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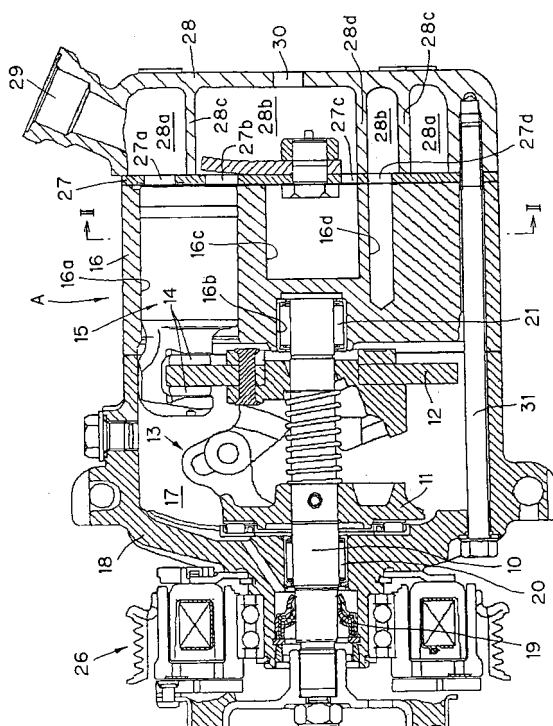
(54) **RECIPROCATING COMPRESSOR**

(57) [Object of the Invention] An object of the present invention is to provide a reciprocal compressor wherein a cylinder block is provided with a void space communicating with a discharge chamber to increase the volume of the discharge chamber and which can resolve the problem of a conventional reciprocal compressor.

[Disclosure of Invention] A reciprocal compressor comprises a rotation shaft, a motion converter for converting rotation to reciprocal motion, pistons driven by the rotation shaft through the motion converter to move reciprocally, a cylinder block provided with cylinder bores in which the pistons are inserted and a center bore in which one end of the rotation shaft is inserted, a valve plate provided with suction holes, discharge holes, suction valves for closing the suction holes and discharge valves for closing the discharge holes and disposed opposite one end of the cylinder block, and a rear housing provided with a suction chamber communicating with the cylinder bores through the suction holes and the suction valves and a discharge chamber communicating with the cylinder bores through the discharge valves and the discharge holes and disposed opposite the valve plate. The cylinder bores are circumferentially distanced from each other, and the cylinder block is provided with a group of secondary discharge chambers which are located closer to the valve plate than the center bore to communicate with the discharge chamber through openings formed in the valve plate. The group of secondary discharge chambers comprises a center secondary discharge chamber adjacent the center bore, and a plurality of satellite secondary discharge chambers located radially outside the center secondary discharge chamber, circumferentially

distanced from each other, and located between the cylinder bores, and each of the secondary discharge chambers communicates with the discharge chamber through the opening formed in the valve plate.

Fig.1



Description

Technical Field

[0001] The present invention relates to a reciprocal compressor.

Background Art

[0002] Patent document 1 discloses a reciprocal compressor comprising a rotation shaft, a motion converter for converting rotation to reciprocal motion, pistons driven by the rotation shaft through the motion converter to move reciprocally, a cylinder block provided with cylinder bores in which the pistons are inserted and a center bore in which one end of the rotation shaft is inserted, a valve plate provided with suction holes, discharge holes, suction valves for closing the suction holes and discharge valves for closing the discharge holes and disposed opposite one end of the cylinder block, and a rear housing provided with a suction chamber communicating with the cylinder bores through the suction holes and the suction valves and a discharge chamber communicating with the cylinder bores through the discharge valves and the discharge holes, wherein the cylinder bores are circumferentially distanced from each other, and the cylinder block is provided with a secondary discharge chamber which is located closer to the valve plate than the center bore to communicate with the discharge chamber through an opening formed in the valve plate.

In accordance with the reciprocal compressor of patent document 1, the volume of the discharge chamber increases to decrease pulsation of discharge pressure caused by refrigerant gas discharging from the cylinder bores to the discharge chamber, thereby decreasing noise of the compressor.

Patent document 1: Japanese Patent Laid-Open Publication No.7-77157

Disclosure of Invention

Problems to be solved

[0003] The reciprocal compressor of patent document 1 has a problem in that the secondary discharge chamber is complicated in structure and troublesome to produce because it is formed by a center cylindrical portion coaxial to the center bore and radial arm portions extending from the center cylindrical portion and located between the cylinder bores.

The center bore of the reciprocal compressor of patent document 1 extends only to the longitudinal middle of the cylinder block. However, such kind of reciprocal compressor also has been used, wherein the center bore extends to one end of the cylinder block adjacent the valve plate and an adjust member is screwed in the center bore to adjust the longitudinal position of the rotation shaft. When the technical concept of the cylinder block

being provided with the secondary discharge chamber, which is the technical concept of patent document 1, is applied to the aforementioned reciprocal compressor, the portion of the center bore closer to the valve plate than the adjust member is communicated with the discharge chamber through the opening formed in the valve plate to increase the volume of the discharge chamber. However, if the portion of the center bore closer to the valve plate than the adjust member is communicated with the discharge chamber through the opening formed in the valve plate, a crank chamber accommodating the rotation shaft and the motion converter communicates with the discharge chamber through the center bore because the portion of the center bore more distant from the valve plate than the adjust member communicates with the portion of the center bore closer to the valve plate than the adjust member through threaded portion of the adjust member. As a result, operation of the reciprocal compressor is impaired.

