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(71) Applicant: **Daikin Industries, Ltd.**
Osaka 530-8323 (JP)

(72) Inventors:
• **SHIMODA, Junichi**
Sakai-shi
Osaka 591-8511 (JP)

• **TAKEICHI, Hisashi**
Izumi-shi
Osaka 594-1111 (JP)
• **UKAI, Takeomi**
Sakai-shi
Osaka 591-8511 (JP)
• **WAKISAKA, Shigetaka**
Sakai-shi
Osaka 591-8511 (JP)

(74) Representative: **HOFFMANN EITLE**
Patent- und Rechtsanwälte
Arabellastrasse 4
81925 München (DE)

(54) **MECHANISM FOR CONTROLLING AND OPERATING COMPRESSOR CAPACITY AND AIR CONDITIONER HAVING THE SAME**

(57) This invention provides a compressor capacity control operation mechanism and an air conditioner provided with this mechanism, whereby cost increases are prevented and the capacity of the compressor can be controlled in the same manner as in a case of using two two-way valves. A compressor capacity control operation circuit (35) includes a pilot valve (90) for use as a four-way switching valve having four connecting capillary tubes (93a to 93d), a suction branching pipe (87), an intermediate pipe (88), and a discharge branching pipe (89). The suction branching pipe (87) is connected to a first capillary tube (93a) as one of the four connecting capillary tubes, and is a pipe branching off from a suction pipe (28) of a compressor (22) and having a larger diameter than the first capillary tube (93a). The intermediate pipe (88) is connected to a second capillary tube (93b) as one of the four connecting capillary tubes, and is a pipe connected to a cylinder intermediate part (79) of the compressor (22) and having a larger diameter than the second capillary tube (93b). The discharge branching pipe (89) is connected to a third capillary tube (93c) as one of the four connecting capillary tubes, and is a pipe branching off from a discharge pipe (30) of the compressor (22) and having a larger diameter than the third capillary tube (93c).

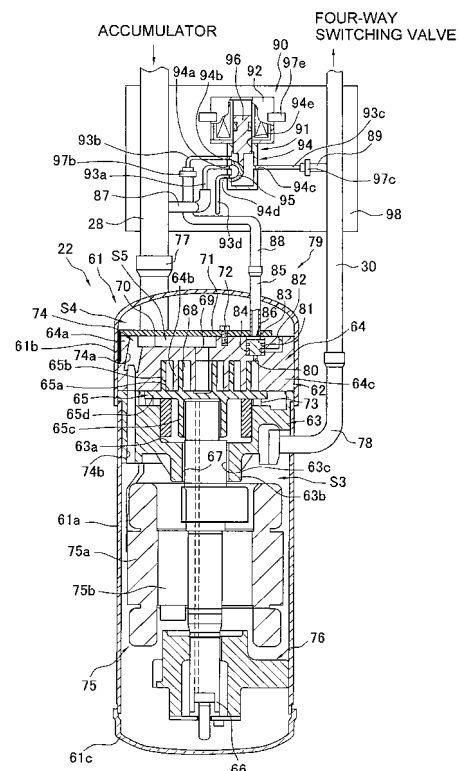


FIG. 3

Description

TECHNICAL FIELD

[0001] The present invention relates to a compressor capacity control operation mechanism and an air conditioner provided with the same; and particularly relates to a compressor capacity control operation mechanism connected to a compressor and capable of controlling the capacity of the compressor, and to an air conditioner provided with this mechanism.

BACKGROUND ART

[0002] Conventionally, there have been air conditioners including a vapor-compression refrigerant circuit. Among air conditioners including this type of refrigerant circuit, there are those that use a configuration in which a compressor capacity control operation circuit is connected to a compressor, thereby making it possible to perform capacity control for switching the operating state of the compressor between a full load operation for bringing the discharge capacity to 100% with respect to the suction capacity, and an unload operation for reducing the discharge capacity relative to the suction capacity. The compressor capacity control operation circuit has a bypass pipe for connecting a cylinder intermediate part of the compressor and a suction pipe of the compressor, an electromagnetic valve provided to the bypass pipe and functioning as a two-way valve, a pilot pipe for connecting the discharge pipe of the compressor and the cylinder intermediate part of the compressor, and a capillary tube provided to the pilot pipe; wherein the compressor can be controlled into the full load operation by closing the electromagnetic valve, and the compressor can be controlled into the unload operation by opening the electromagnetic valve (for example, see Patent Document 1).

<Patent Document 1>

[0003] Japanese Laid-open Patent Application No. 9-72625

DISCLOSURE OF THE INVENTION

[0004] However, in the compressor capacity control operation circuit described above, since merely the capillary tube is provided to the pilot pipe, the refrigerant flowing from the discharge pipe into the bypass pipe through the pilot pipe is added to the refrigerant flowing from the cylinder intermediate part into the suction pipe through the bypass pipe during the unload operation, and a situation occurs in which some of the refrigerant discharged from the compressor is needlessly bypassed to the suction pipe, which is a cause of an increase in power consumption in the compressor during the unload operation.

[0005] To overcome this problem, an electromagnetic valve functioning as a two-way valve is provided not only to the bypass pipe but to the pilot pipe as well, and the electromagnetic valve provided to the bypass pipe is opened and the electromagnetic valve provided to the pilot pipe is closed during the unload operation, thereby making it possible to ensure that refrigerant does not flow from the discharge pipe into the bypass pipe through the pilot pipe. However, in this case, the compressor capacity control operation circuit requires two electromagnetic valves functioning as two-way valves, and the cost increases.

[0006] An object of the present invention is to provide a compressor capacity control operation mechanism and an air conditioner provided with this mechanism, wherein cost increases can be prevented and the capacity of the compressor can be controlled in the same manner as in a case of using two two-way valves.

[0007] A compressor capacity control operation mechanism according to a first aspect of the present invention is a compressor capacity control operation mechanism that is connected to a compressor and is capable of controlling the capacity of the compressor, comprising a flow channel switching valve, a suction branching pipe, an intermediate pipe, a discharge branching pipe, and a fixing member. The flow channel switching valve has a valve main body, a first capillary tube, a second capillary tube, and a third capillary tube. The valve main body has the same function as when two two-way valves are used to form a flow channel configuration capable of switching between a first state in which a first flow channel and a second flow channel are connected and a third flow channel is not connected to either the first or second flow channel, and a second state in which the second flow channel and the third flow channel are connected and the first flow channel is not connected to either the second or third flow channel. The first capillary tube constitutes the first flow channel and extends from the valve main body. The second capillary tube constitutes the second flow channel and extends from the valve main body. A third capillary tube constitutes the third flow channel and extends from the valve main body. The suction branching pipe is a pipe that branches off from a suction pipe of the compressor, is connected to the first capillary tube, and has a larger diameter than the first capillary tube. The intermediate pipe is a pipe connected to a cylinder intermediate part of the compressor, connected to the second capillary tube, and provided with a larger diameter than the second capillary tube. The discharge branching pipe is a pipe that branches off from a discharge pipe of the compressor, is connected to the third capillary tube, and has a larger diameter than the third capillary tube. The fixing member fixes the flow channel switching valve and at least one of the suction branching pipe, the intermediate pipe, and the discharge branching pipe.

[0008] Since the compressor capacity control operation mechanism is configured using a valve having the first, second, and third capillary tubes extending from the

valve main body as the flow channel switching valve, strength is reduced in the portion of the first capillary tube connected to the suction branching pipe, the portion of the second capillary tube connected to the intermediate pipe, and the portion of the third capillary tube connected to the discharge branching pipe.

[0009] In view of this, in the compressor capacity control operation mechanism, excessive stress is prevented from acting on the first, second, and third capillary tubes by fixing the flow channel switching valve and at least one of the suction branching pipe, the intermediate pipe, and the discharge branching pipe to the fixing member. Thus, a compressor capacity control operation mechanism can be provided, whereby the cost increase resulting from the use of two two-way valves is prevented and the same compressor capacity control is achieved as in the case of using two two-way valves.

[0010] A compressor capacity control operation mechanism according to a second aspect of the present invention is the compressor capacity control operation mechanism according to the first aspect of the present invention, wherein among the suction branching pipe, the intermediate pipe, and the discharge branching pipe, one or those fixed to the fixing member are fixed to the fixing member at the portions in proximity to the corresponding capillary tubes.

[0011] In this compressor capacity control operation mechanism, since one or those fixed to the fixing member among the suction branching pipe, the intermediate pipe, and the discharge branching pipe are fixed to the fixing member at the portions in proximity to the corresponding capillary tubes, it is possible to reliably prevent positional misalignment and the like in proximity to the capillary tubes of the suction branching pipe, the intermediate pipe, and the discharge branching pipe. The stress applied to the first, second, and third capillary tubes can thereby be reliably reduced.

