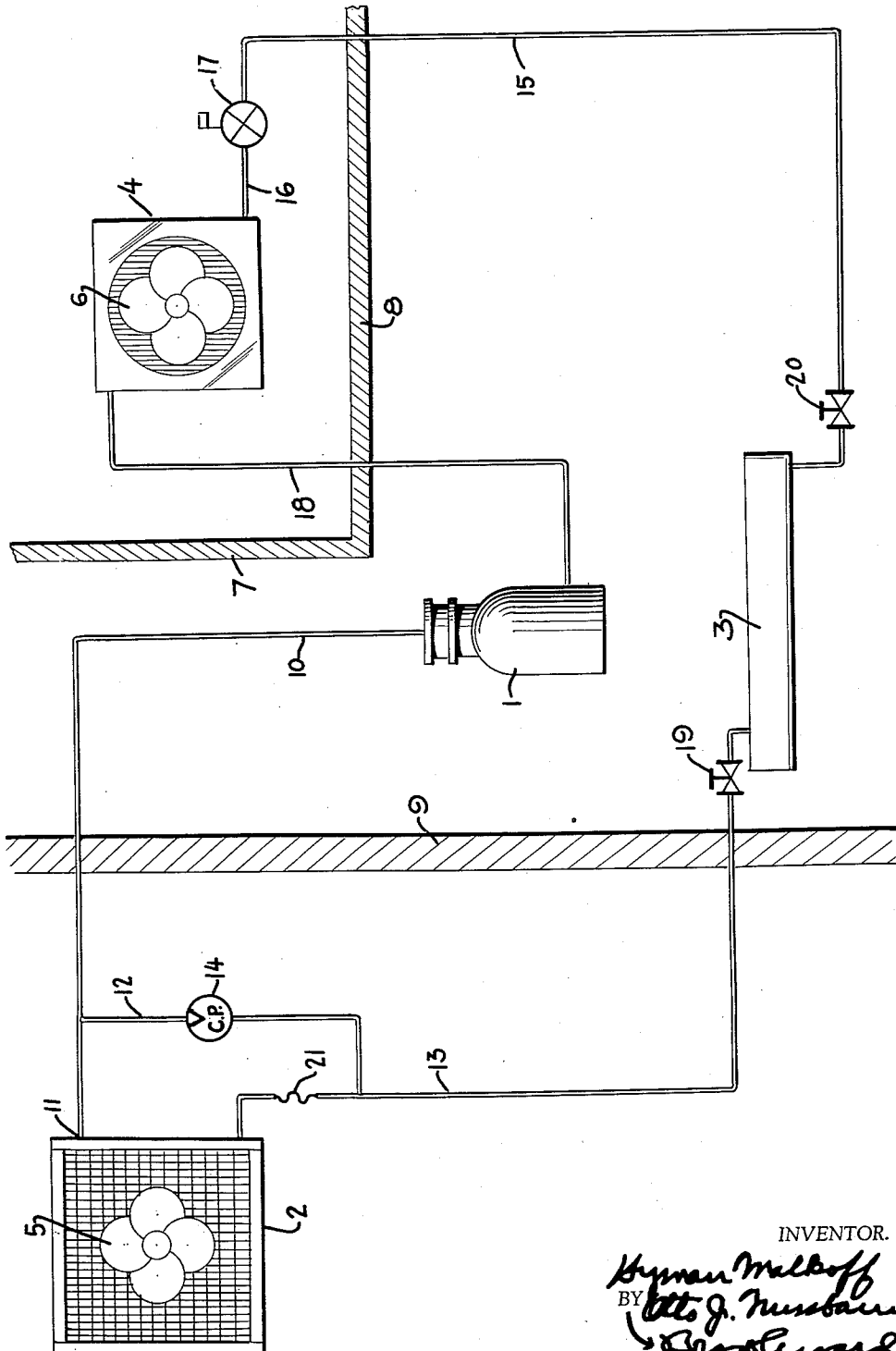


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IN REFRIGERATING SYSTEMS
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2

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MEANS FOR CONTROLLING HIGH SIDE PRESSURE IN REFRIGERATING SYSTEMS

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This invention relates to means for controlling the high side pressure in refrigerating systems, and has for an object to provide for regulating the level of the refrigerant in the condenser and correspondingly regulating the area of effective heat transfer surface inside the condenser.