An object of the present invention is to provide a reciprocal compressor wherein a cylinder block is provided with a void space communicating with a discharge chamber to increase the volume of the discharge chamber and which can resolve the problem of the reciprocal compressor of patent document 1.

Means for Solving the Problems

[0004] In accordance with the present invention, there is provided a reciprocal compressor comprising a rotation shaft, a motion converter for converting rotation to reciprocal motion, pistons driven by the rotation shaft through the motion converter to move reciprocally, a cylinder block provided with cylinder bores in which the pistons are inserted and a center bore in which one end of the rotation shaft is inserted, a valve plate provided with suction holes, discharge holes, suction valves for closing the suction holes and discharge valves for closing the discharge holes and disposed opposite one end of the cylinder block, and a rear housing provided with a suction chamber communicating with the cylinder bores through the suction holes and the suction valves and a discharge chamber communicating with the cylinder bores through the discharge valves and the discharge holes and disposed opposite the valve plate, wherein the cylinder bores are circumferentially distanced from each other, and the cylinder block is provided with a group of secondary discharge chambers which are located closer to the valve plate than the center bore to communicate with the discharge chamber through openings formed in the valve plate, and wherein the group of secondary discharge chambers comprises a center secondary discharge chamber adjacent the center bore, and a plurality of satellite secondary discharge chambers located radially outside the center secondary discharge chamber, circumferentially distanced from each other, and located between the cylinder bores, and each of the secondary discharge chambers communicates with the discharge

chamber through the opening formed in the valve plate. In the reciprocal compressor of the present invention, the secondary discharge chamber is formed not by a center cylindrical portion coaxial to the center bore and radial arm portions extending from the center cylindrical portion and located between the cylinder bores but by a center secondary discharge chamber adjacent the center bore and a plurality of satellite discharge chambers located radially outside the center secondary discharge chamber, circumferentially distanced from each other and located between the cylinder bores. A secondary discharge chamber formed by a center secondary discharge chamber and satellite secondary discharge chambers independent of the center secondary discharge chamber is simpler in structure and easier to produce than a secondary discharge chamber formed by a center cylindrical portion and radial arms continuously extending from the center cylindrical portion.

[0005] In accordance with the present invention, there is provided a reciprocal compressor comprising a rotation shaft, a motion converter for converting rotation to reciprocal motion, pistons driven by the rotation shaft through the motion converter to move reciprocally, a cylinder block provided with cylinder bores in which the pistons are inserted and a center bore in which one end of the rotation shaft is inserted, a valve plate provided with suction holes, discharge holes, suction valves for closing the suction holes and discharge valves for closing the discharge holes and disposed opposite one end of the cylinder block, and a rear housing provided with a suction chamber communicating with the cylinder bores through the suction holes and the suction valves and a discharge chamber communicating with the cylinder bores through the discharge valves and the discharge holes and disposed opposite the valve plate, wherein an adjust member is screwed in the center bore to locate the rotation shaft in the longitudinal direction, the center bore communicates with the discharge chamber at a portion closer to the valve plate than the adjust member through an opening formed in the valve plate, and the contact part between the adjust member and the center bore is sealed by a seal member.

In the reciprocal compressor of the present invention, the center bore communicates with the discharge chamber at a portion closer to the valve plate than the adjust member through an opening formed in the valve plate, and the contact part between the adjust member and the center bore is sealed by a seal member. Therefore, volume of the discharge chamber is increased, pulsation of discharge pressure caused by the refrigerant gas discharging from the cylinder bores to the discharge chamber is decreased, and the compressor noise is decreased, with the portion of the center bore more distanced from the valve plate than the adjust member being prevented from communicating with the portion of the center bore closer to the valve plate than the adjust member through the threaded portion of the adjust member, and with the crank chamber accommodating the rotation shaft and the mo-

tion converter being prevented from communicating with the discharge chamber through the center bore.

[0006] In accordance with a preferred embodiment of the present invention, the cylinder block is provided with a plurality of satellite bores located radially outside the center bore, circumferentially distanced from each other and located between the cylinder bores, and each of the satellite bores communicates with the discharge chamber through an opening formed in the valve plate.

In this embodiment, the volume of the discharge chamber further increases, pulsation of discharge pressure caused by the refrigerant gas discharging from the cylinder bores to the discharge chamber further decreases, and the compressor noise further decreases.

[0007] In accordance with a preferred embodiment of the present invention, not only a bulkhead for separating the discharge chamber from the suction chamber but also legs provided in the discharge chamber clamp the valve plate in cooperation with the cylinder block.

When the secondary discharge chamber or the portion of the center bore closer to the valve plate than the adjust member communicates with the discharge chamber through the opening formed in the valve plate, the balance of the pressure acting on the valve plate is liable to change, the force acting on the valve plate to push it in the direction of the rear housing is liable to become larger than the force acting on the valve plate to push it in the reverse direction, and the valve plate is liable to deform toward the discharge chamber at the center portion. When the legs provided in the discharge chamber as well as the bulkhead for separating the discharge chamber from the suction chamber clamp the valve plate in cooperation with the cylinder block, the deformation of the valve plate is prevented.