[0012] A compressor capacity control operation mechanism according to a third aspect of the present invention is a compressor capacity control operation mechanism connected to a compressor and capable of controlling the capacity of the compressor, the compressor capacity control operation mechanism comprising a pilot valve for use as a four-way switching valve having four connecting capillary tubes, a suction branching pipe, an intermediate pipe, and a discharge branching pipe. The suction branching pipe is connected to a first capillary tube as one of the four connecting capillary tubes and is branched off from a suction pipe of the compressor. The intermediate pipe is connected to a second capillary tube as one of the four connecting capillary tubes and is connected to a cylinder intermediate part of the compressor. The discharge branching pipe is connected to a third capillary tube as one of the four connecting capillary tubes and is branched off from a discharge pipe of the compressor.

[0013] In this compressor capacity control operation mechanism, since the pilot valve for use as a four-way switching valve is used instead of two two-way valves, it

is possible to provide a compressor capacity control operation mechanism whereby the cost increase resulting from the use of two two-way valves is prevented, and the same compressor capacity control is achieved as in the case of using two two-way valves.

[0014] A compressor capacity control operation mechanism according to a fourth aspect of the present invention is the compressor capacity control operation mechanism according to the third aspect of the present invention, wherein a fourth capillary tube as one of the four connecting capillary tubes is closed off.

[0015] In this compressor capacity control operation mechanism, the configuration is simplified because the same flow channel configuration as one configured from two two-way valves can be achieved by a simple process of closing off one of the four connecting capillary tubes of the pilot valve for use as a four-way switching valve.

[0016] An air conditioner according to a fifth aspect of the present invention comprises a vapor-compression main refrigerant circuit including the compressor, a four-way switching valve, a first heat exchanger, an expansion mechanism, and a second heat exchanger; and the compressor capacity control operation mechanism according to the third or fourth aspect of the present invention; wherein the same valve as a pilot valve for use as a four-way switching valve constituting the four-way switching valve is used as the pilot valve for use as a four-way switching valve.

[0017] In this air conditioner, components can be shared, thereby contributing to reducing the cost of the entire air conditioner, because the pilot valve for use as a four-way switching valve used in the compressor capacity control operation mechanism is the same pilot valve for use as a four-way switching valve constituting the four-way switching valve included in the main refrigerant circuit.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018]

FIG. 1 is a schematic configuration diagram of an air conditioner in which a compressor capacity control operation mechanism according to an embodiment of the present invention is used.

FIG. 2 is a perspective view showing the schematic internal structure of an outdoor unit.

FIG. 3 is a schematic longitudinal cross-sectional view showing the structure of part A in FIG. 1 (i.e., the structure of a compressor and a compressor capacity control operation circuit).

EXPLANATION OF THE REFERENCE SIGNS

[0019]

1	Air conditioner
22	Compressor
23	Four-way switching valve
24	Outdoor heat exchanger (first heat exchanger)
25	Expansion valve (expansion mechanism)
41	Indoor heat exchanger (second heat exchanger)
28	Suction pipe
30	Discharge pipe
79	Cylinder intermediate part
87	Suction branching pipe
88	Intermediate pipe
89	Discharge branching pipe
90, 23b	Pilot valve (flow channel switching valve, pilot valve for use as a four-way switching valve)
91,	Valve main body
93a	First capillary tube
93b	Second capillary tube
93c	Third capillary tube
93d	Fourth capillary tube
98	Fixing member

BEST MODE FOR CARRYING OUT THE INVENTION

[0020] Embodiments of the compressor capacity control operation mechanism according to the present invention, and an air conditioner comprising this mechanism are described herein below with reference to the drawings.

(1) Configuration of Air Conditioner

<Entire Configuration>

[0021] FIG. 1 is a schematic configuration diagram of an air conditioner 1 in which a compressor capacity control operation mechanism according to an embodiment of the present invention is used. In the present embodiment, the air conditioner 1 is an apparatus used for cooling and heating a room interior, and is a so-called separated type air conditioner comprising primarily an outdoor unit 2, an indoor unit 4, and a first refrigerant communication pipe 6 and a second refrigerant communication pipe 7 connecting the outdoor unit 2 and the indoor unit 4. Specifically, in the present embodiment, the outdoor unit 2 and the indoor unit 4 are configured by being connected by the refrigerant communication pipe s 6, 7 constructed on site, after the outdoor and indoor units are shipped to the site of installation and installed. A refrigerant circuit 10 of the air conditioner 1 of the present embodiment is configured by connecting the outdoor unit 2 and the indoor unit 4 via the refrigerant communication pipe s 6, 7.

<Indoor Unit>

[0022] Next, the configuration of the indoor unit 4 will

be described using FIG. 1.

[0023] The indoor unit 4 is connected to the outdoor unit 2 via the first refrigerant communication pipe 6 and the second refrigerant communication pipe 7, and the indoor unit 4 constitutes a part of the refrigerant circuit 10. The indoor unit 4 primarily has an indoor refrigerant circuit 10b constituting the part of the refrigerant circuit 10. The indoor refrigerant circuit 10b primarily has an indoor heat exchanger 41 as a second heat exchanger.

[0024] In the present embodiment, the indoor heat exchanger 41 is a heat exchanger that functions as a refrigerant heater during cooling, and as a refrigerant cooler during heating. One end of the indoor heat exchanger 41 is connected to the second refrigerant communication pipe 7, and the other end is connected to the first refrigerant communication pipe 6.

[0025] In the present embodiment, the indoor unit 4 comprises an indoor fan 42 for taking indoor air into the unit and supplying the air to the room interior after heat exchange has been conducted, and the indoor unit 4 is capable of conducting heat exchange between the indoor air and the refrigerant flowing through the indoor heat exchanger 41. The indoor fan 42 is rotatably driven by an indoor fan motor 42a.

[0026] The indoor unit 4 also comprises an indoor controller 43 for controlling the operations of the components constituting the indoor unit 4. The indoor controller 43 has a microcomputer, a memory and the like provided in order to control the indoor unit 4, and is designed so as to be capable of exchanging control signals and the like with an outdoor controller 37 (described hereinafter) of the outdoor unit 2.

<Outdoor Unit>

[0027] Next, the configuration of the outdoor unit 2 will be described using FIGS. 1 through 3. FIG. 2 is a perspective view showing the internal structure of the outdoor unit 2. FIG. 3 is a schematic longitudinal cross-sectional view showing the structure of part A in FIG. 1 (i.e., the structure of a compressor 22 and a compressor capacity control operation circuit 35).

[0028] The outdoor unit 2 is connected to the indoor unit 4 via the first refrigerant communication pipe 6 and the second refrigerant communication pipe 7, and the outdoor unit 2 constitutes an outdoor refrigerant circuit 10a as a part of the refrigerant circuit 10.

[0029] The outdoor unit 2 has a structure (a so-called trunk structure) in which the interior of a unit casing 51 shaped as substantially rectangular parallelepiped box is divided into an air blower chamber S1 and a machinery chamber S2 by a vertically extending partitioning plate 56, and the outdoor unit 2 primarily has the unit casing 51, outdoor refrigerant circuit structural components (described hereinafter) constituting the outdoor refrigerant circuit 10a, an outdoor fan 36, and an electrical component assembly (not shown in FIG. 2) which functions as an outdoor controller 37 (see FIG. 1) for controlling the

operations of the components constituting the outdoor unit 2.

[0030] The unit casing 51 primarily has a bottom plate 52, a top plate 53 (shown by chain double-dashed lines in FIG. 2), a front plate 54 (shown by chain double-dashed lines in FIG. 2), a side plate 55 (shown by chain double-dashed lines in FIG. 2), and a partitioning plate 56.

[0031] The bottom plate 52 is a horizontally-long substantially rectangular metal plate-shaped member constituting the bottom surface portion of the unit casing 51. The peripheral edges of the bottom plate 52 are folded upward. The outer surface of the bottom plate 52 is provided with two fixing arms 57 fixed to the on-site installation surface. The fixing arms 57 are metal plate-shaped members having substantially U shapes in a front view of the unit casing 51 and extending from the front of the unit casing 51 toward the rear.

[0032] The top plate 53 is a horizontally-long substantially rectangular metal plate-shaped member constituting the top surface portion of the outdoor unit 2.

[0033] The front plate 54 is primarily a metal plate-shaped member constituting the front surface portion and the front part of the right-side surface of the unit casing 51, and the bottom part of the front plate 54 is fixed to the bottom plate 52 by screws or the like. Formed in the front plate 54 is a discharge port 54a for blowing out air that has been taken into the air blower chamber S1 through suction ports (not shown) formed in the back surface and left-side surface of the unit casing 51.

