(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 793 020 A1

(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 158(3) EPC

(43) Date of publication:
03.09.1997 Bulletin 1997/36

(21) Application number: **95939397.6**

(22) Date of filing: **08.12.1995**

(51) Int. Cl.[6]: **F04C 18/344**

(86) International application number:
PCT/JP95/02515

(87) International publication number:
WO 96/19667 (27.06.1996 Gazette 1996/29)

(84) Designated Contracting States:
DE FR

(30) Priority: **20.12.1994 JP 334974/94**
03.03.1995 JP 70670/95
05.06.1995 JP 161485/95

(71) Applicant: **Zexel Corporation**
Tokyo 150 (JP)

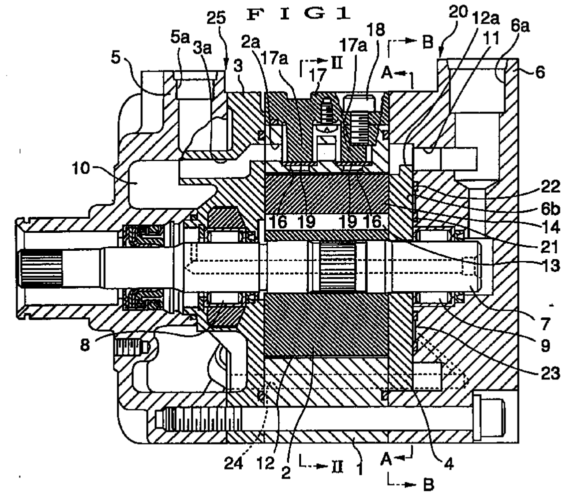
(72) Inventors:
- **MUTA, Shunji**
  Zexel Corporation Kounan-works
  Oosato-gun Saitama-ken 360-01 (JP)
- **MURAYAMA, Toshihiro**
  Zexel Corporation Kounan-works
  Oosato-gun Saitama-ken 360-01 (JP)
- **TAKAHASHI, Tomoyasu**
  Zexel Corporation Kounan-works
  Oosato-gun Saitama-ken 360-01 (JP)
- **MAKIHIRAI, Susumu**
  Zexel Corporation Kounan-works
  Oosato-gun Saitama-ken 360-01 (JP)
- **HASHIMOTO, Katsuhiro**
  Zexel Corporation KounanWorks
  Ossato-gun Saitama-ken 360-01 (JP)

(74) Representative: **Britter, Keith Palmer**
Britter & Co.
Barn West, The Dixies,
High Street, Ashwell
Baldock Hertfordshire SG7 5NT (GB)

(54) VANE TYPE COMPRESSOR

(57) It provides a liquid detergent composition which has an excellent strength to remove sebaceous stains and is good at stock stability. The liquid detergent composition described above comprising: (a) polyoxyethylene alkyl ether having an alkyl group originating in primary alcohol, (b) polyoxyethylene alky ether having an alkyl group originating in secondary alcohol, and c) a solvent, wherein a (a)/(b) weight ratio is 10/1 to 1/10.

FIG 1



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Printed by Rank Xerox (UK) Business Services
2.14.12/3.4

Description

Technical Field

This invention relates to a vane compressor, and more particularly to a vane compressor which is capable of protecting the internal mechanism thereof from liquid compression and increasing the resistance of a rear side member thereof to wear which occurs when an electromagnetic clutch is engaged to start the compressor.

Background Art

FIG. 22 is a longitudinal cross-section of a conventional vane compressor. The vane compressor is comprised of a cam ring 501, a front side block 503 and a rear side block 504 respectively secured to opposite ends of the cam ring 501, a cylindrical rotor 502 rotatably received within the cam ring 501, a front head 505 and a rear head 506 respectively secured to outer ends of the side blocks 503, 504, and a drive shaft 507 for rotating the rotor 502. The drive shaft 507 is rotatably supported by bearings 508, 509 arranged in the side blocks 503, 504, respectively. This kind of vane compressor has been proposed, e.g. by Japanese Laid-Open Patent Publication (Kokai) No. 3-18683.

Recently, aluminum-based materials are widely employed as materials of the main component parts of compression mechanism of the vane compressor, such as the cam ring 501 and the front and rear side blocks 503 and 504, so as to reduce the weight of the compressor.

However, the conventional vane compressor has the following problems:

First, when all the main component parts of the compressor are made of aluminum-based materials, the manufacturing costs of the vane compressor are increased due to costly aluminum-based materials and additional surface-treatments required to be provided on the component parts formed of these materials.

Secondly, it is required to thicken the front and rear side blocks 503 and 504 so as to maintain proof strength thereof against liquid compression, which leads to an increase in weight of the compressor.

Thirdly, when an electromagnetic clutch of the compressor is engaged, the drive shaft 507 and the rotor 502 shift toward the rear side block 504, so that a rear side end face of the rotor 502 is pressed against a rotor-side end face of the rear side block 504, which imposes a heavy impact load on both the rotor 502 and the rear side block 504, leading to abrasion and seizure of them.

Fourthly, when an assembling bolt 600 is tightened to thereby assemble the front head 505, the front side block 503, the cam ring 501, the rear side block 504 and the rear head 506, a rotor-side end face of the front side block and the rotor-side end face of the rear side block are deformed such that they form wavy surfaces, which can cause abrasion and seizure between the rotor 502 and the front side block 503 as well as between the rotor 502 and the rear side block 504.

Fifthly, in the case of the conventional vane compressor having a rear side block provided with outlet holes and discharge valves for directly delivering a high-pressure refrigerant gas from compression chambers to a discharge chamber (proposed e.g. by Japanese Laid-Open Utility Model publication (Kokai) No. 4-14785), it is impossible to form very large outlet holes through the rear side block, so that there is fear of pressure within each compression chamber becoming abnormally high. To avoid this inconvenience, it is required to provide relief valves in addition to the discharge valves, which complicates the construction of the compressor.

The present invention has been made in view of the above circumstances. The objects thereof are to protect the internal mechanism of the vane compressor from liquid compression, without increasing the amount of aluminum-based materials used therefor; to prevent an impact load from being applied when an electromagnetic clutch of the compressor is engaged; to prevent abrasion and seizure from occurring between a rotor and a front side member or a rear side member; and to prevent pressure within compression chambers from becoming abnormally high, without making the construction of the compressor complicated.

Disclosure of the Invention

To solve the above problems, the invention provides a vane compressor including a rotor secured on a drive shaft and rotatably received within a cam ring, vanes slidably received within a plurality of vane slits formed in the rotor, respectively, a front-side member arranged on a front side of the cam ring, a rear-side member arranged on a rear side of the cam ring, and a high-pressure chamber formed in an interior of one of the front-side member and the rear-side member, characterized in that at least one of the front-side member and the rear-side member comprises a head which is secured to one end face of the cam ring, and a movable plate which is held by the head, in a state opposed to the one end face of the cam ring, and at the same time movable along a central axis of the drive shaft.

When the compressor is started, the movable plate is temporarily pressed away from the rotor by pressures within compression chambers formed between vanes to moved away from the rotor, so that there is created a clearance between a rotor-side end face of the movable plate and one end face of the rotor, through which fluid in a liquid state is discharged, whereby liquid compression can be avoided.

Further, at the start of the compressor (when an electromagnetic clutch is engaged), although the drive shaft shifts toward the rear side to press the one end face of the rotor against the rotor-side end face of the movable plate, the movable plate is also temporarily moved away from the rotor, whereby pressures acting on sliding surfaces of the one end face of the rotor and the rotor-side end face of the movable plate are decreased to reduce possibility of seizure occurring to these component parts of the compressor.

According to the vane compressor of the present invention, the movable plate separates compression chambers formed between the vanes from the high-pressure chamber.

The movable plate is pressed against the one end face of the cam ring by pressure within the high-pressure chamber, which ensures that steady compression is carried out during operation of the compressor.

According to the vane compressor of the invention, the at least one of the front-side member and the rear-side member is the rear-side member.

When the electromagnetic clutch is engaged, the drive shaft shifts toward the rear side to thereby press the one end face of the rotor against the rotor-side end face of the movable plate. However, since the movable plate is temporarily moved away from the rotor, pressures acting on sliding surfaces of the one end face of the rotor and the rotor-side end face of the movable plate are decreased to reduce possibility of seizure occurring to these component parts of the compressor.

According to the vane compressor of the invention, the movable plate is formed with outlet holes for directly communicating the compression chambers with the high-pressure chamber, and discharge valves provided for opening/closing the outlet holes, respectively.

Since the movable plate is formed with outlet holes for directly communicating the compression chambers with the high-pressure chamber and the discharge valves for opening/closing the outlet holes, when pressures within compression chambers are increased by rotation of the rotor, the discharge valves open to permit refrigerant compressed within the compression chambers to be directly delivered via the outlet holes to the high-pressure chamber. When the pressures within the compression chambers become still higher, the movable plate is moved away from the rotor, so that there is created a clearance between the rotor-side end face of the movable plate and the end face of the rotor, through which flows out the refrigerant compressed within the compression chambers. Thus, it is possible to prevent the pressure within each compression chamber from becoming abnormally high, without using any relief valve, which contributes to reduction of the thickness of the cam ring and the weight of the compressor.

According to the vane compressor of the invention, the rotor is formed with discharge-promoting grooves for communicating the outlet holes with compression chambers immediately before each of the vanes is brought into a position most retracted into its vane slit.

Since the rotor is formed with the discharge-promoting grooves for communicating the outlet holes with compression chambers immediately before each vane is brought into a position most retracted into its vane slit, at completion of the discharge stroke of each compression chamber, the refrigerant compressed within the compression chamber is delivered to the high-pressure chamber not only directly from the compression chamber but also by way of the discharge-promoting groove of the rotor. This enables a sufficient amount of refrigerant to be discharged to thereby more securely prevent the pressure within the compression chambers from becoming abnormally high.

The vane compressor of the invention is provided with an elastic member for urging the movable plate toward the rotor.

Since the vane compressor is provided with the elastic member for urging the movable plate toward the rotor, the movable plate is urged against the one end face of the cam ring, which ensures that steady compression is carried out during operation of the compressor.

The invention provides a vane compressor including a rotor secured on a drive shaft and rotatably received within a cam ring, vanes slidably received within a plurality of vane slits formed in the rotor, a front-side member arranged on a front side of the cam ring, a rear-side member arranged on a rear side of the cam ring, and a low-pressure chamber formed in an interior of one of the front-side member and the rear-side member, characterized in that the front-side member comprises a front head which is secured to a front-side end face of the cam ring, and a first movable plate which is held by the front head, in a state opposed to the front-side end face of the cam ring and at the same time movable along a central axis of the drive shaft, and the rear side member comprises a rear head which is secured to a rear-side end face of the cam ring, and a second movable plate which is held by the rear head, in a state opposed to the rear-side end face of the cam ring and at the same time movable along the central axis of the drive shaft.

Since the front side member and the rear side member each comprise a head which is secured to an end face of the cam ring and a movable plate which is held by the head, in a state opposed to the end face of the cam ring and at the same time movable along the central axis of the drive shaft, when an assembling bolt is fastened to thereby secure the front head to one end face of the cam ring and the rear head to the other end face of the same, neither of the first movable plate and the second movable plate in contact with the end faces of the cam ring, respectively, is deformed, and pressures acting on sliding surfaces of end faces of the rotor and the rotor-side end faces of the movable plates are not increased to thereby reduce abrasion of the rotor and the front and rear side members, and possibility of seizure occurring thereto.

According to the vane compressor of the invention, one of the first movable plate and the second movable plate separates the compression chambers formed between the vanes from the low-pressure chamber, and a back pressure chamber into which high pressure is introduced is formed on a side of the one of the first movable plate and the second movable plate remote from the cam ring in a fashion surrounding the low-pressure chamber.

Since one of the first and second movable plates separates the compression chambers formed between the vanes from the low-pressure chamber, and the back pressure chamber into which high pressure is introduced is formed on the side of the one movable plate remote from the cam ring in a fashion surrounding the low-pressure chamber, when the movable plate is urged against the end face of the cam ring by high pressure within the back pressure chamber, the movable plate is not deformed such that a central portion thereof protrudes from the periphery of the same. This makes it possible to reduce abrasion of the movable plate and the rotor, and possibility of seizure occurring thereto.

The vane compressor of the invention is characterized in that low pressure-introducing grooves are formed in a movable plate-contact zone of a high-pressure chamber-side end face of the cam ring, where the movable plate is in contact with the cam ring, in a manner such that the low pressure-introducing grooves extend along an inner periphery of the cam ring.

High pressure is applied to a high-pressure chamber-side end face of the movable plate while low pressure is applied to a cam ring-contact zone of the cam ring-side end face of the same to cause a difference between the two pressures, so that pressing force is exerted on an outer periphery of the movable plate to press this portion of the movable plate toward the cam ring. As a result, an amount of deformation of the movable plate is reduced to thereby reduce leakage of the refrigerant from the compression chambers. This makes it possible to prevent the performance of the compressor from being degraded, and at the same time prevent noises from being made due to fluttering of the movable plate.

Further, the vane compressor of the invention is characterized in that low pressure-introducing grooves are formed in a cam ring-contact zone of a cam ring-side end face of the movable plate, where the movable plate is in contact with the cam ring, in a manner such that the low pressure-introducing grooves extend along an inner periphery of the cam ring.

High pressure is applied to the high-pressure chamber-side end face of the movable plate while low pressure is applied to the low pressure-introducing grooves in the cam ring-contact zone of the cam ring-side end face of the same to cause a difference between the two pressures, so that pressing force is exerted on the outer periphery of the movable plate to press this portion of the movable plate toward the cam ring. As a result, the amount of deformation of the movable plate is reduced to thereby reduce leakage of the refrigerant from the compression chambers. This makes it possible to prevent the performance of the compressor from being degraded, and at the same time prevent noises from being made due to fluttering of the movable plate.

The vane compressor of the invention is characterized in that the low pressure-introducing grooves communicate with the compression chambers during a suction stroke.

Since pressing force is exerted on the outer periphery of the movable plate to urge this portion of the movable plate toward the cam ring, the amount of deformation of the movable plate is reduced to decrease leakage of the refrigerant from the compression chambers, whereby it is possible to prevent the performance of the compressor from being degraded, and at the same time prevent noises from being made due to fluttering of the movable plate.

Further, the vane compressor of the invention is characterized in that the low pressure-introducing grooves communicate with a low-pressure chamber in which is stored a low-pressure working fluid to be fed to the compression chambers.

Since pressing force is exerted on the outer periphery of the movable plate to urge this portion of the movable plate toward the cam ring, the amount of deformation of the movable plate is reduced to decrease leakage of the refrigerant from the compression chambers, whereby it is possible to prevent the performance of the compressor from being degraded, and at the same time prevent noises from being made due to fluttering of the movable plate.

Brief Description of the Drawings

FIG. 1 is a longitudinal cross-sectional view of a vane compressor according to a first embodiment of the invention;

FIG. 2 is a cross-sectional view taken on line II-II of FIG. 1;

FIG. 3 is an end view taken from an arrow A in FIG. 1;

FIG. 4 is an end view taken from an arrow B in FIG. 1;

FIG. 5 is a cross-sectional view taken on line C-C of FIG. 4;

FIG. 6 is a longitudinal cross-sectional view of a vane compressor according to a second embodiment of the invention;

FIG. 7 is a longitudinal cross-sectional view of a vane compressor according to a third embodiment of the invention;

FIG. 8 is a longitudinal cross-sectional view of a vane compressor according to a fourth embodiment of the invention;

FIG. 9 is a cross-sectional view taken on line IX-IX of FIG. 8;

FIG. 10 is a cross-sectional view taken on line D-D of FIG. 9;

FIG. 11 is a perspective view of a rotor of the FIG. 8 vane compressor;

FIG. 12 is a longitudinal cross-sectional view of a vane compressor according to a fifth embodiment of the invention;

FIG. 13 is a longitudinal cross-sectional view of a vane compressor according to a sixth embodiment of the invention;

FIG. 14 is an end view of a rear-side end face of a cam ring;

FIG. 15 is an end view of a cam ring-side end face of a front head;

FIG. 16 is a conceptual view useful in explaining the relationship between a cam ring and a movable plate;

FIG. 17 is a conceptual view useful in explaining the relationship between a cam ring and a movable plate;

FIG. 18 is a longitudinal cross-sectional view of a vane compressor according to a seventh embodiment of the invention;

FIG. 19 is a longitudinal cross-sectional view of a vane compressor according to an eighth embodiment of the invention;

FIG. 20 is an end view showing a cam ring-side end face of a cylinder head, with a movable plate fitted therein;

FIG. 21 is an end view showing the cam ring-side end face of the cylinder head, with the movable plate removed therefrom; and

FIG. 22 is a longitudinal cross-sectional view of a conventional vane compressor.