Effect of the Invention

[0008] In accordance with the present invention, there is provided a reciprocal compressor wherein a cylinder block is provided with a void space communicating with a discharge chamber to increase the volume of the discharge chamber and which can resolve the problem of the reciprocal compressor of patent document 1.

Best Mode for Carrying Out the Invention

[0009] Preferred embodiments of the present invention will be described.

First embodiment

[0010] As shown in Figure 1, a variable displacement swash plate compressor A comprises a rotation shaft 10, a rotor 11 fixed to the rotation shaft 10, a swash plate 12 supported by the rotation shaft 10 to be variable in inclination relative to the rotation shaft 10. The swash plate 12 is connected to the rotor 11 by a linkage 13, which allows the inclination of the swash plate 12 to vary, so

as to rotate synchronously with the rotor 11 or the rotation shaft 10.

Pistons 15 are anchored to the swash plate 12 through pairs of shoes 14 slidably engaging the outer circumferential portion of the swash plate 12.

The rotor 11, the linkage 13, the swash plate 12 and the shoes 14 form a motion converter for converting rotation of the rotation shaft 10 to reciprocal motion of the pistons 15.

The pistons 15 are inserted in cylinder bores 16a formed in a cylinder block 16.

The cylinder bores 16a are circumferentially distanced from each other.

A front housing 18 forms a crank chamber 17 for accommodating the rotation shaft 10, the rotor 11, the linkage 13, the swash plate 12 and the shoes 14. The front housing 18 has a cylindrical form closed at one end.

One end of the rotation shaft 10 passes through the closed end of the front housing 18 to extend out of the front housing 18. A seal member 19 is disposed between the front housing 18 and the portion of the rotation shaft 10 passing through the front housing 18.

[0011] The rotation shaft 10 is rotatably supported by a radial bearing 20 pressed in and fixed to the portion of the front housing through which the rotation shaft passes and a radial bearing 21 pressed in and fixed to a center bore 16b formed in the cylinder block 16. The center bore 16b extends to the longitudinal middle of the cylinder block 16.

[0012] Driving power is transmitted from an external power source to the said one end of the rotation shaft 10 through an electromagnetic clutch 26 mounted on the front housing 18. The external power source is not shown in Figure 1.

[0013] A valve plate 27 is disposed opposite one end of the cylinder block 16. The valve plate 27 is provided with suction holes 27a, discharge holes 27b, suction valves for closing the suction holes 27a and discharge valves for closing the discharge holes 27b.

A rear housing 28 is disposed opposite the valve plate 27. The rear housing 28 is provided with a suction chamber 28a communicating with the cylinder bores 16a through the suction holes 27a and the suction valves, and a discharge chamber 28b communicating with the cylinder bores 16a through the discharge valves and the discharge holes 27b. The suction chamber 28a connects to an evaporator of a car air conditioner through a suction port 29 and the discharge chamber 28b connects to a condenser of the car air conditioner through a discharge port 30. The car air conditioner, the evaporator and the condenser are not shown in Figure 1.

[0014] A center secondary discharge chamber 16c of cylindrical shape is formed in the cylinder block 16. The center secondary discharge chamber 16c is disposed adjacent the center bore 16b and located closer to the valve plate 27 than the center bore 16b. The center secondary discharge chamber 16c extends to the aforementioned one end of the cylinder block 16 to communicate

with the discharge chamber 28b through an opening 27c formed in the valve plate 27. As shown in Figures 1 and 2, a plurality of satellite secondary discharge chambers 16d of cylindrical shape with small diameter are formed in the cylinder block 16. The satellite secondary discharge chambers 16d are located radially outside the center secondary discharge chamber 16c, circumferentially distanced from each other and located between the cylinder bores 16a. The satellite secondary discharge chambers 16d extend to the aforementioned one end of the cylinder block 16 to communicate with the discharge chamber 28b through openings 27d formed in the valve plate 27.

Legs 28d are disposed in the discharge chamber 28b in addition to the bulkhead 28c for separating the discharge chamber 28b from the suction chamber 28a to clamp the valve plate 27 in cooperation with the cylinder block 16.

[0015] The front housing 18, the cylinder block 16, the valve plate 27 and the rear housing 28 are assembled as a unitary body by through bolts 31.

The variable displacement swash plate compressor A is provided with an air supply passage communicating the discharge chamber 28b with the crank chamber 17 and a displacement control valve for closing the air supply passage. The variable displacement swash plate compressor A is provided with an air exhaust passage communicating the crank chamber 17 with the suction chamber 28a and a restriction disposed in the air exhaust passage. The air supply passage, the displacement control valve, the air exhaust passage and the restriction are not shown in Figures 1 and 2.