[0034] The side plate 55 is primarily a metal plate-shaped member constituting the rear part of the right-side surface and the right back surface portion of the unit casing 51, and the bottom part of the side plate 55 is fixed to the bottom plate 52 by screws or the like.

[0035] The partitioning plate 56 is a metal plate-shaped member disposed on the bottom plate 52 and extending vertically, and is disposed so as to partition the internal space in the unit casing 51 into two left and right spaces (i.e., the air blower chamber S1 and the machinery chamber S2). The bottom part of the partitioning plate 56 is fixed to the bottom plate 52 by screws or the like.

[0036] Thus, the internal space of the unit casing 51 is divided into the air blower chamber S1 and the machinery chamber S2 by the partitioning plate 56. More specifically, the air blower chamber S1 is a space enclosed by the bottom plate 52, the top plate 53, the front plate 54, and the partitioning plate 56; and the machinery chamber S2 is a space enclosed by the bottom plate 52, the top plate 53, the front plate 54, the side plate 55, and the partitioning plate 56. An outdoor heat exchanger 24 and the outdoor fan 36 are disposed in the air blower chamber S1, and the compressor 22, a four-way switching valve 23, and other outdoor refrigerant circuit structural components, as well as the electrical component assembly (not shown) are disposed in the machinery chamber S2, as will be described hereinafter. In the unit casing 51, the interior of the machinery chamber S2 can be made visible by removing the portion of the front plate

54 that faces the machinery chamber S2.

[0037] The outdoor refrigerant circuit structural components constituting the outdoor refrigerant circuit 10a include primarily an accumulator 21, the compressor 22, the four-way switching valve 23, the outdoor heat exchanger 24 as a first heat exchanger, an expansion valve 25 (not shown in FIG. 2) as an expansion mechanism, a first stop valve 26, and a second stop valve 27. The outdoor heat exchanger 24 is herein disposed in the air blower chamber S1, and the outdoor refrigerant circuit structural components other than the outdoor heat exchanger 24 are disposed in the machinery chamber S2.

[0038] The accumulator 21 is a container for temporarily retaining a low-pressure refrigerant circulating within the refrigerant circuit 10 connected between the suction port of the compressor 22 and the four-way switching valve 23, and is disposed in the right rear corner of the machinery chamber S2 in the present embodiment (see FIG. 2). The outlet of the accumulator 21 is connected to the suction port of the compressor 22 by a first suction pipe 28, and the inlet of the accumulator 21 is connected to the four-way switching valve 23 by a second suction pipe 29.

[0039] The compressor 22 is a compressor having the function of taking in and compressing low-pressure refrigerant and discharging the resulting high-pressure refrigerant, and is disposed in the substantial center of the machinery chamber S2 in a plan view (see FIG. 2) in the present embodiment, in a state in which the space for accommodating the electrical component assembly (not shown in FIG. 2) and the four-way switching valve 23 and other outdoor refrigerant circuit structural components is opened on the upper side. The discharge port of the compressor 22 is connected to the four-way switching valve 23 by a discharge pipe 30. The internal structure of the compressor 22 will be described hereinafter, as will be the compressor capacity control operation circuit 35 (not shown in FIG. 2) as a compressor capacity control operation mechanism connected to the compressor 22. The compressor capacity control operation circuit 35 and the components other than the compressor capacity control operation circuit 35 in the refrigerant circuit 10 are described separately below. In this description, the components other than the compressor capacity control operation circuit 35 in the refrigerant circuit 10 are referred to as the main refrigerant circuit.

[0040] The four-way switching valve 23 is a valve for switching the direction of refrigerant flow when switching between cooling and heating; and the valve is capable of connecting the discharge port of the compressor 22 with the outdoor heat exchanger 24 and the accumulator 21 with the second stop valve 27 during cooling, and of connecting the discharge port of the compressor 22 with the second stop valve 27 and the accumulator 21 with the outdoor heat exchanger 24 during heating. The four-way switching valve 23 is connected to the outdoor heat exchanger 24 by a first refrigerant pipe 31 (only partially shown in FIG. 2) and is connected to the second stop

valve 27 by a fourth refrigerant pipe 34. In the present embodiment, the four-way switching valve 23 has a four-way switching valve main component 23a, and a pilot valve 23b (not shown in FIG. 1) connected to the four-way switching valve main component 23a. The pilot valve 23b is referred to as a pilot valve for use as a four-way switching valve for operating the four-way switching valve main component 23a when the aforementioned switch between cooling and heating is made, and the pilot valve 23b is fixed to the four-way switching valve main component 23a (see FIG. 2).

[0041] In the present embodiment, the outdoor heat exchanger 24 is a heat exchanger that functions as a refrigerant cooler using outdoor air as a heat source during cooling, and as a refrigerant heater using outdoor air as a heat source during heating. One end of the outdoor heat exchanger 24 is connected to the first refrigerant pipe 31 (only partially shown in FIG. 2) via a plurality of branching pipes 24a (not shown in FIG. 2). The other end of the outdoor heat exchanger 24 is connected to a second refrigerant pipe 32 via a plurality of branching pipes 24b (not shown in FIG. 2) and a flow distributor 24c (not shown in FIG. 2). In the present embodiment, the outdoor heat exchanger 24 is a cross-fin type fin-and-tube heat exchanger configured from a heat transfer tube and numerous fins, and is disposed in the air blower chamber S 1. The outdoor heat exchanger 24 has an L shape in a plan view, and is disposed along the left side surface and back surface of the unit casing 51. A tube plate 24d is provided to the right end of the outdoor heat exchanger 24.

[0042] In the present embodiment, the expansion valve 25 (not shown in FIG. 2) is an electrical expansion valve capable of depressurizing the high-pressure refrigerant cooled in the outdoor heat exchanger 24 during cooling before the refrigerant is fed to the indoor heat exchanger 41, and of depressurizing the high-pressure refrigerant cooled in the indoor heat exchanger 41 during heating before the refrigerant is fed to the outdoor heat exchanger 24. One end of the expansion valve 25 is connected to the second refrigerant pipe 32. The other end of the expansion valve 25 is connected to the first stop valve 26 by a third refrigerant pipe 33.

[0043] The first stop valve 26 is a valve provided to the connecting portion between the refrigerant pipe in the outdoor unit 2 (the third refrigerant pipe 33 in the present embodiment) the first refrigerant communication pipe 6 (shown by chain double-dashed lines in FIG. 2). The second stop valve 27 is a valve provided to the connecting portion between the refrigerant pipe in the outdoor unit 2 (the fourth refrigerant pipe 34 in the present embodiment) connects with the second refrigerant communication pipe 7 (shown by chain double-dashed lines in FIG. 2). The second stop valve 27 is connected to the four-way switching valve 23 by the fourth refrigerant pipe 34.

[0044] The outdoor fan 36 is an air-blowing fan that functions so as to take air into the air blower chamber S1 through suction ports (not shown) formed in the left side

surface and back surface of the unit casing 51, and to blow the air from the discharge port 54a formed in the front surface of the unit casing 51 after the air has passed through the outdoor heat exchanger 24. In the present embodiment, the outdoor fan 36 is a propeller fan and is disposed downstream of the outdoor heat exchanger 24 in the air blower chamber S 1. The outdoor fan 36 is configured so as to be rotatably driven by an outdoor fan motor 36a.

[0045] The electrical component assembly (not shown) is disposed in the upper space of the machinery chamber S2, and the assembly has a control board including a microcomputer or the like for performing operation control, an inverter board, and various other electrical components.

[0046] Next, the internal structure of the compressor 22 and the compressor capacity control operation circuit 35 will be described in detail.

[0047] In the present embodiment, the compressor 22 is a hermetic compressor in which primarily a compression element 62, an Oldham ring 73, a compressor motor 75, and a bottom main bearing 76 are housed inside a casing 61, which is an upright cylindrical container.

[0048] The casing 61 primarily has a substantially cylindrical core plate 61 a, a top panel 61 b fixed by welding to the top end of the core plate 61 a, and a bottom panel 61 c fixed by welding to the bottom end of the core plate 61 a.

