurs, control of the expansion valve is completely destroyed, since such control depends upon the maintenance of a gaseous fluid in bellows 31.

In order to insure against such liquefaction of the control fluid, I presented, in my co-pending application identified above, a scheme for impressing upon the control fluid in bellows 31 the temperature of the refrigerant, flowing from the receiver toward the expansion valve, which is ordinarily maintained at substantially room temperature. I accomplished this by coiling a portion 37 of the conduit 17 about the valve body 21 in the region occupied by bellows 31. Thereby, heat from the refrigerant was supplied to the control fluid at a rate dependent upon the load demands on the evaporator.

Where the heat-loss from the evaporator is comparatively rapid so that the periods during which the compressor is not running (or in which the expansion valve is completely closed) are of comparatively short duration, such an expedient has proven quite satisfactory to prevent liquefaction of the control fluid. However, where such heat-loss is so small as to result in periods of relatively long duration during which the compressor is not running, the condition commonly referred to as "frost-back" will occur. When that happens, the conduit 20 leading from the evaporator will give up its heat to the evaporator and in turn become cooled to a temperature below the boiling-point of the control fluid in bulb 35. Very shortly thereafter, the fluid in the entire system including the bellows 31 will become all or partially liquefied and complete loss of control of the expansion valve will result.

By my present invention, I have eliminated the possibility of the occurrence of such a mishap. I have done so by providing means for insuring a continuous, though somewhat reduced, flow of refrigerant through the coiled portion 37 of conduit 17. Even during periods when the compressor is shut down, the refrigerant is maintained in the system, between the receiver and the

expansion valve, at a relatively high pressure. A one-way valve is conventionally provided on the inlet side of the receiver to prevent the loss of this pressure back towards the compressor, and the expansion valve itself, being closed during most of the time when the compressor is not running, prevents pressure loss in the direction of the evaporator.

I have found, therefore, that by providing a by-pass around the expansion valve to permit a constant, though somewhat reduced, flow of refrigerant through coils 37, sufficient heat will be transferred, from the slowly flowing refrigerant to the control fluid in bellows 31, to prevent liquefaction of the fluid.

I have illustrated such a by-pass in the form of a small tube 38, connected at one end to the conduit 17, between the coiled portion 37 thereof and the inlet passage 22 of valve body 21, and at the other end to the conduit 18 ahead of evaporator 19. It will be obvious, that the last-mentioned end of tube 38 could also be connected into conduit 20 at the outlet end of evaporator 19, but it will also be obvious that to do so would reduce the efficiency of the system since that portion of the refrigerant passing through the by-pass 38 would not pass through the evaporator. The illustrated form is, therefore, considered to be the optimum arrangement.

I have found that the optimum size of tube to use for bypass 38 is one having an internal diameter of approximately $\frac{1}{8}$ inch for those systems using compressors having a rating of one horse power or less, and an internal diameter of $\frac{1}{4}$ inch multiplied by the compressor rating for those systems using compressors having ratings greater than one horse power. By-pass diameters substantially less than these sizes will not pass sufficient refrigerant to prevent the occurrence of liquefaction of the control fluid; while by-pass diameters substantially greater than the stated sizes will materially reduce the efficiency of the system.

While I have illustrated and described my concept for providing for a continuous, though diminutive, flow of refrigerant through the coil 37 during periods when the compressor is not running, in the form of the by-pass tube 38, it will, I believe, be apparent to those skilled in the art, in light of this disclosure, that other, though perhaps less satisfactory, expedients for maintaining such continuous flow, could be provided, and it is not intended that the claims herein should be construed to limit my concept precisely to the construction illustrated. One such expedient could be, in the form of expansion valve here illustrated, the provision of a very small passage; such as shown at 40 in Fig. 2, for permitting a continuous, though relatively small flow of refrigerant from the inlet passage 22 into chamber 24, even when the valve needle 26 is solidly seated to close the port 25.

I claim:

1. A system of the class described comprising a compressor, a condenser, a first conduit means connecting said compressor to said condenser, an expansion valve, a second conduit means connecting said condenser to said expansion valve, an evaporator, a third conduit means connecting said expansion valve to said compressor through said evaporator, thermo-responsive means for actuating said expansion valve comprising means providing a chamber having a movable wall, means connecting said movable wall to actuate said valve, and a feeler bulb arranged in heat-exchanging relation with the refrigerant flowing from said evaporator, the interiors of said bulb and said chamber being in communication and filled with an expansible fluid, and means for preventing liquefaction of said expansible fluid comprising means providing a heat-exchanging relation between the refrigerant flowing in said second conduit and the fluid in said chamber, and means providing for a diminutive flow of refrigerant through the last-named means to

said fourth conduit means during periods when said expansion valve is closed.

