

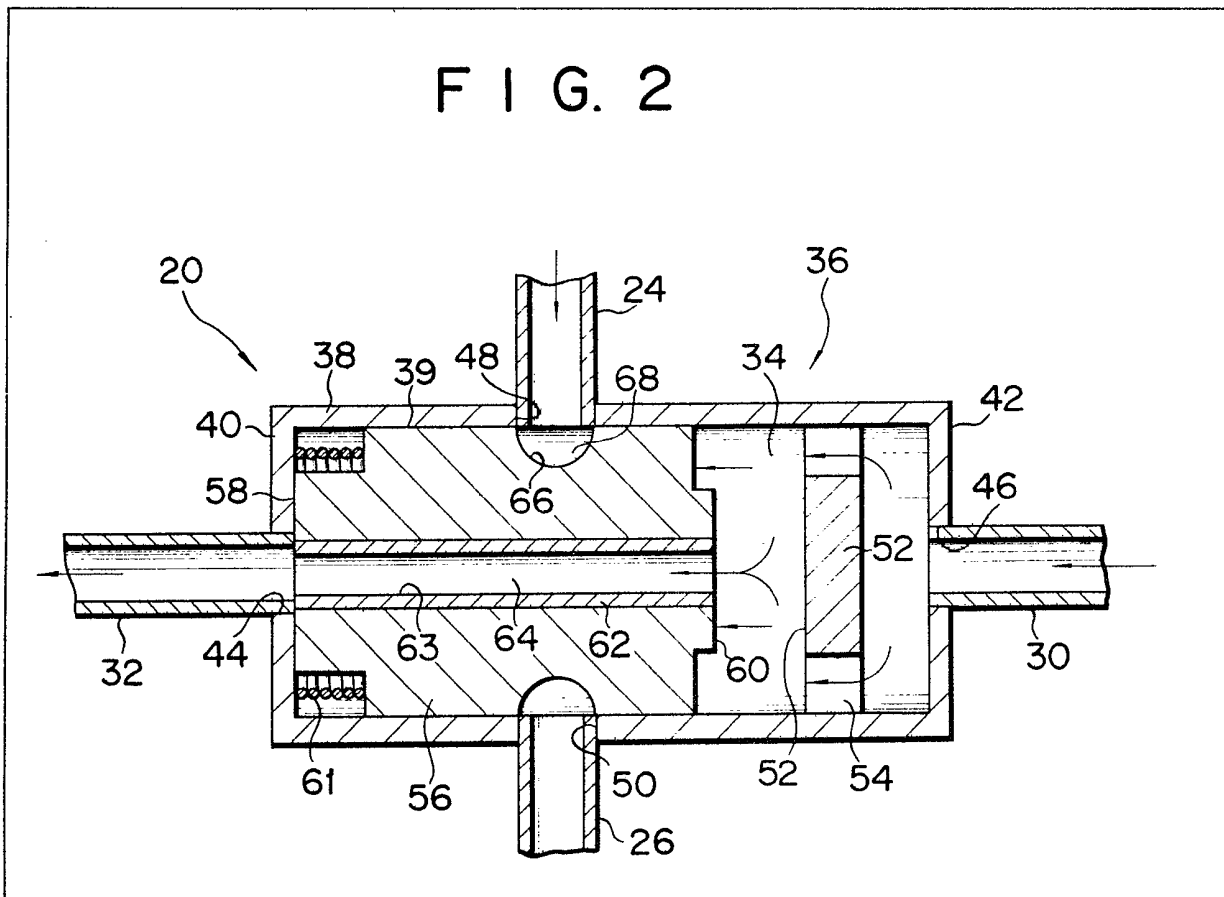
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(54) Refrigeration cycle apparatus

(57) A compression refrigeration cycle apparatus comprises a valve (20) of a pressure responsive type with a housing (36) having a chamber (34), and a valve piston (56) slidably received in the chamber. The suction side of the compressor and discharge side of the evaporator are connected to the chamber

through first and second communication ports (44) (46) respectively. The discharge side of the condenser and suction side of the decompressor are connected to the chamber through first and second guide ports (48) (50) respectively. The valve piston in a first position has a first communication passage (64) for communicating the first and second communication ports, when the pressure of the suction side of the compressor is lower than that of the discharge side of the evaporator and the first and second guide ports communicate with each other through the second communication passage. When the pressure of the suction side of the compressor is higher than that of the discharge side of the evaporator, the valve piston slides to a second position in which communication between the first and second communication ports via a second passage (68) as well as between the first and second guide ports are shut off.