[0016] In the variable displacement swash plate compressor A, driving power of the external power source not shown in Figures 1 and 2 is transmitted to the rotation shaft 10 through the electromagnetic clutch 26 and the rotation of the rotation shaft 10 is transmitted to the swash plate 12 through the rotor 11 and the linkage 13. Rotation of the swash plate 12 causes reciprocal motion of the outer circumferential portion thereof in the direction of the longitudinal axis of the rotation shaft 10. The reciprocal motion of the outer circumferential portion of the swash plate 12 is transmitted to the pistons 15 through the shoes 14 to cause reciprocal motion of the pistons 15 in the cylinder bores 16a. Refrigerant gas returned from the evaporator of the car air conditioner is sucked into the cylinder bores 16a through the suction port 29, the suction chamber 28a, the suction holes 27a and the suction valves. The refrigerant gas is compressed in the cylinder bores 16a and passes out of the compressor to the condenser of the car air conditioner through the discharge holes 27b, the discharge valves, the discharge chamber 28b and the discharge port 30.

The displacement control valve opens and closes the air supply passage between the discharge chamber 28b and the crank chamber 17 to start and stop the introduction of the discharge pressure to the crank chamber 17. Thus, the pressure in the crank chamber 17 is controlled to control the inclination angle of the swash plate 12, there-

by variably controlling the displacement of the compressor A.

[0017] When the compressed refrigerant gas discharges from the cylinder bores 16a to the discharge chamber 28b, the refrigerant gas causes pulsation of discharge pressure. The pulsation of the discharge pressure propagates outside the compressor through the discharge port 30 to resonate with various members close to the compressor, thereby causing compressor noise. However, in the variable displacement swash plate compressor A, the operation of the discharge chamber 28b as an expansion muffler is enhanced to restrict the propagation of the pulsation of the discharge pressure outside the compressor because the center secondary discharge chamber 16c and the plurality of the satellite secondary discharge chambers 16d formed in the cylinder block 16 communicate with the discharge chamber 28b through the opening 27c and the openings 27d formed in the valve plate 27 to increase the volume of the discharge chamber 28b. As a result, the compressor noise decreases.

In the variable displacement swash plate compressor A, the secondary discharge chamber is not formed by a center cylindrical portion coaxial to the center bore and radial arm portions extending from the center cylindrical portion and located between the cylinder bores but by a center secondary discharge chamber 16c adjacent the center bore 16b and a plurality of satellite secondary discharge chambers 16d located radially outside the center secondary discharge chamber 16c, circumferentially distanced from each other and located between the cylinder bores 16a. The secondary discharge chamber formed by the center secondary discharge chamber 16c and the satellite secondary discharge chambers 16d independent of the center secondary discharge chamber 16c is simpler in structure and easier to produce than the secondary discharge chamber formed by the center cylindrical portion and the radial arm portions continuously extending from the center cylindrical portion.

[0018] When the secondary discharge chambers 16c and 16d communicate with the discharge chamber 28b through the openings 27c and 27d formed in the valve plate 27, the balance of the pressure acting on the valve plate 27 is liable to change, the force acting on the valve plate 27 to push it in the direction of the rear housing 28 is liable to become larger than the force acting on the valve plate 27 to push it in the reverse direction, and the valve plate 27 is liable to deform toward the discharge chamber 28b at the center portion. When the legs 28d provided in the discharge chamber 28b as well as the bulkhead 28c for separating the discharge chamber 28b from the suction chamber 28a clamp the valve plate 27 in cooperation with the cylinder block 16, the deformation of the valve plate 27 is prevented.

Second embodiment

[0019] In the following description, the same structures as in the first embodiment will be allotted the same ref-

erence numerals as in the first embodiment.

As shown in Figure 3, a variable displacement swash plate compressor A comprises a rotation shaft 10, a rotor 11 fixed to the rotation shaft 10, a swash plate 12 supported by the rotation shaft 10 to be variable in inclination relative to the rotation shaft 10. The swash plate 12 is connected to the rotor 11 by a linkage 13, which allows the inclination of the swash plate 12 to vary, so as to rotate synchronously with the rotor 11 or the rotation shaft 10.

Pistons 15 are anchored to the swash plate 12 through pairs of shoes 14 slidably engaging the outer circumferential portion of the swash plate 12.

The rotor 11, the linkage 13, the swash plate 12 and the shoes 14 form a motion converter for converting rotation of the rotation shaft 10 to reciprocal motion of the pistons 15.

The pistons 15 are inserted in cylinder bores 16a formed in a cylinder block 16. The cylinder bores 16a extend through the cylinder block 16.

A front housing 18 forms a crank chamber 17 for accommodating the rotation shaft 10, the rotor 11, the linkage 13, the swash plate 12 and the shoes 14. The front housing 18 has a cylindrical shape closed at one end.

One end of the rotation shaft 10 passes through the closed end of the front housing 18 to extend out of the front housing 18. A seal member 19 is disposed between the front housing 18 and the portion of the rotation shaft 10 passing through the front housing 18.

[0020] The rotation shaft 10 is rotatably supported by a radial bearing 20 pressed in and fixed to the portion of the front housing through which the rotation shaft passing and a radial bearing 21 pressed in and fixed to a center bore 16b formed in the cylinder block 16. The center bore 16b passes through the cylinder block 16.

The rotation shaft 10 is clamped by a thrust bearing 22 disposed between the rotor 11 and the front housing 18 and a support member 23 disposed adjacent the other end of the rotation shaft 10. The space between the other end of the rotation shaft 10 and the support member 23 is controlled to a predetermined value by an adjust member 24 screwed in the center bore 16b to locate the rotation shaft 10 in the longitudinal direction.

The contact part between the head of the adjust member 24 and the center bore 16b is sealed by an O-ring 25.