[0049] The compression element 62 is a scroll-type compression element primarily having a housing 63, a fixed scroll 64 disposed above the housing 63, and an orbiting scroll 65 that meshes with the fixed scroll 64. The housing 63 is fixed by press-fitting into the core plate 61 a in the external peripheral surface throughout the entire circumferential direction. The interior of the casing 61 is thereby partitioned into a high-pressure space S3 at the lower part of the housing 63 and a low-pressure space S4 at the upper part of the housing 63. A housing concave part 63a recessed in the center of the top surface and a bearing part 63b extending downward from the center of the bottom surface are also formed in the housing 63. A bearing hole 63c penetrating through the bearing part 63b in the vertical direction is formed therein, and a drive shaft 66 is rotatably fitted into the bearing hole 63c via a bearing 67. The fixed scroll 64 primarily has a panel 64a, a spiral (involute) wrap 64b formed on the bottom surface of the panel 64a, and a second external peripheral wall 64c enclosing the wrap 64b. A discharge channel 69 communicated with a compression chamber 68 (described hereinafter) and an expanding concave part 70 communicated with the discharge channel 69 are formed in the panel 64a. The discharge channel 69 is formed so as to extend vertically in the middle portion of the panel 64a. The expanding concave part 70 is configured from a horizontally expanding concave part that is recessed in the top surface of the panel 64a. A lid 71 is fixed by a bolt 72 to the top surface of the fixed scroll 64 so as to close off the expanding concave part 70. By covering up the ex-

panding concave part 70 with the lid 71, the expanding concave part 70 is partitioned from the low-pressure space S4 (i.e., communicated with the high-pressure space S3), forming a muffler space S5 composed of an expansion chamber for muffling operation noises in the compression element 62. The orbiting scroll 65 primarily has a panel 65a, a spiraling (involute) wrap 65b formed on the top surface of the panel 65a, a bearing part 65c formed in the bottom surface of the panel 65a, and a groove 65d formed in both ends of the panel 65a. The orbiting scroll 65 is supported on the housing 63 by fitting the Oldham ring 73 into the groove 65d. The top end of the drive shaft 66 is also fitted into the bearing part 65c. The orbiting scroll 65 is thus incorporated into the compression element 62, whereby the orbiting scroll 65 revolves within the housing 63 without rotating on its axis due to the rotation of the drive shaft 66. The wrap 65b of the orbiting scroll 65 is meshed with the wrap 64b of the fixed scroll 64, and the compression chamber 68 is formed between the contact parts of the wraps 64b, 65b. The compression chamber 68 is designed so that the volume between the wraps 64b, 65b constricts toward the center along with the revolution of the orbiting scroll 65. A communication channel 74 is formed through the fixed scroll 64 and the housing 63 in the compression element 62. The communication channel 74 is formed so that a scroll-side channel 74a formed in the fixed scroll 64 and a housing-side channel 74b formed in the housing 63 are communicated with each other. The top end of the communication channel 74, i.e., the top end of the scroll-side channel 74a, opens into the expanding concave part 70; and the bottom end of the communication channel 74, i.e., the bottom end of the housing-side channel 74b, opens into the high-pressure space S3 from the bottom end surface of the housing 63.

[0050] The Oldham ring 73 is a member for preventing rotational movement of the orbiting scroll 65 as described above, and is fitted into an Oldham groove (not shown) formed in the housing 63.

[0051] In the present embodiment, the compressor motor 75 is a motor whose frequency can be controlled by an inverter control element or the like mounted on the electrical component assembly (not shown), and the motor is disposed below the compression element 62. The compressor motor 75 primarily has an annular stator 75a fixed to the internal wall surface of the casing 61, and a rotor 75b rotatably housed at a slight gap (air gap channel) from the internal peripheral side of the stator 75a. A copper wire is wound around the stator 75a, and coil ends are formed above and below. The rotor 75b is linked to the orbiting scroll 65 of the compression element 62 by the vertically extending drive shaft 66.

[0052] The bottom main bearing 76 is disposed in a bottom space below the compressor motor 75. The bottom main bearing 76 is fixed to the core plate 61a, forms a bearing at the bottom end of the drive shaft 66, and supports the drive shaft 66.

[0053] The top panel 61b of the casing 61 is provided

with a suction nozzle 77 running vertically through the low-pressure space S4 and having an internal end fitted into the fixed scroll 64 to form the suction port of the compressor 22. The core plate 61a of the casing 61 is also provided with a discharge nozzle 78 whose inside end opens into the high-pressure space S3 to form the discharge port of the compressor 22.

[0054] Furthermore, the compressor capacity control operation circuit 35 is connected to the compressor 22 of the present embodiment to allow capacity to be controlled so that the operating state is switched between a full load operation in which the discharge capacity is 100% with respect to the suction capacity, and an unload operation in which the discharge capacity is reduced with respect to the suction capacity. A cylinder intermediate part 79 is provided in order to implement this type of capacity control. The cylinder intermediate part 79 primarily has an unload channel 80, a valve hole 81, a bypass channel 82, a valve 83, a spring 84, the above-described lid 71, and an intermediate nozzle 85.

[0055] The unload channel 80 is formed in the fixed scroll 64 so as to extend vertically, and the bottom end of the unload channel is communicated with the compression chamber 68.

[0056] The valve hole 81 is formed in the fixed scroll 64 so as to extend upward from the top end of the unload channel 80, and the top end of the valve hole 81 is covered by the lid 71.

[0057] The bypass channel 82 is a channel for guiding the refrigerant from the compression chamber 68 to the low-pressure space S4 during the unload operation by establishing communication between the low-pressure space S4 and the compression chamber 68 via the unload channel 80 and the valve hole 81, thereby substantially delaying the start of compression. The bypass channel 82 is formed in the fixed scroll 64 so as to cause the valve holes 81 to communicate with the low-pressure space S4.

[0058] The valve 83 is disposed in the valve hole 81 in a state of being urged upward by the spring 84, and is designed to be capable of moving vertically within the valve hole 81 due to the balance between the urging force of the spring 84 and the pressure in an operational pressure chamber 86 formed above the valve 83. Therefore, the unload channel 80 and the bypass channel 82 become divided by the valve 83 when the valve 83 has moved downward (i.e., the pressure in the operational pressure chamber 86 is greater than the urging force of the spring 84), and the unload channel 80 and the bypass channel 82 communicate with each other when the valve 83 has moved upward (i.e., the pressure in the operational pressure chamber 86 is less than the urging force of the spring 84).

[0059] The intermediate nozzle 85 is provided so as to pass vertically through the top panel 61b of the casing 61, the low-pressure space S4, and the lid 71; and to be communicated with the operational pressure chamber 86 of the valve hole 81. Thus, in the compressor 2, the

valve 83 is operated according to the pressure applied to the operational pressure chamber 86 through the intermediate nozzle 85, thereby forming a cylinder intermediate part 79 capable of opening and closing the un-load channel 80.

[0060] The compressor capacity control operation circuit 35 is connected to the compressor 22 having this cylinder intermediate part 79, as described above. The compressor capacity control operation circuit 35 primarily has a suction branching pipe 87, an intermediate pipe 88, a discharge branching pipe 89, and a pilot valve 90 as a flow-channel switching valve, and is disposed in the space between the compressor 22 and the four-way switching valve 23 placed one above the other in the present embodiment (not shown in FIG. 2).

[0061] The suction branching pipe 87 is a refrigerant pipe that branches off from the suction pipe 28 of the compressor 22, and is smaller in diameter than the suction pipe 28 in the present embodiment.

[0062] The intermediate pipe 88 is a refrigerant pipe connected to the cylinder intermediate part 79 of the compressor 22 (more specifically, the intermediate nozzle 85), and is substantially the same in diameter as the intermediate nozzle 85 in the present embodiment.

[0063] The discharge branching pipe 89 is a refrigerant pipe that branches off from the discharge pipe 30 of the compressor 22, and is smaller in diameter than the discharge pipe 30 in the present embodiment.

[0064] In the present embodiment, the pilot valve 90 is a pilot valve for use as a four-way switching valve, primarily having a valve main body 91, an electromagnetic coil 92, and four connecting capillary tubes 93a, 93b, 93c, 93d. The valve main body 91 primarily has a valve case 94, a valve body 95, and a plunger 96. The valve case 94 is a substantially cylindrical member having a hollow space in the interior, wherein four ports 94a, 94b, 94c, 94d communicated with the interior space are formed in the external periphery of the valve case 94, and an opening 94e through which the plunger 96 is reciprocally inserted is formed in a portion at one axial end. In the present embodiment, the second port 94b, the first port 94a, and the fourth port 94d are disposed at substantially equal intervals in the axial direction from a position near the opening 94e, and the third port 94c is disposed so as to face the first port 94a. The valve body 95 is disposed inside the valve case 94 and is linked to the axially distal end of the portion of the plunger 96 inserted into the valve case 94. In the present embodiment, the valve body 95 has a bowl shape. Inserting the plunger 96 deep into the valve case 94 causes the valve body 95 to move away from the opening 94e, allowing the first port 94a and the fourth port 94d to communicate with each other and also the second port 94b and the third port 94c to communicate with each other; and reducing the depth of the insertion of the plunger 96 in the valve case 94 causes the valve body 95 to move toward the opening 94e, allowing the first port 94a and the second port 94b to communicate with each other and also

