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(54) Suction valve for compressor

(57) In a reciprocating compressor, a suction valve is abutted against a stopper to hold open a suction port even when the compressor is in a stop state. The suction valve is movable relative to the suction port to open or close the suction port. The stopper is for restricting movement of the suction valve. It is preferable that the suction port is formed in a valve plate placed between a cylinder block and a cylinder head.

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Description

[0001] The present invention relates to a reciprocating compressor for compressing a gaseous fluid.

[0002] A conventional compressor for an air conditioning in a car, such as a reciprocating compressor, is known (e.g., U.S. Patent No. 4,846,049). In such a compressor, a discharge valve and a suction valve are disposed on a valve plate, which is held between a cylinder block with a plurality of cylinder bores arranged therein and a cylinder head for closing the outer end of the cylinder block. The valve plate has discharge and suction ports corresponding to each cylinder bore. The discharge and suction valves close the discharge and suction ports, respectively. A piston is inserted in each cylinder bore and driven to reciprocate along the cylinder bore. When the piston reciprocates, the corresponding discharge and suction valves perform opening/closing operations.

[0003] If the cylinder bore is extended to the left and right and its right end is provided with the valve plate, the opening/closing operation of the suction valve is as follows. When the piston moves towards the left, the gas pressure in the cylinder bore lowers. When the sum of the force in the cylinder bore acting on the suction valve, the bending stress of the suction valve, and the viscous force of oil between the valve and the valve plate, falls below the pressure in a suction chamber defined within the cylinder head, the valve opens. When these forces exceed the suction pressure, the valve closes.

[0004] In another conventional compressor a cylinder block is provided with a notched step portion corresponding to a tip end of a suction valve. The notched step portion forms a stopper restricting the maximum open amount of the suction valve (e.g., JP-Y2 Nos. 35899/1991 and 32881/1978).

[0005] Each of these reciprocating compressors may be used in a car's air conditioning, however, when the in-car cooling load decreases and the refrigerant suction amount decreases, the amount the suction valve opens decreases; thus the suction valve does not abut against the stopper. In such a case, self-exciting vibration is generated in the suction valve, the pulsation of suction gas is increased, and unwanted noise may be generated.

[0006] It is therefore a technical advantage of the present invention to provide a reciprocating compressor which prevents the self-exciting vibration of a suction valve and reduces the pulsation of suction gas and noise.

[0007] Other technical advantage of the present invention will be readily apparent to one skilled in the art.

[0008] According to the present invention, there is provided a reciprocating compressor comprising: a suction port; a suction valve that is movable relative to said suction port for opening or closing said suction port; and a stopper coupled to said suction port for restricting movement of said suction valve, wherein said suction valve is abutted against said stopper to hold open said suction port even when said reciprocating compressor is in a stopped state.

[0009] For a more complete understanding of the present invention and the technical advantages thereof, reference is now made to the following description taken in combination with the accompanying drawings, in which:

Fig. 1 is a longitudinal sectional view of a reciprocating compressor according to an embodiment of the present invention;

Fig. 2 is a schematic sectional view of a main part of the reciprocating compressor illustrated in Fig. 1; and

Fig. 3 is a plan view of a suction valve used in the reciprocating compressor of Figs. 1 and 2.

[0010] Referring to Fig. 1, description will be made of a reciprocating compressor according to an embodiment of the present invention. The reciprocating compressor of the present invention is generally called a swash-plate type variable capacity compressor and is preferably used in an air conditioning system for an automobile or other and other vehicles and similar systems.

[0011] The reciprocating compressor of the present invention includes a cylinder block 12 having a plurality of arranged cylinder bores (only one is shown) 11, a cylinder head defines a suction chamber 13 and a discharge chamber 14, a valve plate 16 held between the cylinder block 12 and the cylinder head 15, and a plurality of pistons (only one is shown) 17 are inserted in the cylinder bores 11 and reciprocate along the cylinder bores 11 to the left and right. The valve plate 16 has a suction port 18 and a discharge port 19 corresponding to each cylinder bore 11. The suction port 18 is connected to the suction chamber 13. The discharge port 19 is connected to the discharge chamber 14.

