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REFRIGERATION

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Fig. 2

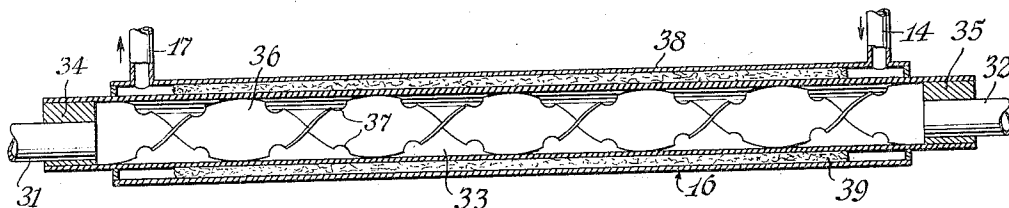


Fig. 1

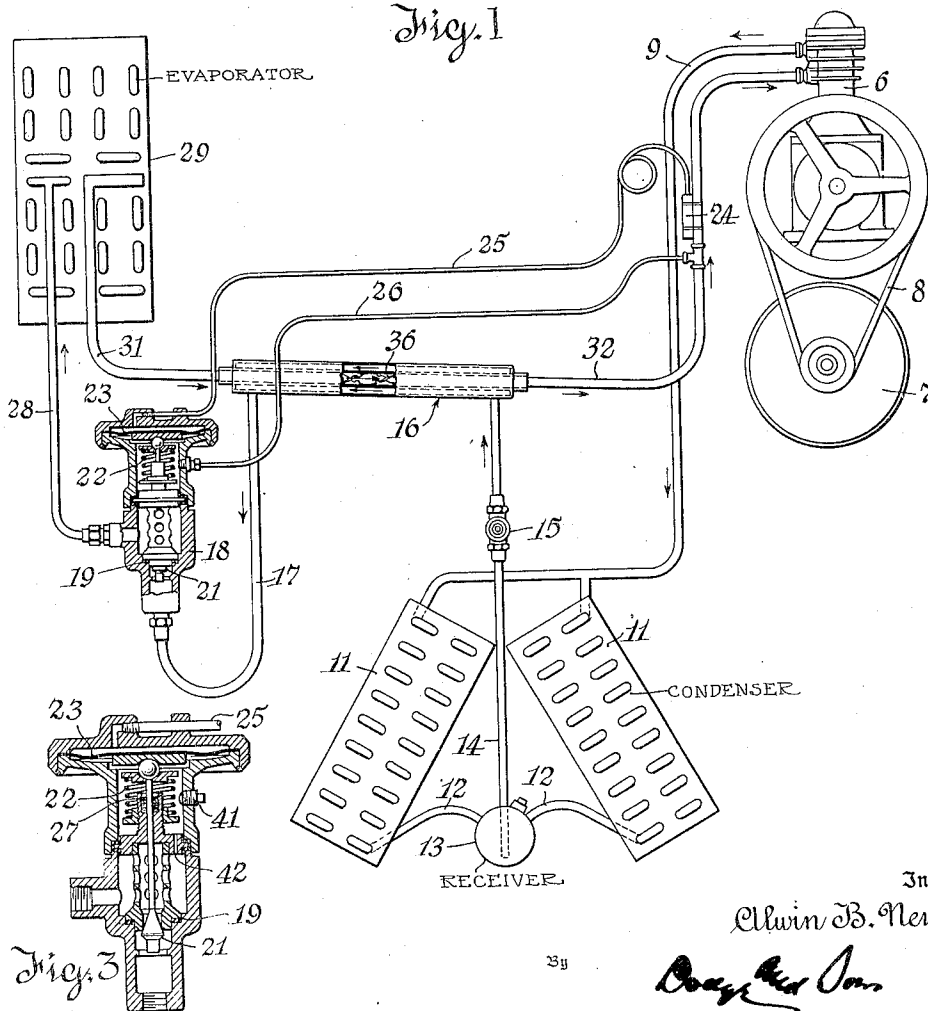


Fig. 3

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REFRIGERATION

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5 Claims. (Cl. 62—3)

This invention relates to refrigeration and provides a control mechanism particularly adapted for automatic systems.

One feature of the invention is the use of a heat exchanger to effect a heat interchange between warm liquid refrigerant leaving the condenser and cold refrigerant leaving the evaporator, partly for the purpose of improving the efficiency of the system, but chiefly for the purpose of insuring the evaporation of any liquid refrigerant leaving the evaporator and the development of a moderate degree of superheat in the vaporous refrigerant approaching the compressor.

Another feature of the invention is the control of an automatic expansion valve in such a way as to protect the compressor against the delivery thereto of any liquid refrigerant by taking advantage of the superheating effect of the exchanger just mentioned.