the third port 94c and the fourth port 94d to communicate with each other. The electromagnetic coil 92 is disposed so as to enclose the external periphery of the portion of the plunger 96 protruding axially out of the valve case 94. In the present embodiment, in the nonconductive state, the plunger 96 is inserted deep into the valve case 94, whereby the valve body 95 moves away from the opening 94e, the first port 94a and the fourth port 94d are brought in communication with each other, and the second port 94b and the third port 94c are brought in communication with each other; and in the conductive state, the depth of the insertion of the plunger 96 into the valve case 94 is reduced, whereby the valve body 95 moves toward the opening 94e, the first port 94a and the second port 94b are brought in communication with each other, and the third port 94c and the fourth port 94d are brought in communication with each other. One end of the first capillary tube 93a is connected to the first port 94a, and the other end is connected to the suction branching pipe 87, which is larger in diameter than the first capillary tube 93a. One end of the second capillary tube 93b is connected to the second port 94b, and the other end is connected to the intermediate pipe 88, which is larger in diameter than the second capillary tube 93b. One end of the third capillary tube 93c is connected to the third port 94c, and the other end is connected to the discharge branching pipe 89, which is larger in diameter than the third capillary tube 93c. One end of the fourth capillary tube 93d is connected to the fourth port 94d, and the other end is closed off. Thus, one of the four connecting capillary tubes, the fourth capillary tube 93d, is closed off, whereby the valve main body 91 of the pilot valve 90 has the same function as when two two-way valves are used to form a flow channel configuration in which the suction branching pipe 87 and the first capillary tube 93a communicated with the first port 94a constitute a first flow channel, the intermediate pipe 88 and the second capillary tube 93b communicated with the second port 94b constitute a second flow channel, and the discharge branching pipe 89 and the third capillary tube 93c communicated with the third port 94c constitute a third flow channel; in which case it is possible to switch between a first state (corresponding to the conductive state of the electromagnetic coil 92 in the present embodiment) in which the first flow channel and the second flow channel are connected and the third flow channel is not connected to either the first or second flow channel, and a second state (corresponding to the nonconductive state of the electromagnetic coil 92 in the present embodiment) in which the second flow channel and the third flow channel are connected and the first flow channel is not connected to either the second or third flow channel. The state of the pilot valve 90 in FIG. 3 corresponds to a case in which the electromagnetic coil 92 is in the nonconductive state. The solid lines associated with the pilot valve 90 in FIG. 1 correspond to a case in which the electromagnetic coil 92 is in the nonconductive state, and the dashed lines associated with the pilot valve 90 in FIG. 1

correspond to a case in which the electromagnetic coil 92 is in the conductive state.

[0065] When the full load operation is performed, the electromagnetic coil 92 is in the nonconductive state, whereby the second port 94b and the third port 94c of the pilot valve 90 are brought into communication with each other, and the first port 94a is not communicated with either of the second or third ports 94b, 94c. The pressure of the cylinder intermediate part 79 in the operational pressure chamber 86 thereby increases, and the unload channel 80 and the bypass channel 82 are divided by the valve 83, therefore allowing compression work to be performed without delaying the start of compression. When the unload operation is performed, the first port 94a and the second port 94b of the pilot valve 90 are brought into communication with each other, and the third port 94c is not communicated with either of the first or second ports 94a, 94b. The pressure of the cylinder intermediate part 79 in the operational pressure chamber 86 thereby decreases, and the unload channel 80 and the bypass channel 82 are brought into communication with each other, the refrigerant is guided into the low-pressure space S4 from the compression chamber 68, and compression work is therefore performed with a delay in the start of compression.

[0066] Thus, since the compressor capacity control operation circuit 35 of the present embodiment uses the pilot valve 90 for the four-way switching valve instead of two two-way valves, the cost increase from using two two-way valves can be prevented, and the same capacity control for the compressor 22 can be achieved as in the case of using two two-way valves. Moreover, when the pilot valve 90 is given a flow channel configuration identical to a flow channel configuration composed of two two-way valves, this is achieved by a simple process of closing off one (the fourth capillary tube 93d in the present embodiment) of the four connecting capillary tubes 93a, 93b, 93c, 93d, and the configuration is therefore simplified. In the present embodiment, the valve used as the pilot valve 90 is the same as the pilot valve 23b for use as a four-way switching valve constituting the four-way switching valve 23 included in the main refrigerant circuit, and components can therefore be shared, thereby contributing to reducing the cost of the entire air conditioner 1.

[0067] However, since the pilot valve 90 for use as a four-way switching valve is used as a flow channel switching valve in the compressor capacity control operation circuit 35 of the present embodiment, a valve is used in which the first, second, and third capillary tubes 93a, 93b, 93c extend from the valve main body 91. Therefore, strength is reduced in the portion of the first capillary tube 93a connected with the suction branching pipe 87, in the portion of the second capillary tube 93b connected with the intermediate pipe 88, and in the portion of the third capillary tube 93c connected with the discharge branching pipe 89.

[0068] In view of this, in the compressor capacity control operation circuit 35 of the present embodiment, the

pilot valve 90 and at least one of the suction branching pipe 87, the intermediate pipe 88, and the discharge branching pipe 89 (the intermediate pipe 88 and the discharge branching pipe 89 herein) are fixed to a fixing member 98, thereby ensuring that excessive stress does not act on the first, second, and third capillary tubes 93a, 93b, 93c, and enabling the use of the pilot valve 90 for use as a four-way switching valve. The fixing member 98 herein is a sheet-shaped member made of sheet metal, and is disposed in the present embodiment so as to at least face the connecting portion between the second capillary tube 93b and the intermediate pipe 88 and the connecting portion between the third capillary tube 93c and the discharge branching pipe 89. In the pilot valve 90, the electromagnetic coil 92 is fixed to the fixing member 98 by a band member 97e. The intermediate pipe 88 and the discharge branching pipe 89 are fixed to the fixing member 98 by band members 97b, 97c, respectively. In the present embodiment, the pipes fixed to the fixing member 98 among the suction branching pipe 87, the intermediate pipe 88, and the discharge branching pipe 89 (the intermediate pipe 88 and the discharge branching pipe 89 herein) are fixed to the fixing member 98 by the portions thereof in proximity to the corresponding capillary tubes 93b, 93c. Therefore, positional misalignment or the like in the capillary tube proximities of the suction branching pipe 87, the intermediate pipe 88, and the discharge branching pipe 89 can be reliably prevented, whereby stress acting on the first, second, and third capillary tubes 93a, 93b, 93c can be reliably reduced. In the present embodiment, the connecting portion between the first capillary tube 93a and the suction branching pipe 87 is not fixed to the fixing member 98, but at least one of the suction branching pipe 87, the intermediate pipe 88, and the discharge branching pipe 89 is preferably fixed to the fixing member 98. For example, the suction branching pipe 87 may be fixed to the fixing member 98 by a band member similar to the intermediate pipe 88 and the discharge branching pipe 89, or any one of the suction branching pipe 87, the intermediate pipe 88, and the discharge branching pipe 89 may be fixed to the fixing member 98.

[0069] The outdoor controller 37 has a microcomputer, a memory and the like provided in order to control the outdoor unit 2, and the outdoor controller 37 is designed to be capable of exchanging control signals or the like with the indoor controller 43 of the indoor unit 4. Specifically, a controller as an operation control means for performing operation control for the air conditioner 1 is configured by the indoor controller 43 and the outdoor controller 37.

[0070] The outdoor refrigerant circuit 10a, the indoor refrigerant circuit 10b, and the refrigerant communication pipes 6, 7 are connected as described above to form the refrigerant circuit 10 that is capable of heating and cooling a room interior and that has the main refrigerant circuit including the compressor 22, the four-way switching valve 23, the outdoor heat exchanger 24 as a first heat

exchanger, the expansion valve 25 as an expansion mechanism, and the indoor heat exchanger 41 as a second heat exchanger, and also has the compressor capacity control operation circuit 35 connected to the compressor 22 and used to enable the capacity of the compressor 22 to be controlled. The air conditioner 1 of the present embodiment is designed to be capable of controlling the devices of the outdoor unit 2 and the indoor unit 4 by a controller configured from the indoor controller 43 and the outdoor controller 37.

(2) Operation of Air Conditioner

< Operation During Full Load Operation >

[0071] First, the operation during cooling will be described using FIGS. 1 and 3.

[0072] During cooling, the four-way switching valve 23 is in the state shown by the solid lines in FIG. 1; i.e., a state in which the discharge side of the compressor 22 is connected to the outdoor heat exchanger 24 and the suction side of the compressor 22 is connected to the second stop valve 27. The degree of opening of the expansion valve 25 is adjustable. The stop valves 26, 27 are in an open state. Furthermore, the electromagnetic coil 92 of the pilot valve 90 is in the nonconductive state.