[0021] Driving power is transmitted from an external power source not shown in Figure 3 to the said one end of the rotation shaft 10 through an electromagnetic clutch 26 mounted on the front housing 18.

[0022] A valve plate 27 is disposed opposite one end of the cylinder block 27. The valve plate 27 is provided with suction holes 27a, discharge holes 27b, suction valves for closing the suction holes 27a and discharge valves for closing the discharge holes 27b.

A rear housing 28 is disposed opposite the valve plate 27. The rear housing 28 is provided with a suction chamber 28a communicating with the cylinder bores 16a through the suction holes 27a and the suction valves and

a discharge chamber 28b communicating with the cylinder bores 16a through the discharge valves and the discharge holes 27b. The suction chamber 28a connects to an evaporator of a car air conditioner through a suction port 29 and the discharge chamber 28b connects to a condenser of the car air conditioner through a discharge port 30. The car air conditioner, the evaporator and the condenser are not shown in Figure 3.

The portion of the center bore 16b closer to the valve plate 27 than the adjust member 24 communicates with the discharge chamber 28 through an opening 27c formed in the valve plate 27.

Legs 28d are disposed in the discharge chamber 28b in addition to the bulkhead 28c for separating the discharge chamber 28b from the suction chamber 28a to clamp the valve plate 27 in cooperation with the cylinder block 16.

[0023] The front housing 18, the cylinder block 16, the valve plate 27 and the rear housing 28 are assembled as a unitary body by through bolts 31.

The variable displacement swash plate compressor A' is provided with an air supply passage communicating the discharge chamber 28b with the crank chamber 17 and a displacement control valve for closing the air supply passage. The variable displacement swash plate compressor A' is provided with an air exhaust passage communicating the crank chamber 17 with the suction chamber 28a and a restriction disposed in the air exhaust passage. The air supply passage, the displacement control valve, the air exhaust passage and the restriction are not shown in Figure 3.

[0024] In the variable displacement swash plate compressor A', driving power of the external power source not shown in Figure 3 is transmitted to the rotation shaft 10 through the electromagnetic clutch 26 and the rotation of the rotation shaft 10 is transmitted to the swash plate 12 through the rotor 11 and the linkage 13. Rotation of the swash plate 12 causes reciprocal motion of the outer circumferential portion thereof in the direction of the longitudinal axis of the rotation shaft 10. The reciprocal motion of the outer circumferential portion of the swash plate 12 is transmitted to the pistons 15 through the shoes 14 to cause reciprocal motions of the pistons 15 in the cylinder bores 16a. Refrigerant gas returned from the evaporator of the car air conditioner is sucked into the cylinder bores 16a through the suction port 29, the suction chamber 28a, the suction holes 27a and the suction valves. The refrigerant gas is compressed in the cylinder bores 16a and passes out of the compressor to the condenser of the car air conditioner through the discharge holes 27b, the discharge valves, the discharge chamber 28b and the discharge port 30.

The displacement control valve opens and closes the air supply passage between the discharge chamber 28b and the crank chamber 17 to start and stop the introduction of the discharge pressure to the crank chamber 17. Thus, the pressure in the crank chamber 17 is controlled to control the inclination angle of the swash plate 12, thereby by variably controlling the displacement of the compres-

sor.

[0025] When the compressed refrigerant gas discharges from the cylinder bores 16a to the discharge chamber 28b, the refrigerant gas causes pulsation of discharge pressure. The pulsation of the discharge pressure propagates outside the compressor through the discharge port 30 to resonate with various members disposed close to the compressor, thereby causing compressor noise. However, in the variable displacement swash plate compressor A', the operation of the discharge chamber 28b as an expansion muffler is enhanced to restrict the propagation of the pulsation of the discharge pressure outside the compressor because the portion of the center bore 16b closer to the valve plate 27 than the adjust member 24 communicates with the discharge chamber 28b through the opening 27c to increase the volume of the discharge chamber 28b. As a result, the compressor noise decreases.

In the variable displacement swash plate compressor A', the contact part between the head of the adjust member 24 and the center bore 16b is sealed by the O-ring 25. Therefore, the portion of the center bore 16b more distanced from the valve plate 27 than the adjust member 24 is prevented from communicating with the portion of the center bore 16b closer to valve plate 27 than the adjust member 24 through the threaded portion of the adjust member 24, and the crank chamber 17 does not communicate with the discharge chamber 28b through the center bore 16b. Therefore, the displacement of the compressor A' is reliably controlled by opening and closing the air supply passage between the discharge chamber and the crank chamber.

[0026] When the portion of the center bore 16b closer to the valve plate 27 than the adjust member 24 communicates with the discharge chamber 28b through the openings 27c formed in the valve plate 27, the balance of the pressure acting on the valve plate 27 is liable to change, the force acting on the valve plate 27 to push it in the direction of the rear housing 28 is liable to become larger than the force acting on the valve plate 27 to push it in the reverse direction, and the valve plate 27 is liable to deform toward the discharge chamber 28b at the center portion. When the legs 28d provided in the discharge chamber 28b as well as the bulkhead 28c for separating the discharge chamber 28b from the suction chamber 28a clamp the valve plate 27 in cooperation with the cylinder block 16, the deformation of the valve plate 27 is prevented.