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FIG. 3

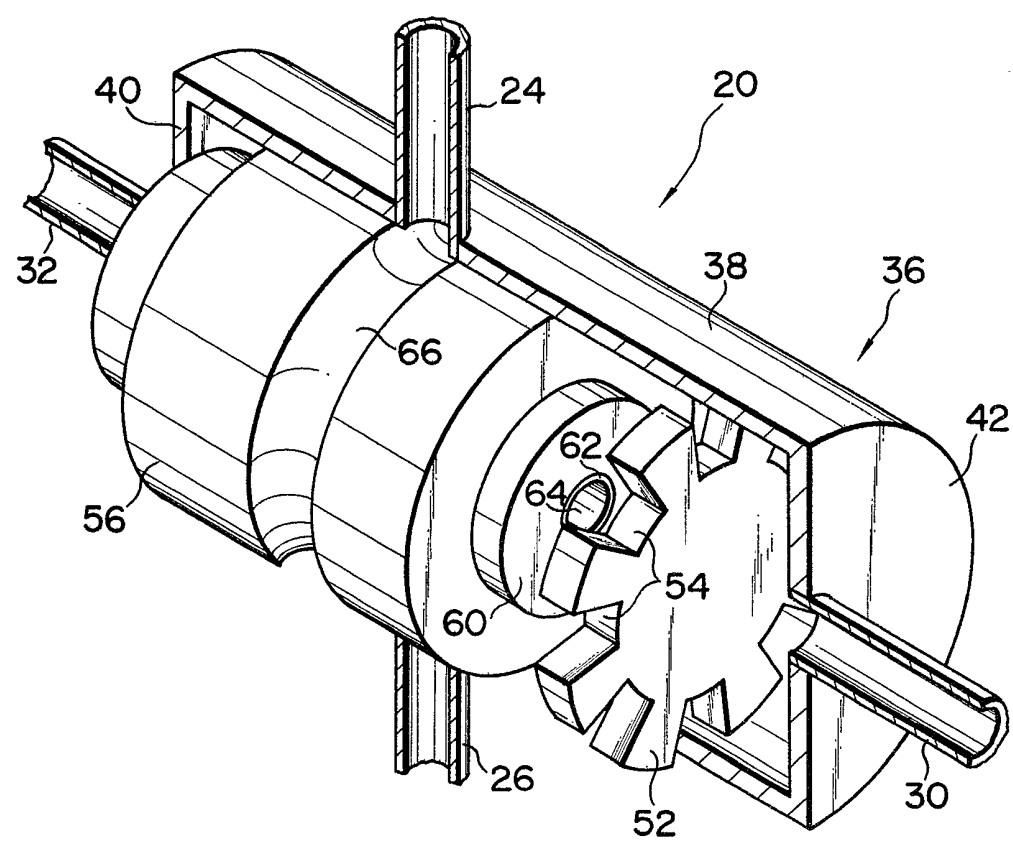


FIG. 4