[0073] When the compressor 22, the outdoor fan 36, and the indoor fan 42 are started up while the refrigerant circuit 10 is in this state, the low-pressure refrigerant is taken in by the compressor 22 and compressed to be a high-pressure refrigerant. Since the electromagnetic coil 92 of the pilot valve 90 is in the nonconductive state herein, the result is a state in which the second port 94b and the third port 94c of the pilot valve 90 are brought into communication with each other, and the first port 94a is not communicated with either of the second or third ports 94b, 94c, whereby compression work is performed in the compressor 22 without delaying the start of compression, and a full load operation is performed in which the discharge capacity is 100% with respect to the suction capacity. The high-pressure refrigerant is then fed via the four-way switching valve 23 to the outdoor heat exchanger 24 functioning as a refrigerant cooler, heat exchange is conducted between the refrigerant and outdoor air supplied by the outdoor fan 36, and the refrigerant is cooled. The high-pressure refrigerant cooled in the outdoor heat exchanger 24 is depressurized by the expansion valve 25 to be a low-pressure gas-liquid two-phase refrigerant, which is fed via the first stop valve 26 and the first refrigerant communication pipe 6 to the indoor unit 4. The low-pressure gas-liquid two-phase refrigerant fed to the indoor unit 4 is heated through heat exchange with indoor air in the indoor heat exchanger 41 functioning as a refrigerant heater, and the refrigerant is thereby evaporated to be a low-pressure refrigerant. The low-pressure refrigerant heated in the indoor heat exchanger 41 is then fed via the second refrigerant communication pipe 7 to the outdoor unit 2, and is again taken in by the compressor

22 via the second stop valve 27, the four-way switching valve 23, and the accumulator 21. Thus, cooling is performed. The capacity of the compressor 22 during the full load operation is controlled primarily by frequency control of the compressor motor 75.

[0074] Next, the operation during heating will be described using FIGS. 1 and 3.

[0075] During heating, the four-way switching valve 23 is in the state shown by the dashed lines in FIG. 1; i.e., a state in which the discharge side of the compressor 22 is connected to the second stop valve 27, and the suction side of the compressor 22 is connected to the outdoor heat exchanger 24. The degree of opening of the expansion valve 25 is adjustable. The stop valves 26, 27 are in an open state. Furthermore, the electromagnetic coil 92 of the pilot valve 90 is in the nonconductive state.

[0076] When the compressor 22, the outdoor fan 36, and the indoor fan 42 are started up while the refrigerant circuit 10 is in this state, the low-pressure refrigerant is taken in by the compressor 22 and compressed to be a high-pressure refrigerant. Since the electromagnetic coil 92 of the pilot valve 90 is in the nonconductive state herein, the result is a state in which the second port 94b and the third port 94c of the pilot valve 90 are brought into communication with each other and the first port 94a is not communicated with either of the second or third ports 94b, 94c, whereby compression work is performed in the compressor 22 without delaying the start of compression, and a full load operation is performed in which the discharge capacity is 100% with respect to the suction capacity. The high-pressure refrigerant is then fed via the four-way switching valve 23, the second stop valve 27, and the second refrigerant communication pipe 7 to the indoor unit 4. The high-pressure refrigerant fed to the indoor unit 4 is then cooled through heat exchange with indoor air in the indoor heat exchanger 41 functioning as a refrigerant cooler, and the refrigerant is then fed via the first refrigerant communication pipe 6 to the outdoor unit 2. The high-pressure refrigerant fed to the outdoor unit 2 is depressurized by the expansion valve 25 to be a low-pressure gas-liquid two-phase refrigerant, and then flows into the outdoor heat exchanger 24 functioning as a refrigerant heater. The low-pressure gas-liquid two-phase refrigerant that has flowed into the outdoor heat exchanger 24 is heated through heat exchange with outdoor air supplied by the outdoor fan 36, the refrigerant is thereby evaporated to be a low-pressure refrigerant, and the refrigerant is taken back into the compressor 22 via the four-way switching valve 23 and the accumulator 21. Thus, heating is performed. The capacity of the compressor 22 during the full load operation is controlled primarily by performing frequency control of the compressor motor 75.

<Action During Unload Operation>

[0077] The full load operation as described above is performed in areas in which the operating efficiency of

the refrigeration cycle is comparatively favorable in cases in which the ratio of the pressure of the high-pressure refrigerant with respect to the pressure of the low-pressure refrigerant in the refrigeration cycle is suppressed at a predetermined range or lower, or in cases in which the frequency of the compressor motor 75 is in a comparatively high range. Therefore, there are many cases in which controlling the frequency of the compressor motor 75 is sufficient to control the capacity of the compressor 22.

[0078] However, in cases in which the ratio of the pressure of the high-pressure refrigerant with respect to the pressure of the low-pressure refrigerant in the refrigeration cycle exceeds the predetermined range, or in cases in which the frequency of the compressor motor 75 is in a low range, conditions arise in which the capacity of the compressor 22 cannot be sufficiently controlled merely by controlling the frequency of the compressor motor 75, or the operation is performed in an area of poor operating efficiency.

[0079] In view of this, the electromagnetic coil 92 of the pilot valve 90 is switched to the conductive state in such a case, creating a state in which the first port 94a and the second port 94b of the pilot valve 90 are brought into communication with each other, and the third port 94c is not communicated with either of the first or second ports 94a, 94b, thereby creating a state in which the unload channel 80 and the bypass channel 82 are communicated with each other and the refrigerant is guided from the compression chamber 68 to the low-pressure space S4. Compression work is thereby performed in the compressor 22 in a state in which the start of compression is delayed, an unload operation is performed in which the discharge capacity is reduced with respect to the suction capacity, and an operation in the state in which the compressor motor 75 has a low frequency is avoided.

[0080] The operating efficiency can thereby be prevented as much as possible from decreasing, even in cases in which the ratio of the pressure of the high-pressure refrigerant with respect to the pressure of the low-pressure refrigerant in the refrigeration cycle exceeds the predetermined range, or in cases in which the frequency of the compressor motor 75 is in a low range. Moreover, the pilot valve 90 is designed so that there are no situations in which some of the refrigerant discharged from the compressor 22 is needlessly bypassed to the suction pipe 28 from the discharge pipe 30, similar to a case of using two two-way valves, and increases in power consumption in the compressor 22 during the unload operation can therefore be suppressed. Furthermore, when switching between the full load operation and the unload operation, unlike a case of using two two-way valves, the number of electrical wires can be reduced and the control specifics can be simplified because it is only necessary to control just the pilot valve 90.

(3) Other Embodiments

[0081] An embodiment of the present invention was described above with reference to the drawings, but the specific configuration is not limited to this embodiment, and modifications can be made within a range that does not deviate from the scope of the invention.

<A>

[0082] In the embodiment described above, the fourth capillary tube 93d was closed off among the four connecting capillary tubes 93a to 93d of the pilot valve 90, but the present invention is not limited to this option, and any one of the four connecting capillary tubes 93a to 93d can be closed off. In this case, the capillary tubes connected to the suction branching pipe 87, the intermediate pipe 88, and the discharge branching pipe 89 are changed according to the closed off capillary tube, whereby the pilot valve 90 preferably has the same flow channel configuration as one configured from two two-way valves, similar to the embodiment described above.

[0083] In the embodiment described above, a scroll compressor was used as the compressor 22, and the compressor motor 75 was disposed in the high-pressure space S3 filled with high-pressure refrigerant, but the present invention is not limited to this option, and a rotary compressor or another such compressor may be used, and the compressor motor 75 may be disposed in a space filled with low-pressure refrigerant.

<C>

[0084] In the embodiment described above, the outdoor unit 2 had a design in which the interior of the unit casing 51 was divided by the partitioning plate 56 into the air blower chamber S1 and the machinery chamber S2 and the air taken into the unit casing 51 was blown out from the front surface of the unit casing 51, but the present invention is not limited to this option, and another type of outdoor unit may be used, such as an outdoor unit having a design in which air taken into the unit casing is blown out from the top surface of the unit casing. In the embodiment described above, the air conditioner 1 was a so-called paired and separated type air conditioner in which one indoor unit 4 was connected to one outdoor unit 2, but other types of air conditioner may also be used, such as a remote-condenser type air conditioner or a multi-type air conditioner in which a plurality of indoor units are connected to one or more outdoor unit.

INDUSTRIAL APPLICABILITY

[0085] Utilizing the present invention makes it possible to provide a compressor capacity control operation mechanism and an air conditioner comprising the mechanism wherein cost increases can be prevented and the

capacity of the compressor can be controlled in the same manner as in a case of using two two-way valves.