Best Mode of Carrying Out the Invention

Next, the invention will now be described in detail with reference to drawings showing preferred embodiments thereof.

FIG. 1 is a longitudinal cross-sectional view of a vane compressor according to a first embodiment of the invention. FIG. 2 is a cross-sectional view of the compressor taken on line II -II of FIG. 1. FIG. 3 is an end view taken from an arrow A of FIG. 1, FIG. 4 an end view taken from an arrow B of FIG. 1, and FIG. 5 a cross-sectional view taken on line C-C of FIG. 4.

The vane compressor is comprises of a cam ring 1, a front-side member 25 and a rear-side member 20 arranged on open opposite ends of the cam ring 1, a rotor 2 rotatably received within the cam ring 1, and a drive shaft 7 on which is secured the rotor 2. The drive shaft 7 is rotatably supported by a pair of radial bearings 8 and 9. An electromagnetic clutch, not shown, is mounted on one end of the drive shaft 7.

The front-side member 25 is comprised of a front side block 3 secured to a front-side end face of the cam ring 1, and a front head 5 secured to a front-side end face of the front side block 3.

The front head 5 is formed with a discharge port 5a through which a refrigerant gas (working fluid) is discharged as a thermal medium, and the discharge port 5a is communicated with a discharge chamber 10 formed by the front head 5 and the front side block 3.

The rear-side member 20 is comprised of a rear head 6 which is secured to a rear-side end face of the cam ring 1, and a substantially disc-shaped movable plate 4 arranged in a state opposed to the rear-side end face of the cam ring 1. The rear head 6 is formed with a suction port 6a through which the refrigerant gas is drawn into the compressor. The suction port 6a communicates with a suction chamber 11 formed within the rear head 6.

The movable plate 4 has a central through hole through which a rear-side end portion of the drive shaft 7 is loosely fitted. The movable plate 4 is received in a recess 6b formed in a rotor-side end face of the rear head 6, in a fashion movable along a central axis of the drive shaft 7. Between the movable plate 4 and the recess 6b of the rear head 6 are mounted a pair of O rings (elastic members) 21, 22, which urge the movable plate 4 against the rear-side end face of the cam ring 1 by the urging force thereof. Further, as shown in 5, the pair of O rings 21, 22 form therebetween a back pressure chamber 23 into which a high-pressure refrigerant gas (or high-pressure oil) is introduced from the discharge chamber (high-pressure chamber) 10, referred to hereinafter, via a high pressure-introducing passage 24 (indicated by broken lines in FIG. 1). The movable plate 4 is urged against the rear-side end face of the cam ring 1 by the high-pressure refrigerant drawn into the back pressure chamber 23. Further, as shown in FIGS. 3 and 4, the movable plate 4 is formed with a pair of inlet ports 12a, 12a at upper and lower locations in a fashion corresponding to a pair of upper and lower compression spaces 12, 12 (see FIG. 2), referred to hereinbelow, respectively. The suction chamber 11 is communicated with the compression spaces 12, 12 via the inlet ports 12a, 12a.

As best shown in FIG. 2, the pair of compression spaces 12 are defined at diametrically opposite locations between an inner peripheral surface of the cam ring 1 and an outer peripheral surface of the rotor 2 (only one of the compression spaces is shown in FIG. 1). The rotor 2 has its outer peripheral surface formed therein with a plurality of vane slits 13, in each of which a vane 14 is radially slidably fitted. Each compression space 12 is divided by vanes 14 into compression chambers, the volume of each of which is varied with rotation of the rotor 2.

A pair of outlet ports 16 are formed through lateral side walls of the cam ring 1 (only one of the outlet ports 16 is shown in FIG. 1). The lateral side walls of the cam ring 1 are provided with discharge valve covers 17, each formed integrally with a valve stopper 17a, and fixed to the cam ring 1 by bolts 18. Discharge valves 19 are mounted between the respective lateral side walls of the cam ring 1 and the valve stoppers 17a for opening and closing the outlet ports 16. When the outlet ports 16 are open, high-pressure refrigerant gas compressed within the compression chambers is delivered via the outlet ports 16, communication passages 2a, 3a, the discharge chamber 10, and the discharge port 5a.

Next, the operation of the vane compressor constructed as above will be explained.

As torque is transmitted from an engine, not shown, to the drive shaft 7 via the electromagnetic clutch, the rotor 2 is driven for rotation. Refrigerant gas flowing out of an outlet port of an evaporator, not shown, is drawn into the suction chamber 11 of the compressor via the suction port 6a thereof. The refrigerant gas is drawn into the compression spaces 12 from the suction chamber 11 via the inlet ports 12a. The compression spaces 12 are divided by the vanes into the compression chambers, each of which is varied in capacity with rotation of the rotor 2, whereby refrigerant gas trapped in each compression chamber is compressed, and the compressed refrigerant gas opens the discharge valves 19 to flow out via the outlet ports 16 into the discharge chamber 10, followed by being discharged via the discharge port 5a.

When the compressor is not in operation, the movable plate 4 stays urged against the rear-side end face of the cam ring 1 by the urging force of the O rings 21, 22.

Generally, when the compressor is started, if a rotor is rotated with a refrigerant in a liquid state held within compression spaces, a so-called liquid compression occurs in the compressor. In the case of the vane compressor of the invention, however, the movable plate 4 urged by compression pressure developed on this occasion is temporarily moved away from the rotor 2 against the urging force of the O rings 21, 22. As a result, there is created a clearance between the rotor-side end face of the movable plate 4 and the rear-side end face of the rotor 2, which permits the liquid refrigerant to be delivered therethrough. Thus, the liquid compression can be avoided to prevent breakage or dragging of the rotor 2, whereby the internal mechanism of the compressor is protected.

Further, when the drive shaft 7 shifts toward the rear side at the start of the compressor (i.e. when the electromagnetic clutch is engaged) to urge the rotor 2 against the rotor-side end face of the movable plate 4, the movable plate 4 is also moved away from the rotor against the urging force of the O rings 21 and 22, so that pressures acting between sliding surfaces of the rear-side end face of the rotor 2 and the rotor-side end face of the movable plate 4 are reduced. As a result, it is possible to reduce abrasion of the rotor 2 and the movable plate 4 and prevent seizure from occurring thereto.

Still further, when the compressor is started, the pressure within the discharge chamber 10 is lower than when the compressor is in operation, and the clearance between the movable plate 4 and the rotor 2 is relatively wide. Therefore, a high-pressure refrigerant is supplied to the bottom space of each axial vane slits 13 in a short time period, which enables the vanes 14 to project out easily. On the other hand, after the start of the compressor, the pressure within the discharge chamber 10 becomes high, so that the movable plate 4 is pressed against the rear-side end face of the cam ring 1, thereby providing secure sealing between the movable plate 4 and the cam ring 1. Thus, the function of the movable plate 4 enhances the starting characteristics of the compressor, and at the same time eliminates the need for a trigger valve which is employed in a conventional vane compressor for opening a passage communicating a discharge chamber with the bottom of each slit, when pressure within the discharge chamber is below a predetermined level, and closing the passage when the pressure rises up to the predetermined level, to thereby assist the vanes to project out at the start of the compressor.

When the compressor enters a steady operative state after the start thereof, high-pressure refrigerant gas or high-pressure oil is supplied from the discharge chamber 10 or an oil sump therein to the back pressure chamber 23 via the high pressure-introducing passage 24. As a result, the movable plate 4 is pressed against the rear-side end face of the cam ring 1 by the high-pressure refrigerant gas or oil, which enables the compressor to perform compression in a stable manner.

In the present embodiment, a thin movable plate 4 formed of a ferrous material, which does not require surface treatment, is employed instead of a rear-side block formed of an aluminum-based material, so that the whole amount of aluminum-based materials used for the compressor is decreased thereby making it possible to reduce the manufacturing costs of the compressor, as well as to reduce the thickness and size of the movable plate 4 while maintaining high rigidity thereof.

Further, since the inlet ports 12a are formed in the movable plate 4, it is possible to cope with changes in suction characteristics simply by replacing the movable plate 4 by another. That is, differently from a case in which a cam ring or a side block is formed with inlet ports 12a, it is not required to remodel the compressor, but the compressor can be redesigned simply by replacing the movable plate 4 with another movable plate 4 formed with inlet ports 12a each cut into a different shape from the older one.

Although in the first embodiment, the discharge chamber 10, which serves as a high-pressure chamber, is formed on the front side of the compressor, this is not limitative, but it may be provided on the rear side of the compressor, and at the same time, two movable plates may be arranged on the front and rear sides of the compressor, respectively. Further, although the O rings 21 and 22 are employed in the present embodiment, X rings, not shown, may be used instead of the O rings 21 and 22.

FIG. 6 is a longitudinal cross-sectional view of a vane compressor according to a second embodiment of the invention.

Component parts and elements similar to those of the first embodiment are designated by identical reference numerals, and detailed description thereof will be omitted. In the first embodiment, the front-side member 25 is comprised of the front side block 3 secured to the front-side end face of the cam ring 1 and the front head 5 secured to the front-side end face of the front side block 3, while the rear-side member 20 is comprised of the rear head 6 which is secured to the rear-side end face of the cam ring 1 and the disc-shaped movable plate 4 which is held by the rear head 6, in a state opposed to the rear-side end of the cam ring 1, such that the movable plate 4 can be moved along the central axis of the drive shaft 7. The second embodiment is distinguished from the first embodiment in that, as shown in FIG. 6, the vane compressor has a rear-side member 50 comprised of a rear side block 34 which is secured to a rear-side end face of a cam ring 1 and a rear head 36 which is secured to a rear-side end face of the rear side block 34, and a front-side member 55 comprised of a front head 35 which is secured to a front-side end face of the cam ring 1, and a disc-shaped movable plate 33 which is held by the front head 35, in a state opposed to the front side end face of the cam ring 1, such that the movable plate 33 can be moved along the central axis of the drive shaft 7.

The movable plate 33 has a central through hole through which the drive shaft 7 is loosely fitted. The movable plate 33 is received within a recess 35b formed in a rotor-side end face of the front head 35, in a fashion movable along the central axis of the drive shaft 7. Between the movable plate 33 and the recess 35b of the front head 35 are mounted an O ring (elastic member) 26. The movable plate 33 is urged against the front-side end face of the cam ring 1 by the urging force of the O ring 26. The movable plate 33 separates a discharge chamber 40 from compression spaces 12.

According to the vane compressor of the second embodiment, when the compressor is started, if the rotor 2 is rotated with a refrigerant in a liquid state held within the compression spaces 12, the movable plate 33 is temporarily pressed away from the rotor 2 by compression pressure within the compression spaces 12 to be moved away from the rotor 2 against the urging force of the O ring 26, so that there is created a clearance between the rotor-side end face of the movable plate 33 and the front-side end face of the rotor 2, which permits the liquid refrigerant to be delivered therethrough. As a result, it is possible to avoid liquid compression to thereby protect the internal mechanism of the compressor, similarly to the case of the first embodiment.

Since the movable plate 33 separates the discharge chamber 40 and the compression spaces 12 from each other, when the compressor is in a steady operating condition, the movable plate 33 is pressed against the front-side end face of the cam ring 1 by pressure within the discharge chamber 40, which ensures stable compression. Further, since it is not required to provide a high pressure-introducing passage 24 (see FIG. 1), the construction of the compressor can be further simplified compared with that of the compressor of the first embodiment.

Further, since the thin movable plate 33, which is formed of a ferrous material and does not require surface treatment, is employed instead of a front side block formed of an aluminum-based material, it is possible, similarly to the first embodiment, to decrease the whole amount of aluminum-based materials used for the compressor to thereby reduce the manufacturing costs of the compressor, as well as to reduce the thickness and size of the movable plate while maintaining high rigidity thereof.

FIG. 7 is a longitudinal cross-sectional view of a vane compressor according to a third embodiment of the invention. Component parts and elements similar to those of the above embodiments are designated by identical reference numerals, and detailed description thereof will be omitted. Some component parts and elements including a discharge valve are not shown in the figure.

In the third embodiment, a front-side member 85 is formed by a front head 65 alone which is secured to a front-side end face of a cam ring 51, while a rear-side member 80 is comprised of a rear head 66 which is secured to a rear-side end face of the cam ring 51 and a disc-shaped movable plate 64 which is held by the rear head 66 , in a state opposed to the rear-side end of the cam ring 51, such that the movable plate 64 can be moved along the central axis of a drive shaft 7.

The third embodiment is distinguished from the first embodiment in that the vane compressor has a discharge chamber 70 formed on a rear side thereof and a suction chamber 71 formed on a front side thereof, and that a front side block is omitted.

The movable plate 64 has a central through hole through which the drive shaft 7 is loosely fitted. The movable plate 64 is received within a recess 66b formed in a rotor-side end face of the rear head 66, in a fashion movable along the central axis of the drive shaft 7. Between the movable plate 64 and the recess 66b of the front head 66, there is mounted an O ring (elastic member) 27. The movable plate 64 is urged against the rear-side end face of the cam ring 1 by the urging force of the O ring 27. The discharge chamber 70 and compression spaces 12 are separated by the movable plate 64.

The third embodiment can provide the same advantageous effects as obtained by the second embodiment. Further, according to the third embodiment, at the start of the compressor (i.e. when the electromagnetic clutch is engaged), pressure acting on sliding surfaces of the rear-side end face of the rotor 2 and the rotor-side end face of the-movable plate 64 can be reduced, so that it is possible to reduce abrasion of the rotor 2 and the movable plate 64 and prevent seizure from occurring thereto.

FIG. 8 is a longitudinal cross-sectional view of a vane compressor according to a fourth embodiment of the invention. FIG. 9 is a cross-sectional view taken on line IX-IX of FIG. 8. FIG. 10 is a cross-sectional view taken on line D-D of FIG. 9, and FIG. 11 a perspective view of a rotor of the FIG. 8 vane compressor. Component parts and elements similar to those of the preceding embodiments are designated by identical reference numerals, and detailed description thereof will be omitted.

The fourth embodiment is an application of the third embodiment shown in FIG. 7. In this embodiment, similarly to the third embodiment, a front-side member 85 is formed by a front head 65 alone which is secured to a front-side end face of a cam ring 61, while a rear-side member 90 is comprised of a rear head 76 which is secured to a rear-side end face of the cam ring 61 and a disc-shaped movable plate 74 which is held by the rear head 76, in a state opposed to the rear-side end face of the cam ring 61, such that the movable plate 74 can be moved along the central axis of the drive shaft 7.

Also, the fourth embodiment is also similar to the third embodiment in that the vane compressor has a discharge chamber (high-pressure chamber) 80 formed on a rear side thereof and a suction chamber (low-pressure chamber) 71 formed on a front side thereof, and that a front side block is omitted.

Further, the fourth embodiment is similar to the third embodiment in that the movable plate 74, which separates the discharge chamber 80 from compression spaces 12, is movably received within a recess 76b formed in a rotor-side end face of the rear head 76, and that the movable plate 74 is urged against the rear-side end face of the cam ring 61 by the urging force of an O ring 27 (elastic member) which is mounted between the movable plate 74 and the recess 76b of the rear head 76.

In the fourth embodiment, as shown in FIGS. 9 and 10, the movable plate 74 is provided with outlet holes 96 for communicating compression chambers directly with the discharge chamber 80, and discharge valves 99 for opening/closing the outlet holes 96. One end of each discharge valve 99 is fixed to the movable plate 74 together with a valve stopper 95 by means of a screw 98. The rotor 2 is formed with discharge-promoting grooves 97 (see FIG. 11) for communicating the outlet holes 96 with compression chambers immediately before each of vanes 14 forming the compression chambers is brought into a position most retracted into its vane slit 13.

According to the vane compressor of the fourth embodiment, when pressures within the compression chambers are increased by rotation of the rotor 2, the discharge valves 99 open to permit the refrigerant to be delivered from the compression chambers directly into the discharge chamber 80 via the outlet holes 96. When the pressures within the compression chambers becomes still higher, the movable plate 74 is moved away from the rotor 2. As a result, between a rotor-side end face of the movable plate 74 and a rear-side end face of the rotor 2 is created a clearance, through which the high-pressure refrigerant is permitted to be delivered. Therefore, it is possible to prevent the pressures within the compression chambers from becoming abnormally high, without using any relief valves, which leads to reduction of the thickness of the cam ring 61 and the weight of the compressor.