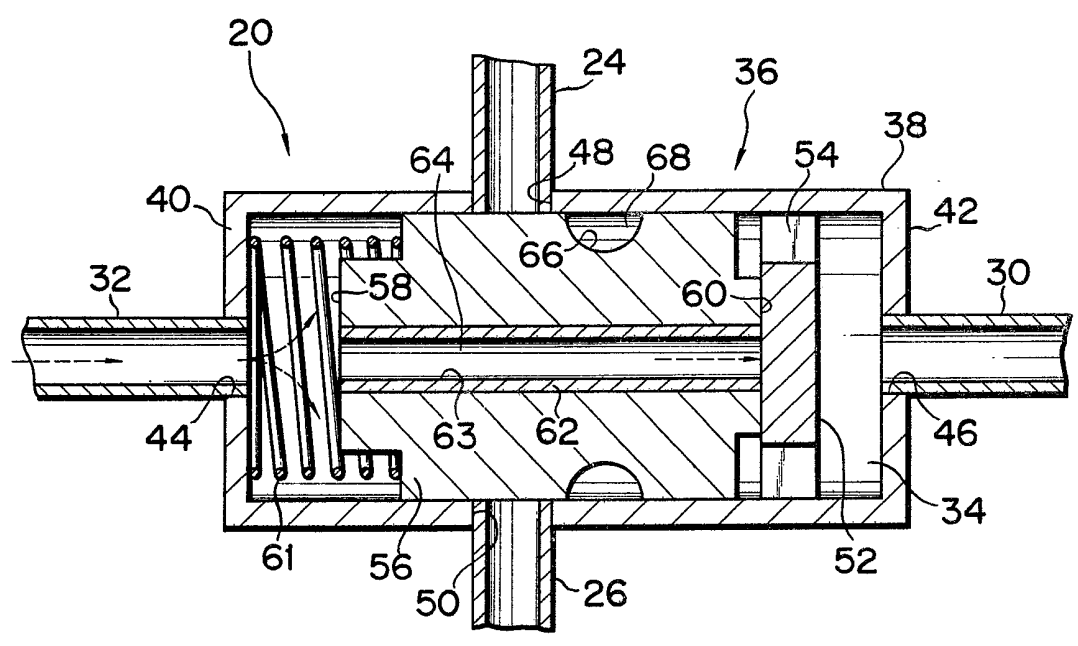


FIG. 5

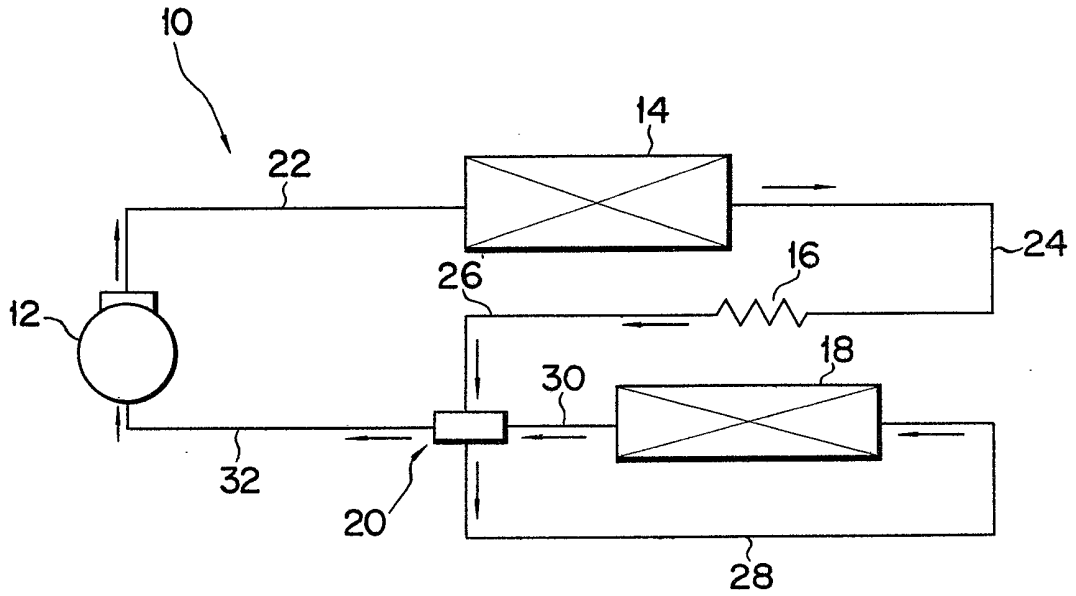
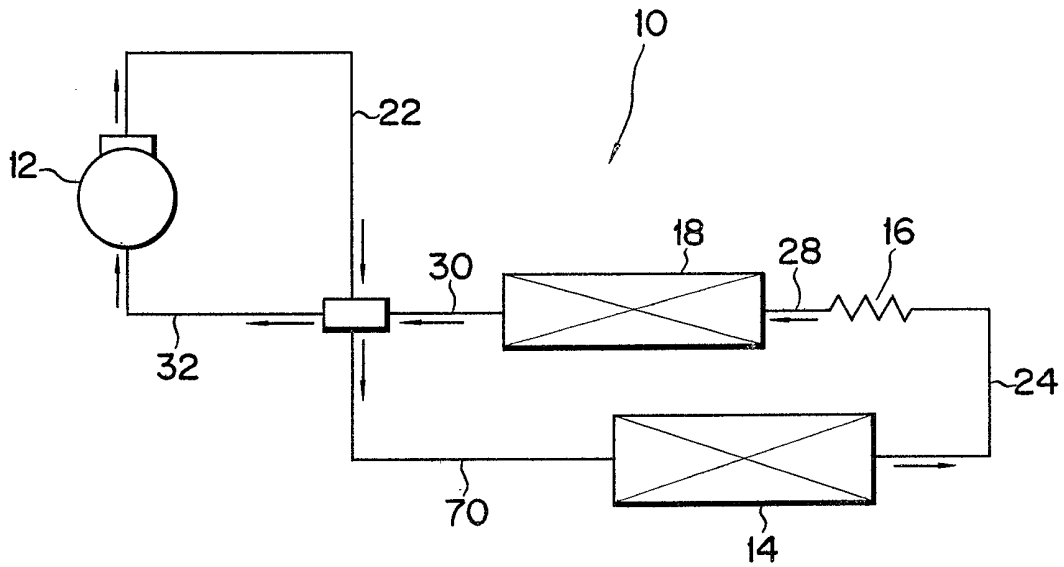


