

(19)



(11)

EP 2 045 465 A1

(12)

EUROPEAN PATENT APPLICATION
published in accordance with Art. 153(4) EPC

(43) Date of publication:

08.04.2009 Bulletin 2009/15

(51) Int Cl.:

F04B 27/08 (2006.01) **F04B 39/10** (2006.01)
F04B 39/12 (2006.01)

(21) Application number: **07791218.6**

(86) International application number:

PCT/JP2007/064486

(22) Date of filing: **24.07.2007**

(87) International publication number:

WO 2008/013162 (31.01.2008 Gazette 2008/05)

(84) Designated Contracting States:

DE FR GB

Designated Extension States:

AL BA HR MK RS

(72) Inventors:

- **KAGEYAMA, Hiroshi**
Saitama 331-8501 (JP)
- **KOBAYASHI, Nobuyuki**
Saitama 331-8501 (JP)

(30) Priority: **26.07.2006 JP 2006203061**

(74) Representative: **Grünecker, Kinkeldey,**

Stockmair & Schwanhäusser
Anwaltssozietät
Leopoldstrasse 4
80802 München (DE)

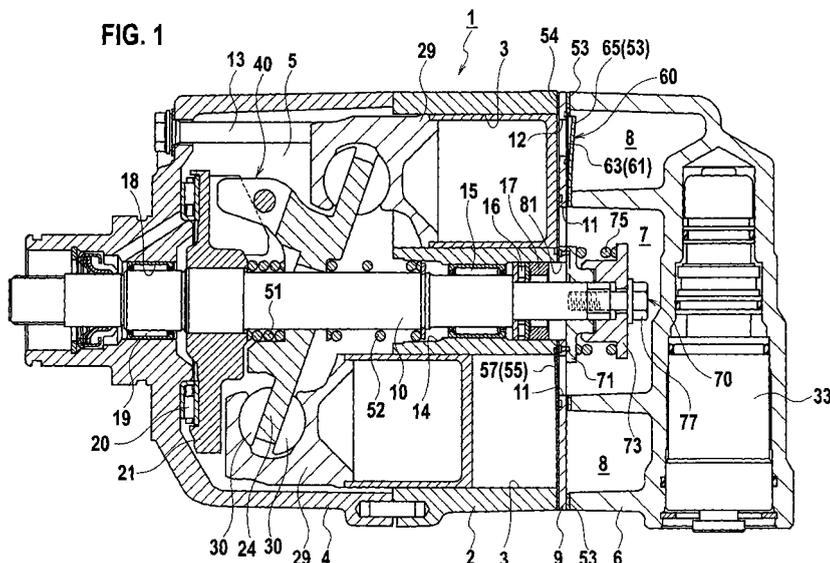
(71) Applicant: **Calsonic Kansei Corporation**
Saitama-shi, Saitama 331-8501 (JP)

(54) **COMPRESSOR**

(57) A compressor (1) includes communication holes (83) penetrating through a valve plate (9) at positions opposite to regulation steps of a cylinder block (2) and communicating cylinder bores (3) and suction chamber (7), a rotary valve (71) configured to rotate with the drive shaft (10) and be in rotational slide contact with a suction chamber side of the valve plate (9) as covering the communication holes (83) of the valve plate (9). The rotary

valve (71) is formed with a residual pressure release passage (71c). As the rotary valve (71) rotates, the residual pressure release passage (71c) connects by turns one of the communication holes (83) communicating with one of the cylinder bores (3) having finished discharge and another of the communication holes (83) communicating with another of cylinder bores (3) having lower pressure than the one of the cylinder bores (3).

FIG. 1



EP 2 045 465 A1

Description

TECHNICAL FIELD

[0001] The present invention relates to a compressor.

BACKGROUND ART

[0002] A compressor is disclosed in Japanese Patent Application Laid-Open No. 2005-163714. The compressor includes a cylinder block, a front housing and a rear housing. The cylinder block is formed with a bearing hole to rotatably support a driving shaft at a center of the cylinder block and is formed with cylinder bores spaced from each other at an interval along a circumferential direction of the cylinder block around the bearing hole. The front housing is attached to a front end of the cylinder block and forms a crankcase therein. The rear housing is attached to a rear end of the cylinder block via a valve plate and forms a suction chamber and a discharge chamber therein.

[0003] The valve plate is formed with suction holes communicating the cylinder bore with the suction chamber and discharge holes communicating the cylinder bore with the discharge chamber. A reed type suction valve is provided at the cylinder bore side of the valve plate to open and close the suction holes. A reed type discharge valve is provided at the discharge chamber side of the valve plate to open and close the discharge holes.

[0004] A piston is reciprocatably arranged in each cylinder bore. In the crank chamber, a conversion mechanism is provided to convert rotations of the drive shaft into reciprocations of the pistons. With this configuration, when the drive shaft rotates, the pistons reciprocate within the cylinder bores. When the pistons reciprocate, refrigerant is sucked into the cylinder bores from the suction chamber, and the sucked refrigerant is compressed in the cylinder bores and then discharged out from the cylinder bores into the discharge chamber.

[0005] In general, even when the piston is located in the top dead center thereof, a small amount of high-pressure refrigerant remains in the cylinder bore since the refrigerant cannot completely be discharged out into the discharge chamber.

[0006] Such a residual refrigerant is reexpanded in a suction stroke in which the piston moves from the top dead center to the bottom dead center. The reexpansion amount of the residual refrigerant reduces fresh refrigerant to be sucked through the suction holes from the suction chamber. As a result, the suction amount of the fresh refrigerant decreases and the suction efficiency decreases.

[0007] Therefore, the above conventional art is configured such that the high-pressure residual gas which remained in one of the cylinder bores after a compression stroke is discharged to another of the cylinder bores having lower pressure than the one of the cylinder bores. In particular, communication holes are provided which ra-

dially extend through the cylinder block so as to connect the cylinder bores to the bearing hole rotatably supporting the drive shaft at the center of the cylinder block. Moreover, a residual-gas bypass passage is formed in a groove shape or in a hole shape on the outer peripheral surface of the drive shaft. As the drive shaft rotates, the residual-gas bypass passage connects one of the cylinder bores having finished a discharge stroke to another of the cylinder bores which has lower pressure than the one of the cylinder bores. In other words, the residual-gas bypass passage connects one of the communication holes which communicates with one of the cylinder bores having finished the discharge stroke to another of the communication holes which communicates with another of the cylinder bores having lower pressure than the one of the cylinder bores. Therefore, the high-pressure residual gas which remained in one of the cylinder bores at the end of the compression stroke can be released to another of the cylinder bores having lower pressure than the one of the cylinder bores.

DISCLOSURE OF THE INVENTION

PROBLEM TO BE SOLVED BY THE INVENTION

[0008] In the above-mentioned conventional compressor, since the communication holes are open at inner circumference surfaces of the cylinder bores, the communication holes have been required to be machined to prevent bad slide contacts between the inner circumference surfaces of the cylinder bores and outer circumference surfaces of the pistons. This requires high machining accuracy and the manufacturing cost tends to become more expensive.

[0009] Moreover, communication holes that communicate the bearing hole provided at the center of the cylinder block with the cylinder bores provided around the bearing hole have comparatively large interior spaces so that the residual gas tend to easily remain in the communication holes.

[0010] The present invention is invented based on such a conventional art, and the object of the present invention is to provide a compressor capable of obtain a good slide contact between inner circumference surface of cylinder bores and outer circumference surface of pistons even though a high-pressure residual gas release path is provided.

MEANS FOR SOLVING PROBLEM

[0011] An aspect of the present invention is a compressor including: a cylinder block formed with cylinder bores spaced from each other in an interval along a circumferential direction of the cylinder block around a drive shaft; a housing attached to the cylinder block via a valve plate through which suction holes are penetrated and forming a suction chamber therein; reed type suction valves disposed on a cylinder bore side of the valve plate

and configured to open and close the suction holes, regulation steps recessed, at the periphery of the cylinder bore, from a valve plate side of the cylinder block and configured to limit maximum lift positions of the suction valves; pistons reciprocally disposed in the cylinder bores respectively and configured to reciprocate with rotation of the drive shaft to perform an suction stroke and a discharge stroke by turns within the cylinder bores; communication holes penetrating through the valve plate at positions opposite to the regulation steps and connecting the cylinder bores and the suction chamber; and a rotary valve configured to be in rotational slide contact with the suction chamber side of the valve plate with covering the communication holes of the valve plate as rotating with the drive shaft; a residual pressure release passage formed in the rotary valve. As the rotary valve rotates, the residual pressure release passage sequentially connects one of the communication holes which communicates with one of the cylinder bores which has finished a discharge stroke and another of the communication holes which communicates with another of the cylinder bores which has a lower-pressure than the one of the cylinder bores.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012]

[Fig. 1] Fig. 1 is a sectional view of a compressor according to an embodiment of the present invention.