Further, as described above, the rotor 2 is formed with the discharge-promoting grooves 97 for communicating the outlet holes 96 with the compression chambers immediately before each vane 14 is brought into a position most retracted into its vane slit 13, so that at completion of each discharge stroke, the refrigerant is delivered from the compression chambers to the discharge chamber 80 through the outlet holes 96 not only directly but also by way of the discharge-promoting grooves 97. Thus, a sufficient amount of refrigerant can be discharged.

Still further, since the movable plate 74 is provided with the outlet holes 96 and the discharge valves 99 each formed by a flat valve, the construction of the compressor can be further simplified than those of the compressors according to the first to third embodiments in which the cam ring 1 is provided with the outlet holes 16 and the discharge valves each formed of a roll valve, whereby ease of assembling of the compressor is increased.

FIG. 12 is a longitudinal cross-sectional view of a vane compressor according to a fifth embodiment of the invention. Component parts and elements similar to those of the preceding embodiments are designated by identical reference numerals, and detailed description thereof will be omitted. Some component parts and elements including a discharge valve are not shown in the figure.

According to the embodiments described hereinabove, the movable plate 4, 33, 64 or 74 is arranged either in the front side member 25, 55 or 85 or in the rear side member 20, 50, 80 or 90, whereas in the fifth embodiment, movable plates 43 and 84 are used for both of a front side member 125 and a rear side member 100, respectively.

That is, in the fifth embodiment, the front-side member 125 is compressed of a front head 75 which is secured to a front-side end face 81a of a cam ring 81 and a movable plate (first movable plate) 43 which is held by the front head 75, in a state opposed to the front-side end face 81a of the cam ring 81, such that the movable plate 43 can be moved along the central axis of a drive shaft 7, while the rear-side member 100 is formed by a rear head 86 which is secured to a rear-side end face 81b of the cam ring 81 and a movable plate (second movable plate) 84 which is held by the rear head 86, in a state opposed to the rear-side end face 81b of the cam ring 81, such that the movable plate 84 can be moved along the central axis of the drive shaft 7.

The movable plate 43 has a central through hole through which the drive shaft 7 is loosely fitted. The movable plate 43 is received within a recess 75a formed in a cam ring-side end face of the front head 75 with an O ring 28 interposed between the movable plate 43 and the bottom of the recess 75a. The movable plate 43 is urged against the front-side end face of the cam ring 81 by the urging force of the O ring 28. A back pressure chamber 29 is defined by the O ring 28, the bottom of the recess 75a and a front-side end face of the movable plate 43. A suction chamber 91 and a pair of compression spaces 12 are separated by the movable plate 43.

The movable plate 43 has two inlet ports 43a formed in a manner corresponding to the two compression chambers 12 (only one of which is shown in 12). The suction chamber 91 communicates with the compression chambers 12 via the inlet ports 43a. Further, the movable plate 43 is formed with a high pressure-introducing hole 43b for introducing high pressure into the back pressure chamber 29 from a high pressure-introducing hole 81d, referred to hereinafter.

The rear head 86 is formed with a discharge port 86a through which a refrigerant gas is discharged, and the discharge port 86a communicates with a discharge chamber 110 formed within the rear head 86.

The movable plate 84 has a central through hole through which the drive shaft 7 is loosely fitted. The movable plate 84 is held by a rotor-side end face of a boss of the rear head 86 via an O ring 30. The movable plate 84 is urged against a rear-side end face 81b of the cam ring 81 by the urging force of the O ring 30.

The cam ring 81 has a pair of discharge spaces 48 (only one of which is shown in FIG. 12) formed therein in a manner corresponding to the two compression spaces 12. A partition wall 81c, which separates the discharge spaces 48 from the compression spaces 12, is formed with two outlet ports 16 (only one of which is shown in FIG. 12). The discharge spaces 48 communicate with a discharge chamber 110, and discharge valves, not shown, for opening/closing the respective outlet ports 16 are received in the discharge spaces 48. When the outlet ports 16 are open, the discharge spaces 48 communicate with the compression spaces 12. Further, the cam ring 81 is formed with a high pressure-introducing hole 81d for introducing high pressure into the high pressure-introducing hole 43b of the movable plate 43.

When the outlet ports 16 are open, the high-pressure refrigerant gas flows out of the compression chambers into the discharge spaces 48 via the outlet ports 16 and then pass through the discharge chamber 110, followed by being discharged from the discharge port 86a. Part of the high-pressure refrigerant gas which flows into the discharge spaces 48 is supplied to the back pressure chamber 29 via the high pressure-introducing holes 81d and 43b. A periphery of the movable plate 43 is urged against the front-side end face of the cam ring 81 by the high pressure within the back pressure chamber 29.

When the pressure within the compression chambers becomes abnormally high, the movable plates 43 and 84 are moved away from the rotor. As a result, there are created clearances between the rotor-side end face of the movable plate 43 and the front-side end face of the rotor 2 as well as between the rotor-side end face of the movable plate 84 and the rear-side end face of the rotor 2, whereby the high-pressure refrigerant leaks into the discharge chamber 110 and the back pressure chamber 29 through the clearances.

According to the vane compressor of the fifth embodiment, when an assembling bolt, not shown, is tightened to thereby secure the front head 75 to the front-side end face 81a of the cam ring 81, and the rear head 86 to the rear-side end face 81b of the same, neither of the movable plates 43 and 84, which are brought into sliding contact with the respective end faces of the rotor, is deformed, and pressure exerted on the sliding surfaces of the rotor 2 and those of the movable plates 43 and 84 does not increase. This makes it possible to prevent abrasion and seizure from occurring to the rotor 2 and the front and rear side members 100 and 125.

The back pressure chamber 29 is formed on the side of the movable plate 43 remote from the cam ring 81 in a manner surrounding the suction chamber 91, so that it is possible to prevent the movable plate 43 from being deformed such that the central portion thereof protrudes toward the rotor 2, when the movable plate 43 is urged against the rear-side end face 81a of the cam ring 81 by the high pressure within the back pressure chamber 29. This makes it possible to reduce abrasion of the rotor-side end face of the movable plate 43 and the front-side face end of the rotor 2 to thereby reduce possibility of seizure occurring to the two component parts of the compressor.

Further, the fifth embodiment is distinguished from the first embodiment, in which the vane compressor has the back pressure chamber 23 formed between the two O rings 21 and 22 mounted between the rear-side end face of the movable plate 4 and the rear head 6b, in that the back pressure chamber 29 is formed by the use of only one O ring 28. This contributes to reduction of manufacturing costs of the compressor.

FIG. 13 is a longitudinal cross-sectional view of a vane compressor according to a sixth embodiment of the invention, and FIG. 14 is an end view of a rear-side end face of a cam ring thereof. Component parts and elements similar to those of the preceding embodiments are designated by identical reference numerals, and detailed description thereof will be omitted.

In the sixth embodiment, four low pressure-introducing grooves 231, 232, 233 and 234 for preventing deformation of a movable plate 84 are formed in a movable plate-contact zone A (enclosed by a two-dot chain line designating the movable plate 84 in FIG. 14) of the rear-side end face 101b of the cam ring 101, with which the movable plate 84 is brought into contact, such that they are circumferentially located along an inner periphery of the cam ring 101. The low pressure-introducing grooves 231 and 233 and the low pressure-introducing grooves 232 and 234 are formed at diametrically opposite locations of the zone A of the cam ring 101.

The low pressure-introducing grooves 231 and 233 are communicated with compression chambers during the suction stroke, and a low-pressure refrigerant is introduced into the low pressure-introducing grooves 231 and 233.

On the other hand, the low pressure-introducing grooves 232 and 234 are communicated with a suction chamber 111 formed in a front side of the compressor, via passages 235 and 236 formed in the cam ring 101. Neither of the low pressure-introducing grooves 231 and 233 is communicated with the compression chambers.

The four low pressure-introducing grooves 231 to 234 are blocked by the front-side end face of the movable plate 84 respectively as shown by the two-dot chain line in FIG. 14, so that four chambers are formed by the low pressure-introducing grooves 231 to 233 and the movable plate 84.

FIGS. 16 and 17 are conceptual views useful in explaining the relationship between a cam ring and a movable plate.

The FIG. 16 and FIG. 17 vane compressors both have an inner space of a cam ring 81 or 101 and a discharge chamber 110 separated by a movable plate 84. A pressure within the discharge chamber 110 is higher than a pressure within the cam ring 81 or 101, so that the movable plate 84 is pressed against a movable plate-contact zone A in a rear-side end face 81b or 101b of the cam ring 81 or 101. There is a very small clearance between the movable plate 84 and the zone A in the rear-side end face 81b of the cam ring 81, so that according to the 16 vane compressor, high pressure is applied to both end faces of the movable plate 84 in a manner balanced in pressure level, whereby force urging the outer periphery of the movable plate 84 toward the cam ring 81 is canceled. As a result, as shown in FIG. 16 (b), the movable plate 84 is deformed (central portion thereof protrudes toward the cam ring 81 to form a convexity). This can cause leakage of a refrigerant from compression chambers, which degrades performance of the compressor, or fluttering of the movable plate 84, which makes untoward noises.

On the other hand, according to the FIG. 17 vane compressor of the present embodiment, four low pressure-introducing grooves 231 to 234 are formed in the movable plate-contact zone A of the rear-side end face 101b of the cam ring 101, such that they are circumferentially located along the inner periphery of the cam ring 101, so that high pressure is applied to a high-pressure chamber-side end face of the movable plate 84 and low pressure is applied to a cam ring contact area of the cam ring-side end face of the same. Since there is a difference between the two pressures, the urging force is exerted on the periphery of the movable plate 84 as shown in FIG. 17 (b), whereby the amount of deformation of the movable plate 84 is largely reduced. The relationship between an amount of protrusion Δd_1 (lateral distance between the rear-side end face of the cam ring and the center of the cam ring-side end face of the deformed movable plate 84) of the central portion of the movable plate 84 of the FIG. 16 vane compressor and an amount of protrusion Δd_2 of the central portion of the movable plate 84 of the FIG. 17 vane compressor is expressed as follows:

$$\Delta d_1 \gg \Delta d_2$$

According to the FIG. 17 vane compressor, the amount of deformation of the movable plate 84 is largely reduced, and hence leakage of the refrigerant from the compression chambers is decreased, whereby it is possible to prevent the performance of the compressor from being degraded as well as to prevent noises from being made due to fluttering of the movable plate 84.

Further, in the vane compressor of the present embodiment, a rear head 86 is formed with a high pressure-introducing passage 86c for introducing a high-pressure refrigerant from the discharge chamber 110 into a bearing-receiving chamber 150 which receives therein a bearing 9 supporting a rear-side end of a drive shaft 7, and a high-pressure passage 84a is formed in the central portion of the movable plate 84 for supplying the high-pressure refrigerant from the bearing-receiving chamber 150 to the bottom of each vane slit 13.

Therefore, at the start of the compressor, the high-pressure refrigerant is supplied to the bottom of each vane slit 13 not only through a clearance between the movable plate 84 and the rotor 2, but also by way of the high pressure-introducing passage 86c, the bearing-receiving chamber 150 and the high-pressure passage 84a. This enables each vane 14 to project out more easily to thereby enhance starting characteristics of the compressor.

FIG. 15 is an end view of a cam ring-side end face of a front head of the embodiment.

According to the vane compressor of the embodiment, a front-side member 135 is formed by a front head 105 alone. A cam ring-side end face 105a of the front head 105 has a sliding surface 151, on which slide a front-side end face of the rotor 2 and front-side end faces of the vanes 14, with a suction chamber 111 opens in the cam ring-side end face 105a in a fashion surrounding the periphery of the sliding surface 151, and an O ring groove 105b formed on the cam ring-side end face 105a thereof such that it extends around the suction chamber 111. The sliding surface 151 is formed with inlet ports 152 and 153 at diametrically opposite locations thereof for supplying low-pressure refrigerant gas to the compression chambers during the suction stroke.

Since the suction chamber 111 is formed in the front head 105 such that it opens in the cam ring-side end face of the front head 105 in a fashion extending around the periphery of the sliding surface 151 to form an annular shape, and further the inlet ports 152 and 153 are formed in the sliding surface 151, the front-side member 125 can be formed by the front head 105 alone, whereby the cam ring-side end face of the front head 105 can be secured directly to the front-side end face 101a of the cam ring 101.

Therefore, the front-side member 135 conventionally formed by a front head and a front side block is formed by a single component (front head 105) as a unitized member of the front head and the front side block, so that it is possible to reduce the number of component parts of the compressor and at the same time increase capacity of the suction chamber 111, whereby low-pressure pulsation is reduced.

Although in the above embodiment, the low pressure-introducing grooves 231 to 234 are formed in the cam ring 101, this is not limitative, but in another embodiment, low pressure-introducing grooves may be formed in a cam ring-contact zone of the cam ring-side end face of the movable plate 84, where the movable plate 84 is in contact with the cam ring 101. This embodiment can provide the same advantageous effects as obtained by the above embodiment.

FIG. 18 is a longitudinal cross-sectional view of a vane compressor according to a seventh embodiment of the invention. Component parts and elements similar to those of the preceding embodiments are designated by identical reference numerals, and detailed description thereof will be omitted.

In this embodiment, an O ring 154 of a smaller diameter and another O ring 155 of a larger diameter are mounted between a movable plate 204 and a rotor-side end face 186a of a central portion of a rear head 186. The movable plate 204 is urged against a rear-side end face 101b of a cam ring 101 by the urging forces of the O rings 154 and 155. The two O rings 154 and 155 form therebetween a low pressure-introducing chamber 156 into which a low-pressure refrigerant is introduced from compression chambers during the suction stroke via a low pressure-introducing passage 204a formed in the movable plate 204.

The FIG. 18 vane compressor has the low pressure-introducing chamber 156 formed between a high-pressure chamber-side end face of the central portion of the movable plate 204 and the rotor-side end face 186a of the central portion of the rear head 186, so that low pressure is applied to the high-pressure chamber-side end face of the central portion of the movable plate 204 while high pressure is applied to a cam ring-side end face of the central portion of the same. This causes a difference between the pressures exerted on the two sides of the movable plate 204. As a result, the central portion of the movable plate 204 is prevented from protruding toward the front side of the compressor, and the amount of deformation of the movable plate 204 is reduced.

FIG. 19 is a longitudinal cross-sectional view of a vane compressor according to an eighth embodiment of the invention. FIG. 20 shows a cam ring-side end face of a cylinder head with a movable plate mounted therein, while FIG. 21 shows the cam ring-side end face of the cylinder head with the movable plate removed therefrom. Component parts and elements similar to those of the preceding embodiments are designated by identical reference numerals, and detailed description thereof will be omitted.

In this embodiment, a front-side member 425 is comprised of a front head 305 which is secured to a front-side end face 101a of a cam ring 101, and a movable plate 343 which is held by the front head 305, in a state opposed to the front-side end face 101a of the cam ring 101, such that the movable plate 343 can be moved along the central axis of a drive shaft 7. A suction chamber 311 and compression spaces 12 are separated by the movable plate 343.

The movable plate 343 has a central through hole through which the drive shaft 7 is loosely fitted. The movable plate 343 is received in a recess 305a formed in a cam ring-side end face of the front head 305, with an O ring 355 of a larger diameter and another O ring 354 of a smaller diameter interposed between the movable plate 343 and the bottom of the recess 305a. The movable plate 343 is urged against the front-side end face of the cam ring 101 by the urging forces of the O rings 354 and 355. The O rings 354 and 355 are mounted in O ring grooves 364 and 365 (see FIG. 21) formed in the recess 305a, respectively, and a back pressure chamber 356 is formed between the O rings 354 and 355. A high-pressure refrigerant is introduced from discharge spaces 48 to the back pressure chamber 356 via a high pressure-introducing passage 343b formed in the movable plate 343.

A pair of inlet ports 343a are formed through the movable plate 443 at diametrically opposite locations in a manner corresponding to two compression spaces 12, 12 (only one of which is shown in FIG. 19) respectively (see FIG. 20). A suction chamber 311 communicates with the compression spaces 12 via the inlet ports 343a.