FIG. 6



SPECIFICATION

Refrigeration cycle apparatus

5 This invention relates to a refrigeration cycle apparatus. A refrigeration cycle apparatus generally comprises a compressor, condenser, electromagnetic valve, capillary tube acting as a decompressing device, evaporator and stop valve all arranged in series. The stop valve is connected to the compressor, thereby assuring a refrigeration cycle. The compressor causes a coolant to circulate through a refrigerating cycle by passing through the above-mentioned members in succession. The coolant is volatilized in the evaporator, and performs refrigeration by absorbing evaporation latent heat from the surrounding region. When the compressor is brought to rest, a signal is issued to close the electromagnetic valve. At this time, a coolant gas in the process of being compressed in the cylinder of the compressor flows back to the suction side of the compressor, that is, the side of the stop valve. However, the stop valve prevents the back-flowing coolant gas from running into the evaporator. Further, the electromagnetic valve which is closed at this time prevents a liquid coolant collected in the condenser from flowing into the evaporator. In other words, when the compressor is at rest, the high and low pressure sides of the evaporator are shut off by the stop valve and electromagnetic valve. As a result, the temperature of the evaporator increases only slightly when the compressor stops, thereby reducing loss of the refrigerating capacity of the refrigeration cycle apparatus when it is started again. The compressor substantially retains the gas pressure prevailing immediately before its stoppage. When started again, therefore, the internal pressure of the compressor quickly rises, thereby assuring the reduction of power consumption.

40 However, the conventional refrigeration cycle apparatus of the above-mentioned arrangement has the drawbacks as follows. Since the apparatus is necessary to provide an electromagnetic valve and stop valve, piping work is complicated. The electromagnetic valve is relatively expensive and an electric circuit has to be provided for the actuation of the electromagnetic valve. Therefore the refrigeration cycle apparatus is expensive. In addition, a relatively large power consumption is involved.

50 This invention has been accomplished in view of the above-mentioned circumstances, and is intended to provide a relatively inexpensive refrigeration cycle apparatus involving a small power consumption.