[Fig. 2] Fig. 2 is an expanded sectional view of a residual pressure release mechanism of the compressor.

[Fig. 3] Fig. 3 is an exploded perspective view of the compressor, explaining a stacked structure including a suction valve plate, a valve plate and a rotary valve.

[Fig. 4] Fig. 4 is an exploded perspective view of the residual pressure release mechanism, explaining an assembly of the valve plate, a stopper and a coil spring.

[Fig. 5] Fig. 5 is a rear view of the valve plate.

[Fig. 6] Fig. 6 is a sectional view along SA-SA line in Fig. 2, explaining connecting states between the residual pressure release passage and communication holes as the rotary valve rotates, and particularly, showing a state before the connection.

[Fig. 7] Fig. 7 is a sectional view along SA-SA line in Fig. 2, explaining the connecting states between the residual pressure release passage and communication holes as the rotary valve rotates, and particularly, showing the connection state.

[Fig. 8] Fig. 8 is a sectional view along SA-SA line in Fig. 2, explaining the connecting states between the residual pressure release passage and communication holes as the rotary valve rotates, and particularly, showing a state after the connection.

[Fig. 9] Fig. 9 is a view of a rotary valve of a com-

pressor according to a first modification.

[Fig. 10] Fig. 10 is a view of a valve plate of a compressor according to a second modification.

[Fig. 11] Fig. 11 is a view of a valve plate and a rotary valve of a compressor according to a third modification.

BEST MODE FOR CARRYING OUT THE INVENTION

[0013] Hereafter, compressors according to embodiments of the present invention will be explained with reference to drawings.

[0014] First, an embodiment of the present invention will be explained with reference to Figs. 1-8. A discharge valve plate is omitted in Figs. 6 to 8.

Overall Structure of the Compressor

[0015] The compressor 1 of the present embodiment is a swash plate type variable capacity compressor as shown in Fig. 1. This compressor 1 has a cylinder block 2 which has two or more cylinder bores 3 spaced evenly apart from each other in a circumferential direction thereof, a front housing 4 which is attached to a front end of the cylinder block 2 and forms therein a crank chamber 5 communicating with the cylinder bore 3, a rear housing 6 which is attached to a rear end of the cylinder block 2 with a valve plate 9 therebetween and forms therein a suction chamber 7 and a discharge chamber 8. The cylinder blocks 2, the front housing 4 and the rear housing 6 are attached and fastened together with through bolts 13 so as to constitute an overall housing of the compressor.

[0016] Between the valve plate 9 and the rear housing 6, a gasket 53 intervenes to maintain sealing of the suction chamber 7 and the discharge chamber 8. Between the valve plate 9 and the cylinder block 2, a gasket 54 (see Fig. 2) intervenes to maintain sealing of the cylinder bore 3.

[0017] The valve plate 9 is formed in an approximately circular disk shape. The valve plate 9 is formed with suction holes 11 communicating the cylinder bores 3 with the suction chamber 7, and discharge holes 12 communicating the cylinder bores 3 with the discharge chamber 8.

[0018] In the suction chamber 7, a suction valve plate 55 (refer to Fig. 3) having reed type suction valves 57 to open and close the suction holes 11 is provided on the front side of the valve plate 9 (the cylinder block side of the valve plate 9). In the discharge chamber 8, a discharge valve plate 61 having reed type discharge valves 63 to open and close the discharge holes 12 is provided on the rear side of the valve plate 9 (the rear housing side of the valve plate 9).

[0019] The suction valve plate 55 is formed as an elastic thin plate (for example, a metallic thin plate etc.) and is sandwiched between the valve plate 9 and the cylinder block 2 as shown in Fig. 1. The suction valve plate 55 is

formed with the reed type suction valves 57 at positions corresponding to the suction holes 11. The suction valves 57 normally cover and close the suction holes 11. When pressure in the cylinder bore 3 declines in a suction stroke and a pressure difference between the suction chamber 7 and the cylinder bore 3 becomes greater than predetermined level, the suction valve 57 is flexurally deformed to open the suction hole 11. Maximum lift positions of the suction valves 57 are regulated by regulation steps 59 (see Fig. 2) which are recessed at peripheries of the cylinder bores 3 from the rear end of the cylinder block 2 (the side of the cylinder block 2 to which the rear housing 6 is attached). On the other hand, the discharge valve plate 61 is formed as an elastic thin plate (for example, a metallic thin plate etc.) and is sandwiched between the valve plate 9 and the rear housing 6 as shown in Fig. 1. The discharge valve plate 61 is formed with the reed type discharge valves 63 at positions corresponding to the discharge holes 12. The discharge valves 63 normally cover and close the discharge holes 12. In a compression stroke, the discharge valve 63 is flexurally deformed so as to open the discharge hole 12 when the inside of the cylinder bore 3 exceeds predetermined pressure. Maximum lift positions of the discharge valves 63 are regulated by stopper parts 65 formed on the gasket 53.

[0020] Annular grooves 11c and 12c (refer to Figs. 5-6) are recessed around the suction holes 11 and the discharge holes 12 so as to decrease a contact area where the suction valve 57 contacts with the valve plate 9 and a contact area where the discharge valve 63 contacts with the valve plate 9, and therefore the suction valve 57 and the discharge valve 63 open easily.

[0021] The drive shaft 10 is rotatably supported by center through holes 14 and 18 of the cylinder block 2 and the front housing 4 via radial bearings 15 and 19, and thereby, the drive shaft 10 is rotatable in the crank chamber 5.

[0022] The thrust bearing 20 intervenes between an inner surface of the front housing 4 and a front side of a rotor 21 fixed to the drive shaft 10 in the crank chamber 5. The thrust bearing 16 intervenes between a step portion formed on the drive shaft 10 and the adjustable screw 17 fixed to the center through hole 14 of the cylinder block 2. This configuration stops axial movements of the drive shaft.

[0023] In the crank chamber 5, a conversion mechanism is provided to convert rotation of the drive shaft 10 into reciprocation of the pistons 29. The conversion mechanism includes the rotor 21 as a rotation member fixed to the drive shaft 10, a swash plate slidably and inclinably attached to the drive shaft 10, and a connection mechanism 40 connecting the rotor 21 and the swash plate 24 such that the rotor 21 and the swash plate 24 rotate as one unit with permitting variation of the inclination angle of the swash plate 24. The pistons 29 each is attached to an outer peripheral portion of the swash plate 24 with a pair of hemispherical piston shoes 30 and 30. When the swash plate 24 rotates, the pistons 29 recip-

rocate in the cylinder bores 3 according to the inclination angle of the swash plate 24. As the pistons 29 reciprocate, refrigerant is sucked from the suction chamber 7 into the cylinder bores 3 through the suction holes 11 of the valve plate 9, and compressed within the cylinder bores 3, and then the compressed refrigerant is discharged out into the discharge chamber 8 through the discharge holes 12 of the valve plate 9.

[0024] When the swash plate 24 moves toward the cylinder block 2 against a return spring 52, the inclination angle of the swash plate 24 decreases, and when the swash plate 24 moves away from the cylinder block 2 against a return spring 51, the inclination angle of the swash plate 24 increases.

Control of Variable Capacity

[0025] In order to change the refrigerant discharge capacity, the inclination angle of the swash plate 24 is controlled to change the piston stroke. Based on a pressure difference (pressure balancing) between crank chamber pressure P_c at the rear side of the piston 29 and suction chamber pressure P_s at the front side of the piston 29, the inclination angle of the swash plate 24 is changed and the piston stroke is changed. Therefore, a pressure control mechanism is provided in the variable capacity compressor. The pressure control mechanism has a gas releasing passage (not shown) communicating the crank chamber 5 with the suction chamber 7 and a gas supplying passage (not shown) communicating the crank chamber 5 with the discharge chamber 8, and a control valve 33 provided in a middle of the gas supplying passage and configured to control to open and close the gas supplying passage.