The two discharge spaces 48, 48 (only one of which is shown in FIG. 19) are formed in the cam ring 101 in a manner corresponding to the two compression spaces 12, 12 respectively, and two pairs of outlet ports 16 (only one pair of which is shown in FIG. 19) are formed through a partition wall 101c of the cam ring 101 which separates the discharge spaces 48 from the compression spaces 12. The discharge spaces 48 communicate with the discharge chamber 110, and accommodate discharge valves, not shown, for opening/closing the refrigerant outlet port 16, respectively. When the outlet ports 16 open, the discharge spaces 48 communicate with compression chambers. Further, the cam ring 101 is formed with a high pressure-introducing hole 101d for introducing a high-pressure refrigerant from one of the discharge spaces 48 to the high pressure-introducing hole 343b of the movable plate 343.

When the outlet ports 16 open, the high-pressure refrigerant gas flows out of the compression chambers into the discharge spaces 48 via the outlet ports 16, and then after passing through the discharge chamber 110, it is discharged from a discharge port 86a. Part of the high-pressure refrigerant gas which has flowed into the discharge spaces 48 is supplied to the back pressure chamber 356 through the high pressure-introducing holes 101d and 343b. A peripheral portion of the movable plate 343 is urged against the front-side end face 101a of the cam ring 101 by the high pressure within the back pressure chamber 356.

When the pressure within the compression chambers becomes abnormally high, the movable plates 343 and 84 are moved away from the rotor side to create clearances between a rotor-side end face of the movable plate 343 and a front-side end face of the rotor 2 and between a rotor-side end face of the movable plate 84 and a rear-side end face of the rotor 2, through which the high-pressure refrigerant leaks into the discharge chamber 110 and the back pressure chamber 356.

According to the vane compressor of the present embodiment, when an assembling bolt, not shown, is fastened to thereby secure the front head 305 to the front-side end face 101a of the cam ring 101, and the rear head 86 to the other end face 101b of the cam ring, neither of the movable plates 343 and 84 which are brought into contact with the end faces of the rotor 2, is deformed, and pressures acting on the sliding surfaces of the rotor 2 and the movable plates 343 and 84 do not increase. This makes it possible to prevent abrasion and seizure from occurring between the rotor 2 and the side members 425 and 1100.

Further, since the back pressure chamber 356 is formed on the side of the movable plates 343 remote from the cam ring in a fashion enclosing the suction chamber 311, so that when the movable plate 343 is urged against the front-side end face 101a of the cam ring 101 by the high-pressure within the back pressure chamber 356, the movable plate 343 is not deformed such that the central portion thereof protrudes toward the rotor 2 from the periphery thereof. This makes it possible to reduce abrasion of the rotor-side end face of the movable plate 343 and the front-side end face of the rotor 2 to thereby reduce wear and possibility of occurrence of seizure between the rotor-side end face of the movable plate 343 and the front side end face of the rotor 2.

Still further, since the movable plate 343 is formed with the inlet ports 343a, it is possible to easily cape with changes in suction characteristics simply by replacing the movable plate 343 by another. That is, differently from the case in which inlet ports are formed in a cam ring or a side block, it is not required to remodel the compressor, but the compressor can be redesigned simply by replacing the movable plate 343 thereof with another movable plate 343 formed with inlet ports 343a each cut into a different shape from the older one.

Industrial Applicability

As described in detail heretofore, the vane compressor according to the present invention is useful as a refrigerant compressor to be employed in an air conditioning system for an automotive vehicle.

Claims

1. A vane compressor including a rotor secured on a drive shaft and rotatably received within a cam ring, vanes slidably received within a plurality of vane slits formed in said rotor, respectively, a front-side member arranged on a front side of said cam ring, a rear-side member arranged on a rear side of said cam ring, and a high-pressure chamber formed in an interior of one of said front-side member and said rear-side member, characterized in that at least one of said front-side member and said rear-side member comprises a head which is secured to one end face of said cam ring, and a movable plate which is held by said head, in a state opposed to said one end face of said cam ring, and at the same time movable along a central axis of said drive shaft.

2. A vane compressor according to claim 1, wherein said movable plate separates compression chambers formed between said vanes from said high-pressure chamber.

3. A vane compressor according to claim 2, wherein said at least one of said front-side member and said rear-side member is said rear-side member.

4. A vane compressor according to claim 2 or 3, wherein said movable plate is formed with outlet holes for directly communicating said compression chambers with said high-pressure chamber, and discharge valves provided for opening/closing said outlet holes, respectively.

5. A vane compressor according to claim 4, wherein said rotor is formed with discharge-promoting grooves for communicating said outlet holes with said compression chambers immediately before each of said vanes is brought into a position most retracted into its vane slit.

6. A vane compressor according to any one of claims 1 to 5, including an elastic member for urging said movable plate toward said rotor.

7. A vane compressor including a rotor secured on a drive shaft and rotatably received within a cam ring, vanes slidably received within a plurality of vane slits formed in said rotor, a front-side member arranged on a front side of said cam ring, a rear-side member arranged on a rear side of said cam ring, and a low-pressure chamber formed in an interior of one of said front-side member and said rear-side member, characterized in that said front-side member comprises a front head which is secured to a front-side end face of said cam ring and a first movable plate which is held by said front head, in a state opposed to said front-side end face of said cam ring and at the same time movable along a central axis of said drive shaft, and said rear side member comprises a rear head which is secured to a rear-side end face of said cam ring, and a second movable plate which is held by said rear head, in a state opposed to said rear-side end face of said cam ring and at the same time movable along said central axis of said drive shaft.

8. A vane compressor according to claim 7, wherein

one of said first and second movable plate separates said compression chambers formed between said vanes from said low-pressure chamber, and a back pressure chamber into which high pressure is introduced is formed on a side of said one of said first movable plate and said second movable plate remote from said cam ring in a fashion surrounding said low-pressure chamber.

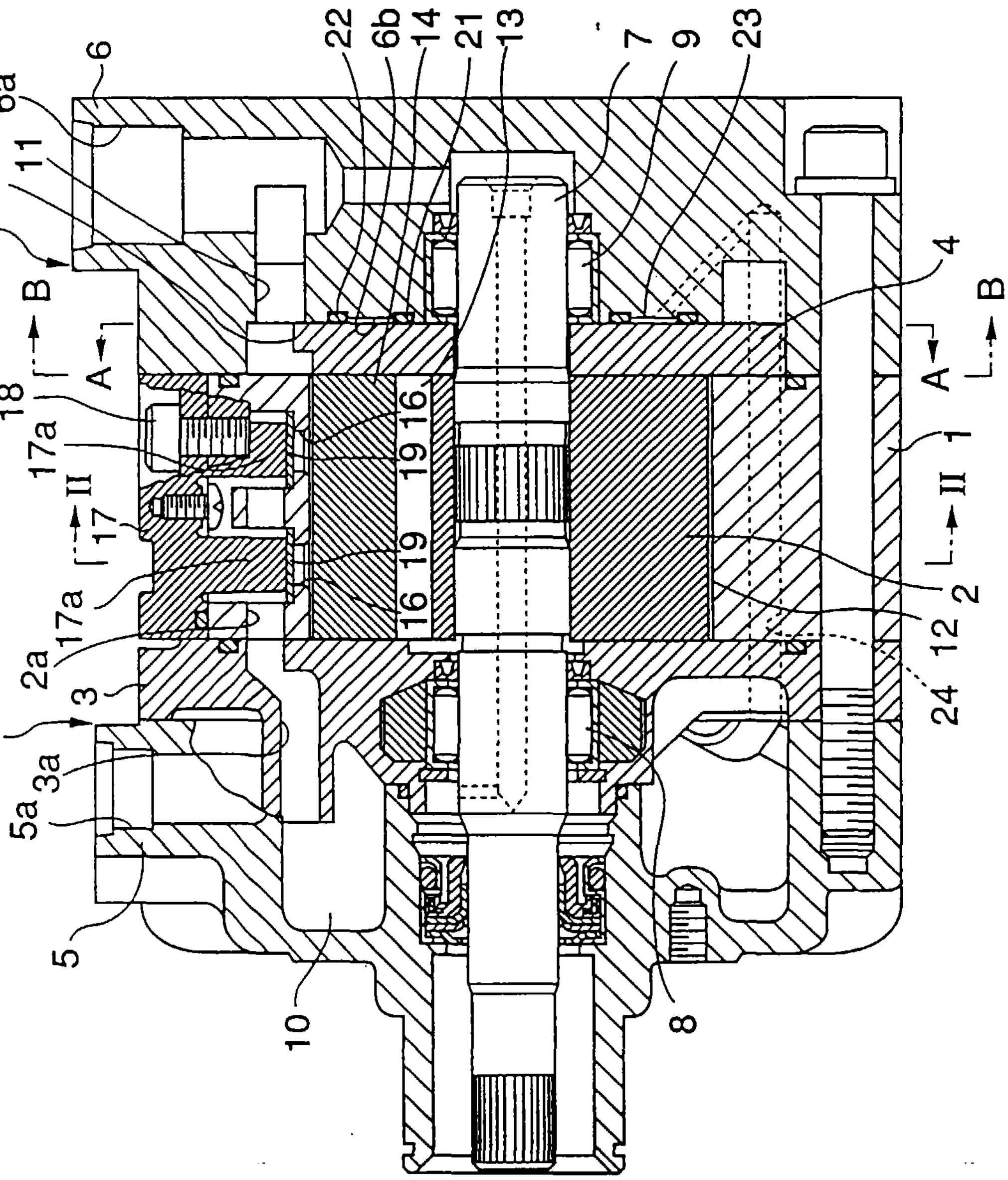
9. A vane compressor according to claim 2, wherein low pressure-introducing grooves are formed in a movable plate-contact zone of a high-pressure chamber-side end face of said cam ring, where said movable plate is in contact with said cam ring, in a manner such that said low pressure-introducing grooves extend along an inner periphery of said cam ring.

10. A vane compressor according to claim 2, wherein low pressure-introducing grooves are formed in a cam ring-contact zone of a cam ring-side end face of said movable plate, where said movable plate is in contact with said cam ring, in a manner such that said low pressure-introducing grooves extend along an inner periphery of said cam ring.

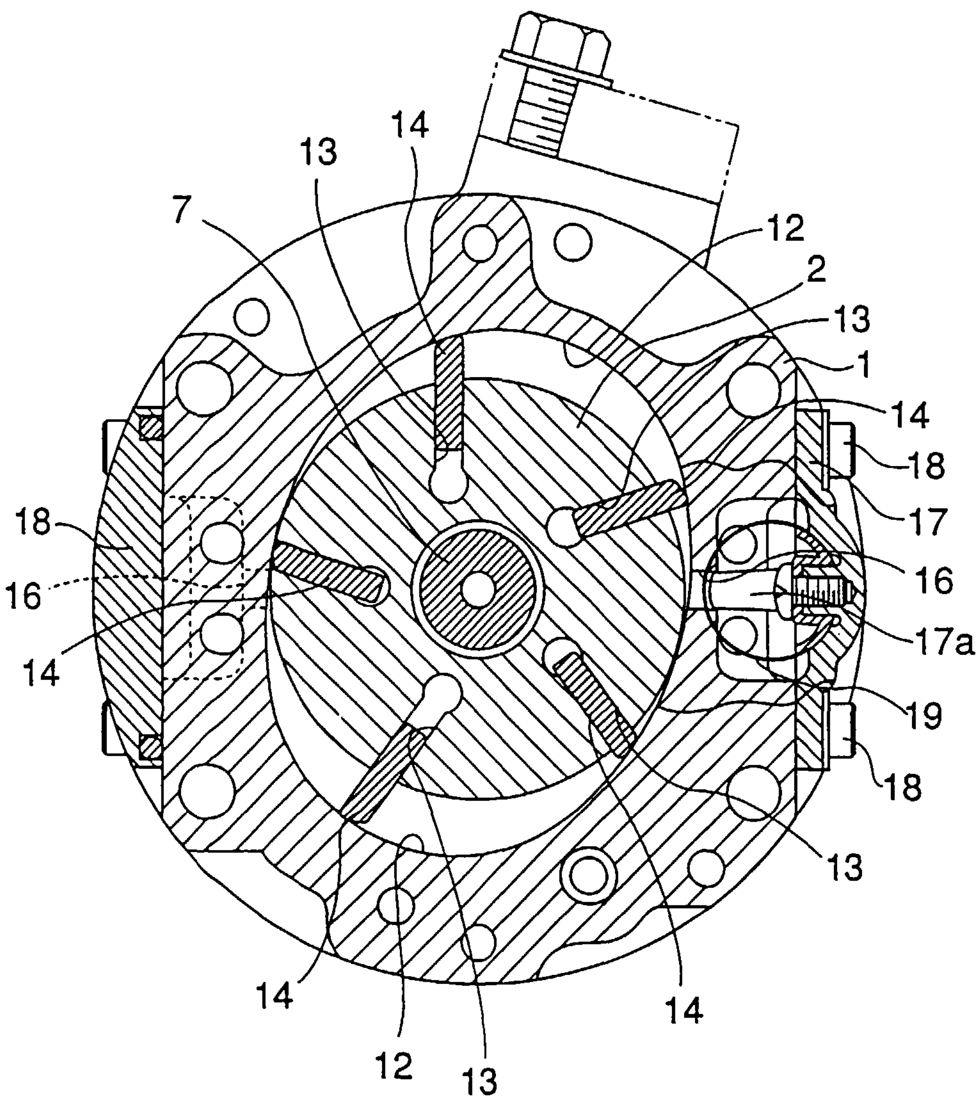
11. A vane compressor according to claim 9 or 10, wherein said low pressure-introducing grooves communicate with said compression chambers during a suction stroke.

12. A vane compressor according to claim 9 or 10, wherein said low pressure-introducing grooves communicate with a low-pressure chamber in which is stored a low-pressure working fluid to be fed to said compression chambers.