55 According to an aspect of the invention, a refrigeration cycle apparatus comprises:

- a compressor;
- a condenser connected to the discharge side of the compressor;
- 60 an evaporator connected to the suction side of the compressor;
- a decompressor connected between the condenser and evaporator; and
- a valve which includes a housing having a chamber communicating with the suction side of the

compressor and the discharge side of the evaporator and first and second guide ports open to the interior of the chamber; and a valve piston slidably received in the chamber and provided with a first operation plane receiving the pressure of the suction side of the compressor, a second operation plane receiving the pressure of the discharge side of the evaporator, a first communication passage for effecting communication between the suction side of the compressor and the discharge side of the evaporator and a second communication passage for effecting communication between the first and second guide ports; the valve being so designed that when the suction side of the compressor has a low pressure than the discharge side of the evaporator, the valve slides to a first position for effecting communication between the suction side of the compressor and the discharge side of the evaporator through the first communication passage and for effecting communication between the first and second guide ports through the second communication passage; and when the suction side of the compressor has a higher pressure than the discharge side of the evaporator, the differential valve slides to a second position for shutting off communication between the suction side of the compressor and the discharge side of the evaporator as well as between the first and second guide ports; and wherein the first and second guide ports are connected between the discharge side of the compressor and the suction side of the evaporator.

A refrigeration cycle apparatus embodying this invention arranged as described above is provided with a valve of a pressure responsive type in place of a stop valve and electromagnetic valve. The valve is provided with a valve piston which slides due to a pressure difference between the suction side of the compressor and the discharge side of the evaporator. When the suction side of the compressor has a higher pressure than the discharge side of the evaporator, that is, when the compressor stands at rest, the valve piston slides to a second position to shut off communication between the suction side of the compressor and the discharge side of the evaporator as well as between the first and second guide ports. For instance, when the discharge side of the condenser is connected to the first guide port, and the suction side of the decompressor is connected to the second guide port, the valve piston slides to the second position, thereby shutting off communication between the discharge side of the condenser and the suction side of the decompressor. Thus, the valve acts both as a stop valve and as an electromagnetic valve. Therefore, the refrigeration cycle apparatus of this invention eliminates the necessity of providing an electromagnetic valve and an electric circuit for actuating said electromagnetic valve, and consequently, can be manufactured at low cost. Further, the valve which requires no power for the operation of the valve piston reduces the power consumption of the subject refrigeration cycle apparatus.

This invention can be more fully understood from the following detailed description when taken in conjunction with the accompanying drawings, in

which:

Figures 1 to 4 show a refrigeration cycle apparatus embodying this invention; in which *Figure 1* is a block circuit diagram of a refrigeration cycle undertaken by the subject refrigeration cycle apparatus, *Figure 2* is a longitudinal sectional view of a valve used with the subject refrigeration cycle apparatus, *Figure 3* is an oblique view, partly in section, of the differential valve, *Figure 4* is a longitudinal sectional view of the valve indicating a different operating condition from that of *Figure 2*; and

Figures 5 and 6 are block circuit diagrams of the refrigeration cycles performed by the different modifications of the refrigeration cycle apparatus of the invention.

Description will now be given with reference to the accompanying drawings of a refrigeration cycle apparatus embodying this invention. As shown in *Figure 1*, the subject refrigeration cycle apparatus comprises a compressor 12, condenser 14, capillary tube 16 acting as a decompressor, evaporator 18 and valve 20 of a pressure responsive type. The suction side of the condenser 14 is connected to the discharge side of the compressor through a coolant pipe 22. The discharge side of the condenser is connected to the valve 20 through a coolant pipe 24. The suction side of the capillary tube 16 is connected to the valve 20 through a coolant pipe 26. The discharge side of the capillary tube 16 is connected to the suction side of the evaporator 18 through a coolant pipe 28. The discharge side of the evaporator 18 is connected to the valve 20 through a coolant pipe 30. The suction side of the compressor 12 is connected to the valve 20 through a coolant pipe 32. The above-mentioned arrangement constitutes a refrigeration cycle in the apparatus of this invention. When the compressor 12 is driven, a coolant runs through the refrigeration cycle system in the direction of the arrows shown in *Figure 1*.

