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E. L. SCHULZ ET AL

2,523,451

LOAD-RESPONSIVE REFRIGERATION CONTROL

Filed Feb. 2, 1946

FIG. 1

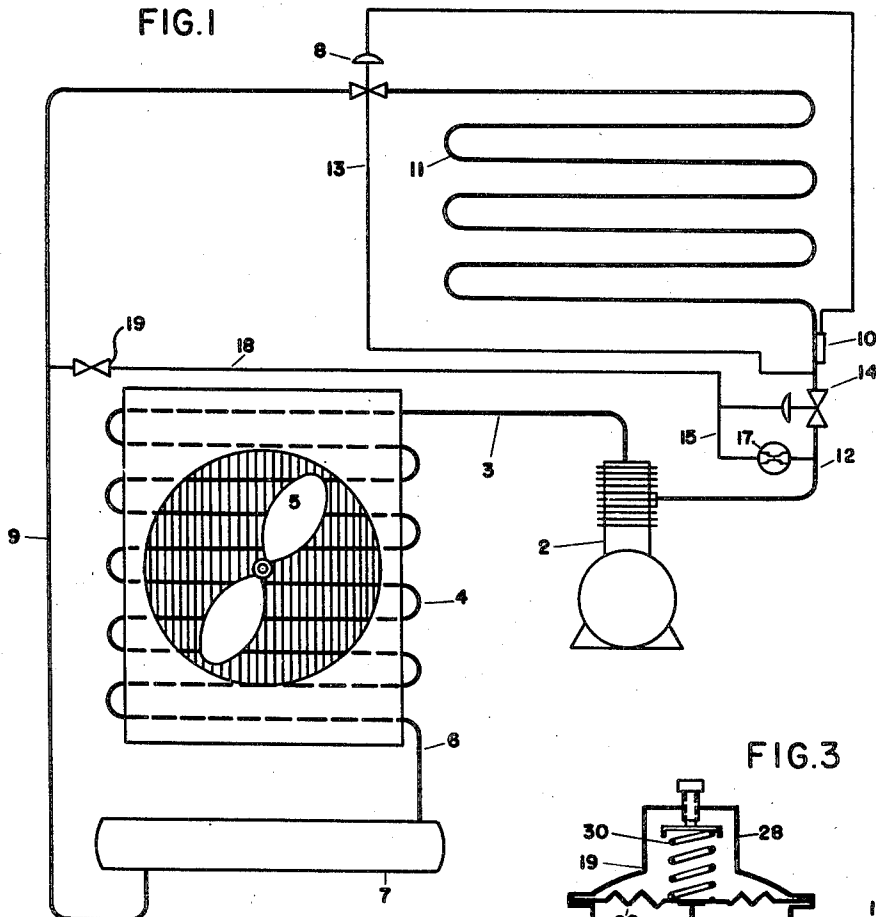


FIG. 3

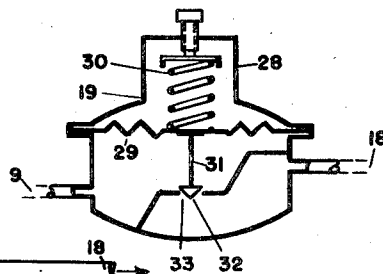


FIG. 2

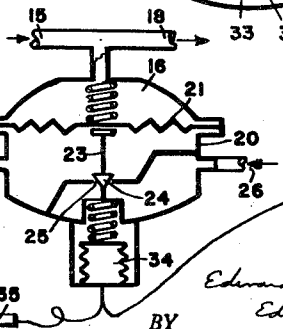
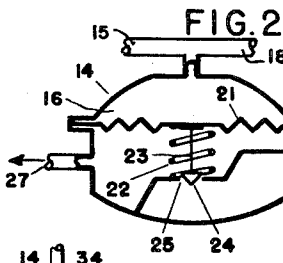


FIG. 6

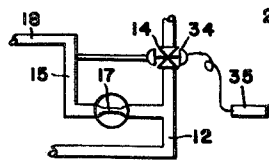


FIG. 4

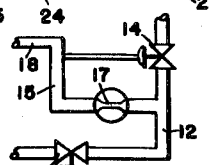


FIG. 5

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LOAD-RESPONSIVE REFRIGERATION
CONTROL

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4 Claims. (Cl. 62—2)

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This invention relates to the art of refrigeration and more particularly to a control arrangement for regulating production of refrigeration effect, the control arrangement being responsive to variation in load conditions and being adapted to compensate for overload conditions arising from unforeseen causes. The control arrangement may also be responsive to the temperature of the area being served to compensate for conditions of partial load.

The chief object of the present invention is to provide a simple and effective control arrangement for regulating evaporator pressure in accordance with an increase in condenser pressure above a predetermined level.

An object of the invention resides in the provision of a control arrangement in the low side of a refrigeration system which is responsive to an increase in pressure above a predetermined level in the high side of the system to reduce the quantity of refrigerant returning to the compressor thereby increasing the evaporator temperature when the condenser pressure exceeds a predetermined maximum.