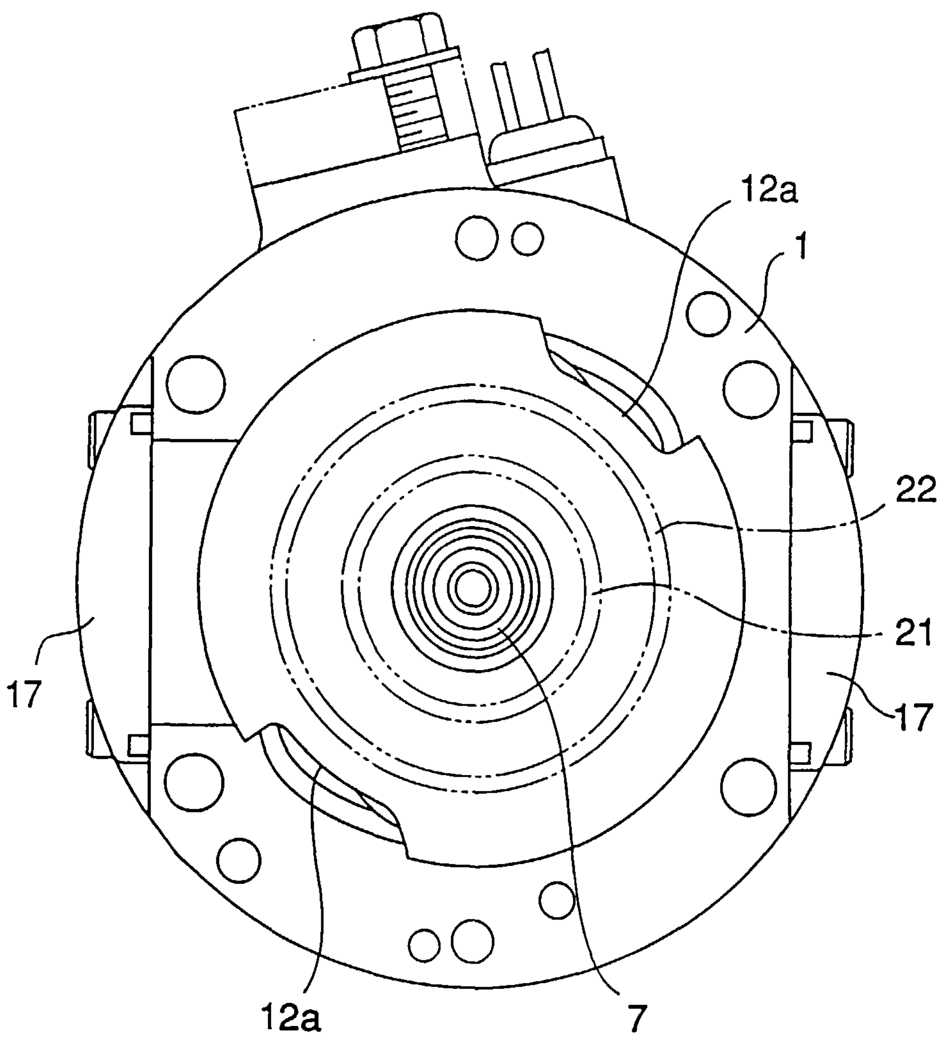
FIG. 1



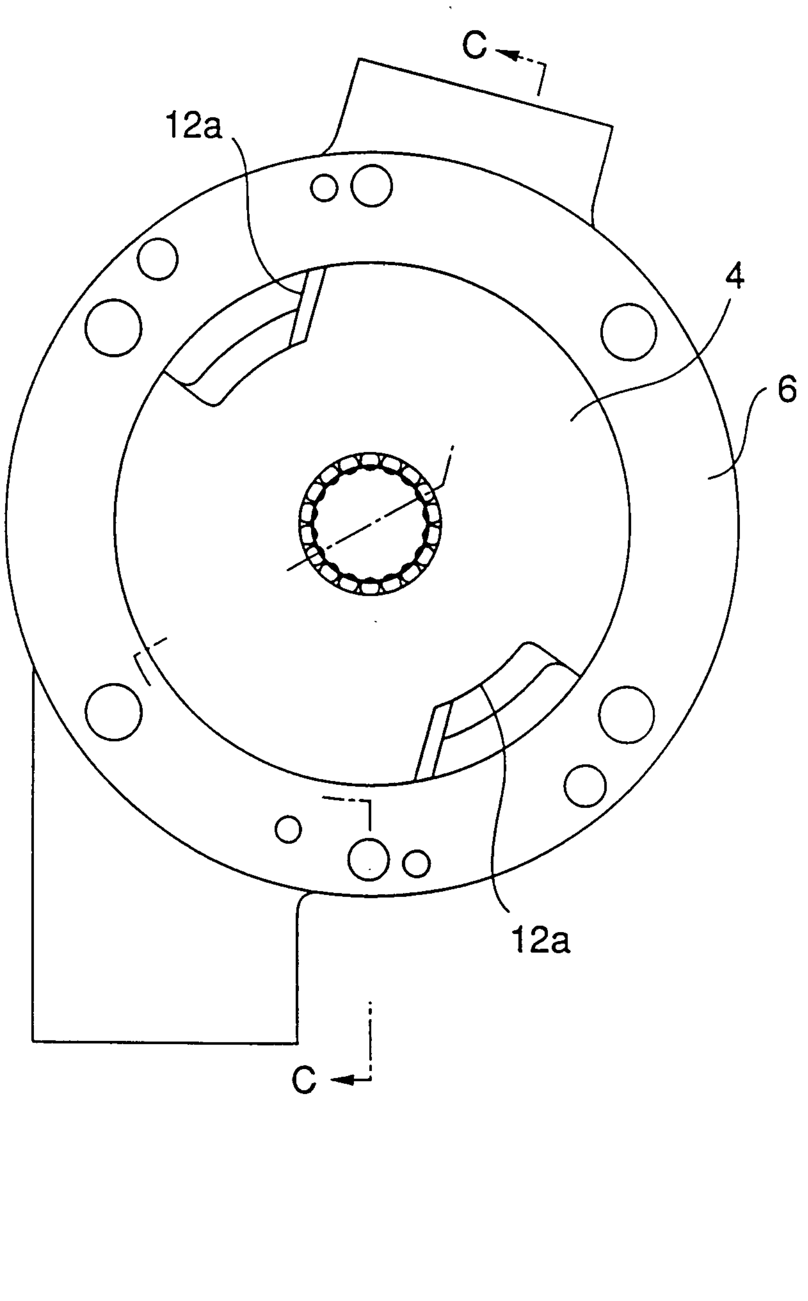
F I G 2



F I G 3



F I G 4



F I G 5

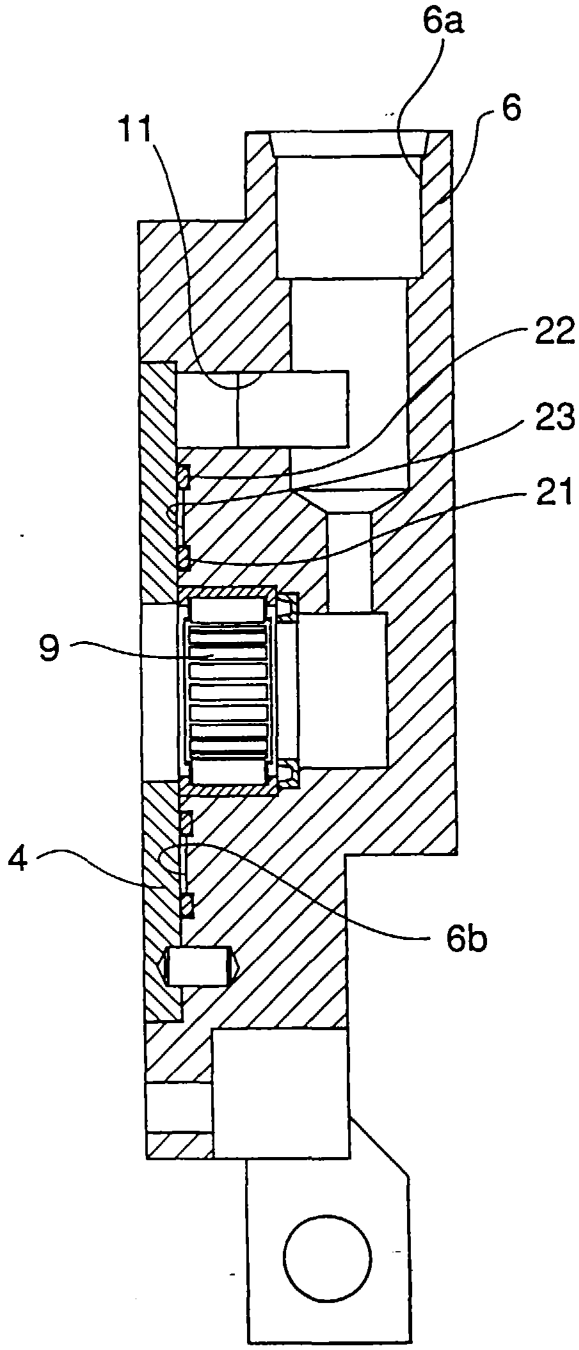
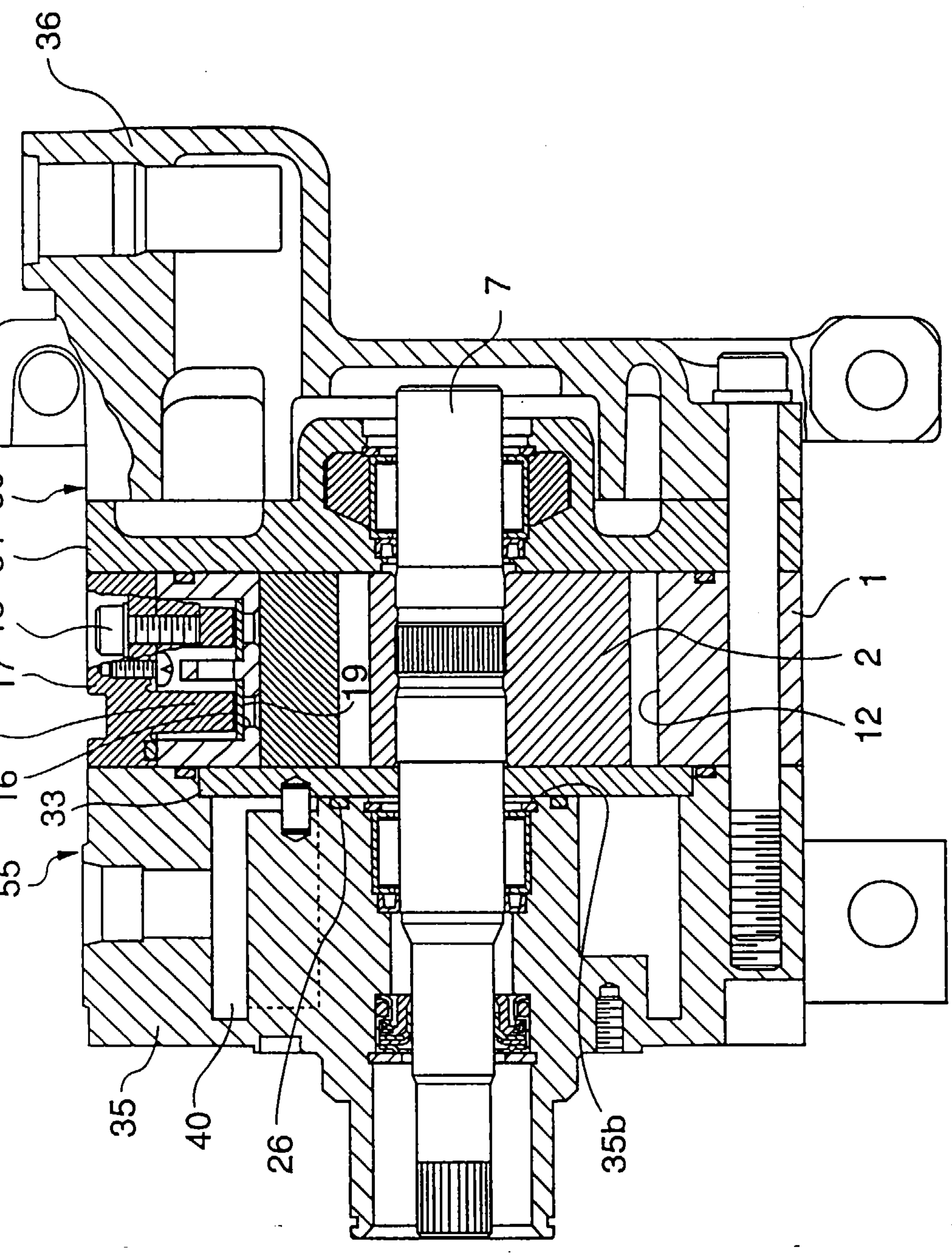


FIG 6



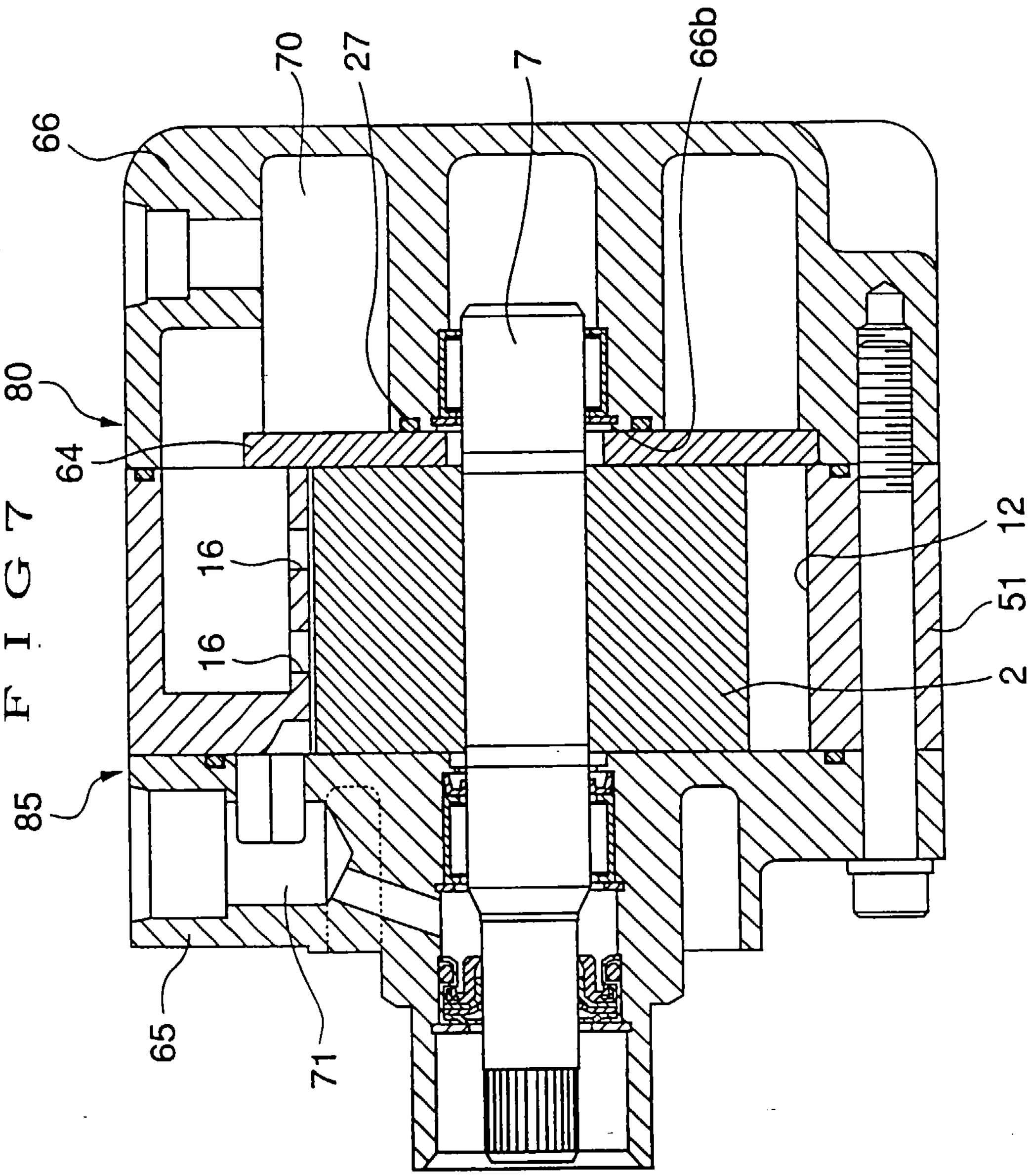
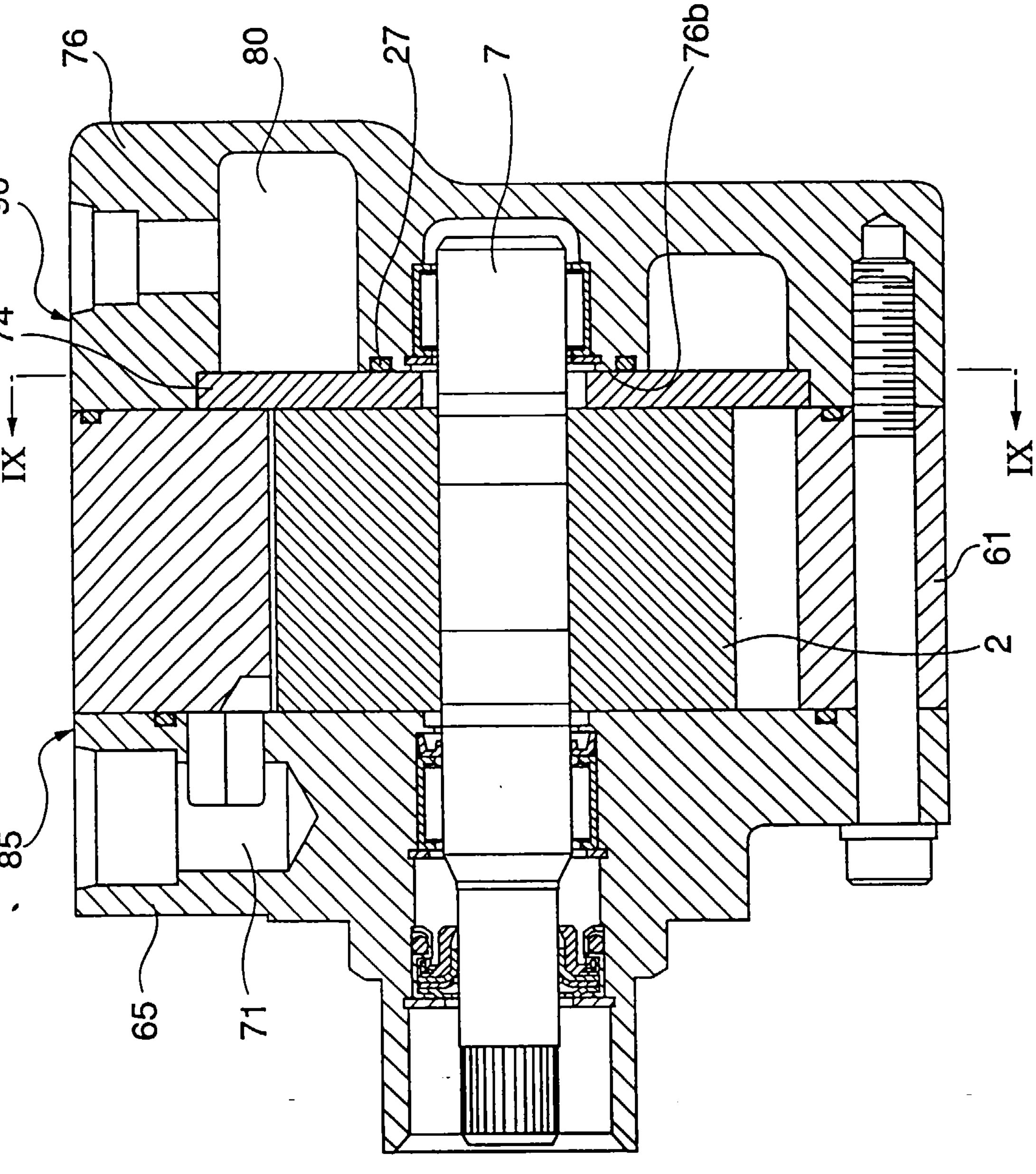
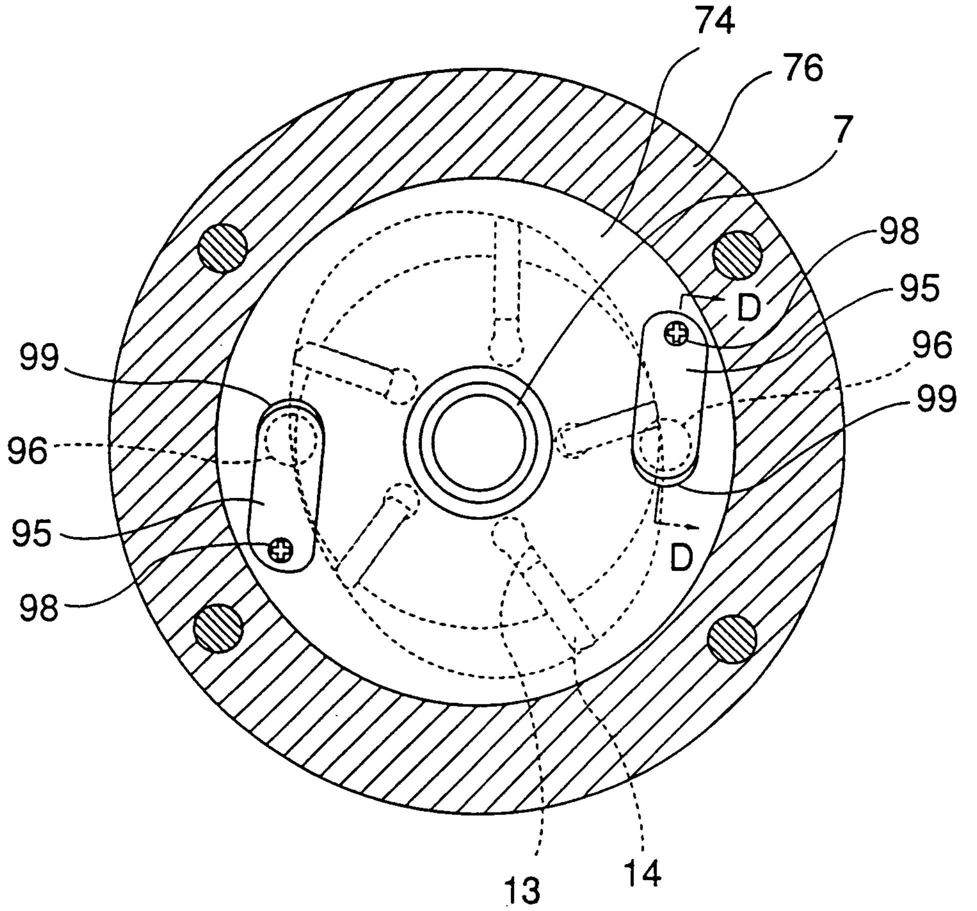