[0026] Regardless of opening or closing of the control valve 33, refrigerant gas is released from the crank chamber 5 through the gas releasing passage into the suction chamber 7.

[0027] When the control valve 33 opens the gas supplying passage, high-pressure refrigerant gas flows from the discharge chamber 8 into the crank chamber 5 through the gas supplying passage, and thereby, the pressure in the crank chamber 5 rises. As the pressure in the crank chamber 5 rises, the swash plate 24 moves toward the cylinder block 2 and the inclination angle of the swash plate 24 decreases. Therefore, the piston stroke becomes small and the discharge amount of the compressor 1 decreases.

[0028] On the other hand, when the control valve 33 closes the gas supplying passage, the pressure difference between the suction chamber 7 and the crank chamber 5 reduces to be zero. Then, the swash plate 24 moves away from the cylinder block 2 to increase the inclination angle of the swash plate, the piston stroke becomes large and the discharge amount of the compressor 1 increases.

Residual Pressure Release Mechanism

[0029] Next, a residual pressure release mechanism 70 will be explained.

[0030] The compressor of the present embodiment further includes communication holes 83 (Figs. 2, 3) formed in the valve plate 9 at positions corresponding to the cylinder bores 3 and includes the residual pressure release mechanism 70 (Fig. 2) configured to connect and disconnect the communication holes 83 each other. The residual pressure release mechanism 70 is configured to release the high pressure residual gas which remained one of the cylinder bores 3 having finished discharge to another of the cylinder bores 3 having lower-pressure than the one of the cylinder bores 3 concerned.

[0031] The residual pressure release mechanism 70 is provided on the rear side of the valve plate 9 (the rear housing 6 side of the valve plate 9). The residual pressure release mechanism 70 is provided with a rotary valve 71, a stopper 73 and an elastic member (in this embodiment, a coil spring 75 as a spring). The rotary valve 71, the stopper 73 and the coil spring 75 are arranged in the suction chamber 7 as shown in Figs. 1 and 2.

[0032] The rotary valve 71 is formed with a cylindrical boss part 71a and a main part 71b outwardly extending from the boss part 71a and formed in a circular disk shape as shown in Figs. 2-4. The boss part 71a of the rotary valve 71 is fitted around an outer circumferential surface of the drive shaft 10 which extends through a center through hole 81 of the valve plate 9 into the suction chamber 7, so that the rotary valve can rotatably and axially slidably move with respect to the drive shaft 10. The main part 71b of the rotary valve 71 is formed with a residual pressure release passage 71c formed in an arc slot shape and recessed on a slide contact surface where the rotary valve 71 slidably contacts (Fig. 2-4).

[0033] The stopper 73 is formed with a cylindrical boss part 73a and a flange part 73b outwardly projected from the boss part 73a in a circular disk shape as shown in Figs. 2 and 4. The boss part 73a of the stopper 73 is fixedly attached to an axial end 10a of the drive shaft 10 with the bolt 77 as a fastening means, so that the stopper 73 rotates with drive shaft 10 together. As shown in Fig. 4, the axial end 10a of the drive shaft 10 is formed as a hexagon shaped fitting part 10a, and an inside of the boss part 73a of the stopper 73 is formed as a hexagon shaped fitting hole 73c into which the fitting part 10a of the drive shaft is fitted.

[0034] As shown in Figs. 2 and 4, a pair of arms 73d is projected from the boss part 73a of the stopper 73 towards the boss part 71a of the rotary valve 71. The arms 73d and the boss part 73a of the rotary valve have rotation transmission faces 71e and 73e respectively which carry out facing contact each other and transmit rotation of the stopper 73 to the rotary valve 71. Thereby, the rotary valve 71 and the drive shaft 10 rotate as one unit with the stopper 73.

[0035] As shown in Fig. 2, the coil spring 75 is com-

pressed between the flange part 73b of the stopper 73 and the main part 71b of the rotary valve 71. Thereby, the rotary valve 71 is biased toward the valve plate 9 so as to be in close contact with the valve plate 9.

[0036] When the rotary valve 71 which is in close contact with the valve plate 9 rotates with the drive shaft 10, the residual pressure release passage 71c on the rotary valve 71 rotates, and thereby, connections occur sequentially between one of the communication holes 83 which communicates with one of the cylinder bores 3 having finished a compression stroke (a discharge stroke) and another of the communication holes 83 which communicates with another of the cylinder bores 3 having lower-pressure than the one of the cylinder bores 3.

[0037] In particular, the valve plate 9 is formed with the communication holes 83 provided at positions facing to the regulation steps 59 of the cylinder bores 3. The residual pressure release passage 71c includes an inlet port 71f, an outlet port 71 h, and a connection part 71 g connecting the inlet port 71 f and the outlet port 71 h. The communication holes 83 are located on rotational tracks of the inlet port 71f and the outlet port 71h but out of a rotational track of the connection part 71g.

[0038] With this configuration, as the rotary valve 71 rotates, the inlet port 71f of the residual pressure release passage 71c connects with the communication hole 83 of one of the cylinder bores 3 having finished a compression stroke one by one, and the outlet port 71h of the passage 71c connects with the communication hole 83 of another of the cylinder bore 3 having lower-pressure than the one of the cylinder bores 3 one by one. Therefore, the high-pressure residual gas remaining in one of the cylinder bore 3 which has finished a discharge stroke flows into another of the cylinder bores 3 having lower-pressure than the one of the cylinder bores 3.

[0039] In this embodiment, the communication holes 83 of the valve plate 9 are penetrated from the bottoms of the annular grooves 11c which are formed around the suction holes 11.

Effect

[0040] Next, effects of this embodiment will be explained.

[0041] The compressor 1 of this embodiment includes the communication holes 83 extending through the valve plate 9 at the positions opposite to the regulation steps 59 of the cylinder bores 3 and connecting the cylinder bores 3 and the suction chamber 7, and the rotary valve 71 configured to rotate with the drive shaft 10 with covering the communication hole 83 of the valve plate 9 and be in rotational slide contact with the suction chamber side of the valve plate 9. The rotary valve 71 is formed with the residual pressure release passage 71c. As the rotary valve 71 rotates, the residual pressure release passage 71c interconnects by turns one of communication holes 83 of the valve plate communicating with one of the cylinder bores 3 having finished discharge and

another of the communication holes 83 of the valve plate communicating with another of the cylinder bores 3 having lower pressure than the one of the cylinder bores having finished discharge.

[0042] Therefore, the high pressure residual gas which remained in the one of the cylinder bores 3 without being discharged out in a compression stroke thereof escapes from the one of the cylinder bores 3 (that is, a cylinder bore 3 in an early stage of a suction stroke) into another of the cylinder bores 3 having lower-pressure than the one of the cylinder bores 3 concerned (that is, a cylinder bore 3 in a early stages or a middle stage of a compression stroke). Thus, the reexpansion of the high pressure residual gas decreases in a suction stroke, and the suction efficiency improves.

[0043] Unlike the above-mentioned conventional art (for example, JP2005-163714), no openings are formed on an inner circumferential surface of the cylinder bore 3, so that good slide contact between the inner circumferential surface of the cylinder bores 3 and an outer circumferential surface of the piston 29 can be obtained.

[0044] Moreover, since the communication hole 83 of the valve plate 9 extends through the valve plate 9, the inside space of the communication hole 83 tends to be smaller than the conventional art (for example, JP2005-163714) which has communication holes extending through from a bearing hole at a center of a cylinder block to a cylinder bore provided around the bearing hole. Therefore, the suction efficiency improves further.

[0045] Furthermore, since the communication holes 83 of the valve plate 9 are provided at the positions opposite to the regulation steps 59, this configuration allows to use spaces 85 between the regulation steps 59 and the valve plate 9.

[0046] Moreover, in the compressor 1 of this embodiment, the annular grooves 11c are formed around the suction holes 11 on the front side of the valve plate 9 (the cylinder bore 3 side of the valve plate 9).

