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(54) **Refrigerating system.**

(57) A refrigerating apparatus with a differential pressure valve comprising: a rotary compressor, a condenser, a differential valve, an evaporator, and a check valve, all these being connected in series by piping, the differential pressure valve having first and second stage throttles before and after the valve, the pressure differential valve being structured so that a pressure intermediate between those of the first stage throttle and the second stage throttle is opposed, through a diaphragm, by the pressure on the suction side of the rotary compressor and that the valve is actuated by the difference of the two pressures.

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BACKGROUND OF THE INVENTION

The present invention relates to a refrigerating system with reduced restarting load and more particularly to a refrigerating system with a differential pressure value to block a circuit to prevent condensed medium from flowing into an evaporator when a compressor operation is stopped.

Improvement in power efficiency of the refrigerator is achieved by balancing the cooling medium pressure before and after the compressor when the compressor is stopped and by blocking the flow of condensed medium into the evaporator while at the same time keeping the high pressure of the condensed medium in the condensor, in order to reduce the restarting load.

For this purpose, it has been the common practice to provide a solenoid valve between the condensor and the capillary tube, which is operated by the compressor operation signal in such a way that it is opened during operation of the compressor and closed while in halt. With refrigerators which are usually used continuously for many hours, however, it is desirable to eliminate use of the solenoid valve even if the power consumption of the solenoid valve is small. It has also been pointed out that the solenoid valve operation can be noisy depending on the location of the refrigerator.

In recent years, therefore, a technology has been developed that employs a pressure valve in place of the solenoid valve.

Fig. 1 shows a refrigerating apparatus using the pressure valve accomplished according to the previous patent

application filed by the inventor of this invention. In this example, a rotary compressor A, a condenser B, a capillary tube C, and an evaporator D are connected in series by a pipe E; a differential pressure valve V1 is installed in the pipe between the capillary tube C and the evaporator D; a pressure introducing tube F is connected to the suction side of the rotary compressor A; and a check valve V2 is installed between the evaporator D and the rotary compressor A.

The differential pressure valve V1, as shown in Fig. 2, has a primary port 2 and a secondary port 3 formed in its body 1. Between these ports is formed a valve seat 4 with which a ball 5 comes into or out of contact. The ball 5 is provided on the secondary port side. At the top of the valve body 1 is mounted a diaphragm 8 which is held at its periphery by upper and lower covers 6, 7. A pressure chamber is formed in the upper cover 6 and is communicated with the pressure introducing tube F. A valve rod 9 is abutted against the underside of the diaphragm 8 and a spring 10 is installed between the rod 9 and the lower cover 7. The primary port 2 is connected with a pipe E1 coming from the capillary tube C and the secondary port 3 with a pipe E2 leading to the evaporator D.

In the above construction, during the operation of the rotary compressor A, the pressure loss of evaporator D and the force of spring 10 combines to cause the ball 5 to open, thus performing the cooling operation. When the compressor is stopped, the differential pressure valve V1 closes because of pressure increase on the suction side caused by back flow from the rotary compressor A and because of the pressure drop at the input of evaporator D or secondary port 3 caused by the absence of the evaporator's pressure loss.

In this construction the differential pressure valve is actuated by a small pressure difference between the pressure on the rotary compressor suction side and the relatively low pressure at the entrance of the evaporator. Therefore, once the operation starts, the pressure at the entrance of the evaporator becomes higher than the pressure on the suction side of the compressor whatever the external atmospheric condition may be. This enables the valve to be opened by a small spring load. That is, the differential pressure valve can be actuated by a slight pressure increase at the suction of the rotary compressor caused by the back flow of high pressure liquid. Thus, it is possible to prevent the back flow of high pressure liquid to the evaporator by rapidly actuating the differential pressure valve when the rotary compressor stops.

In the technique employed in the previous application, a capillary tube is provided as a throttle before the differential pressure valve. The cooling medium after passing through the throttle is reduced in pressure and can absorb heat, and therefore there is an energy loss in the pipe section leading to the refrigerating box.

To avoid this, it is desirable to install inside the refrigerating box the pipe section after the throttle including the valve. However, this is difficult due to space limitation.

SUMMARY OF THE INVENTION

To overcome the above drawback, the present invention has throttles before and after the differential pressure valve, with all these installed outside the refrigerating box, to perform the pressure reduction in two stages, thereby

preventing energy loss while maintaining response speed of the differential pressure valve when the compressor operation stops.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is an explanatory drawing of the prior art;

Figure 2 is a cross section of the differential pressure valve of the prior art; and

Figure 3 is one embodiment of this invention with the cross section of the differential pressure valve shown.

DETAILED DESCRIPTION OF THE EMBODIMENT

Fig. 3 shows an embodiment of the present invention in which the same reference numbers as those in the prior art structure represent the identical components. A rotary compresser A, a condenser B, a capillary tube C, a differential pressure valve V1,a second capillary tube C', an evaporator D, and a check V2 are provided. More specifically, said condenser B and said evaporator D are connected in series with each other. A first capillary tube C is provided in said series connection between said condenser B and evaporator D. Said rotary compresser A has a delivery side and a suction side. Said delivery side is connected to the condenser B whereas said suction side is connected to the evaporator D. Between said evaporator D and the suction side is provided the check valve V2.