FIG 7

FIG 8



F I G 9



F I G 1 0

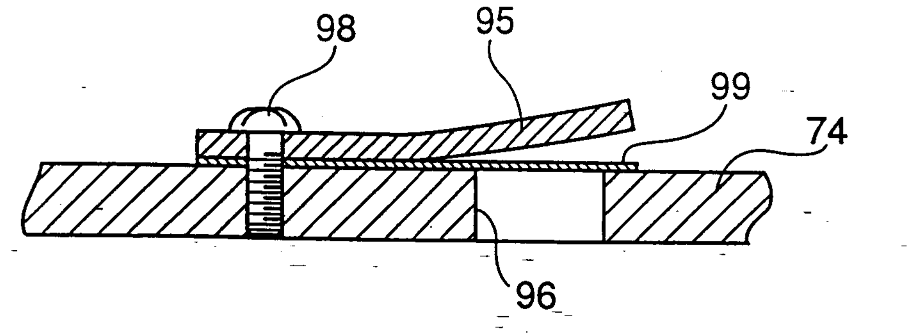


FIG11

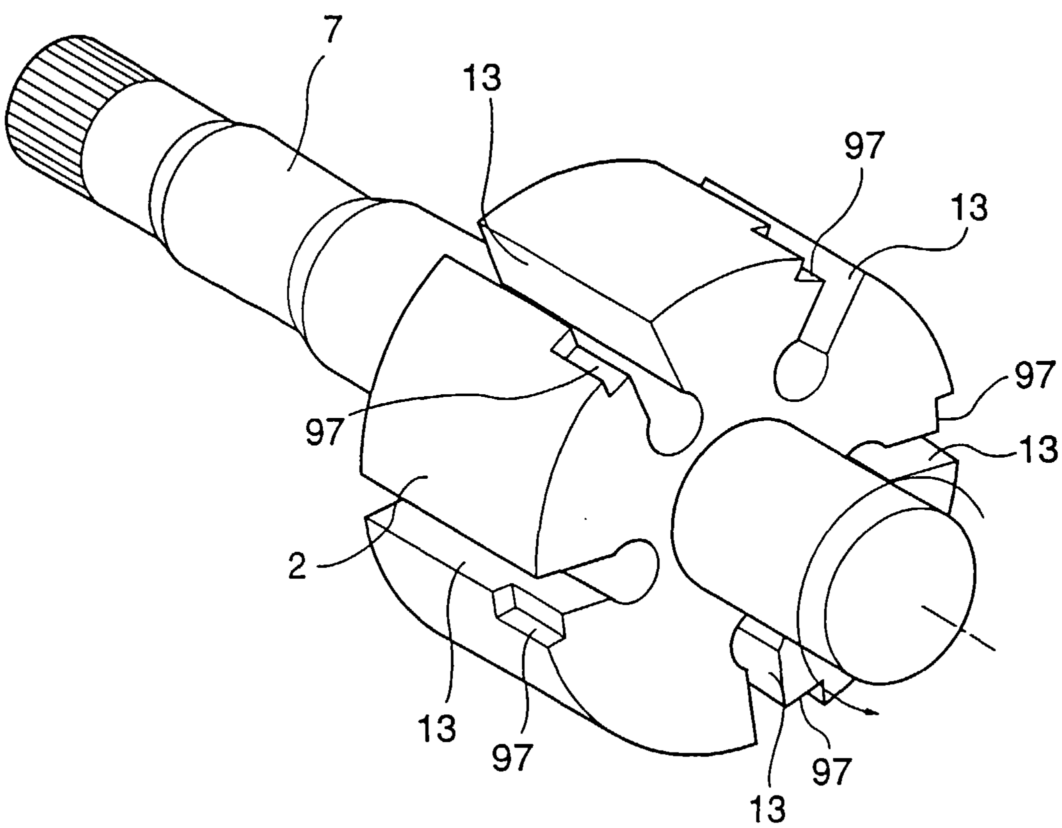


FIG12

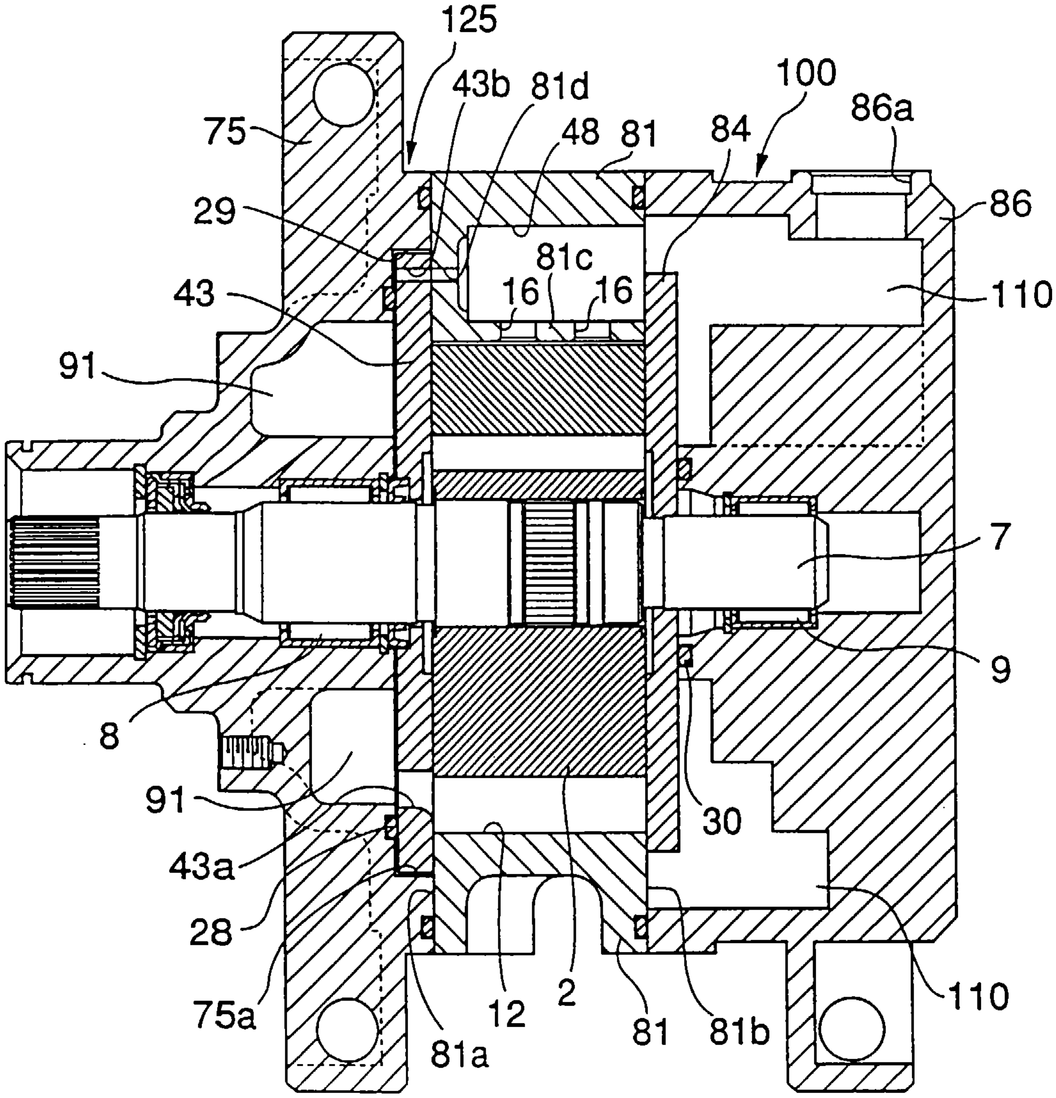
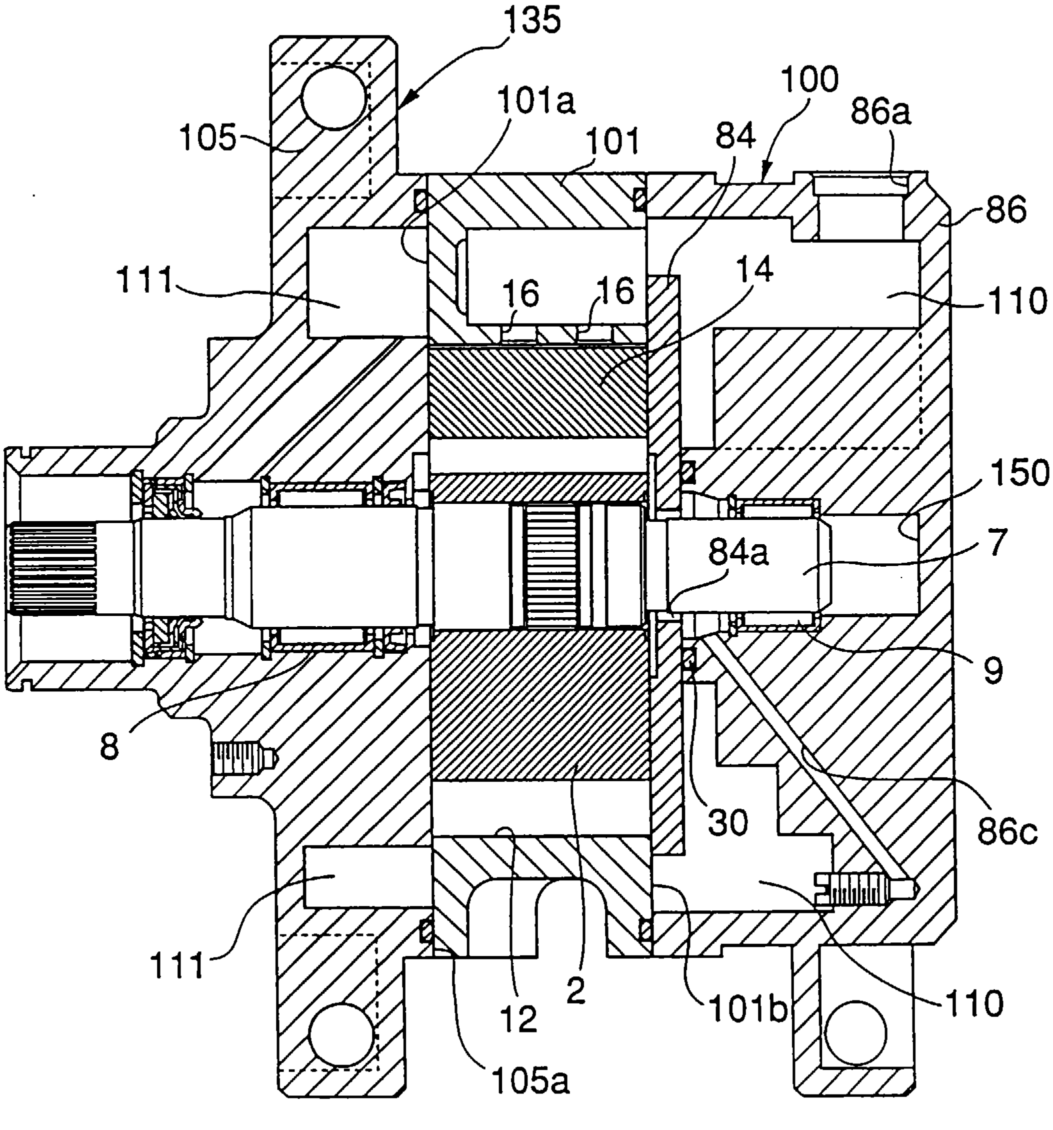

125
43b
81d
100
86a
75
48
81
84
86
29
81c
16
16
110
43
91
7
9
8
91
30
43a
28
110
75a
12
2
81
81b
81a

FIG13


135
101a
100
86a
105
101
84
86
111
16
16
14
110
150
84a
7
9
8
30
86c
111
12
2
101b
110
105a