[0047] With the annular grooves 11c, the suction valves 57 easily open, and the suction efficiency further improves. And since the communication holes 83 are provided at the annular grooves 11c of the valve plates 9 (i.e., since the communication holes 83 are provided in thin portions of the valve plate 9), length of the communication holes 83 become small. Therefore, the suction efficiency further improves because the inside spaces of the communication holes 83 becomes smaller and dead volume becomes smaller.

[0048] The compressor 1 of the embodiment has the through hole 81 of the valve plate 9 to allow the drive shaft 10 extend into the suction chamber 7, so that the rotary valve 71 is directly or indirectly connected to the drive shaft 10 in the suction chamber 7 to rotate with the drive shaft 10.

[0049] Therefore, the rotary valve 71 and the drive shaft 10 rotates together with such a simple structure.

[0050] In the compressor 1 of this embodiment, the stopper 73 is provided which is fixed to the drive shaft 10

and configured to rotate with the drive shaft 10 in the suction chamber 7, and the rotary valve 71 is axially slidably and rotatably fitted to the drive shaft 10 and axially slidably and unrotatably connected to the stopper 73 such that the rotary valve 71 and the drive shaft 10 rotates as one unit. And the rotary valve 71 is biased towards the valve plate 9 by the elastic member 75 compressed between the stopper 73 and the rotary valve 71.

[0051] Therefore, the rotary valve 71 is in close contact to the valve plate 9 firmly. With this, the compression efficiency improves because the high pressure compression medium compressed within the cylinder bores 3 hardly leaks from the suction holes 11 of the cylinder bores 3, through clearance between the valve plate 9 and the rotary valve 71, into the suction chamber 7.

[0052] If the pressure in the cylinder bore 3 goes up extremely high, the rotary valve 71 lift up away from the valve plate 9, and the superfluous pressure in the cylinder bore 3 can be released out into the suction chamber 7. Therefore, the safety of the compressor 1 improves.

[0053] Moreover, the coil spring 75 does not touch the rear housing 6, so that vibration of the rotary valve 71 is prevented from being transmitted to the rear housing 6 through the coil spring 75. Thereby, the compressor 1 of this embodiment improves the vibration suppression.

[0054] In the embodiment, the stopper 73 of the coil spring 75 rotates with the rotary valve 71, it is unnecessary to provide a thrust bearing between the coil spring and the stopper or between the coil spring and the rotary valve. This brings about low cost manufacturing because such an expensive thrust bearing is unnecessary.

[0055] The present invention is not limited only to the embodiment described above.

35 First Modification

[0056] For example, the above embodiment has the residual pressure release passage which has one inlet port and one outlet port, but the residual pressure release passage may have two or more outlet ports 71h-1 and 71h-2 such as a modification shown in Fig. 9. According to the first modification, it is advantageous that the timing for releasing the residual pressure can be made in varieties.

45 Second Modification

[0057] The above embodiment has the communication holes 83 which penetrate from the bottoms of the annular grooves 11c recessed around the suction holes 11, but the communication holes 83 may be provided outside the annular grooves 11c like a modification of a valve plate 9 shown in Fig. 10. Such a modification has larger interior space of the communication holes 83 than the above embodiment, but other than that, achieves the same effect as the above embodiment.

Third Modification

[0058] Even though the above embodiment has six cylinder bores 3, a modification shown in Fig. 11 which has five cylinder bores 3 or other number of the cylinder bores will have the same effect as or similar effect to the above embodiment.

Fourth Modification

[0059] In the above embodiment, the rotary valve 71 is rotatably and axially slidably fitted to the drive shaft 10 and is unrotatably and axially slidably connected to the stopper 73 so that the rotary valve 71 rotates with the drive shaft 10 as the rotary valve 71 is axially slidably with respect to the drive shaft. In the present invention, the rotary valve 71 may be axially slidably and unrotatably fitted to the drive shaft 10, without engaging with the stopper 73. For example, in case of directly transmitting the rotation of a drive shaft 10 to a rotary valve 71 without a stopper 73, the drive shaft 10 is provided with a slide guide portion having the same noncircular sectional shape as extending along the axial direction and the rotary valve 71 is provided with a fitting hole in which the slide guide portion is fitted, so that the rotary valve 71 can be axially slidably and unrotatably connected to the drive shaft 10. If the sectional shapes of the slide guide portion and the fitting hole are a regular polygon (for example, right hexagon) or a spline shape, etc., the slide guide portion and the fitting hole are easy to fabricate.

Fifth Modification

[0060] The above embodiment uses the swash plate (rotary cam plate 24); however the present invention can use a wobble plate (non-rotary cam plate).

Sixth Modification

[0061] In the above embodiment, the swash plate 24 is directly attached to the drive shaft 10, but the swash plate 24 may be attached to the drive shaft 10 via a sleeve.

Seventh Modification

[0062] The connection mechanism 40 is not limited to the configuration of the above embodiment.

[0063] The present invention can be implemented with various other modifications without departing from technical scope of the present invention.

Claims

1. A compressor, comprising:
a cylinder block formed with cylinder bores spaced away each other in an interval in a cir-

cumferential direction of the cylinder block around a drive shaft;
a housing attached to the cylinder block via a valve plate and forming a suction chamber therein, the valve plate formed with suction holes penetrating therethrough;
reed type suction valves arranged on a cylinder bore side of the valve plate and configured to open and close the suction holes; regulation steps provided at peripheries of the cylinder bores and recessed from a side of the cylinder block where the valve plate is attached, the regulation steps configured to limit maximum lift positions of the suction valves;
pistons configured to reciprocate in the cylinder bores as the drive shaft rotates so as to carry out a suction stroke and a discharge stroke by turns in the cylinder bores;
communication holes penetrating through the valve plate at positions opposite to the regulation steps, the communication holes communicating the cylinder bores and the suction chamber; a rotary valve configured to rotate with the drive shaft and be in rotational slide contact with a suction chamber side of the valve plate with covering the communication holes of the valve plate; and
a residual pressure release passage configured to connect one of the communication holes communicating with one of the cylinder bores having finished discharge and another of the communication holes communicating with another of cylinder bores having lower pressure than the one of the cylinder bores by turns, as the rotary valve rotates.

2. The compressor according to Claim 1, wherein annular grooves are formed around the suction holes on the cylinder bore side of the valve plate, and the communication holes are formed in the annular grooves.
3. The compressor according to Claim 1, wherein the residual pressure release passage is formed with two or more outlet ports.
4. The compressor according to Claim 1, wherein the drive shaft extends into the suction chamber through a through hole extending through the valve plate, and the rotary valve is directly or indirectly connected to the drive shaft so as to rotate with the drive shaft together.
5. The compressor according to Claim 4, further comprising a stopper fixed to the drive shaft so as to rotate with the drive shaft in the suction chamber, wherein the rotary valve is axially slidably and rotat-

ably fitted to the drive shaft and is axially slidably and unrotatably fitted to the stopper so that the rotary valve rotates with the drive shaft, and wherein the rotary valve is biased toward the valve plate by the elastic member compressed between the stopper and the rotary valve. 5