[0027] It is possible to form a plurality of satellite bores like the satellite secondary discharge chambers 16d in the first embodiment, which are located radially outside the center bore 16b, circumferentially distanced from each other and located between the cylinder bores 16a, in the cylinder block 16 and form openings like the openings 27d in the first embodiment in the valve plate 27 to communicate the satellite bores to the discharge chamber 28b through the openings in the valve plate, in addition to communicating the portion of the center bore 16b

closer to the valve plate 27 than the adjust member 24 with the discharge chamber 28b through the opening 27c formed in the valve plate 27.

In the aforementioned case, the volume of the discharge chamber 28b further increases, the pulsation of the discharge pressure caused by the refrigerant gas discharging from the cylinder bores 16a to the discharge chamber 28b further decreases and the compressor noise further decreases.

Industrial Applicability

[0028] The present invention can be widely used in reciprocal compressors such as swash plate compressors, wobble plate compressors, etc.

Brief Explanation of Drawings

[0029]

Figure 1 is a sectional view of a reciprocal compressor in accordance with the first preferred embodiment of the present invention.

Figure 2 is a view in the direction of arrows II-II in Figure 1.

Figure 3 is a sectional view of a reciprocal compressor in accordance with the second preferred embodiment of the present invention.

Claims

1. A reciprocal compressor comprising a rotation shaft, a motion converter for converting rotation to reciprocal motion, pistons driven by the rotation shaft through the motion converter to move reciprocally, a cylinder block provided with cylinder bores in which the pistons are inserted and a center bore in which one end of the rotation shaft is inserted, a valve plate provided with suction holes, discharge holes, suction valves for closing the suction holes and discharge valves for closing the discharge holes and disposed opposite one end of the cylinder block, and a rear housing provided with a suction chamber communicating with the cylinder bores through the suction holes and the suction valves and a discharge chamber communicating with the cylinder bores through the discharge valves and the discharge holes and disposed opposite the valve plate, wherein the cylinder bores are circumferentially distanced from each other, and the cylinder block is provided with a group of secondary discharge chambers which are located closer to the valve plate than the center bore to communicate with the discharge chamber through openings formed in the valve plate, and wherein the group of secondary discharge chambers comprises a center secondary discharge chamber adjacent the center bore, and a plurality of satellite secondary discharge chambers located radially outside the center secondary discharge chamber, circumferentially distanced from each other, and located between the cylinder bores, and each of the secondary discharge chambers communicates with the discharge chamber through the opening formed in the valve plate.
2. A reciprocal compressor comprising a rotation shaft, a motion converter for converting rotation to reciprocal motion, pistons driven by the rotation shaft through the motion converter to move reciprocally, a cylinder block provided with cylinder bores in which the pistons are inserted and a center bore in which one end of the rotation shaft is inserted, a valve plate provided with suction holes, discharge holes, suction valves for closing the suction holes and discharge valves for closing the discharge holes and disposed opposite one end of the cylinder block, and a rear housing provided with a suction chamber communicating with the cylinder bores through the suction holes and the suction valves and a discharge chamber communicating with the cylinder bores through the discharge valves and the discharge holes and disposed opposite the valve plate, wherein an adjust member is screwed in the center bore to locate the rotation shaft in the longitudinal direction, the center bore communicates with the discharge chamber at a portion closer to the valve plate than the adjust member through an opening formed in the valve plate, and the contact part between the adjust member and the center bore is sealed by a seal member.
3. A reciprocal compressor of claim 2, wherein the cylinder block is provided with a plurality of satellite bores located radially outside the center bore, circumferentially distanced from each other, and located between the cylinder bores, and each of the satellite bores communicates with the discharge chamber through an opening formed in the valve plate.
4. A reciprocal compressor of anyone of claims 1 to 3, wherein not only a bulkhead for separating the discharge chamber from the suction chamber but also legs provided in the discharge chamber clamp the valve plate in cooperation with the cylinder block.