[0012] The reciprocating compressor further includes a front housing 31 fixed to the front end surface of the cylinder block 12, a drive shaft 34 rotatably supported by a radial bearing 32 provided in the front housing 31 and by a radial bearing 33 provided in the cylinder block 12, a rotor 36 fixed to the drive shaft 34 and disposed opposite to the front housing 31 via a thrust bearing 35, a swash plate 38 connected to the rotor 36 via a hinge mechanism 37 so that it can be changed in its inclination, and a wobble plate 41 rotatably supported on the swash plate 38 via a bearing 39. The swash plate 38 rotates together with the rotor 36 through the hinge mechanism 37, and its inclined angle to the drive shaft 34 is variable. The piston 17 is connected to the peripheral part of the wobble plate 41 via a piston rod 42. Additionally, there is provided a guide 43 for preventing the wobble plate 41 from rotating.

[0013] The operation of reciprocating compressors

is generally described in U.S. Patent No. 4,846,049. When the drive shaft 34 is rotated or driven, for example, by an automobile engine or the like, the rotor 36 and the swash plate 38 rotate. Since the wobble plate 41 is prevented from rotating by the guide 43, the plate wobbles in accordance with the inclination of the swash plate without rotating. As a result, the piston 17 reciprocates in the cylinder bore 11 via the piston rod 42. Since the stroke of the piston 17 fluctuates in accordance with a change in the inclined angle of the incline plate 38, the compression capacity is variable.

[0014] Referring to Fig. 2, the valve plate 16 has a first surface 16a facing the rear end surface of the cylinder block 12 and a second surface 16b facing the front end surface of the cylinder head 15. A suction valve 21 is attached on the first surface 16a of the valve plate 16. The suction valve 21 is shown in Fig. 3 and is for opening and closing each suction port 18. A discharge valve 22 is attached on the second surface 16b of the valve plate 16. The discharge valve 22 has a shape known in the art and is for opening and closing each discharge port 19. The suction and the discharge valves 21 and 22 are made of metal plates having elasticity. The valve plate 16 is further provided with a retainer 23 for preventing excessive deflection of the discharge valve 22 in a manner known in the art.

[0015] The cylinder block 12 further has a notch portion 24 extending from the rear end surface of the cylinder block 12 and continuous to each cylinder bore 11. A portion of the notch portion 24 forms a stopper 25 that restricts movement of the suction valve 21. Because of the stopper 25, the suction valve 21 is restricted from being opened its maximal amount.

[0016] The suction valve 21 is formed to slightly bend toward the piston 17 beforehand. As a result, the suction valve 21 abuts against the stopper 25 when the compressor is not driven and is in a stop state. Specifically, when there is no force acting on the suction valve 21, the end tip of the suction valve 21 is detached from the first surface 16a of the valve plate 16 and engaged with the stopper 25. On the other hand, the discharge valve 22 extends along the second surface 16b of the valve plate 16 when the compressor is in the stop state.

[0017] When the compressor is driven and is in an operation state, the piston 17 reciprocates in the cylinder bore 11. When the piston 17 moves towards the right direction to carry out a discharge stroke, a gaseous fluid is compressed in the cylinder bore 11. In the discharge stroke, the suction valve 21 is pressed onto the first surface 16a of the valve plate 16 by an increase of gas pressure in the cylinder bore 11 to close the suction port 18. Simultaneously, the discharge valve 22 opens the discharge port 19 by the gas pressure.

[0018] When the piston 17 moves towards the left direction to carry out a suction stroke, the discharge valve 22 is pressed onto the second surface 16b of the valve plate 16 by gas pressure of the discharge chamber 14 to close the discharge port 19. In this event, the gas pressure lowers in the cylinder bore 11. Therefore, the suction valve 21 opens the suction chamber 18 by a restoring force thereof and negative pressure in the cylinder bore 11.

[0019] In the manner described above, the suction valve 21 holds the suction port 18 open during the stop state of the compressor. However, in the operation state of the compressor, the suction valve 21 opens the suction port 18 on the suction stroke and closes the suction port 18 on the discharge stroke. Because the suction valve 21 is slightly bent, while still rigid, and thus acts differently from to a conventional suction valve, the delay in opening the suction valve 21 is reduced. Additionally, even with a low load having a small amount of refrigerant flow, the suction valve 21 is completely opened because it is slightly bent and abuts against the stopper 25 so that self-exciting vibration is prevented.