10

15

20

25

30

35

40

45

50

55

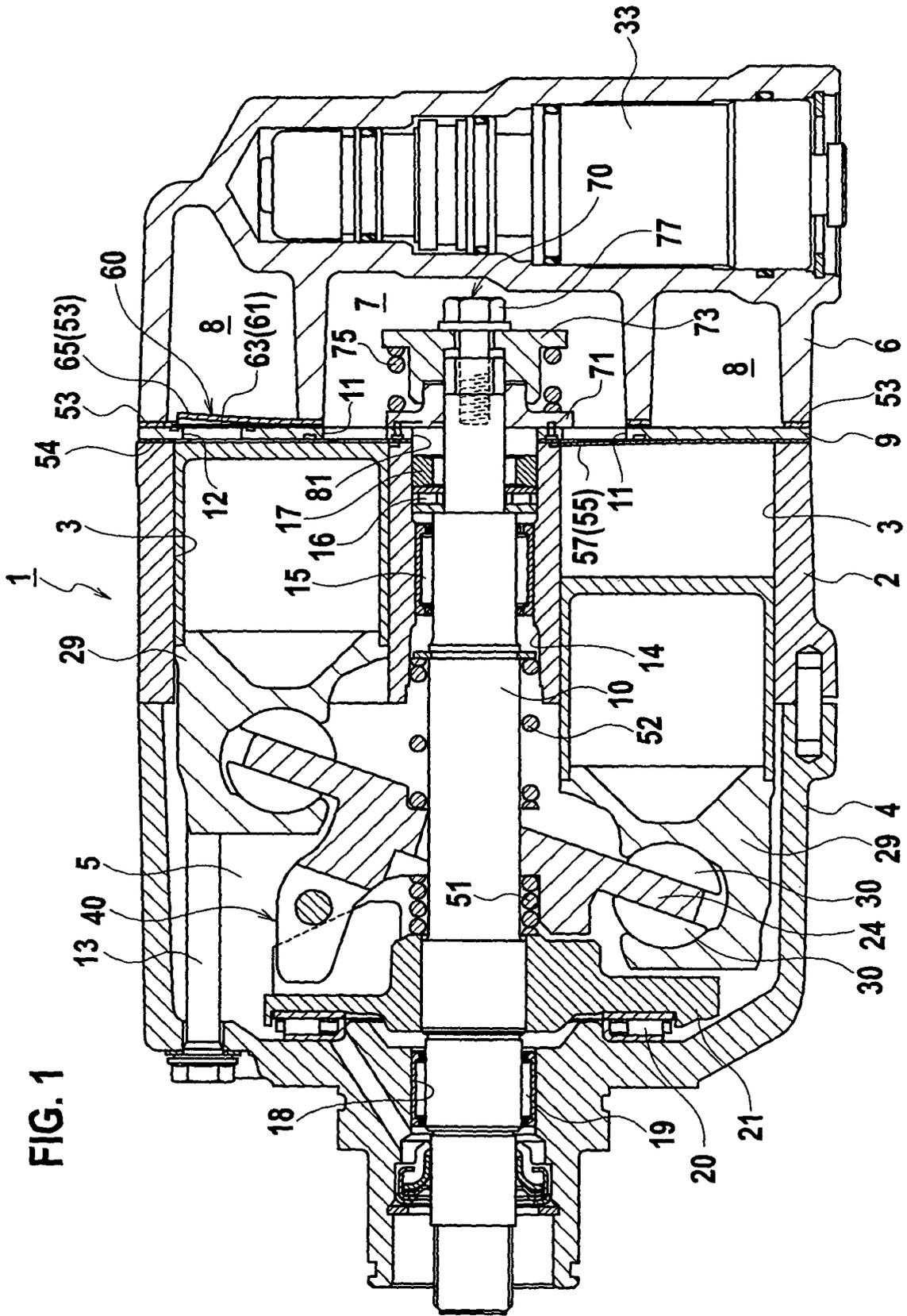


FIG. 1

FIG. 2

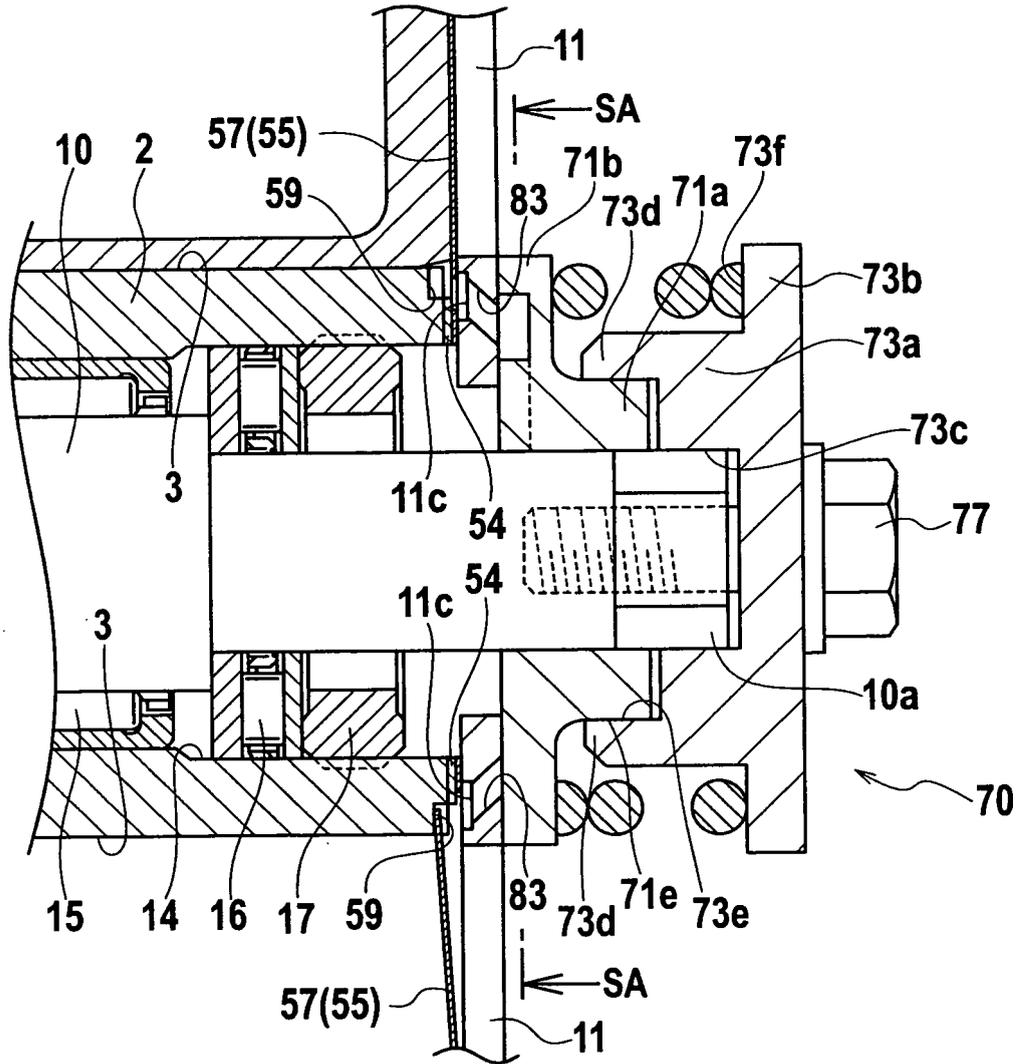