F I G 1 4

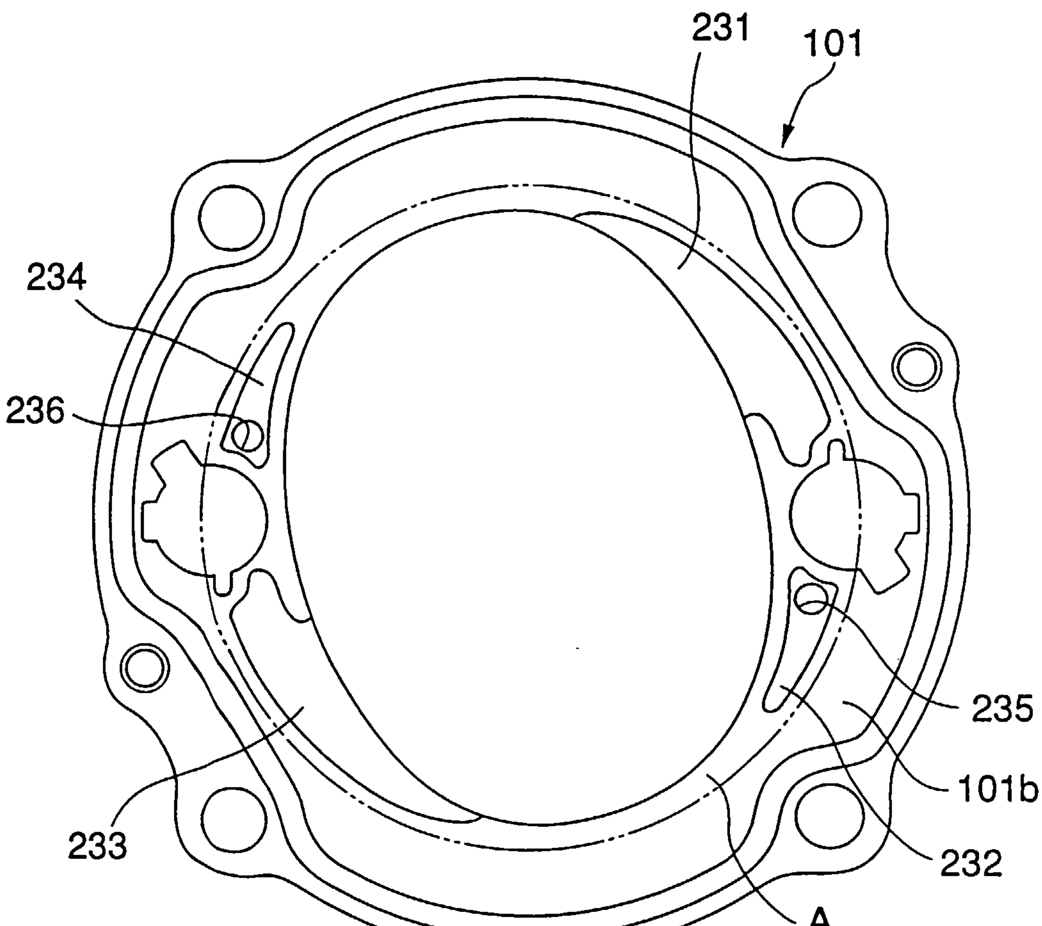


FIG15

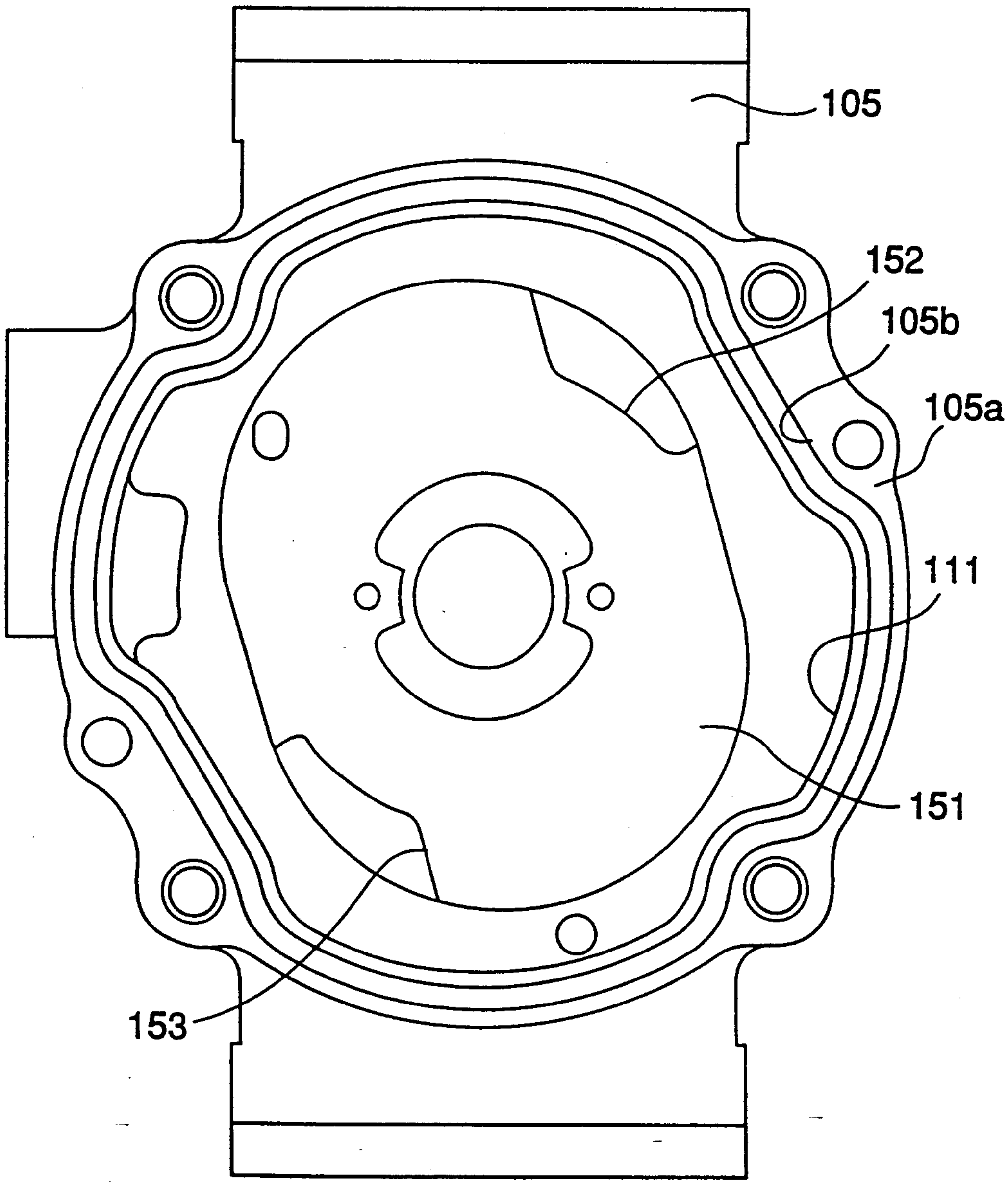


FIG16

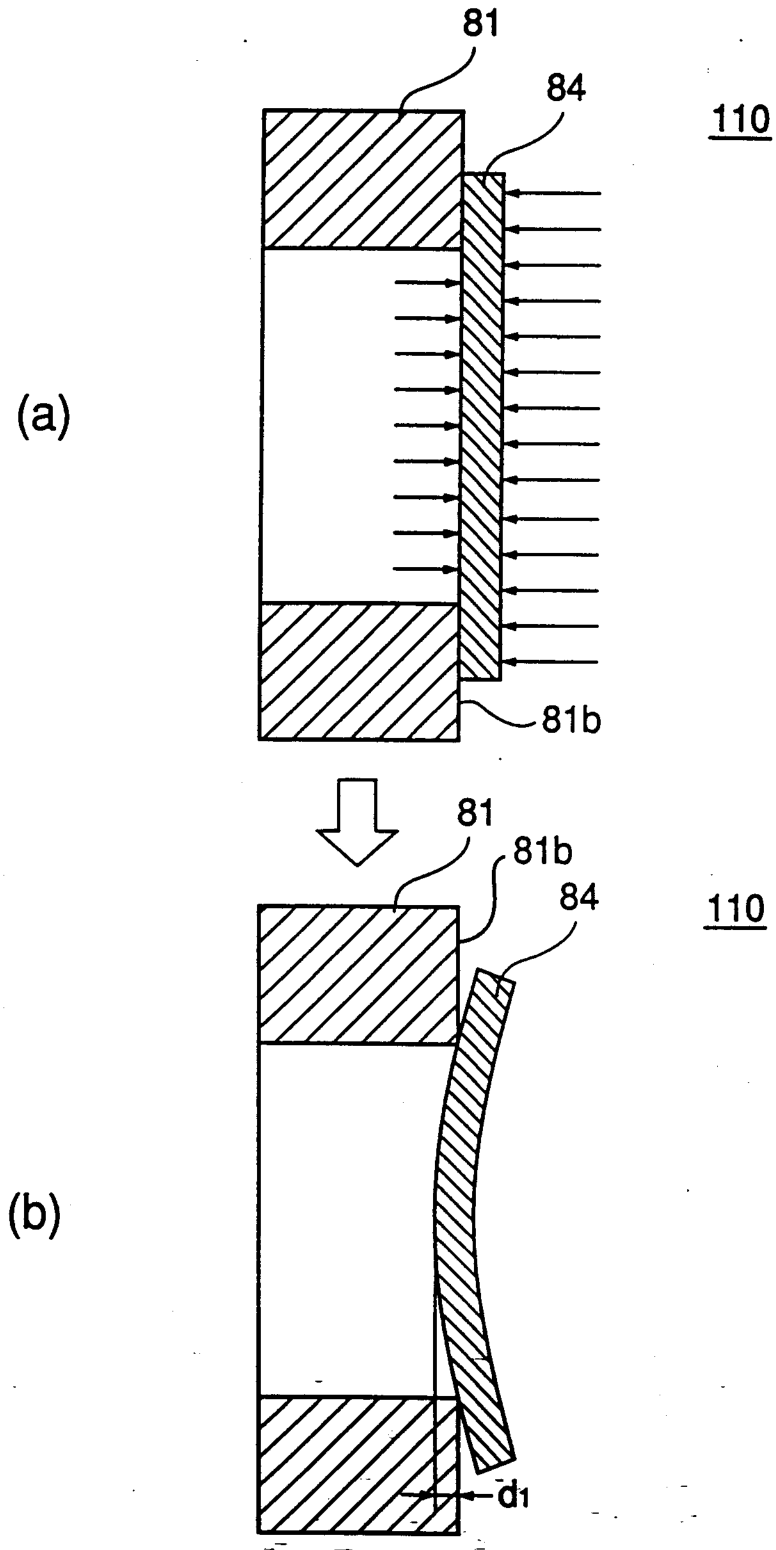
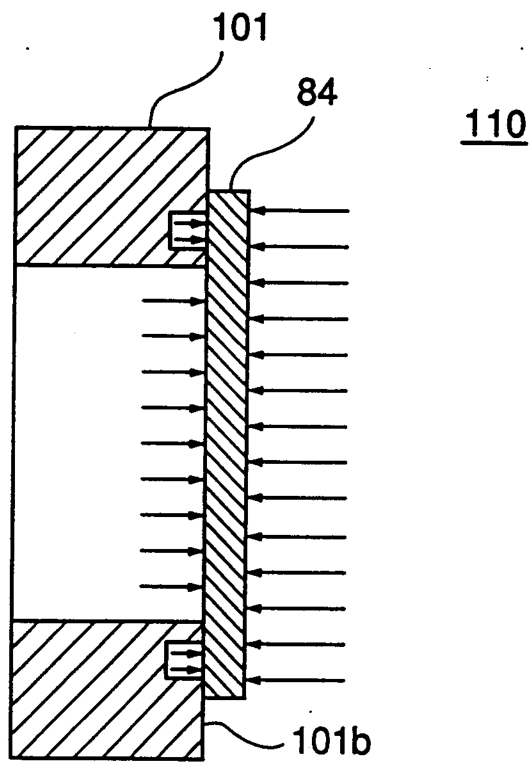
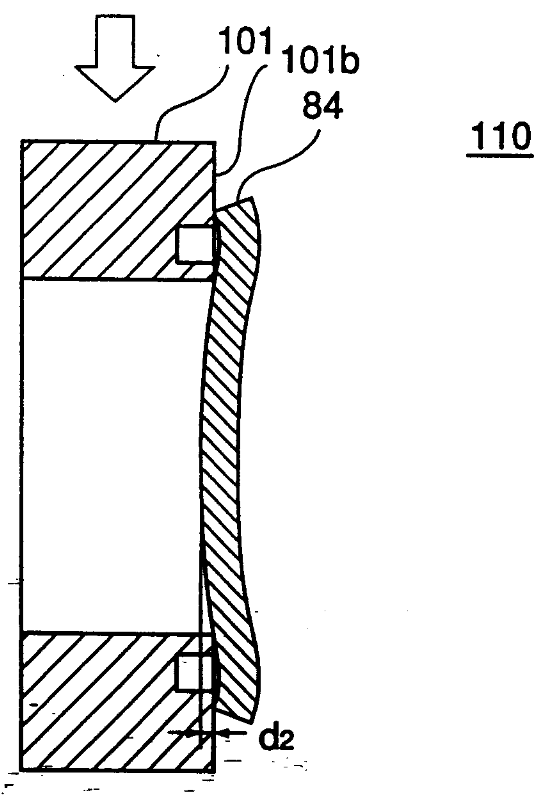


FIG17

(a)



(b)