As seen from *Figures 2 and 3*, the valve 20 has a housing 36 in which a chamber 34 is defined. The housing 36 includes a cylindrical body 38, a first circular end plate 40 closing one end of the housing body 38 and a second circular end plate 42 closing the other end of the housing body 38. The chamber 34 is defined by the inner peripheral wall of the cylindrical housing body 38 and the inner walls of the first and second end plates 40, 42. The housing 36 is further provided with a first communication port 44 formed at the center of the first end plate 40 to be opened to the interior of the chamber 34, and a second communication port 46 drilled at the center of the second end plate 42 to be opened to the interior of the chamber 34. Further, the housing 36 is provided with first and second guide ports 48, 50 drilled in the peripheral wall of the cylindrical housing body 38 to be opened to the interior of the chamber 34. The guide ports 48, 50 face each other across the cylindrical body 38. Further, the housing 36 is fitted with a disc-shaped stopper 52 facing the second end plate 42 at a prescribed distance. The peripheral portion of the disc stopper 52 is provided with a plurality of communication ports spatially arranged in the circumferential direction.

The coolant pipe 32 is connected to the first

communication port 44. Another coolant pipe 30 is connected to the second communication port 46. As a result, the suction side of the compressor 12 and the discharge side of the evaporator 18 are made to communicate in the chamber 34. The coolant pipe 24 is connected to the first guide port 48. Another coolant pipe 26 is connected to the second guide port 50.

The valve 20 includes a substantially columnar shaped piston 56 set in the chamber 34 between the first end plate 40 and stopper 52. The valve piston 56 has a diameter substantially equal to the inner diameter of the housing body 38, and is made slidable through the housing 36 with the outer peripheral surface of the valve piston 56 brought into contact with the inner peripheral wall of the housing 38. The outer peripheral surface defines a sliding surface 39. The valve piston 56 has a first operation plane 58 which faces the first end plate 40 and receives the pressure of the suction side of the compressor 12, and a second operation plane 60 which faces the stopper 52 and receives the pressure of the discharge side of the evaporator 18. The outer peripheral portions of the first and second operation planes 58, 60 are each provided with a stepped concave portion. A compression spring 61 of low elasticity is provided between the first end plate 40 and first operation plane 58. The valve piston 56 is urged toward the stopper 52 by the compression spring 61. An insert pipe 62 is forced into the valve piston 56 concentrically therewith. The insert pipe 62 has an inner diameter slightly smaller than the diameter of the communication port 44. Both ends of said insert pipe 62 are respectively open to the first and second operation planes 58, 60 of the valve piston 56. A penetrating hole 63 is defined by the inner wall of the insert pipe 62. The penetrating hole 63 constitutes a first communication passage 64. An angular guide groove 66 is formed in the outer peripheral wall of the valve piston 56 concentrically therewith. This annular guide groove 66 defines the second communication passage 68. The valve piston 56 slides between a first position in which the first operation plane 58 of the valve piston 56 is pressed against the first end plate 40 and a second position in which the second operation plane 60 is pressed against the stopper 52. The first and second guide ports 48, 50 are formed in that portion of the housing body 38 which slidably contact with the outer peripheral surface of the valve piston 56. When the valve piston 56 takes a first position, the guide groove 66 faces the first and second guide ports 48, 50 as seen from *Figure 2*. As a result, the coolant pipes 24, 26 communicate with each other through the second communication passage 68. The coolant pipe 32 communicates with the coolant pipe 30 through the first communication passage 64, chamber 34 and communication hole 54. When the valve piston 56 takes the second position, the first communication passage 64 is closed by the stopper 52 as seen from *Figure 4*. In this case, the guide groove 66 is removed from the first and second guide ports 48, 50, which in turn are closed by the outer peripheral surface of the valve piston 56.