FIG. 3

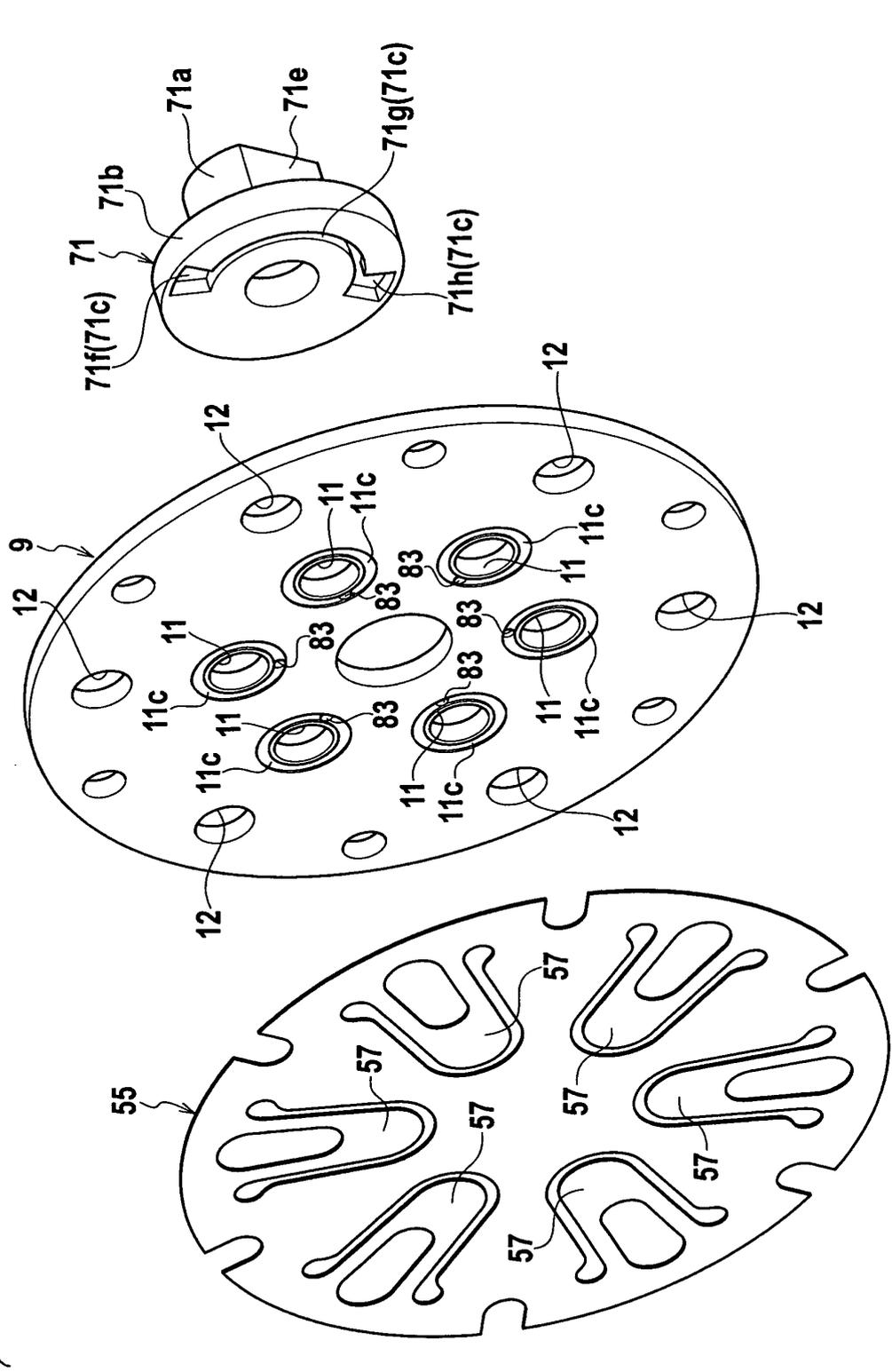


FIG. 4

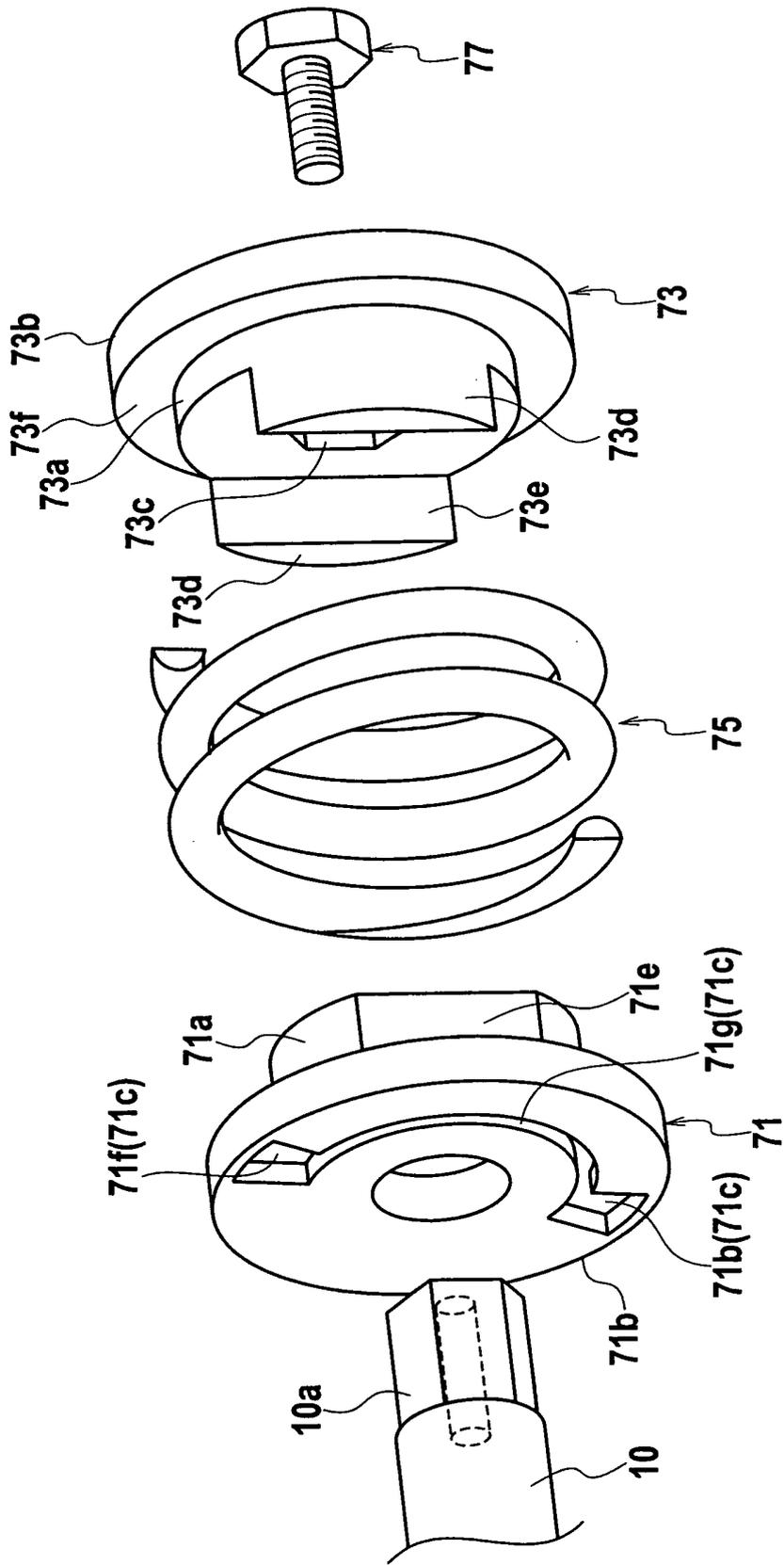


FIG. 5