Claims

1. A compressor capacity control operation mechanism that is connected to a compressor (22) and is capable of controlling the capacity of the compressor; the compressor capacity control operation mechanism comprising:

a flow channel switching valve (90) including a valve main body (91) configured to have the same function as when two two-way valves are used to constitute a flow channel configuration capable of switching between a first state in which a first flow channel and a second flow channel are connected and a third flow channel is not connected to either the first flow channel or the second flow channel, and a second state in which the second flow channel and the third flow channel are connected and the first flow channel is not connected to either the second flow channel or the third flow channel; a first capillary tube (93a) constituting the first flow channel and

extending from the valve main body; a second capillary tube (93b) constituting the second flow channel and extending from the valve main body; and a third capillary tube (93c) constituting the third flow channel and extending from the valve main body;

a suction branching pipe (87) branching off from a suction pipe (28) of the compressor, being connected to the first capillary tube, and having a larger diameter than the first capillary tube; an intermediate pipe (88) connected to a cylinder intermediate part (79) of the compressor, being connected to the second capillary tube, and having a larger diameter than the second capillary tube;

a discharge branching pipe (89) branching off from a discharge pipe (30) of the compressor, being connected to the third capillary tube, and having a larger diameter than the third capillary tube; and

a fixing member (98) to which are fixed the flow channel switching valve and at least one of the suction branching pipe, the intermediate pipe, and the discharge branching pipe.

2. The compressor capacity control operation mechanism according to claim 1, wherein among the suction branching pipe (87), the intermediate pipe (88), and the discharge branching pipe (89), one or those fixed to the fixing member (98) are fixed to the fixing member at the portions in proximity to the corre-

sponding capillary tubes (93a, 93b, 93c).

3. A compressor capacity control operation mechanism that is connected to a compressor (22) and is capable of controlling the capacity of the compressor; the compressor capacity control operation mechanism comprising:

a pilot valve (90) for use as a four-way switching valve having four connecting capillary tubes; a suction branching pipe (87) connected to a first capillary tube as one of the four connecting capillary tubes (93a, 93b, 93c, 93d) and branched off from a suction pipe (28) of the compressor;

an intermediate pipe (88) connected to a second capillary tube as one of the four connecting capillary tubes and connected to a cylinder intermediate part (79) of the compressor; and

a discharge branching pipe (89) connected to a third capillary tube as one of the four connecting capillary tubes and branched off from a discharge pipe (30) of the compressor.

4. The compressor capacity control operation mechanism according to claim 3, wherein a fourth capillary tube as one of the four connecting capillary tubes (93a, 93b, 93c, 93d) is closed off.

5. An air conditioner comprising:

a vapor-compression main refrigerant circuit including the compressor (22), a four-way switching valve (23), a first heat exchanger (24), an expansion mechanism (25), and a second heat exchanger (41); and

the compressor capacity control operation mechanism according to claim 3 or 4, wherein the same valve as a pilot valve (23b) for use as a four-way switching valve constituting the four-way switching valve is used as the pilot valve (90) for use as a four-way switching valve.