Description will now be given of the operation of

described above. When the compressor 12 is driven, a coolant gas is compressed and runs through a refrigeration cycle system in the direction of the arrows shown in Figure 1. The compressed coolant

5 gas is brought to the condenser 14 where it is condensed into a liquid. Then, the liquid coolant is carried to the capillary tube 16 through the valve 20 to be decompressed by the capillary tube 16. Thereafter, the liquid coolant is volatilized in the

10 evaporator 18. At this time, the coolant absorbs evaporation latent heat from the surrounding atmosphere to effect refrigeration. The volatilized coolant is carried into the compressor 12 through the valve 20. Thereafter, the above-mentioned refrigeration

15 cycle is repeated. During the operation of the compressor 12, the pressure in the suction side of the compressor 12, that is, the pressure in the coolant pipe 32, is rendered negative to be lower than the pressure of

closed by the outer peripheral wall of the valve piston 56. As a result, communication between the discharge side of the condenser 14 and the suction side of the capillary tube 16 is shut off, thereby

70 obstructing the flow of the coolant. As described above, when the compressor 12 stops, the valve 20 has a double function of acting as a stop valve for preventing the back-flow of the coolant from the compressor 12 to the evaporator

75 and also acting as an electromagnetic valve for stopping the flow of the coolant collected in the condenser 14 to the evaporator 18. Therefore, the refrigeration cycle apparatus 10 serves these purposes simply by applying a single valve in place of

80 the stop valve and electromagnetic valve used with the conventional refrigeration cycle apparatus, and consequently, can be manufactured at low cost. Unlike the electromagnetic valve, the valve used in this invention is actuated by a pressure difference

85 between the suction side of the compressor and the discharge side of the evaporator 18. Therefore, it is unnecessary to use an electric circuit and electric power for the actuation of the valve 20, thereby assuring the inexpensive manufacture of the re-

90 frigeration cycle apparatus 10 of this invention and a reduction in the power consumption of the apparatus 10. It will be noted that the invention is not limited to the above-mentioned embodiment. In this embodi-

95 ment, the first and second guide ports 48, 50 were designed to effect communication between the coolant pipes 24, 26. However, this arrangement need not be exclusively followed. The first and second guide ports need only be connected between

100 the discharge side of the compressor 12 and the suction side of the evaporator 18. It is possible, as shown in Figure 5, to connect the discharge side of the capillary tube 16 to the first guide port 48 through the coolant pipe 26, and to connect the

105 suction side of the evaporator 18 to the second guide port 50 through the coolant pipe 28. It is also possible, as shown in Figure 6, to connect the discharge side of the compressor 12 to the first guide port 48 through the coolant pipe 22 and to connect

110 the suction side of the condenser 14 to the second guide port 50 through the coolant pipe 70. The above-mentioned two modifications in which the valve 20 has the same arrangement as the aforementioned embodiment assures the same effect as said

115 embodiment. The housing body 38 and valve piston 56 need not be shaped like a round cylinder or column, but may be made in the form of an angular or square column. The compression spring 61 is not always a require-

120 ment. The valve piston 56 can be fully driven by a pressure difference between the suction side of the compressor 12 and the discharge side of the evaporator 18. However, the provision of the compression spring 61 has the advantage of accelerating the

125 movement of the valve piston 56. If the second communication port 46 is formed in the outer peripheral portion of the second end plate 42 of the housing 36, the stopper 52 can be omitted. In the foregoing embodiment, the second communication

130 passage 68 was defined by the guide groove 66.

the subject refrigeration cycle apparatus arranged as
 However, the second communication passage may
 be defined by a through hole formed, for example, in
 the valve piston 56. Moreover, the insert pipe 62 may
 5 have an inner diameter slightly larger than the
 diameter of the communication port 44.