F I G 1 8

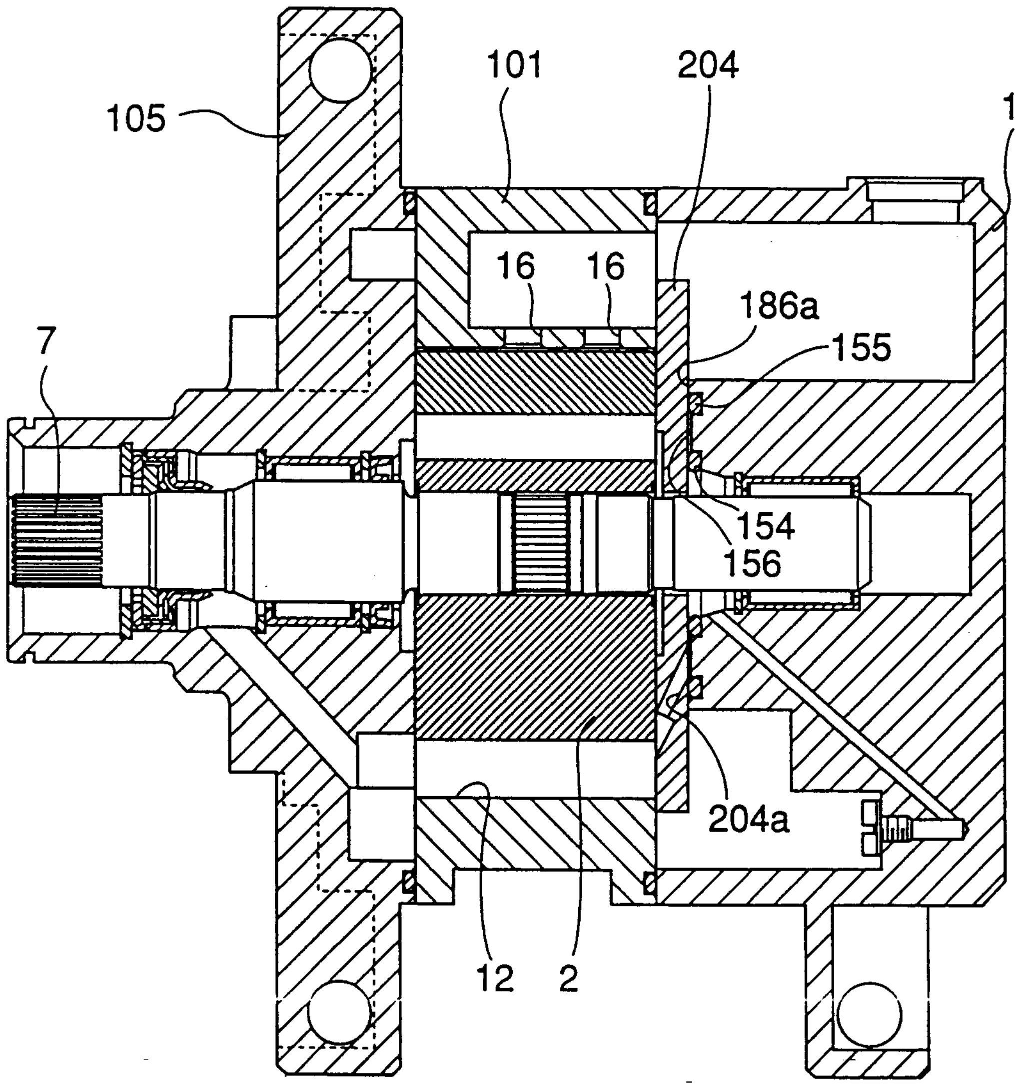
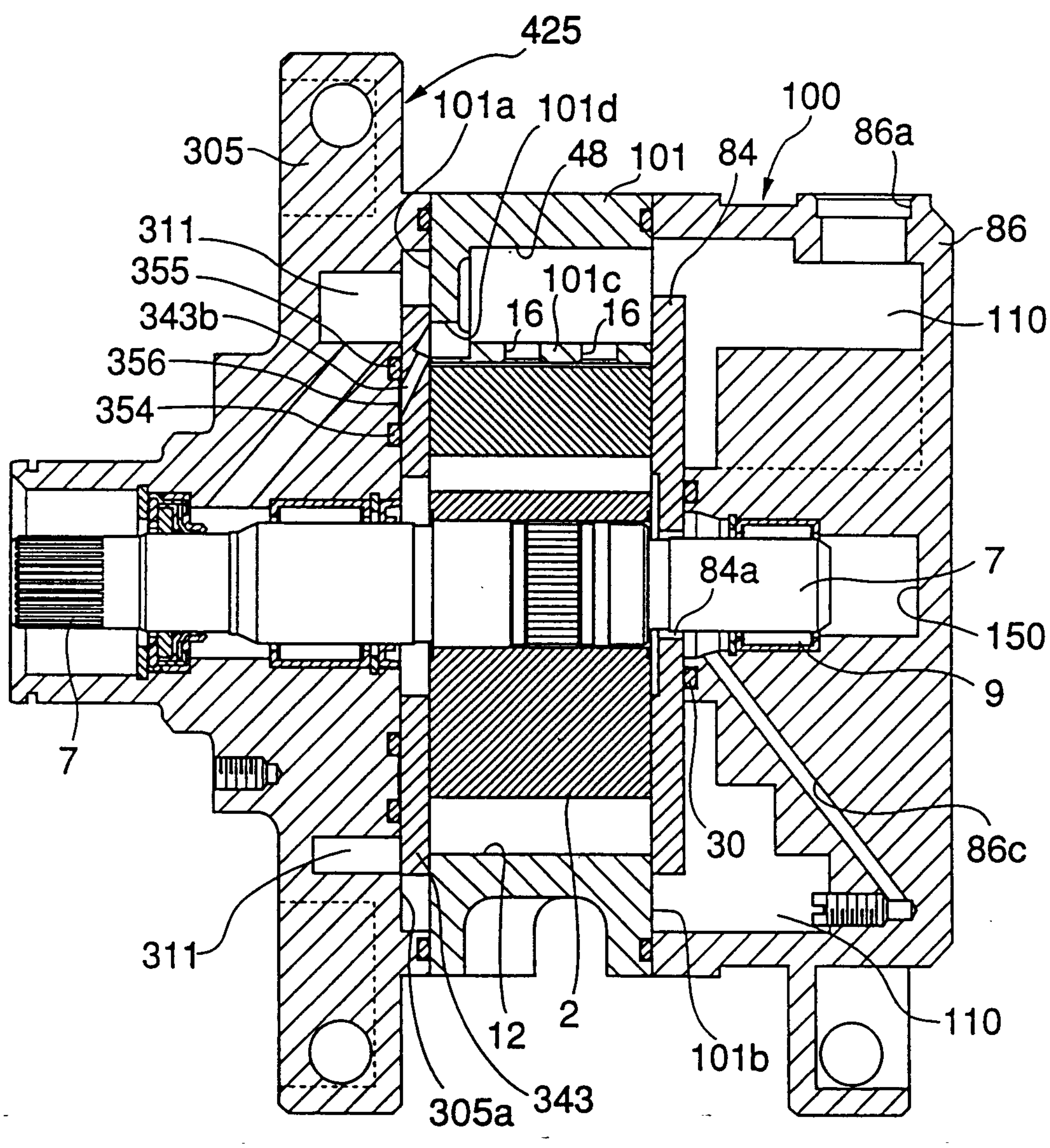


FIG19


425
101a
101d
100
86a
305
48
101
84
311
86
355
101c
343b
16
16
110
356
354
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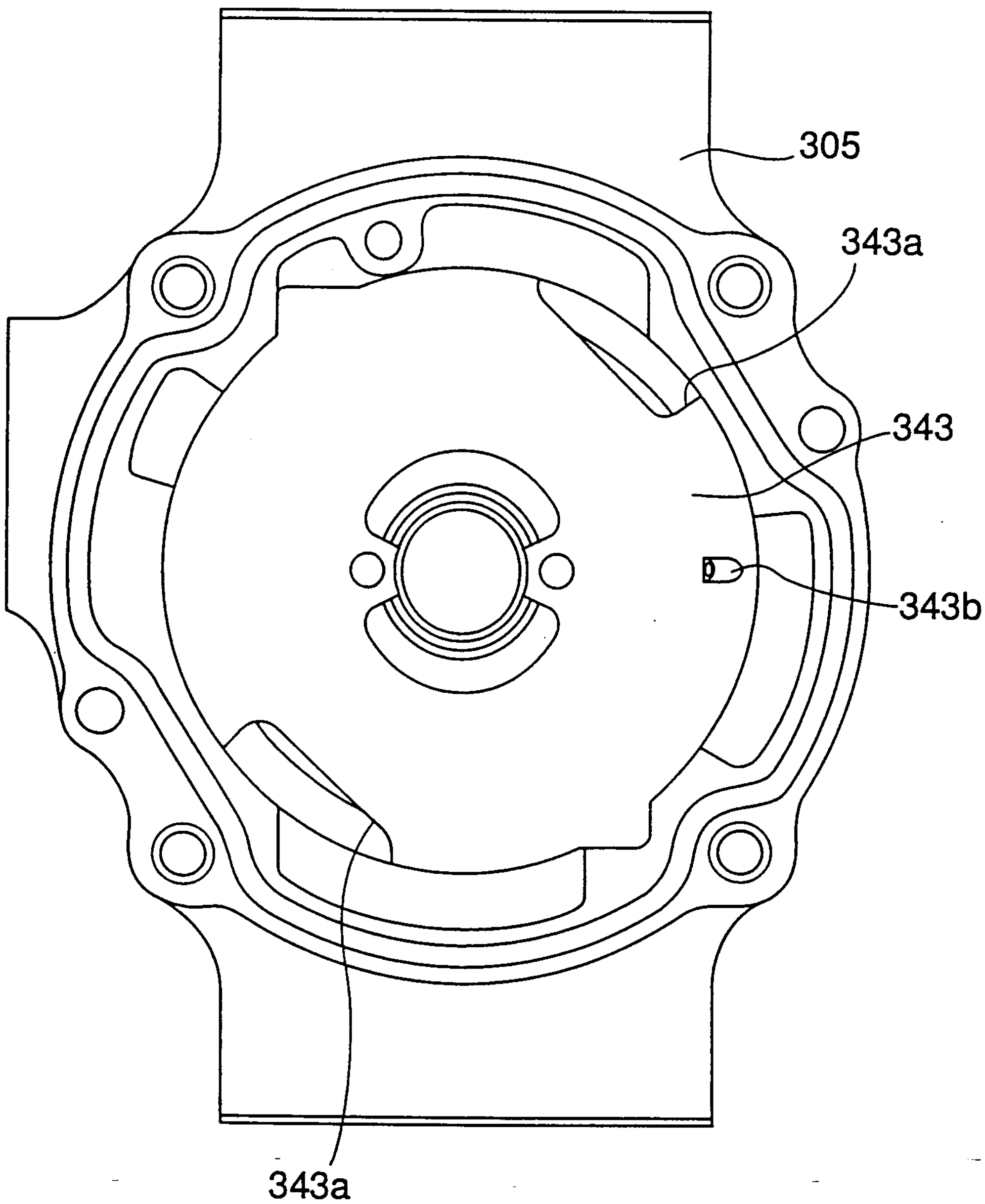
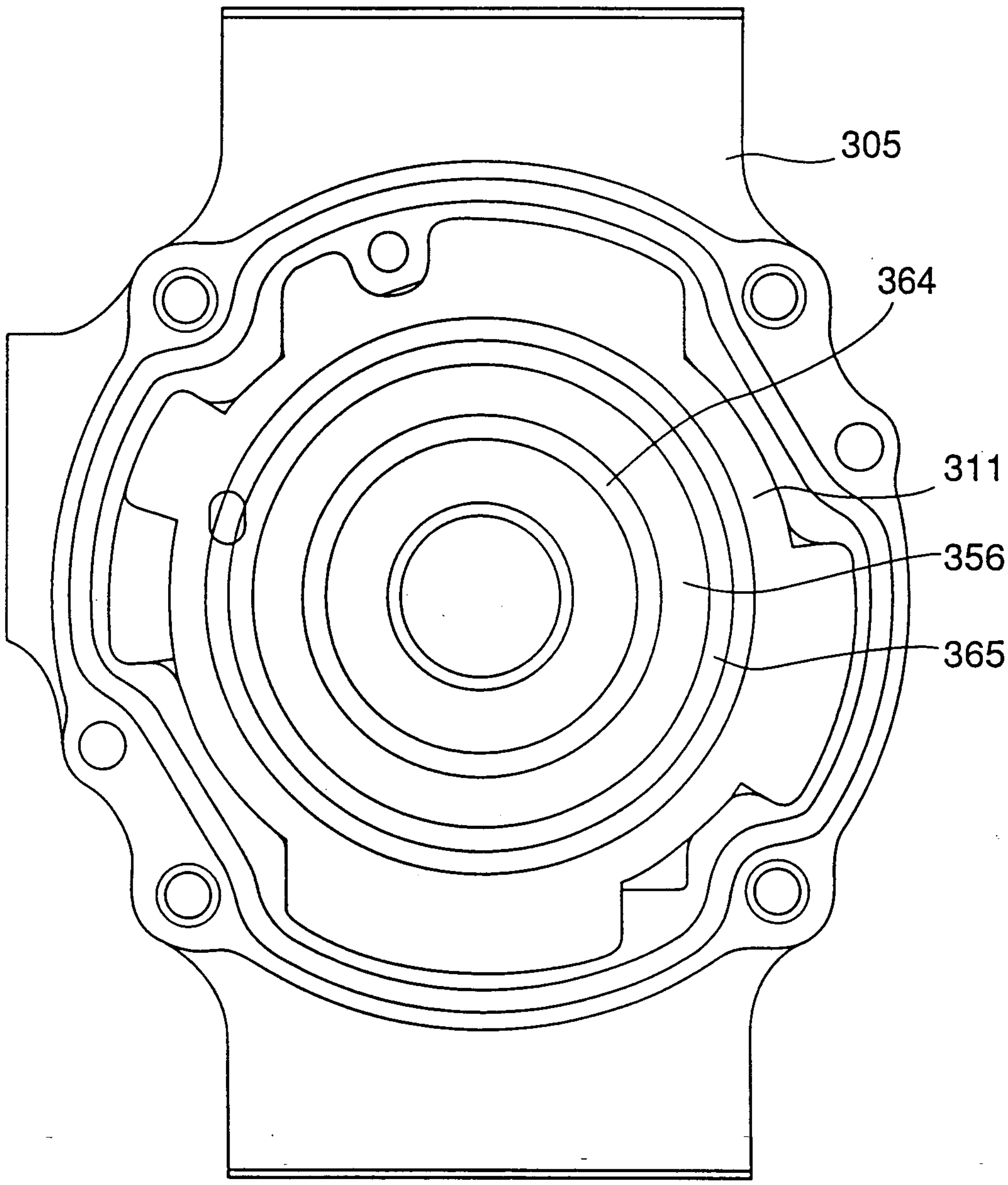
84a
7
150
9
7
30
86c
311
110
12
2
101b
305a
343

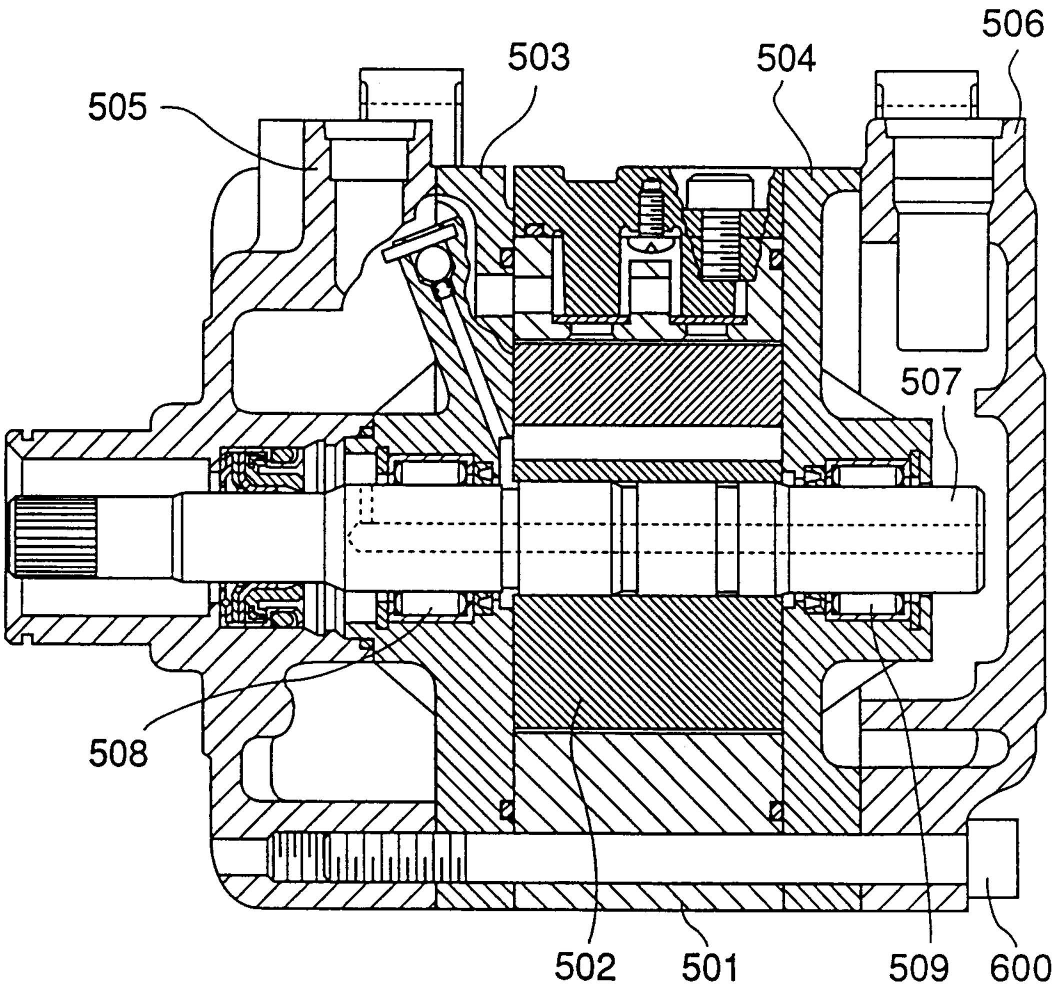
FIG20



F I G 2 1



F I G 2 2



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP95/02515

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl^6 F04C18/344

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)

Int. Cl^6 F04C18/344

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

Jitsuyo Shinan Koho 1926 - 1995
Kokai Jitsuyo Shinan Koho 1971 - 1995

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	JP, 60-256578, A (Mitsubishi Motors Corp.), December 18, 1985 (18. 12. 85) Page 2	1 - 12
Y	JP, Microfilm of the specification and drawings annexed to the written application of Japanese Utility Model Application No. 56405/1983 (Laid-open No. 160875/1984) (Nissan Motor Co., Ltd.), October 27, 1984 (27. 10. 84) All pages	1 - 12
Y	JP, Microfilm of the specification and drawings annexed to the written application of Japanese Utility Model Application No. 54453/1990 (Laid-open No. 14785/1992) (Zexel Corp.), February 6, 1992 (06. 02. 92) Fig. 5, Discharge Propulsion Groove 20, Discharge Hole 16, Discharge Valve 17	4 - 5
Y	JP, Microfilm of the specification and drawings	8 - 12

[X] Further documents are listed in the continuation of Box C. [ ] See patent family annex.

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"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
"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
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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
January 9, 1996 (09. 01. 96)	February 6, 1996 (06. 02. 96)
Name and mailing address of the ISA/ Japanese Patent Office	Authorized officer
Facsimile No.	Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP95/02515

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	annexed to the written application of Japanese Utility Model Application No. 57095/1990 (Laid-open No. 17186/1992) (Miwa Seiki K.K.), February 13, 1992 (13. 02. 92) All pages	

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