[0020] Further, any deterioration of refrigerating ability caused by a closing delay during valve opening (because it is slightly bent) is cancelled out by the reduction of opening delay during valve opening. Additionally, even though when the refrigerant flow amount is extremely small during the low load, the closing delay of the suction valve may be increased, which may decrease its ability, there is not a problem because this state generally requires no little or ability.

[0021] Moreover, it is a matter of course that a similar implementation of the present invention may be used in a compressor with a fixed capacity, even though the above description has been in reference to a variable capacity compressor.

Claims

1. A reciprocating compressor comprising:

a suction port;
a suction valve that is movable relative to said suction port for opening or closing said suction port; and
a stopper coupled to said suction port for restricting movement of said suction valve, wherein said suction valve is abutted against said stopper to hold open said suction port even when said reciprocating compressor is in a stop state.

2. A reciprocating compressor comprising:

a suction port;
a suction valve that is movable relative to said suction port for opening or closing said suction port; and
a stopper coupled to said suction port for restricting movement of said suction valve, wherein said suction valve is slightly bent away from said suction port.

3. A reciprocating compressor according to claim 1 or claim 2, further comprising:

a cylinder block having an end surface and a cylinder bore opening at said end surface;
a piston inserted in said cylinder bore and reciprocated along said cylinder bore; and
a valve plate placed on said end surface of the cylinder block, said suction port being formed in said valve plate to communicate with said cylinder bore.

4. A reciprocating compressor according to claim 3, further comprising:

a discharge port formed in said valve plate to communicate with said cylinder bore; and
a discharge valve movable relative to said discharge port for opening or closing said discharge port.

5. A reciprocating compressor according to claim 4, wherein said cylinder block further comprises a notch portion extended from said end surface of the cylinder block, wherein said notch portion comprises said stopper.

6. A reciprocating compressor according to claim 4, wherein said valve plate has a first surface facing said end surface of the cylinder block and a second surface opposite to said first surface, said suction valve being connected to said first surface and extending to said notch portion.

7. A reciprocating compressor according to claim 3, wherein said discharge valve is connected to said second surface of the valve plate.

8. A reciprocating compressor according to claim 6, further comprising a cylinder head placed on said second surface of the valve plate, said cylinder head defining a suction chamber connected to said suction port and a discharge chamber connected to said discharge port.

9. A reciprocating compressor according to claim 2, wherein said suction valve that is slightly bent causes said suction valve to be abutted against said stopper to hold open said suction port even when said reciprocating compressor is in a stop state.

10. A reciprocating compressor according to claim 3, further comprising a second piston, wherein said cylinder block further comprises a second cylinder bore in which said second piston is inserted, wherein the first and second pistons reciprocate with a predetermined phase difference there between.