2. In a system of the class described, a compressor, a condenser, a first conduit means connecting said compressor to said condenser, a receiver, a second conduit means connecting said condenser to said receiver, an expansion valve, a third conduit means connecting said receiver to said expansion valve, an evaporator, a fourth conduit means connecting said expansion valve to said evaporator, a fifth conduit means connecting said evaporator to said compressor, thermo-responsive means for controlling said expansion valve comprising means providing an expansible chamber having a movable wall, means operatively connecting said movable wall to actuate said valve, a feeler bulb mounted in heat-exchanging relation with the refrigerant in said fifth conduit means, and means providing communication between the interior of said bulb and the interior of said chamber, said bulb, said communication establishing means and said chamber being filled with an expansible fluid, a portion of said third conduit means being arranged in heat-exchanging relation with the fluid in said chamber, and means for maintaining a diminutive flow of refrigerant through said portion of said third conduit means during periods when said compressor is not running comprising means providing an uninterrupted, but restricted flow-path for refrigerant, flowing from said portion of said third conduit means, from the side of said expansion valve to which said third conduit means is connected, to the side of said valve to which said fourth conduit means is connected.

3. The system of claim 2 in which the last-named means comprises a tube of relatively small diameter connected between said third conduit means and said fourth conduit means to form a by-pass around said expansion valve.

4. The system of claim 3 in which said tube has an internal diameter equal to substantially $\frac{1}{8}$ inch for systems using compressors having a rating of one horse-power or less, and an internal diameter equal to substantially $\frac{1}{4}$ inch multiplied by the horse-power rating of the compressor for systems using compressors having a rating greater than one horse-power.

5. In a low temperature refrigerating system, a compressor, a condenser, a first conduit means connecting said compressor to said condenser, a receiver, a second conduit means connecting said condenser to said receiver, an expansion valve, a third conduit means connecting said receiver to said expansion valve, an evaporator, a fourth conduit means connecting said expansion valve to said evaporator, a fifth conduit means connecting said evaporator to said compressor, thermo-responsive means for controlling said expansion valve comprising means providing a variable-volume chamber having a movable wall, a feeler bulb arranged in heat-exchanging relation with said fifth conduit means, means providing communication between the interior of said bulb and the interior of said chamber, said bulb, said communication providing means and said chamber being filled with an expansible fluid having a boiling point below normal atmospheric temperatures but above the temperature desired to be attained at said evaporator, and means operatively connecting said valve to move in response to movements of said movable wall, and means for maintaining the fluid in said chamber above its boiling point comprising means establishing a heat-exchanging relation between a portion of said third conduit means and said chamber, and a tube of relatively small internal diameter connected to said third conduit means, at a point between said portion thereof and said expansion valve, said tube further being connected to said fourth conduit means to maintain a diminutive flow of refrigerant through said portion during periods when said expansion valve is closed.

5

6. In a refrigerating system which includes a thermostatically-controlled expansion valve controlling refrigerant flow from the receiver to the evaporator, said valve being dominated by an expansible fluid subject to the temperatures of the refrigerant flowing from the evaporator toward the compressor and acting upon a movable wall mechanically connected to move said valve, and means arranged to impress upon the fluid in said chamber the temperature of the refrigerant flowing from said receiver toward said expansion valve, the invention of means for maintaining a diminutive flow of refrigerant through the last-named means during times when said expansion valve is in its fully closed position, such means comprising means providing a by-pass for the refrigerant around said expansion valve.

7. The system of claim 6 in which said means providing said by-pass comprises a tube connected across the inlet and outlet sides of said expansion valve to permit a diminutive flow of refrigerant therethrough

6

at all times, said tube having an internal diameter of substantially $\frac{1}{64}$ inch for systems using a compressor having a rating of one horse-power or less, and an internal diameter of substantially $\frac{1}{64}$ inch multiplied by the horse-power rating of the compressor for systems using a compressor having a rating greater than one horse-power.

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