A further object is to provide a control arrangement for a refrigeration system in which control means are disposed in the suction line, the control means being responsive to an increase in condenser pressure above a predetermined level, and serving to limit the quantity of refrigerant passing to the compressor to an amount which can be handled safely by the compressor.

A further object is to provide a ready and simple control arrangement for decreasing or increasing the quantity of refrigerant returning to the compressor when the temperature of an area being served varies from a predetermined level.

In the operation of refrigeration systems it is usual to employ an expansion valve for maintaining a predetermined super-heat at the exit or discharge end of the evaporator. The expansion valve is usually set to provide a super-heat of 12° to 15° as may be desired.

The expansion valve tries to maintain this degree of super-heat in the suction line regardless of any undesirable situation such as excessive head pressure which may develop in the rest of the system. This is true particularly of liquid charged expansion valves. However, gas charged expansion valves do limit excessive head pressure to a certain extent since they remain closed until the suction pressure drops below a certain predetermined point depending on the charge of the thermal bulb. These types of ex-

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pansion valves do not protect the rest of the system against the effect of excessive head pressure caused by unusual conditions such as excessively high ambient temperatures, dirty condenser surfaces, or break-down of the cooling system. A conventional refrigeration machine is usually protected against such conditions by a high pressure switch which stops the refrigeration machine. This gives protection but at the same time cuts off all refrigeration and hence the use of such device per se is undesirable and unsatisfactory.

This invention is designed to obviate such undesirable results by reducing the amount of refrigerant admitted to the compressor to that which may be handled safely by the compressor. As a result, regardless of deficiencies in the operation of the condenser or regardless of load conditions affecting the system, the control arrangement will enable the system to function effectively with maximum utility having due regard for such impairment as may affect any of the component parts.

The control arrangement of the present invention is directed to a simple and ready means of controlling the amount of refrigerant admitted or returned to the compressor, such means being responsive to an increase in condenser pressure above a predetermined level to limit the quantity of refrigerant flowing through the system to that which can be handled safely by the compressor without overload.

The attached drawings illustrate a preferred embodiment of our invention in which:

Figure 1 is a diagrammatic view of a refrigeration system illustrating a preferred embodiment of the present invention;

Figure 2 is a diagrammatic view of a control valve for use in the system of Figure 1;

Figure 3 is a diagrammatic view of a relief valve for use in the system shown in Figure 1;

Figures 4 and 5 are fragmentary views illustrating modified forms of the invention;

Figure 6 is a diagrammatic view of a control valve for use in the system of Figure 4.

Referring to the drawings, there is shown a compressor 2 of the reciprocating type, although it may be of any desired type, adapted to discharge compressed refrigerant gas through a line 3 to condenser 4. Condenser 4 may be air or water cooled as desired. As illustrated, condenser 4 is air cooled by means of fan 5. Condensed refrigerant passes through line 6 to receiver 7. Receiver 7 is connected to an expansion valve 8 by means of a discharge line 9. Expansion valve 8

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operates in the usual manner under the control of bulb 10 attached to the discharge side of evaporator 11 to maintain a predetermined superheat in the refrigerant discharged from evaporator 11. Evaporator 11 is connected to expansion valve 8 and is joined to compressor 2 by suction line 12. An equalizer line 13 is provided connecting expansion valve 8 and suction line 12. Equalizer line 13, as is well known in the art, serves to equalize pressure imposed upon the diaphragm of expansion valve 8.

A control valve 14 is disposed in suction line 12. A line 15 connects the chamber 16 of valve 14 to suction line 12 as will be hereinafter explained. An orifice 17 is disposed in line 15. The chamber 16 of control valve 14 is connected to discharge line 9 by means of a line 18. A relief valve 19 is disposed in line 18. Under normal conditions relief valve 19 remains in a closed position preventing passage of refrigerant through line 18.

Control valve 14 is shown diagrammatically in Figure 2. Valve 14 includes a housing 20 containing chamber 16. A diaphragm 21 is disposed within the chamber. One side of the diaphragm is exposed to pressure exerted through lines 15 and 18 while forces are exerted upon the opposite side of the diaphragm by means of a spring 22. A valve stem 23 carrying a valve member 24 is adapted to close a port 25 in the valve. Under normal conditions refrigerant enters the housing 20 through port 26, passes through port 25 and leaves the housing through port 27.

Relief valve 19 is shown diagrammatically in Figure 3. Valve 19 includes a housing 28 having a diaphragm 29 disposed therein. A spring 30 is disposed on one side of diaphragm 29 and is adapted to exert forces thereon to flex the diaphragm in one direction. The opposite side of the diaphragm is exposed to condenser pressure in line 9. A valve stem 31 is secured to one side of diaphragm 29 and carries a valve member 32 adapted to close a port 33 in the valve. An increase in condenser pressure above a predetermined level flexes diaphragm 29 in an opposite direction and moves valve member 32 away from port 33 permitting the passage of refrigerant through the valve.