Another object is to accomplish the above stated control by an arrangement which includes means for simultaneously supplying refrigerant to the inlet of the condenser and to its outlet conduit.

Another object is to provide such an arrangement which includes a device positioned between and connected with the compressor discharge and the condenser outlet conduit, which device is designed and adapted to maintain an approximately constant pressure at its outlet side.

Another object is to provide such an arrangement in which the constant pressure device is of the modulating type, such as a constant outlet pressure modulating valve.

Another object is to provide such an arrangement which includes refrigerant flow restricting means between the condenser and the connection of the constant outlet pressure device with the condenser outlet conduit.

Another object is to provide such an arrangement in which the control of high side pressure is automatically effective even though the condenser is located out-of-doors and subject to low ambient temperatures, and even though the heat load within the evaporator is subject to variations that affect pressure conditions.

A further object is to provide certain improvements in the form, construction and arrangement of the several parts, whereby the above named and other objects inherent in the invention may be effectively attained.

In brief summary, the invention is directed to refrigerating systems that include compressor, condenser and evaporator, and contemplates the automatic maintenance of an approximately constant pressure of predeterminable degree in the high side of the system, regardless of the cooling temperature affecting the condenser or the heat load in the evaporator, by regulating the area of effective heat transfer surface inside the condenser through provision of the arrangement set forth in the above recited objects.

A practical embodiment of the invention is diagrammatically represented in the accompanying drawing.

It is known to refrigeration engineers that, in a given system under a given evaporator heat load, the head or high side pressure is related to the condensing temperature of the refrigerant within the condenser, while the latter is governed by the relative temperature of the condensing medium or coolant acting upon the condenser to abstract heat from the refrigerant gas therewithin and effect its condensation. Thus, for instance, if air is the coolant, as in air-cooled condensers, and also in evaporative condensers, any radical fall in the ambient temperature can and frequently does result in such a decrease of head or high side pressure as sharply to reduce refrigerating capacity by lessening the rate of feeding of refrigerant through the usual thermostatic expansion valve,

and likewise deleteriously to affect defrosting of the evaporator by hot gas from the compressor. A similar condition can arise in the use of water as a coolant; and reduction in evaporator heat load will of itself occasion lessening of high side pressure in the system. The present invention is calculated to eliminate any such disadvantage or difficulty by automatic maintenance of satisfactory high side pressure regardless of ambient conditions to which the condenser is subjected, and heat load to which the evaporator is subjected.

It may be pertinent here to mention that the heat transfer characteristics of evaporator and condenser differ markedly in that complete flooding of the former with refrigerant, as compared with partial flooding, enhances its heat transfer capacity; while complete flooding of the condenser nullifies its heat transfer capacity by preventing the compressor discharge hot gas from contacting the inner surface of the condenser and being liquefied. It is thus evident that graduated flooding of the condenser will cause graduated reduction of its heat transfer capacity with corresponding increase in the head or high side pressure of the system, and that control of this condition in the condenser can serve to maintain a predetermined minimum head or high side pressure regardless of variations in the ambient temperature at the condenser or evaporator heat load.

Referring to the embodiment of the invention illustrated in the accompanying drawing, the compressor is denoted by 1, the condenser by 2, the receiver by 3, and the evaporator by 4. These parts may be of any well known or approved form and construction, and the condenser and evaporator are preferably fitted with the usual fans, marked 5 and 6 respectively, driven by motors (not shown) and also preferably automatically controlled by customary means (not shown). The evaporator 4 is shown as located within a refrigeration chamber, two walls of which are marked 7, 8; and the compressor and receiver are shown as located within a building structure, one wall of which is denoted by 9, that also houses the refrigeration chamber 7, 8; while the condenser is shown as located without the building and subject to outside ambient temperature.

The compressor discharge is connected by a hot gas conduit 10, that traverses the building wall 9, with the inlet 11 of the condenser.