CLAIMS

10 1. A refrigeration cycle apparatus which comprises:
 a compressor;
 a condenser connected to the discharge side of the
 compressor;
 15 an evaporator connected to the suction side of the
 compressor;
 a decompressor connected between the condenser
 and evaporator; and
 a valve which includes a housing having a chamber
 20 communicating with the suction side of the
 compressor and the discharge side of the evaporator
 and first and second guide ports open to the interior
 of the chamber, and
 a valve piston slidably received in the chamber
 25 and provided with a first operation plane receiving
 the pressure of the suction side of the compressor, a
 second operation plane receiving the pressure of the
 discharge side of the evaporator, a first communication
 passage for effecting communication between
 30 the suction side of the compressor and the discharge
 side of the evaporator and a second communication
 passage for effecting communication between the
 first and second guide ports, the valve, when the
 suction side of the compressor has a lower pressure
 35 than the discharge side of the evaporator, sliding to
 a first position in which the suction side of the
 compressor communicates with the discharge side
 of the evaporator through the first communication
 passage and the first guide port communicates with
 40 the second guide port through the second communication
 passage; and the valve, when the suction side
 of the compressor has a higher pressure than the
 discharge side of the evaporator, sliding to a second
 position in which communication between the suction
 45 side of the compressor and the discharge side of
 the evaporator as well as between the first and
 second guide ports are shut off; and wherein the first
 and second guide ports are connected between the
 discharge side of the compressor and the suction
 50 side of the evaporator.

2. The refrigeration cycle apparatus according to
 claim 1, wherein said housing comprises a cylindrical
 body in which the first and second guide ports are
 formed, a first end plate which closes one end of the
 55 cylindrical body and is provided with a first communication
 port connected to the suction side of the compressor,
 and a second end plate which closes the other end of
 the cylindrical body and is provided with a second
 communication port connected to the discharge side
 60 of the evaporator; and the chamber is defined by the
 inner wall of the cylindrical body and the inner walls
 of the first and second end plates.

3. The refrigeration cycle apparatus according to
 claim 2, wherein said valve piston includes a sliding
 65 surface which slides over the inner wall of the

cylindrical body and closes the first and second
 guide ports when the valve piston occupies a second
 position; the first operating plane faces the first end
 plate; and the second operating plane faces the first
 70 end plate.

4. The refrigeration cycle apparatus according to
 claim 3, wherein said cylindrical body is shaped in a
 round cylindrical form, and the valve piston is
 shaped in a round columnar form whose diameter is
 75 made substantially equal to the inner diameter of the
 cylindrical body, and is so set that the outer
 peripheral wall of the valve piston can slide over the
 inner peripheral wall of the cylindrical body.

5. The refrigeration cycle apparatus according to
 80 claim 4, wherein said first and second guide ports
 are made to face each other across the cylindrical
 body; and the valve piston includes a penetrating
 hole which is formed in the valve piston, both ends
 of which are open to the first and second operating
 85 planes to define the first communication passage,
 and an annular guide groove which is formed in the
 outer peripheral wall of the valve piston to define the
 second communication passage, the guide groove
 facing the first and second guide ports, when the
 90 valve piston assumes the first position.

6. The refrigeration cycle apparatus according to
 claim 5, wherein said penetrating hole is concentrically
 formed with the valve piston; the first and second
 communication ports face both ends of the
 95 penetrating hole; the housing comprises a disc
 stopper which is set in the chamber apart from the
 second end plate to face the second operating plane
 and whose outer peripheral portion is provided with
 a plurality of communication holes; and when the
 100 valve piston occupies the first position, the first
 operating plane is pressed against the first end plate
 of the housing, and when the valve piston occupies
 the second position, the second operating plane is
 pressed against the stopper, which in turn closes the
 105 penetrating hole of the valve piston.

7. The refrigeration cycle apparatus according to
 claim 6, wherein said valve is provided with an
 urging member which is set between the first end
 plate and the first operating plane to urge the valve
 110 piston toward the stopper.

8. The refrigeration cycle apparatus according to
 claim 1, wherein the discharge side of the condenser
 is connected to the first guide port, and the suction
 side of the decompressor is connected to the second
 115 guide port.

9. The refrigeration cycle apparatus according to
 claim 1, wherein the discharge side of the decompressor
 is connected to the first guide port; and the suction
 side of the evaporator is connected to the
 120 second guide port.

10. The refrigeration cycle apparatus according to
 claim 1, wherein the discharge side of the compressor
 is connected to the first guide port; and the suction
 side of the condenser is connected to the
 125 second guide port.

11. A refrigeration cycle apparatus, substantially
 as hereinbefore described with reference to the
 accompanying drawings.