Under normal conditions of operation valve member 14 remains in an open position. Assume, however, an increase in condenser pressure above a predetermined level, for example 200 pounds; under such conditions, relief valve 19 is moved toward an open position permitting condenser pressure to be exerted against the diaphragm 21 of valve 14 thereby urging valve 14 toward a closed position. It will be appreciated orifice 17 in line 15 prevents the refrigerant flowing to the suction line in large quantities and assures that condenser pressure is exerted upon the diaphragm of valve 14. Movement of valve 14 toward a closed position decreases the quantity of refrigerant passing to the compressor to an amount which can be handled safely by the compressor. The movement of valve 14 toward a closed position also serves to increase the evaporator pressure in an amount corresponding to the increase in condenser pressure. Upon a decrease in condenser pressure below a predetermined level relief valve 19 is permitted to close, thus preventing the action of condenser pressure upon valve 14 and permitting valve 14 to be moved toward an open position thereby increasing the quantity of refrigerant being supplied to the compressor.

Under some conditions it is desirable that valve 14 also be responsive to the temperature of an area being served. If desired, as shown in Fig-

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ures 4 and 6 valve 14 may include a diaphragm or bellows 34 responsive to the temperature of an area being served as reflected by a bulb 35 disposed in such area. A decrease in temperature in the area being served below a predetermined level as reflected by bulb 35 moves valve 14 toward a closed position thereby reducing the quantity of refrigerant passing through compressor 2 in accordance with the requirements of the reduced load imposed upon the refrigeration system. If desired, a second control valve 40, as shown in Figure 5 may be provided in the suction line for this purpose.

The present invention provides a ready and simple control arrangement for a refrigeration system to regulate the refrigeration effect in response to variations in load conditions. The system compensates for overload conditions arising from unforeseen causes and may be designed to compensate for partial load conditions arising from a decrease in load imposed upon the system. The control means so provided compensate automatically for conditions resulting in overload of the system and serve to reduce the quantity of refrigerant supplied to the compressor to an amount which can be handled safely by the compressor.

While we have described and illustrated a preferred embodiment of our invention, it will be understood our invention is not limited thereto since it may be otherwise embodied within the scope of the following claims.

We claim:

1. In a refrigeration system, the combination of a compressor, a condenser connected to the compressor, an expansion valve, a discharge line connecting the expansion valve and the condenser, an evaporator connected to the expansion valve, a suction line connecting the evaporator with the compressor, means for governing the operation of the expansion valve in response to temperature in the suction line, a control valve disposed in the suction line, a line connecting the control valve with the discharge line, and second means in said connecting line for controlling passage of refrigerant therethrough, an increase in pressure in the discharge line above a predetermined level opening said second means and permitting the increase in pressure to be exerted on the control valve tending to move the control valve toward a closed position, movement of the control valve toward a closed position decreasing the quantity of refrigerant passing through the suction line.

2. In a refrigeration system, the combination of a compressor, a condenser connected to the compressor, an expansion valve, a discharge line connecting the expansion valve and the condenser, an evaporator connected to the expansion valve, a suction line connecting the evaporator and the compressor, means for governing the operation of the expansion valve in response to temperature in the suction line, a control valve disposed in the suction line, a line connecting the control valve with the discharge line, a relief valve disposed in said connecting line, said relief valve being responsive to an increase in condenser pressure above a predetermined level to open permitting such pressure to be exerted upon the control valve, the increased pressure serving to move the control valve toward a closed position to decrease the quantity of refrigerant passing through the suction line.

3. In a refrigeration system, the combination of a compressor, a condenser connected to the compressor, an expansion valve, a suction line connecting the compressor and the expansion

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valve, an evaporator connected to the expansion valve, a suction line connecting the evaporator and the compressor, means for governing the operation of the expansion valve in response to temperature in the suction line, a control valve in the suction line, a line extending from the control valve to the suction line to permit pressure in the suction line to be exerted upon the diaphragm of the valve, an orifice in said line, a second line connecting the control valve with the discharge line, and means in the second line adapted to close said second line, said means in response to an increase in pressure above a predetermined level moving toward an open position to permit pressure in the line to be exerted upon the diaphragm of the control valve, the increase in pressure tending to move the control valve toward a closed position to decrease the quantity of refrigerant passing through the suction line.

4. In a refrigeration system, the combination of a compressor, a condenser connected to the compressor, an expansion valve, a discharge line connecting the expansion valve and the condenser, an evaporator connected to the expansion valve, a suction line connecting the evaporator and the compressor, means for governing the operation of the expansion valve in response to temperature in said suction line, a control

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valve disposed in the suction line, said control valve including a diaphragm disposed within a chamber, a line connecting the chamber to the suction line, an orifice in said line, a second line connecting the chamber of the control valve to the discharge line, a relief valve in said second line closing said line to prevent pressure in the discharge line influencing movement of the control valve, an increase in pressure in the discharge line above a predetermined level tending to move the relief valve toward an open position permitting such pressure to be exerted against the diaphragm of the control valve thereby urging the control valve toward a closed position to decrease the quantity of refrigerant passing through the suction line.

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