Aug. 31, 1937. A. S. LOCKE 2,091,787

EXPANSION VALVE MECHANISM FOR REFRIGERATING SYSTEMS

Filed Sept. 28, 1935

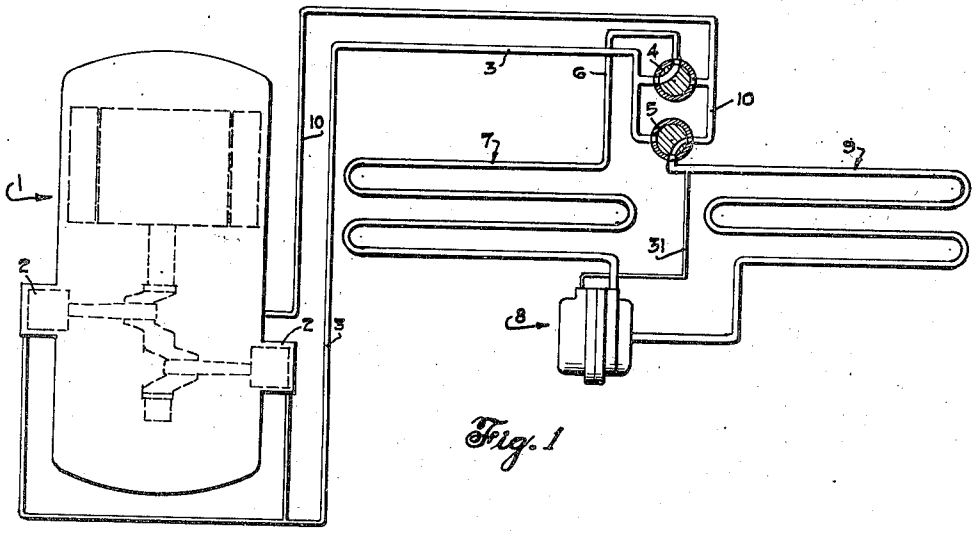


Fig. 1

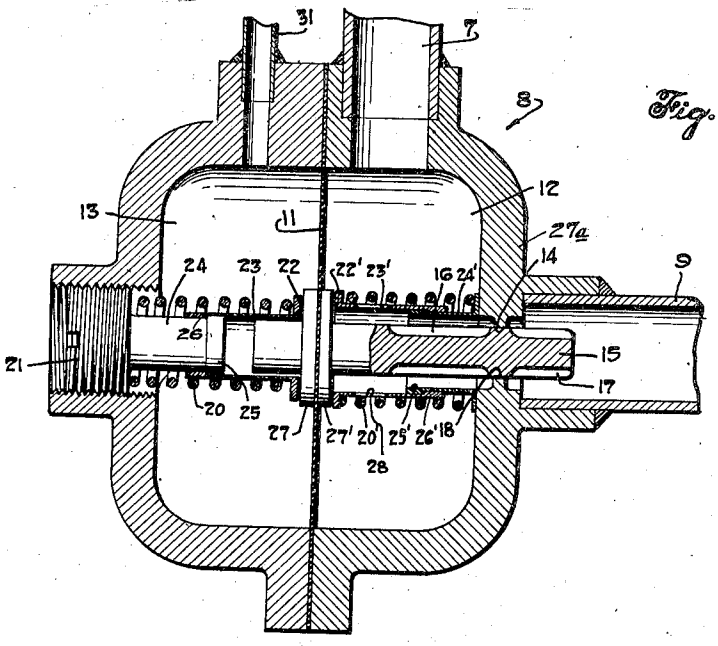


Fig. 2

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Patented Aug. 31, 1937

2,091,787

UNITED STATES PATENT OFFICE

2,091,787

EXPANSION VALVE MECHANISM FOR REFRIGERATING SYSTEMS

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Application September 28, 1935, Serial No. 42,591

8 Claims. (Cl. 62—8)

This invention relates generally to a refrigeration system in which the functions of a condenser and evaporator are interchanged for heating or cooling purposes, and relates more particularly to an improved expansion valve mechanism for such a system.

Various expansion valve and trap arrangements have heretofore been proposed for use in refrigerating systems of the type wherein the condenser and evaporator functions are interchanged, but the valve or trap devices have certain defects either in expense, complication of structure or delay in bringing the refrigerating cycle up to normal.

It is one object of my invention to provide an improved expansion valve mechanism operable to control flow of high pressure refrigerant in either direction therethrough with equal degrees of effectiveness and to do so with a device which is relatively simple in structure and mode of operation.

A further object is to provide an improved dual functioning expansion valve mechanism that is operable with either cycle to prevent flow of refrigerant during the period in which the refrigerant is being pumped up to substantially its normal high pressure. As a result of this improved mode of operation, there is the possibility of accumulating condensed refrigerant at the expansion valve orifice before opening thereof regardless of the direction of flow therethrough. Hence there is little likelihood of gas flowing through the expansion valve orifice during the initial operation of the refrigeration cycle. A further result of my improved mechanism particularly in combination with the condenser and evaporator is that the expansion valve orifice, in either direction of fluid flow therethrough, will be controlled automatically in accordance with the rate of evaporation of the liquid refrigerant.