It has heretofore been the practice to control an automatic expansion valve partly or wholly in response to the temperature of refrigerant leaving the evaporator. A common arrangement was to control in response to temperature of refrigerant leaving the evaporator, the control being modified by pressure at the same point, or more commonly by pressure on the discharge side of the expansion valve. According to the present invention the control is effected either by the temperature of the suction line between the heat exchanger and the compressor modified by the pressure of the refrigerant at the same point, or, in cases where a constant speed compressor is used, by the pressure of refrigerant on the discharge side of the expansion valve. This last alternative arrangement is possible because where a constant speed machine is used the pressure drop through the evaporator and the heat exchanger is approximately constant so that a constant correction factor can be introduced in the adjustment of the expansion valve.

In any event the principle underlying the control is that if the expansion valve is so operated that refrigerant approaching the compressor is slightly superheated, no liquid refrigerant can be present. This follows from the fact that it is impossible under normal operating conditions to superheat the vapor in contact with the liquid.

A preferred embodiment of the invention will now be described in connection with the accompanying drawing, in which,—

Fig. 1 is a diagrammatic view chiefly in elevation but with certain parts shown in section,

of a refrigerating circuit embodying the invention.

Fig. 2 is a longitudinal axial section, on an enlarged scale, of the heat exchanger.

Fig. 3 is a slightly enlarged section of the expansion valve shown in Fig. 1, with certain modifications hereinafter described.

Referring first to Fig. 1, the air cooled compressor 6 is driven by an electric motor 7, or other suitable means, through a belt drive 8, and discharges compressed refrigerant through the line 9 and through an air cooled condenser 11, here illustrated as comprising two fin and tube units connected in parallel as to refrigerant flow and arranged to deliver liquefied refrigerant through the liquid lines 12 to the receiver 13. The dip pipe 14 delivers liquid refrigerant from the receiver through a normally open stop valve 15 to the outer annular shell of a heat exchanger, indicated generally at 16, and hereinafter more fully described. From the exchanger the liquid refrigerant flows through pipe 17 to the expansion valve, generally indicated by the numeral 18 applied to its body.

This expansion valve, for which no novelty is here claimed, comprises a valve seat member 19 and a poppet valve 21 urged upwardly, that is, in a closing direction, by a coil compression spring 22. The valve is forced in an opening direction by vapor pressure developed on a diaphragm 23 by evaporation of a volatile liquid in the thermostatic bulb 24 which is connected to the space above the diaphragm 23 by the small tube 25.

Pressure acting downwardly on the diaphragm 23 is opposed by vapor pressure conducted to the space below the diaphragm through a branch connection 26. A packing gland 27 (see Fig. 3) isolates the space below the diaphragm from the space on the discharge side of the expansion valve 21, so that the diaphragm 23 is not affected directly by pressure on the discharge side of the expansion valve.

Refrigerant passing the expansion valve flows through the pipe 28 to an evaporator 29 of the fin and tube type. From this a pipe 31 conducts refrigerant to the central passage of the exchanger 16, which is connected by a pipe 32 with the suction connection of the compressor 6. The thermostatic bulb 24, previously mentioned, is mounted on the pipe 32 between the heat exchanger and the compressor or is otherwise arranged to respond to the temperature of refrigerant flowing between the heat exchanger and the compressor. The pipe 26, previously men-

tioned, communicates with the interior of the pipe 32 at a point closely adjacent the bulb 24 so that the lower side of the diaphragm 3 is subject to the suction pressure in the system adjacent the bulb 24.

Referring now more particularly to Fig. 2, the heat exchanger 16 comprises a tube 33 with apertured plugs 34 and 35 in its ends. The tubes 31 and 32 communicate with the interior of the tube 33 through the plugs and are tightly connected to the plugs. Between the plugs 34 and 35 is a spirally twisted strip of metal 36 whose edges may be notched at intervals, as indicated at 37, or these notches may be omitted if desired. The function of the strip 36 is to impart a rotary or whirling motion to vapor flowing through the tubes 33. This develops sufficient centrifugal effect upon droplets of liquid which may be entrained with vapor leaving the evaporator to cause these droplets to move outward into contact with the inner surface of the tube 33 where they will be evaporated.

Surrounding the tube 33 and substantially co-extensive in length therewith, is a shell or jacket 38 which is filled with a filtering material 39. Bronze wool has been used in practice for this purpose, and serves effectively as an extension of the heat transfer surface. The exchanger is made of copper and the components are suitably brazed together. The pipe 14 conducts the liquid refrigerant to one end of the jacket and the pipe 17 withdraws it from the other end, the parts being so arranged that there is a counterflow relation between the cold vaporous refrigerant flowing from left to right and the warm liquid refrigerant flowing from right to left (as viewed in the drawing).