Fig.1

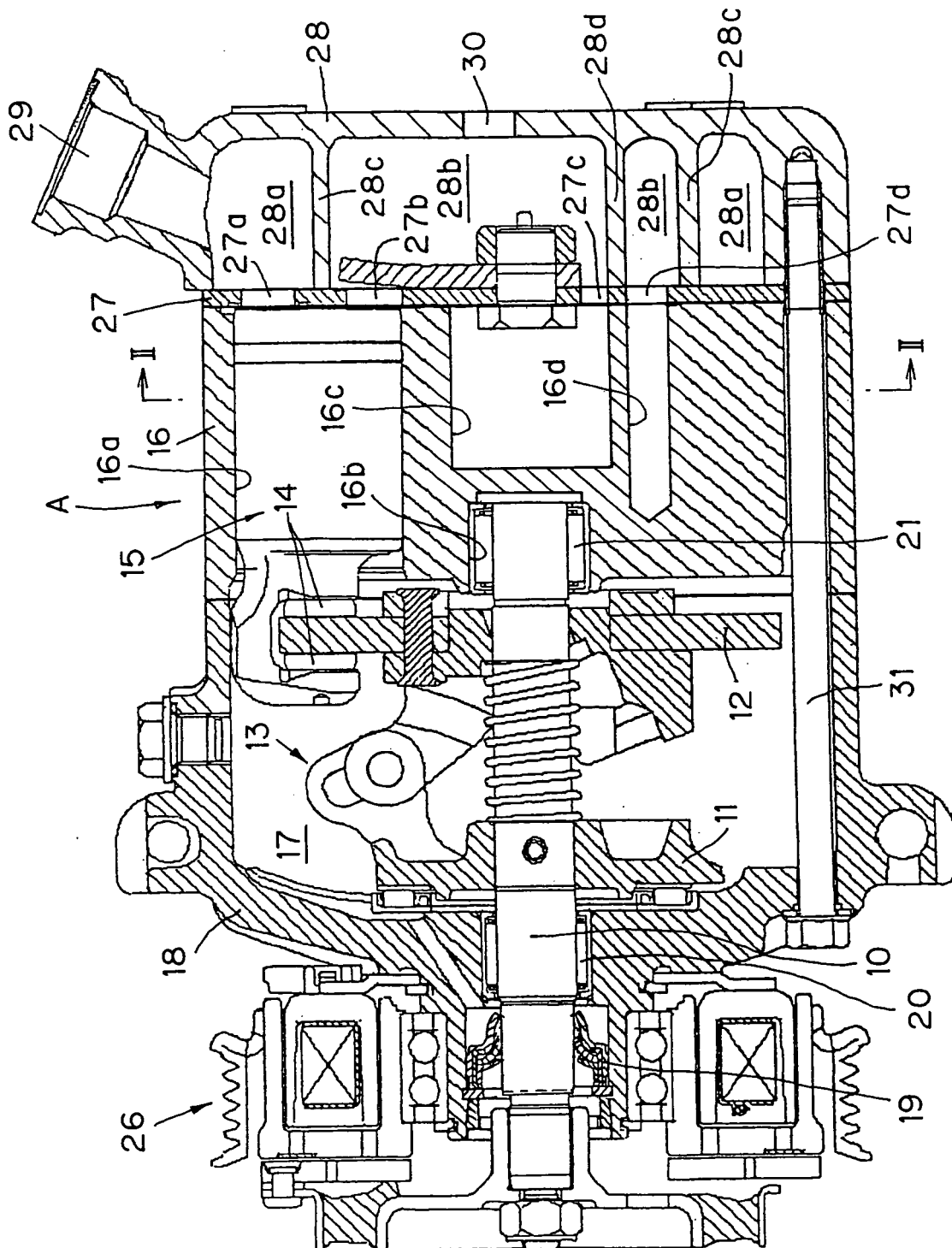


Fig.2

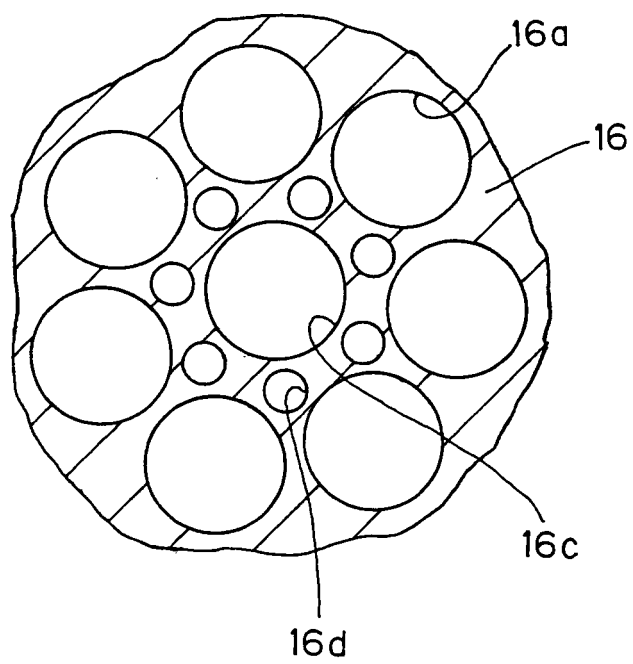
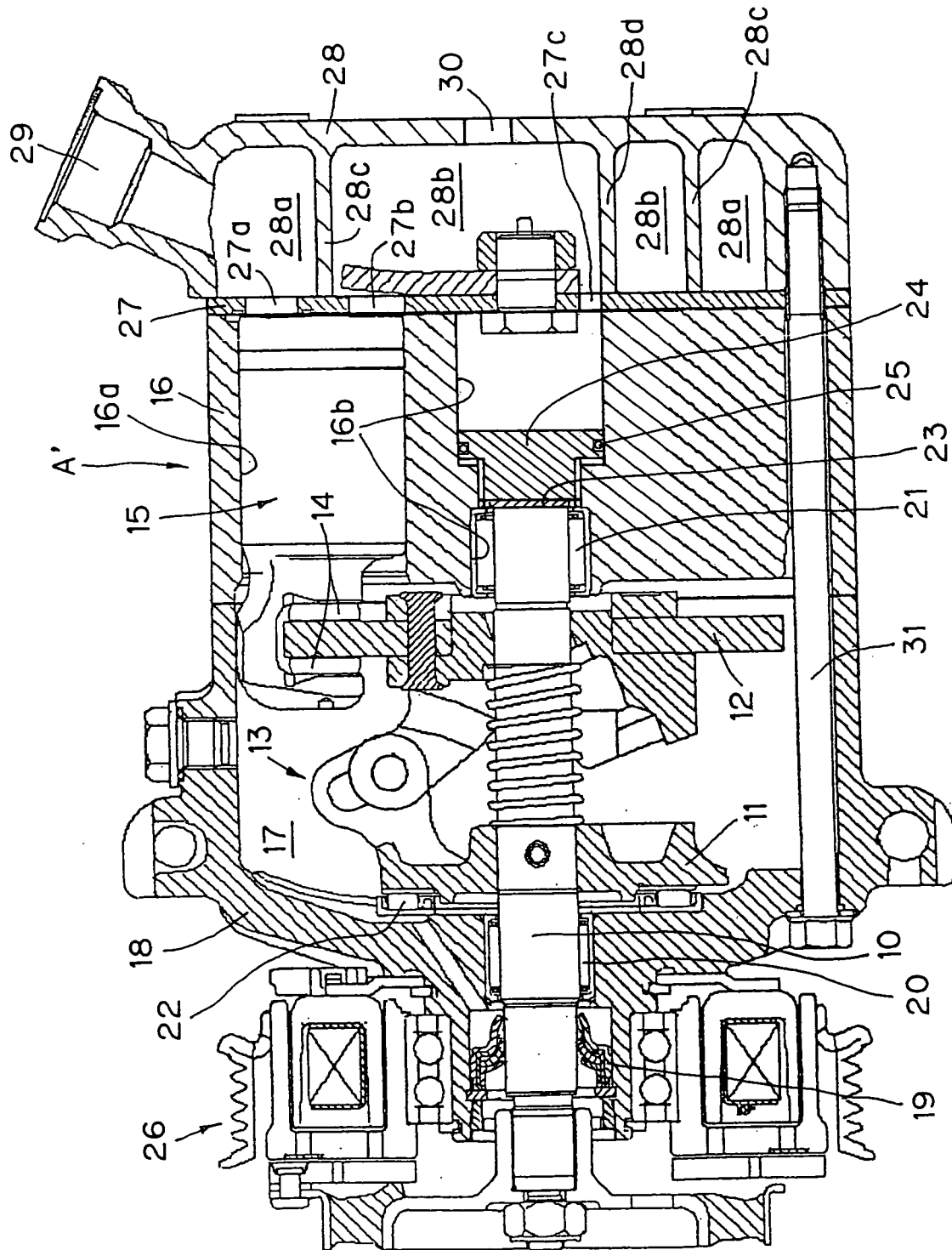