A branch conduit 12 connects the hot gas conduit 10 with the outlet conduit 13 of the condenser which leads to the receiver, so that this branch conduit provides communication between the hot gas conduit 10 and the receiver 3, and in this branch conduit 12 is positioned a device 14 that is designed and adapted to maintain an approximately constant pressure at its outlet side, i.e. its side that is toward the condenser outlet conduit and is the outlet for refrigerant gas passing through the said device from compressor to receiver. We prefer to use a constant outlet pressure modulating valve, but there may be substituted therefor other devices such as a constant pressure automatic expansion valve, or a solenoid valve combined with a pressure switch, or any other mechanism or combination thereof which will maintain its outlet or downstream pressure at the desired predetermined degree. The device may be modulating or not and may be adjustable or factory pre-set; but, we prefer to use one that is modulating and adjustable.

The outlet conduit 13 of the condenser is connected, as usual, with the inlet of receiver 3, the outlet of which is connected by the customary supply conduit 15 with the inlet 16 of the evaporator 4, a suitable pressure reducing device, such as a thermostatic expansion valve 17, being positioned in conduit 15 adjacent the evaporator. The outlet of the evaporator is in communication with the inlet of the compressor 1 by a suction conduit

18, as is the usual practice. Hand valves 19, 20, for servicing, are inserted in the conduits 13 and 15, respectively, at points close to the receiver 3; and it will be observed that the conduit 13 passes through the building wall 9 while the conduits 15 and 18 pass through the wall 8 of the refrigeration chamber.

Refrigerant flow restricting means is positioned in the outlet conduit 13 of the condenser between the condenser itself and the connection of the branch conduit 12, in which is fitted the constant outlet pressure device 14, with the conduit 13. The said restricting means is shown as a serpentine restrictor tube 21 of suitable internal diameter, but other devices could be substituted such, for instance, as a spring loaded check valve or a valve (preferably modulating) with inlet pressure control, or even an insert with properly sized orifice. The restrictor, of whatever form, should be designed to cause a pressure drop which is sufficient in magnitude to balance and hold up a column of liquid equal in height to the actual height of the condenser, and we have found that a pressure drop of four to six pounds per square inch is satisfactory. Such flow restricting means positioned at any point in the condenser circuit will serve to effect the desired pressure drop, but there are certain advantageous factors resulting from locating it at the condenser outlet, e.g. minimum reduction of condenser capacity which is of much importance in warm weather; and avoidance of undesirable increase of head pressure on the compressor especially during the periods of high pressure which immediately follow hot gas defrosting cycles. In these periods the location of the restrictor at the condenser outlet permits the condenser to act, so to speak, as a surge drum to absorb or, at least, lessen the effects of refrigerant surge.

It should also be noted that the branch conduit 12 may be connected to any portion of the high side of the system between the outlet of the condenser and the thermostatic expansion valve 17, though the connection to the conduit 13, as shown in the drawing, is convenient and efficient.

In the use of this system during normal temperature, which may be exemplified by a temperature of, say, 60° F. or higher, pressure conditions at outlet conduit 13 of the condenser may be expected to be such that the valve 14 is closed. Hence the hot refrigerant gas from the compressor discharge will flow through the conduit 10 and enter the condenser 2 at its inlet 11, be condensed therein and pass through conduit 13 into the receiver 3, from which latter the warm but condensed refrigerant will flow through supply conduit 15 to expansion valve 17 wherein such pressure reduction will take place as to cause the refrigerant to enter evaporator 4 in the form of cool liquid and gas. The usual vaporization of the cool liquid with its chilling effect upon the refrigeration chamber will take place in the evaporator and the vaporized refrigerant will flow from the latter through the suction conduit 18 to the compressor inlet for recompression and recirculation all as is familiar to those skilled in this industrial field.

If, now, the ambient temperature at the condenser 2 falls below 60° F., or such other degree of temperature as may have been selected for the opening of valve 14, the pressure at the outlet side of the latter will be reduced, causing this valve to open and supply an amount of hot refrigerant gas to the condenser outlet conduit 13, with the result that gas will be flowing to the condenser at both its inlet and outlet. The restricting effect of tube 21 will, however, cause the pressure in branch conduit 12 at its connection with the outlet conduit 13 of the condenser to be higher than the pressure at the condenser outlet, and the liquid resulting from condensation will accumulate in the condenser until it floods the interior of the latter to such an extent as to reduce the area of its effective heat transfer surface and thereby raise the pressure at the outlet side of valve 14 sufficiently

to impel the latter to close; whereupon the continued action of the compressor will cause the condensed refrigerant to be withdrawn from the condenser to the receiver and flow to the evaporator for the normal refrigerating function.