It will be observed that the expansion valve is controlled in response to the temperature and pressure of refrigerant between the exchanger 16 and the compressor 6, and the loading spring 22 is so adjusted and the parts are so proportioned that the valve 21 will be opened sufficiently to insure the existence of a slight degree of superheat in the pipe 32. This control takes advantage of such superheat as is imparted to refrigerant in the suction line by the heat exchanger, with the result that the expansion valve opens slightly wider than it would if the control were arranged according to conventional practice, at some point near the discharge from the evaporator, say on the pipe 31 in advance of the exchanger. By arranging the pressure and temperature controls at the same point, precise regulation in response to superheat may be had. In case the compressor 6 is a constant speed machine, the pressure drop from the expansion valve 18 through the evaporator 29 and heat exchanger 16 to the point at which the bulb 24 is located, is substantially constant. This means that the pressure on the discharge side of valve 18 is a simple function of the pressure in the pipe 32 adjacent bulb at 24. It follows, therefore, that where a constant speed machine is used the pipe 26 may be omitted and its connection plugged, as indicated at 41 in Fig. 3. In such case a port 42, also shown in Fig. 3, is drilled to afford communication from the space below the diaphragm 23 to the space on the discharge side of the expansion valve 21. This port is not present in the construction shown in Fig. 1.

In many cases this simplified arrangement may be used to provide a control which is approximately in response to superheat and sufficiently precise for ordinary commercial purposes.

The adjustment is primarily one of the stress in the loading spring 22. In any case the effect of the heat exchanger is beneficial and the novel location of the thermostatic bulb or of the thermostatic bulb and pressure connection, improves the operation of the evaporator because the evaporator may be operated completely flooded. The adjustment is such that slight slop-overs into the suction line 31 are unobjectionable, it being understood that the heat exchanger 16 will furnish sufficient heat to evaporate any liquid refrigerant which may reach the exchanger through the pipe 31 and supply such superheat as is desired. Because the evaporator is flooded, it will carry a heavier refrigerative load than would otherwise be practicable.

Certain modifications have been suggested and others within the scope of the invention are possible.

In order to show the invention in a commercial environment, it has been illustrated as embodied in a commercial room cooler in which the condenser is of the split air cooled type and in which the evaporator is interposed in the air stream to be cooled. In commercial practice the air is blown through the condenser by means not shown in the drawing, and air to be conditioned is fed in contact with the evaporator by a fan, not shown. The invention, however, is not limited to the use of any specific type of evaporator or condenser, nor is it limited to use in room coolers.

What is claimed is:—

1. The method of controlling the admission of refrigerant to the evaporator of a refrigerating circuit of the compressor, condenser, evaporator type, which comprises imparting heat to refrigerant flowing from the evaporator to the compressor by heat exchange with refrigerant flowing from the condenser to the evaporator, and regulating the admission of refrigerant to the evaporator in response to the combined effect of temperature and pressure of refrigerant, the temperature and pressure being sensed at approximately the same point after such heat has been imparted.

2. The combination of a compressor, a condenser and an evaporator, and connections connecting the same in the order stated, in a closed refrigerating circuit containing a volatile refrigerant; a surface heat exchanger so interposed in said circuit as to effect transfer of heat from liquid refrigerant flowing from the condenser to the evaporator with refrigerant flowing from the evaporator to the compressor; valve means serving to control the admission of refrigerant to the evaporator; and means for controlling said valve means, responsive at least in part to the temperature of refrigerant flowing from said exchanger to said compressor.

3. The combination defined in claim 2, in which the exchanger is so arranged that the liquid path surrounds the vapor path, the two being separated by means forming a transfer surface, and means are provided to cause whirling of the vapor in its path, whereby liquid particles entrained in the vapor are urged toward said transfer surface.

4. The combination of a compressor, a condenser and an evaporator, and connections connecting the same in the order stated, in a closed refrigerating circuit containing a volatile refrigerant; a surface heat exchanger so interposed in said circuit as to effect transfer of heat from liquid refrigerant flowing from the condenser to the evaporator with refrigerant flowing from the evaporator to the compressor; valve means serv-

ing to control the admission of refrigerant to the evaporator; and means for controlling said valve means, responsive to the opposing effects of temperature and pressure of the refrigerant flowing
5 from said exchanger to said compressor.

5. The combination of a refrigerating circuit of the compressor, condenser, evaporator circuit type; a heat exchanger arranged to effect transfer of heat from liquid flowing from condenser

to evaporator, to refrigerant flowing from evaporator to compressor; and automatic regulating means controlling flow of refrigerant in the circuit and responsive to the pressure and temperature of refrigerant approaching the compressor
5 for ensuring that the exchanger imparts superheat to the refrigerant heated thereby.

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