Fig.3



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2006/314546

A. CLASSIFICATION OF SUBJECT MATTER

F04B39/00(2006.01) i, F04B27/08(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)

F04B39/00, F04B27/08

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	1996-2006
Kokai Jitsuyo Shinan Koho	1971-2006	Toroku Jitsuyo Shinan Koho	1994-2006

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.
A	JP 7-77157 A (Toyoda Automatic Loom Works, Ltd.), 20 March, 1995 (20.03.95), Full text; all drawings & WO 1994/028305 A1 & US 5674054 A & DE 4493590 T1	1, 4
A	JP 2003-239855 A (Denso Corp.), 27 August, 2003 (27.08.03), Full text; all drawings & US 2003/86792 A1 & DE 10250591 A1 & CN 1415856 A	1, 4
A	JP 2001-12345 A (Sanden Corp.), 16 January, 2001 (16.01.01), Full text; all drawings & US 6368070 B1	2-4

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

* Special categories of cited documents:

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"P" document published prior to the international filing date but later than the priority date claimed

"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

"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

"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

"&" document member of the same patent family

Date of the actual completion of the international search
27 September, 2006 (27.09.06)Date of mailing of the international search report
10 October, 2006 (10.10.06)Name and mailing address of the ISA/
Japanese Patent Office

Authorized officer

Facsimile No.

Telephone No.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2006/314546

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 8-200218 A (Toyoda Automatic Loom Works, Ltd.), 06 August, 1996 (06.08.96), Full text; all drawings & US 5842836 A & DE 19603109 A1 & KR 189577 B1 & CN 1135576 A	4

Form PCT/ISA/210 (continuation of second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2006/314546

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:

A matter common to the inventions in Claims 1-4 is such a point that "the reciprocating compressor comprises the rotating shaft, the motion converting mechanism, the pistons, the cylinder block in which the cylinder bores and the center bore are formed, the valve plate in which the suction hole and the discharge hole are formed, having the suction valve and the discharge valve, and opposed to one end of the cylinder block, and the rear housing having the suction chamber and the discharge chamber and opposed to the valve plate". However, the common matter is not a special technical feature in the meaning (continued to extra sheet)

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 an additional fee, this Authority did not invite payment of any additional fee.
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 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.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2006/314546

Continuation of Box No.III of continuation of first sheet(2)

of the second sentence of PCT Rule 13.2 since it is merely a well-known technical matter as disclosed in, for example, Document JP 7-77157 A (Toyoda Automatic Loom Works, Ltd.), 20 March, 1995 (20.03.95).

On the other hand, Claims 2-4 are so technically related as to involve a special technical feature.

As a result, each of the invention in Claim 1 and the inventions in Claims 2-4 is considered to be classified into the other group of inventions.

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- JP 7077157 A [0002]