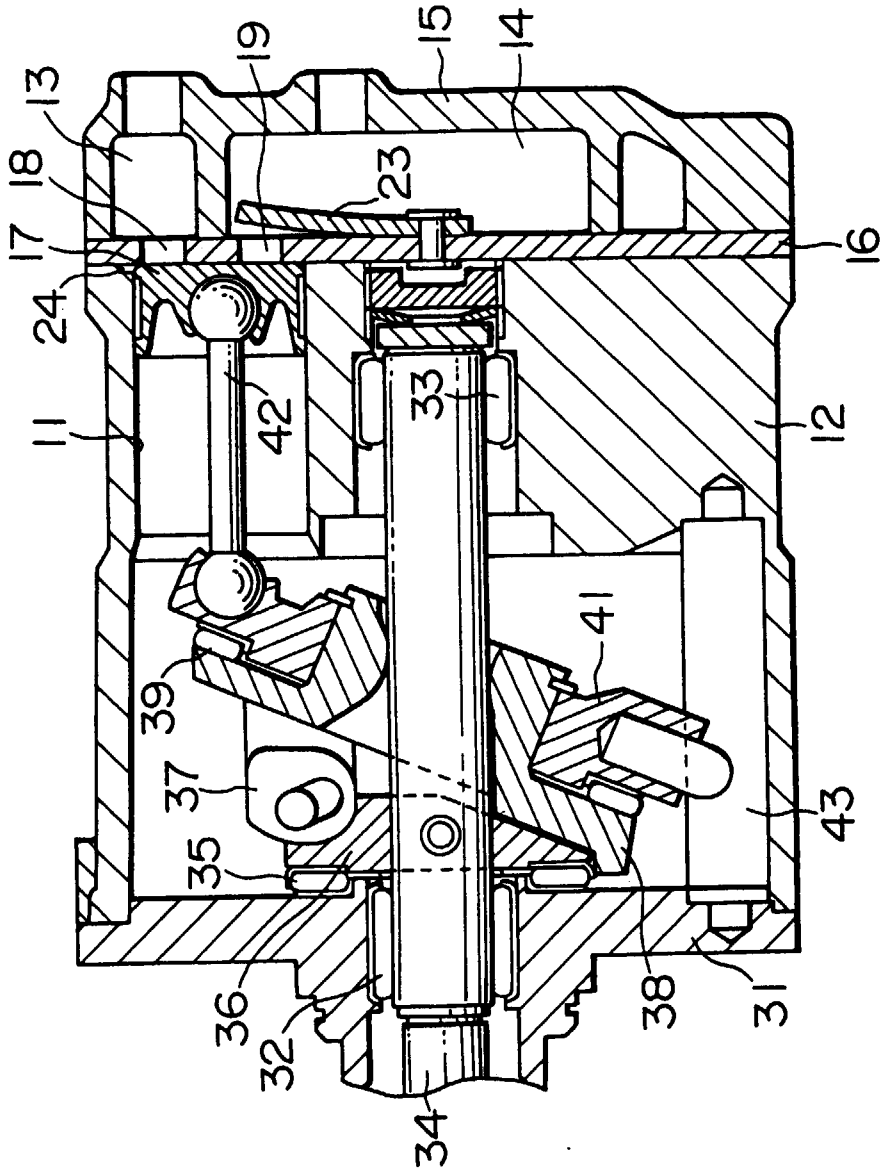

FIG. 1

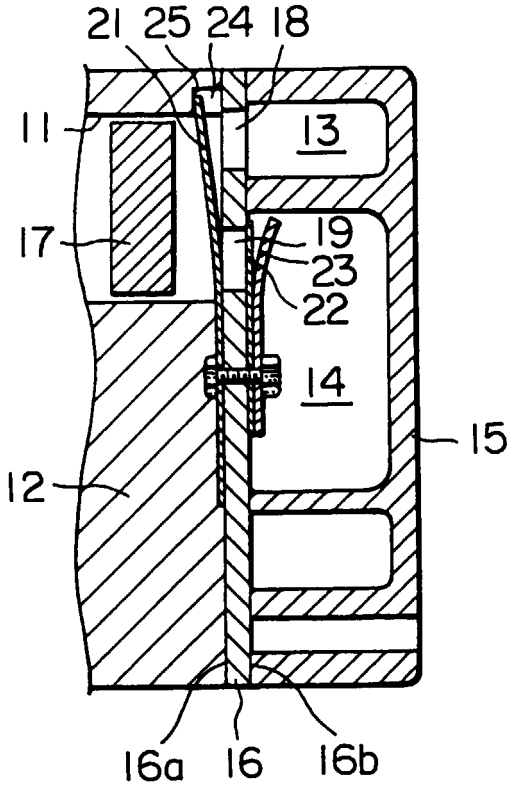

FIG. 2

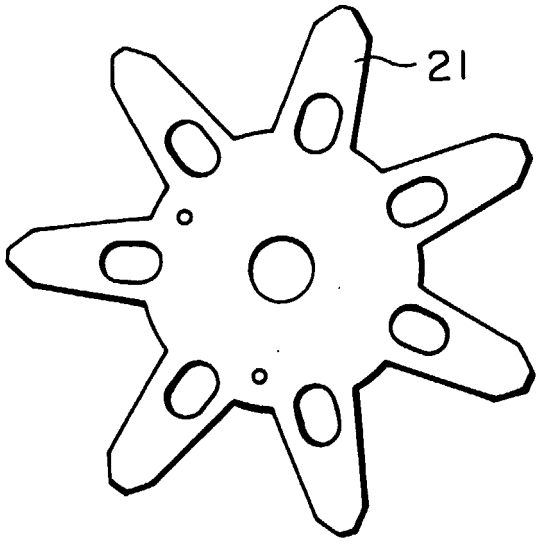

FIG. 3