Said differential pressure valve V1 is provided between the first capillary tube C and the evaporator D and has a valve section Vs and the control section Cs. Said second

capillary tube C' is provided between the differential pressure tube Vl and the evaporator D. There is further provided a pressure introducing tube F communicating the suction side of the rotary compressor with the control section Cs of the differential pressure valve Vl.

Said valve section Vs of the differential pressure valve Vl includes a valve body 1 having a primary port 2 and a secondary port 3. Said primary port 2 communicates with the first capillary tube C whereas said secondary port 3 communicates with the second capillary tube C'. Further, said primary port 2 defines a valve seat 4 within the valve body 1. Said valve body 1 has a bore 1' formed therein communicating with the first primary port 2 and the second primary port 3. A ball is housed within said bore 1' and adapted to rest on said valve seat 4. Said valve body 1 is formed with an annular groove 1" around said bore 1' at an axial end thereof.

Said control section Cs includes a housing H, a diaphragm 8 provided within said housing H to devide the same into a first chamber Rl and a second chamber R2 and a valve rod 9 extending within said second chamber longitudinally movably. Said valve rod 9 has a ring member 9' attached to the first end thereof to abut against the diaphragm 8. In other words, said diaphragm 8 is held at its periphery by upper and lower covers 6 and 7. Said first chamber Rl of the control section Cs communicates with the pressure introducing tube F. Said lower cover 7 has an opening to communicate said second chamber with the secondary port 3. Said valve body 1 is attached to the lower cover 7 such that said annular groove 1" and said bore 1' communicates the second chamber R2. Thus, the valve rod 9 is allowed to extend out of the control section Cs into the

bore 1' to actuate the ball 5 at a second end thereof for closure of the primary port 2. There is further provided a coil spring 10 within said annular groove 1" between the body 1 and the ring member 9'.

A star-shaped leaf spring 23 having radially extending portions is provided between the coil spring 10 and the ring member 9'. Said radially bent portions are bent to extend within said annular groove 1" and expand radially outward to contact the valve body 1 within the annular groove 1".

Since the pressure in the secondary port which is opposed, through the diaphragm 8, by the pressure increase at the suction side caused by back flow from the rotary compressor A, is intermediate between the pressure at the first stage throttle C and that at the second stage throttle C', the differential pressure valve can be quickly actuated. Also the capillary tube C' as a second stage throttle to achieve a desired pressure reduction can be installed inside the refrigerating box thus eliminating energy loss.

Since this invention has the above construction, the differential pressure valve can rapidly be actuated when the rotary compressor is stopped, thereby reducing the restarting load and eliminating energy loss during operation.

WHAT IS CLAIMED IS:

1. A refrigerating system comprising

a condenser and an evaporator connected in series with each other;

first throttle means provided in said series connection between said condenser and evaporator;

a rotary compressor having a delivery side and a suction side, said delivery side being connected to the condenser, said suction side being connected to the evaporator;

a check valve provided between said evaporator and said suction side of the rotary compressor;

a differential pressure valve provided between said first throttle means and said evaporator and having a valve section and a control section;

second throttle means provided between said evaporator and said differential pressure valve; and

a pressure introducing tube communicating the suction side of the rotary compressor with the control section of the differential pressure valve;

said valve section of the differential pressure valve including a valve body having a primary port therein communicating with the first throttle means and defining a valve seat within the valve body and a secondary port communicating with the second throttle means, a ball housed within said valve body and adapted to rest on said valve seat;

said control section including a housing, a diaphragm provided within said housing to devide the same into a first chamber and a second chamber, and a valve rod extending within said second chamber longitudinally movably and abutting against said diaphragm at a first end thereof;

said first chamber of the control section communicating with said pressure introducing tube;

said second chamber of the control section having an

opening to communicate said same second chamber with the secondary port and to allow the valve rod to extend out of the control section into the valve section to actuate at a second end thereof said ball for closure of the primary port.

2. A refrigerating system according to claim 1, wherein said valve body is formed with a bore in communication with the primary port and the secondary port.

3. A refrigerating system according to claim 2, wherein said valve body has an annular groove around the bore at an axial end thereof.

4. A refrigerating system according to claim 3, further including resilient means for maintaining the abutment of the valve rod against the diaphragm.

5. A refrigerating system according to claim 4, wherein said valve rod has a ring member attached to the first end thereof, said resilient means including a coil spring installed within said annular groove between the valve body and the ring member.

6. A refrigerating system according to claim 5, further including a leaf spring held between said coil spring and said ring member, said leaf spring being start-shaped and having radially extending portions bent to extend within said annular groove and to expand outward to contact said valve body within the annular groove.