Other objects and advantages will be more apparent to those skilled in the art from the following description of the accompanying drawing in which:

Fig. 1 is a diagrammatic outline of a compressor, a pair of complementary heat exchange elements functioning respectively either as a condenser or evaporator, and my improved expansion valve mechanism;

Fig. 2 is an enlarged sectional view of the expansion valve mechanism.

In the particular embodiment of the invention which is disclosed herein merely for the purpose of illustrating one specific form among possible others that the invention might take in practice, I have shown in Fig. 1 a motor-compressor unit 1 specifically of the piston and cylinder type although it will be understood that any other suitable form of compressor may be employed. High pressure refrigerant is discharged from cylinders 2 thence through a high pressure pipe 3 connected to two reversing valves 4 and 5. With the valves in the position as shown, the high pressure fluid flows through a pipe 6 to one of the heat exchange elements 7 now functioning as a condenser. The high pressure fluid thence flows through the expansion valve mechanism generally indicated at 8 and through the other heat exchange element 9 now functioning as an evaporator. The element 9 then communicates through valve 5 with a suction pipe 10 leading to the intake of the compressor. When valves 4 and 5 are rotated through 90°, discharge pipe 3 is connected through valve 5 to heat exchange elements 9 and suction pipe 10 is connected through valve 4 to pipe 6, thereby reversing the evaporator and condenser functions of the heat exchange elements. It will be understood that any suitable medium such as air or water is circulated over the heat exchange elements 7 and 9 depending upon the type of heat transfer system that is employed.

The specific expansion valve mechanism comprises a split casing with a diaphragm 11 interposed therebetween, thereby forming two chambers 12 and 13. An expansion orifice 14 is formed in one wall of chamber 12 while a valve 15, secured to the diaphragm, is slidably received within said orifice and has flutes 16 and 17 terminating short of each other to provide a continuous peripheral portion 18 of suitable axial length depending upon how far it is desired to have the valve move before permitting flow of refrigerant through the expansion orifice. A spring 20 is interposed between an adjustable plug 21 and a flange 22 of a sleeve 23, the plug being suitably hermetically sealed after adjustment. This sleeve is slidably supported upon a cylindrical guide 24 formed integrally with plug 21, while a stop flange 25 is adapted for engagement with a shoulder 26 formed on sleeve 23. This arrangement limits inward movement of flange 22 so that it is preferably just slightly spaced from a collar 27 of the diaphragm when in its neutral position as shown in Fig. 2. A similar spring and sleeve arrangement is provided on the other side of the diaphragm and the corresponding parts have the same reference numbers primed, it being noted however that guide 24' is hollow and somewhat larger than guide 24 so as to receive valve 15 and

is secured directly to the casing 27a. Any suitable number of ports or openings 28 may be formed in the elements 23' or 24' to permit free flow of refrigerant throughout the chamber or to the expansion orifice. Chamber 13 is in continuous communication with heat exchange element 9 as through a pipe 31.

In operation.—With the valves 4 and 5 in the position as indicated in Fig. 1, heat exchange elements 7 and 9 function respectively as a condenser and evaporator. Assuming that the compressor is not running and that the pressure throughout the system is equalized, then diaphragm 11 is in its neutral position and expansion valve 15 is in its closed position as shown in Fig. 2. Upon starting of the compressor, pressure will build up in condenser 7 and chamber 12 before the expansion valve 15 opens. Movement in a left hand direction of diaphragm 11 under this increasing pressure will be resisted by spring 20 up to some predetermined pressure at which accumulation of condensed liquid refrigerant in chamber 12 will be insured. When such a predetermined pressure has been reached, diaphragm 11 will then move to compress spring 20 and open expansion orifice 14. The spring 20' will be unable to move diaphragm 11 to the left because of stop flange 25' being in engagement with shoulder 26'. The movement of diaphragm 11 to the left is assisted by reason of chamber 13 being subjected to the suction pressure in the low pressure or evaporator side 9 of the system, this communication being established through a pipe 31. So long as the rate of evaporation is such that the suction pressure is maintained within its normal limits, then diaphragm 11 by being subjected to this suction pressure on its left side will permit the cooperating high pressure in chamber 12 to maintain expansion valve 15 in its open position, that is, so that liquid flows through flute 17 to pipe 9. However, if the rate of evaporation should decrease so that suction pressure in chamber 13 would increase to some predetermined value, then the forces on the diaphragm will tend to become balanced with the result that valve 15 will move in a right hand direction to either restrict or close off flow of condenser refrigerant through the expansion orifice. However, when the rate of expansion increases so that the suction pressure decreases, then the expansion orifice will again open in a left hand direction.