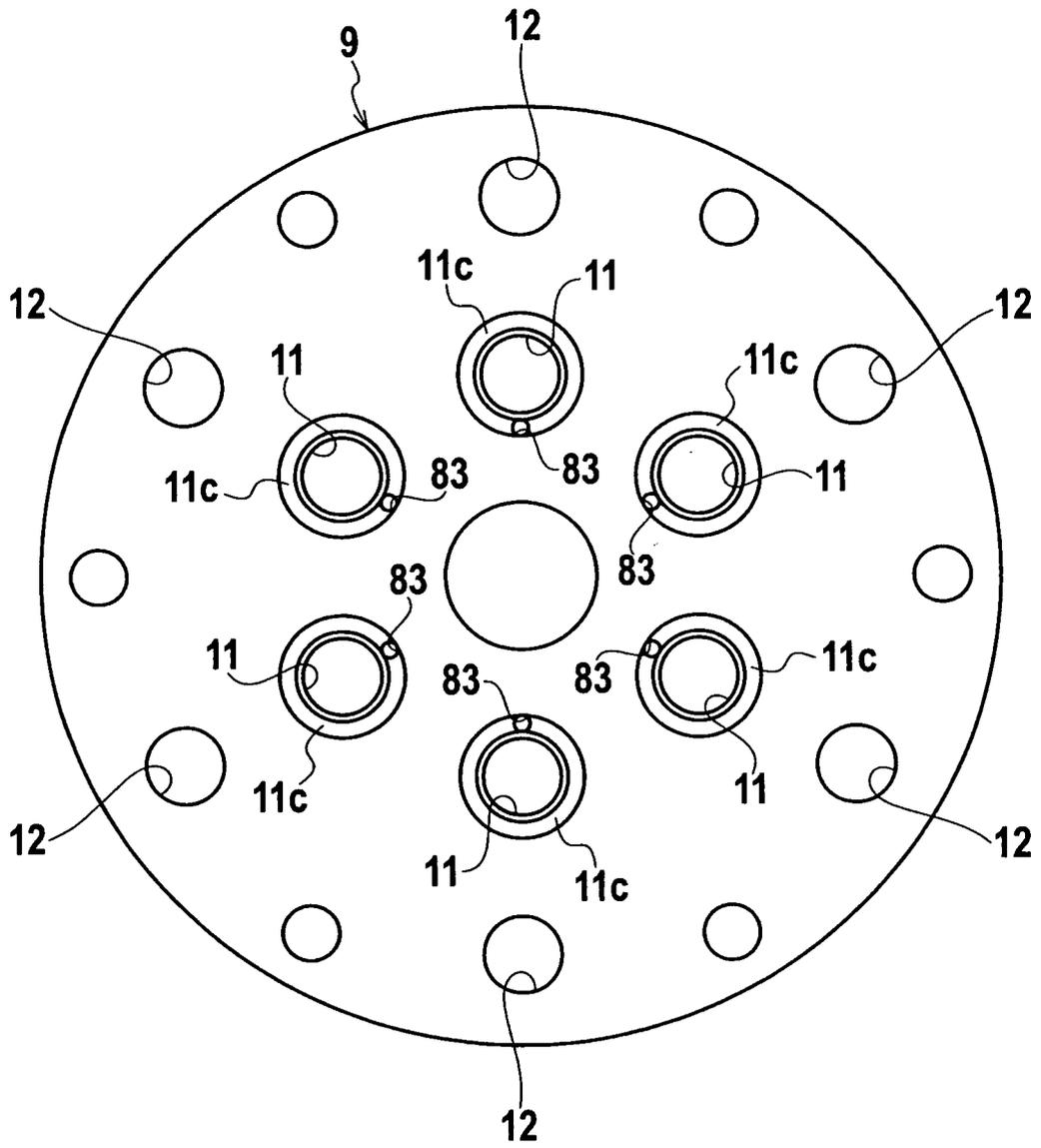


FIG. 6

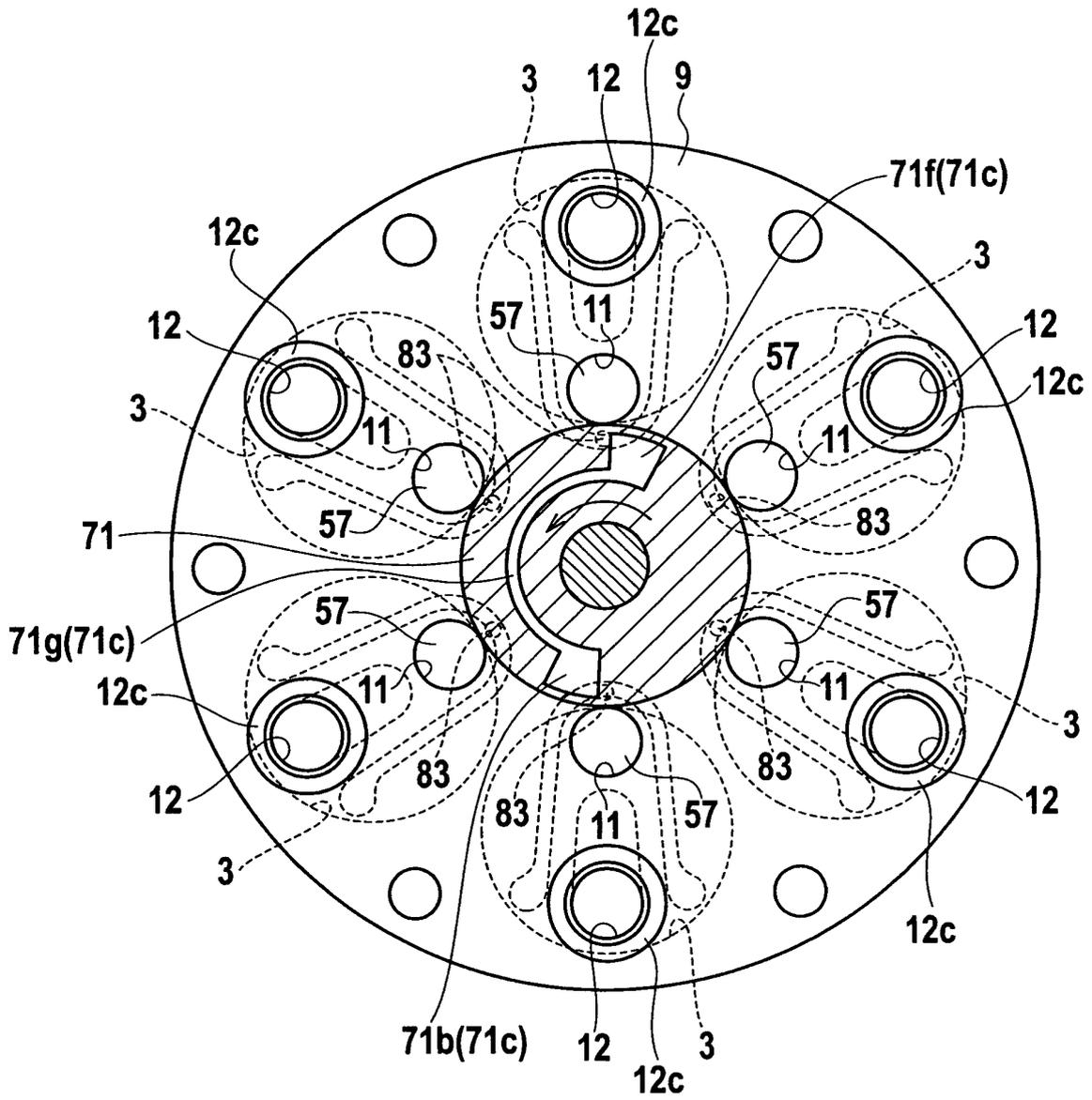


FIG. 7

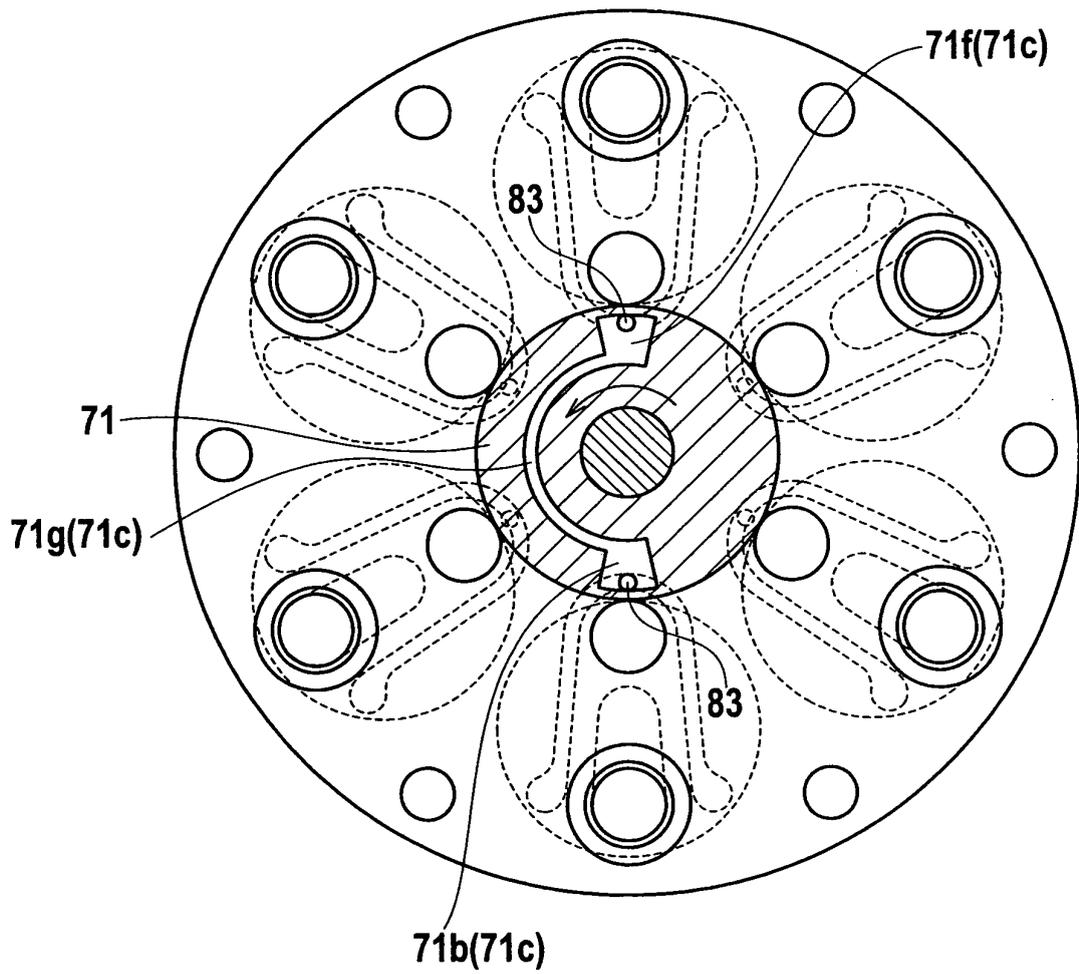