It will thus be seen that the accelerated functioning of the condenser due to lower ambient temperature, resulting in reduced pressure at the outlet side of valve 14, will be counterbalanced by reduction in the area of its internal heat transfer surface; and, as the difference in operating pressure across valve 14 is slight, i.e., two to five pounds per square inch, the effect of the said valve in maintaining a nearly constant pressure at its outlet side results in the maintenance of a nearly or approximately constant pressure throughout the high side of the system, i.e., from compressor discharge to the thermostatic expansion valve 17. As already indicated, when the flooding of the condenser resulting from the flow of refrigerant to both its inlet and outlet has served the purpose of reducing the area of internal heat transfer surface to the needed extent, valve 14 will close due to rise in pressure at its outlet and the condensed refrigerant will resume its outflow through conduit 13 to receiver 3. Thus, a constant balance is automatically maintained between the effective ambient temperature and the effective heat transfer surface area of the condenser to obtain the objective of constant high side pressure in the system, and the refrigerant reaches the expansion valve 17 at a pressure sufficient to cause flooding of the evaporator 4 regardless of low ambient temperature at the condenser.

The effects just recited as resulting from drop in ambient condenser temperature will also be occasioned by drop in heat load of the evaporator, because that will reduce pressure at the condenser and the outlet of valve 14 even in the absence of the temperature drop.

It should be mentioned that the valve 14 should be located above the flooding level of the condenser in order to avoid the possibility of the existence of any liquid head on its outlet side which might hamper its proper functioning with respect to opening and the supplying of a modulated amount of refrigerant gas to the condenser outlet.

Referring to the operation of the invention, it should be stated that, when the valve 14 opens and permits refrigerant gas to flow to the outlet conduit of the condenser, the gas does not necessarily actually enter the condenser. It may to some extent or it may not, and it may not even reach the condenser. But, in any event, the flow of the gas to the condenser outlet conduit establishes a pressure condition which restrains the outflow of condensed refrigerant from the condenser and thus causes the accumulation of liquid in the condenser to reduce its area of effective heat transfer surface, as above explained. It is in this sense that, in the specification we describe and in the claims we call for, a branch conduit adapted to permit the flow of refrigerant gas to the condenser outlet under certain conditions, and we do not intend that language to be limited by the understanding that the gas actually enters the condenser or even reaches the outlet thereof; it being sufficient that the gas flow establishes the above mentioned pressure condition at the outlet of the condenser.

We desire it to be understood that various changes may be resorted to in the form, construction, material and arrangement of the several parts of the system without departing from the spirit or scope of the invention, and hence, we do not intend to be limited to details herein shown or described except as the same may be included in the claims or be required by disclosures of the prior art.

What we claim is:

1. In a refrigerating system including operatively interconnected compressor, condenser, evaporator, receiver, and a refrigerant pressure reducing device posi-

5

tioned in operative relationship to the evaporator inlet, means for automatically preventing the refrigerant pressure in the high side of the system adjacent the said pressure reducing device from falling below a predetermined minimum, regardless of ambient temperature at the condenser or heat load in the evaporator, by controlling the level of the liquid refrigerant in the condenser and thus regulating the area of effective heat transfer surface inside the condenser, said means comprising, a hot gas conduit connecting compressor discharge with the condenser inlet, a condenser outlet conduit connecting the condenser with the receiver inlet, a branch conduit extending from the hot gas conduit and providing communication between the hot gas conduit and the receiver, a constant outlet pressure modulating valve in the branch conduit for establishing temporary pressure conditions to restrain flow of refrigerant from the condenser outlet to the receiver whenever condenser pressure drops below a predetermined minimum degree, together with refrigerant flow restricting means in the condenser outlet conduit adapted to establish a predetermined refrigerant pressure drop in the said conduit for cooperating with the said valve in the branch conduit.

6

2. A system as defined in claim 1, in which the branch conduit connects the hot gas conduit with the condenser outlet conduit, and the refrigerant flow restricting means in the condenser outlet conduit is positioned between the condenser and the connection of the branch conduit with the condenser outlet conduit.

3. A system as defined in claim 1, in which the refrigerant flow restricting means is adapted to cause a refrigerant pressure drop sufficient in magnitude to balance and hold up a column of liquid refrigerant equal in height to the actual height of the condenser.

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