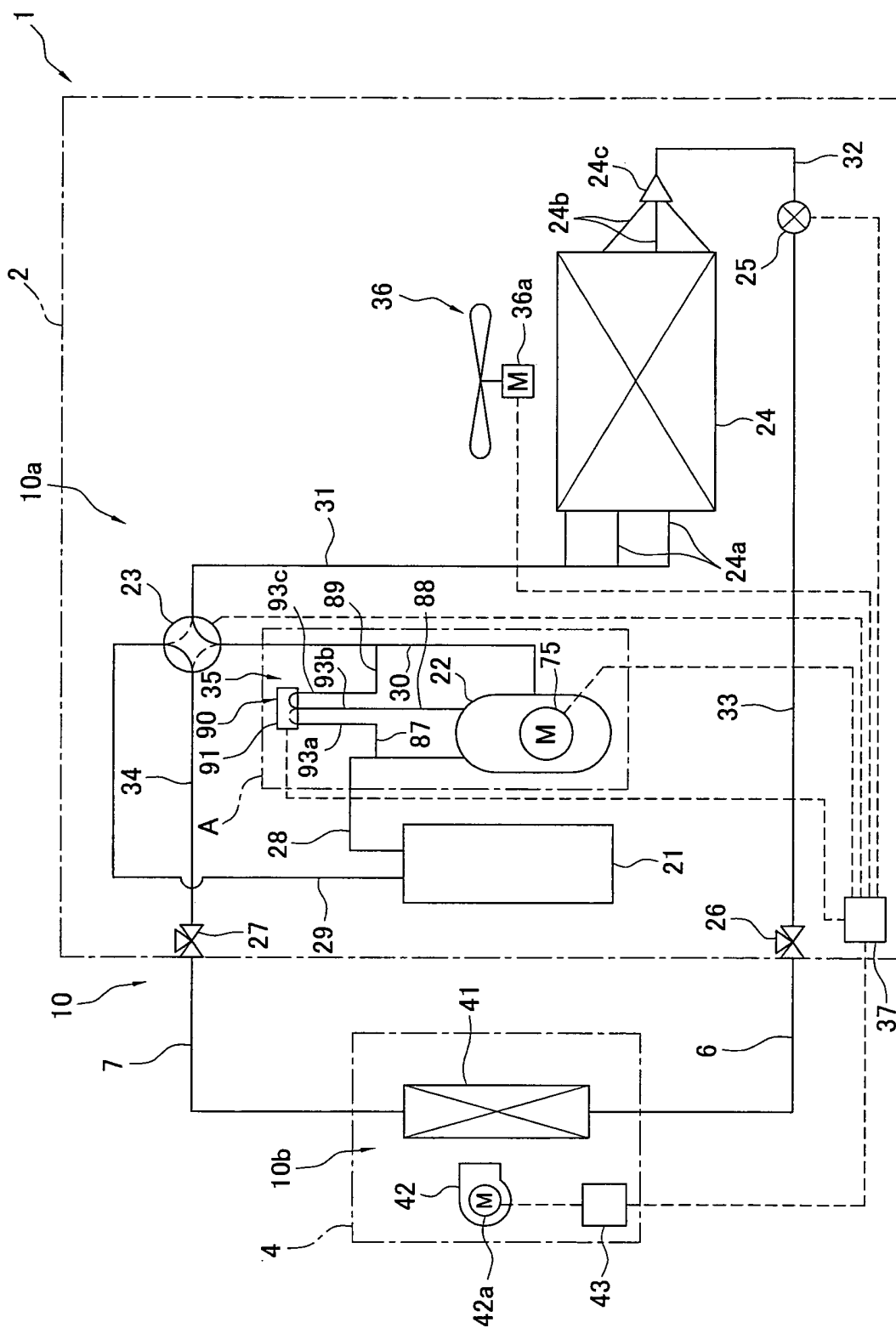


FIG. 1

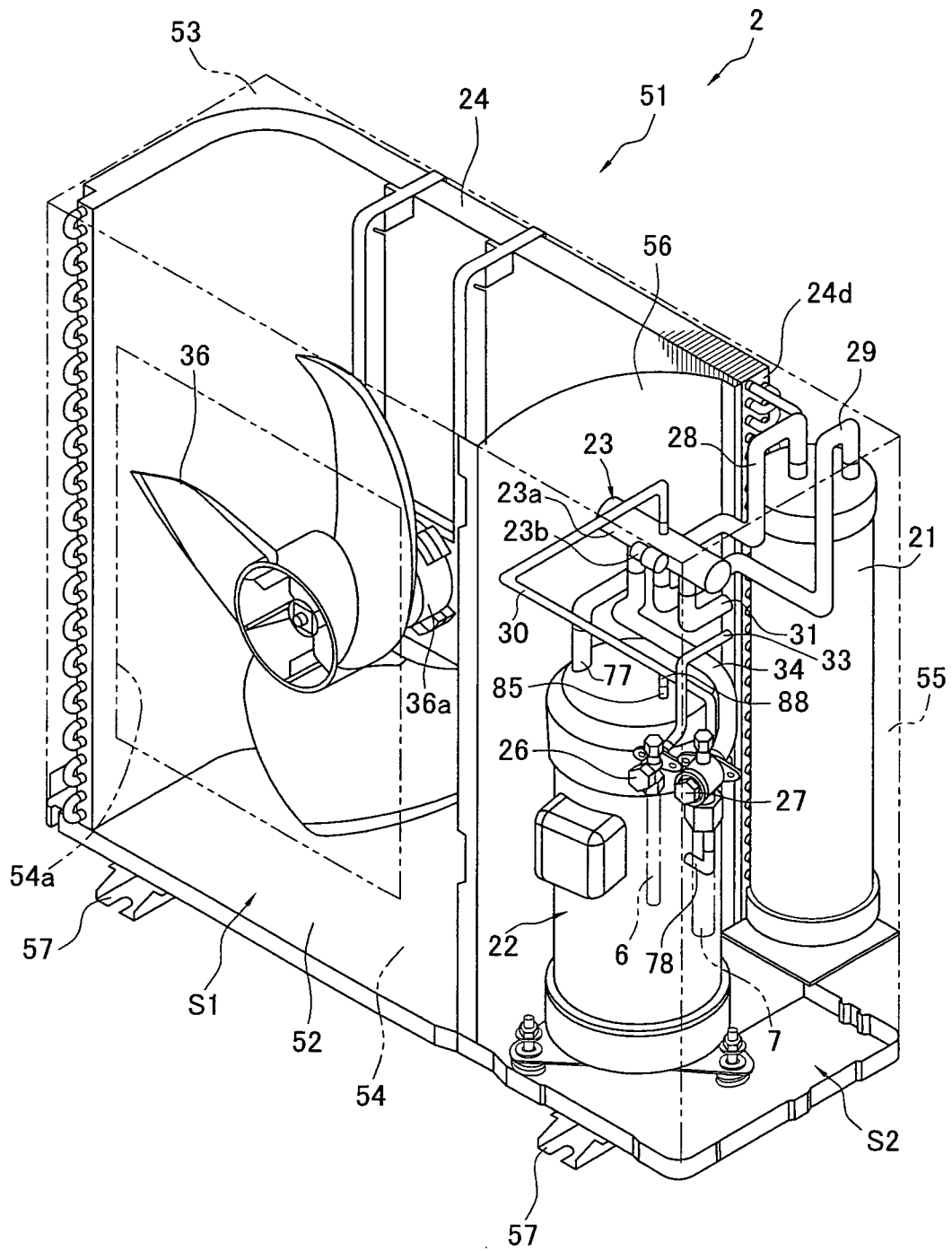


FIG. 2

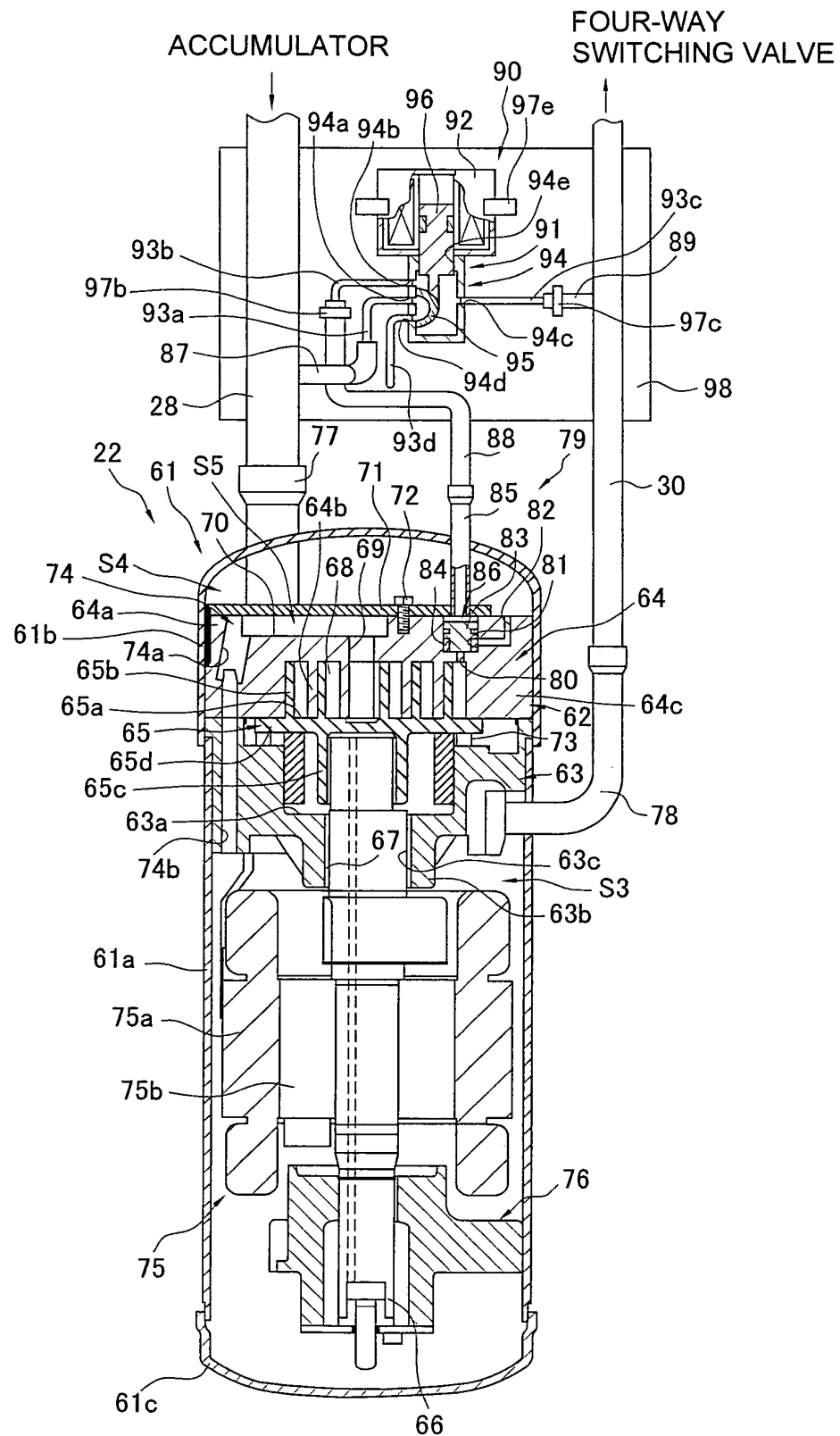


FIG. 3

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2008/055367

A. CLASSIFICATION OF SUBJECT MATTER

F04C28/26 (2006.01) i, F25B41/04 (2006.01) i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

F04C28/26, F25B41/04

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2008

Kokai Jitsuyo Shinan Koho 1971-2008 Toroku Jitsuyo Shinan Koho 1994-2008

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	JP 2006-132520 A (LG Electronics Inc.), 25 May, 2006 (25.05.06), Par. Nos. [0013] to [0018]; Fig. 6 & US 2006/0093504 A1 & DE 102005000897 A & KR 10-2006-0040163 A & CN 1769711 A	1-4 5
Y	JP 6-2688 A (Matsushita Refrigeration Co.), 11 January, 1994 (11.01.94), Fig. 2 (Family: none)	1-2
Y	JP 11-14097 A (Fujitsu General Ltd.), 22 January, 1999 (22.01.99), Fig. 2 (Family: none)	1-2

☒ Further documents are listed in the continuation of Box C.
 ☐ See patent family annex.

* Special categories of cited documents:	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A" document defining the general state of the art which is not considered to be of particular relevance	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E" earlier application or patent but published on or after the international filing date	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&" document member of the same patent family
"O" document referring to an oral disclosure, use, exhibition or other means	
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search
11 June, 2008 (11.06.08)Date of mailing of the international search report
24 June, 2008 (24.06.08)Name and mailing address of the ISA/
Japanese Patent Office

Authorized officer

Facsimile No.

Telephone No.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2008/055367

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 139740/1986 (Laid-open No. 46761/1988) (Mitsubishi Electric Corp.), 30 March, 1988 (30.03.88), Fig. 2 (Family: none)	1-2
Y A	JP 2004-85047 A (Daikin Industries, Ltd.), 18 March, 2004 (18.03.04), Par. No. [0042] (Family: none)	3-4 5
Y	JP 5-340485 A (Hitachi, Ltd.), 21 December, 1993 (21.12.93), Page 2, problems to be solved by the invention (Family: none)	3-4
Y	JP 2002-147627 A (Fuji Koki Corp.), 22 May, 2002 (22.05.02), Par. Nos. [0024] to [0026] (Family: none)	3-4
A	JP 2-191882 A (Hitachi, Ltd.), 27 July, 1990 (27.07.90), Fig. 2 (Family: none)	1-5
A	JP 62-45993 A (Toyoda Automatic Loom Works, Ltd.), 27 February, 1987 (27.02.87), Fig. 1 (Family: none)	1-5

Form PCT/ISA/210 (continuation of second sheet) (April 2007)

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2008/055367

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

The invention of claims 1-2 relates to the fixation means of the flow path switch valve.

The invention of claims 3-5 relates to the mixed-purpose means for the pilot valve.

1. ☒ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest
the

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☒ No protest accompanied the payment of additional search fees.

Form PCT/ISA/210 (continuation of first sheet (2)) (April 2007)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 9072625 A [0003]