When the condenser and evaporator functions are interchanged by rotation of valves 4 and 5 through 90°, then high pressure in heat exchange element 9 (now functioning as a condenser) will be transmitted through pipe 31 to chamber 13, whereas chamber 12 by being connected to heat exchange element 7 (now functioning as an evaporator) will be subjected to suction pressure. Hence the operation of expansion valve 15 will be reversed to that above described. With this reversed operation, liquid will accumulate in the bottom of heat exchange element 9 adjacent to the right hand side of expansion orifice 14. The valve 15 will move in a right hand direction to permit flow of liquid refrigerant through flutes 16 and thence through chamber 12 to heat exchange element 7. In this reverse cycle of operation, the diaphragm will be working against spring 20' and accordingly the action of the expansion valve in response to variations in suction pressure will be controlled in the same manner as previously described for the other cycle of operation, wherein chamber 13 was subjected to suction pressure.

From the foregoing disclosure it is seen that I have provided a simple and effective expansion valve mechanism operative in a so-called reverse cycle refrigerating system so as to assist in having the expansion orifice open substantially only when there is an accumulation of liquid thereby preventing free flow of gas through the expansion orifice when the compressor is started. In previous expansion valves for reverse cycle refrigeration, if the compressor has been shut down and the system is filled only with refrigerant gas, then an appreciable period of time may be required to build up sufficient condenser pressure for effecting condensation of the refrigerant due to the fact that refrigerant gas will immediately start to flow through the orifice, whereas in my improved arrangement there is a definite stoppage of the flow of gas through the expansion orifice until a predetermined high pressure has been reached. It is also seen that the foregoing results are accomplished automatically in response to the direction of fluid flow through the heat exchange elements and that substantially similar pressure conditions operate the expansion valve mechanism in either direction of flow therethrough.

It will of course be understood that various changes in details of construction and arrangement of parts may be made by those skilled in the art without departing from the spirit of the invention as set forth in the appended claims.

I claim:

1. In combination, a refrigerating system having high and low pressure sides, means for interchanging said sides, an expansion orifice through which high pressure flows in either one of opposite directions depending upon which one of the sides of the refrigerating system is under high pressure, and means for controlling flow of refrigerant through said orifice in accordance with a predetermined pressure on the high side.

2. The combination set forth in claim 1 further characterized in that said control means includes a valve element for said orifice, a diaphragm to which said valve is operatively connected, and means forming a pair of pressure chambers on opposite sides of said diaphragm.

3. The combination set forth in claim 1 further characterized in that said control means includes a valve element for said orifice, a diaphragm to which said valve is operatively connected, means forming a pair of pressure chambers on opposite sides of said diaphragm, and means whereby said chambers communicate respectively with the opposite sides of the refrigeration system.

4. The combination set forth in claim 1 further characterized in that said control means includes a valve element for said orifice, a diaphragm to which said valve is operatively connected, means forming a pair of pressure chambers on opposite sides of said diaphragm, means whereby said chambers communicate respectively with the opposite sides of the refrigeration system, and a spring for resisting movement of the diaphragm in one direction from a neutral position.

5. The combination set forth in claim 1 further characterized in that said control means includes a valve element for said orifice, a diaphragm to which said valve is operatively connected, means forming a pair of pressure chambers on opposite sides of said diaphragm, means

whereby said chambers communicate respectively with the opposite sides of the refrigeration system, a spring for resisting movement of the diaphragm in one direction from a neutral position, and means for preventing said spring from moving the diaphragm in the opposite direction from said neutral position.

6. The combination set forth in claim 1 further characterized in that said control means includes a valve element for said orifice, a diaphragm to which said valve is operatively connected, means forming a pair of pressure chambers on opposite sides of said diaphragm, means whereby said chambers communicate respectively with the opposite sides of the refrigeration system, and a pair of springs adapted to resist movement of the diaphragm in either of opposite directions from a neutral position.

7. The combination set forth in claim 1 further characterized in that said control means includes a valve element for said orifice, a diaphragm to which said valve is operatively connected, means forming a pair of pressure chambers on opposite sides of said diaphragm, means whereby said chambers communicate respectively with the opposite sides of the refrigeration system, a spring for resisting movement of the diaphragm in one direction from a neutral position, means for preventing said spring from moving the diaphragm in the opposite direction from said neutral position, and means for preventing said springs from moving said diaphragm in either direction past said neutral position.

8. Expansion apparatus for a refrigerating system having high and low pressure sides adapted to be interchanged comprising, in combination, an expansion orifice, a valve for controlling refrigerant flow therethrough in either one of opposite directions depending upon which side of the refrigerating system is under high pressure, and pressure responsive means for actuating said valve to control flow of refrigerant through said orifice in accordance with a predetermined pressure on the high side.

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