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FIG. 1

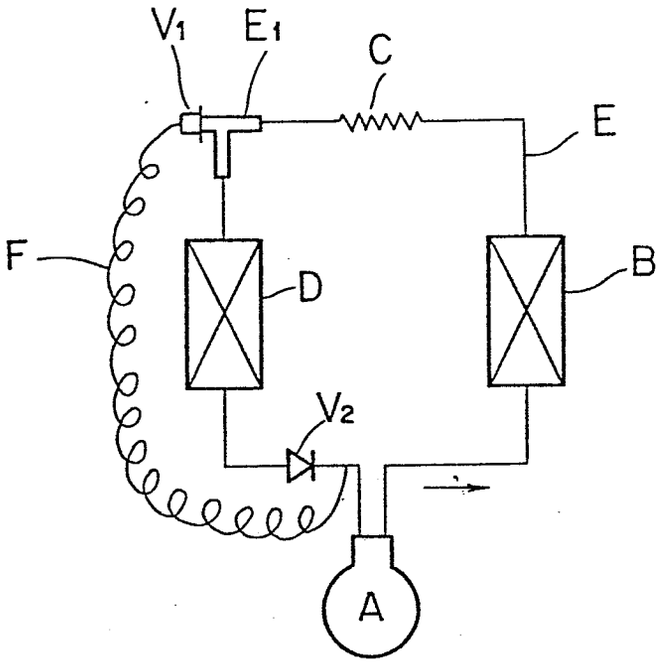

FIG. 2

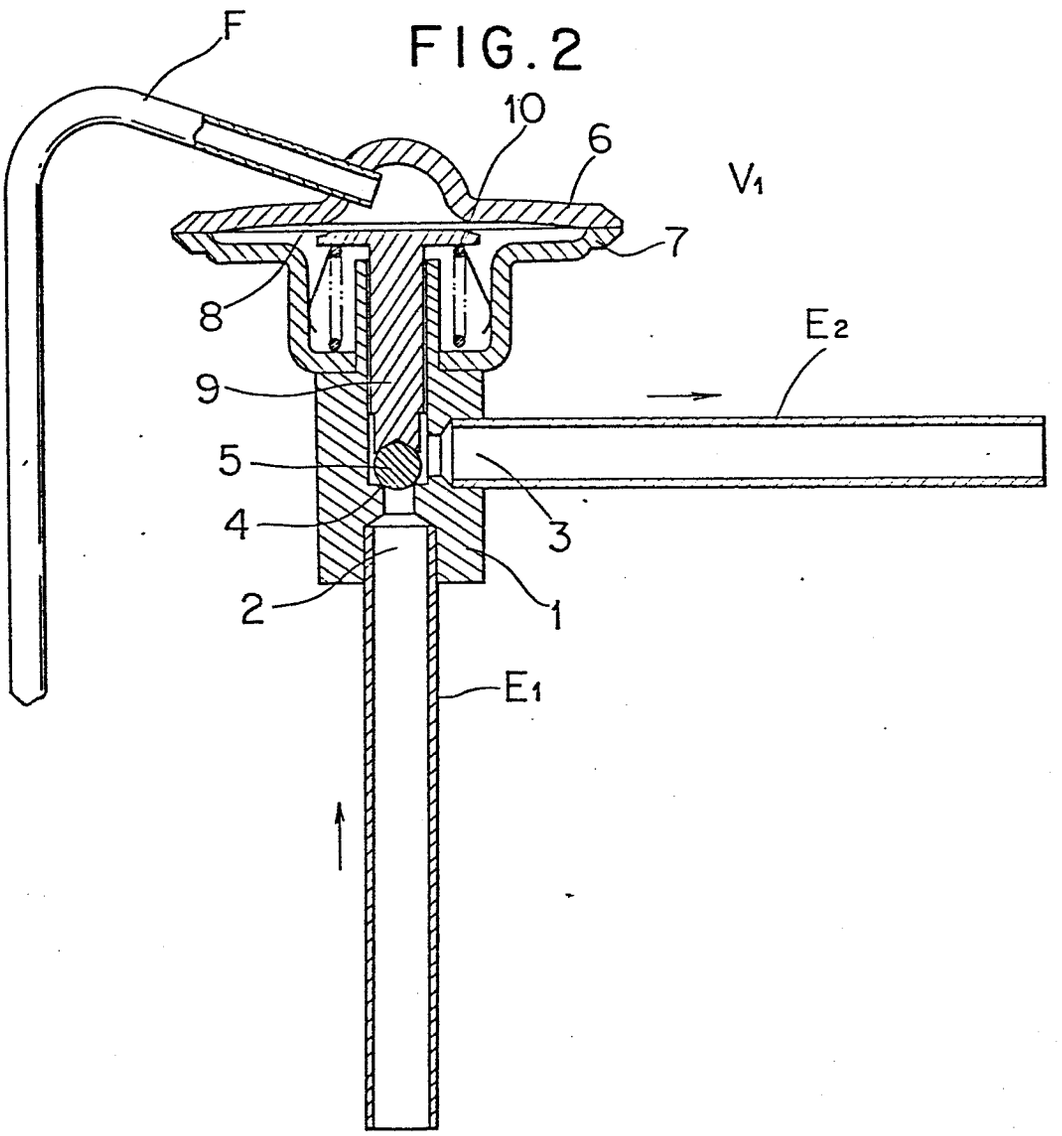

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FIG. 3