FIG. 8

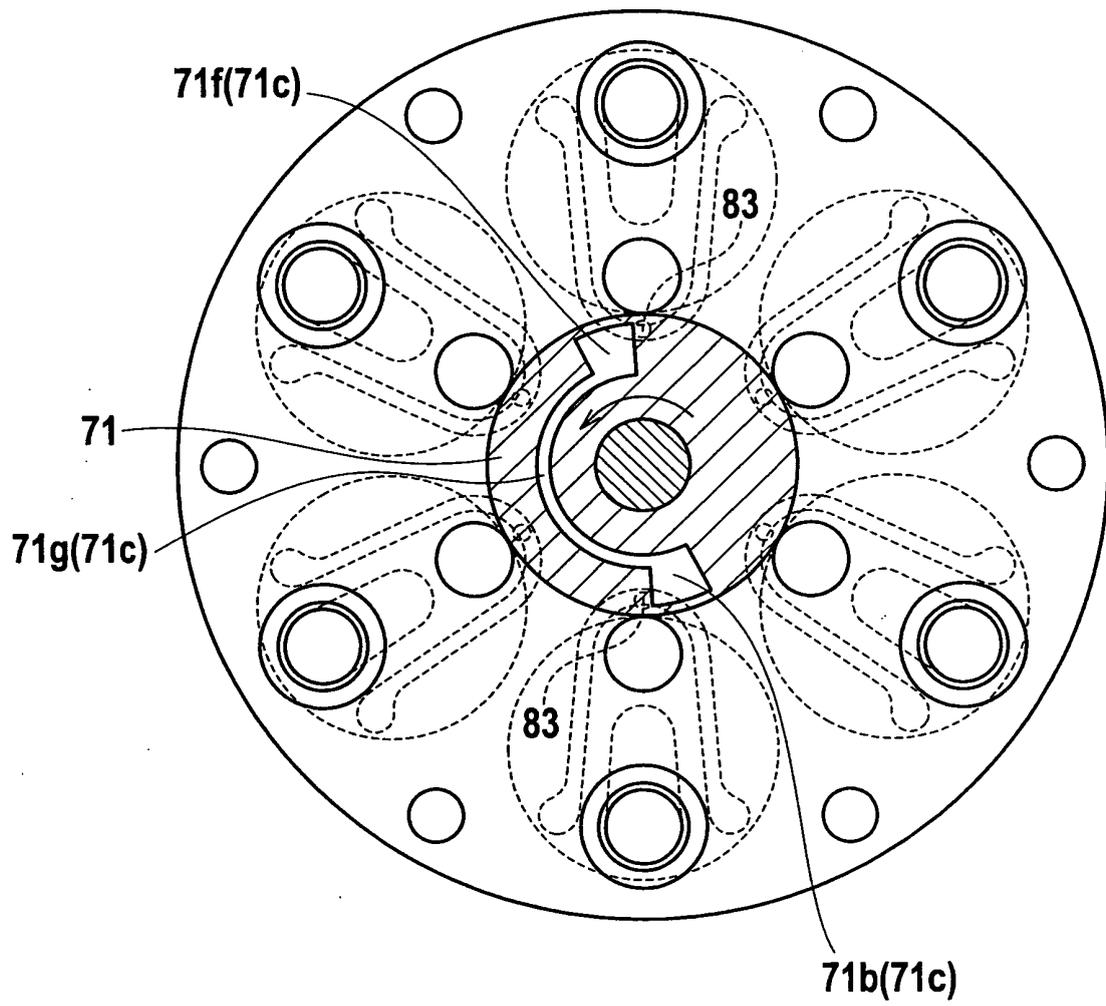


FIG. 9

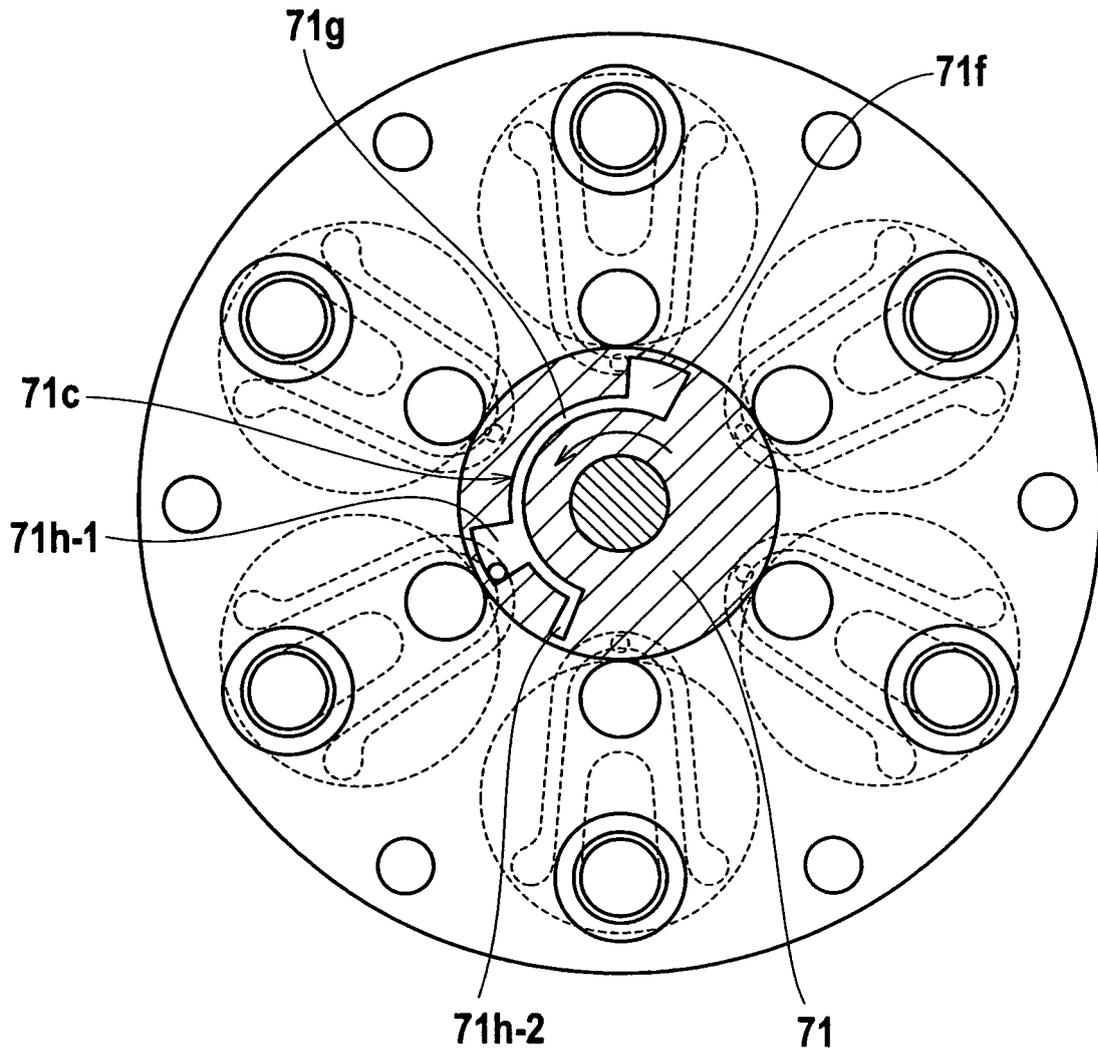


FIG. 10

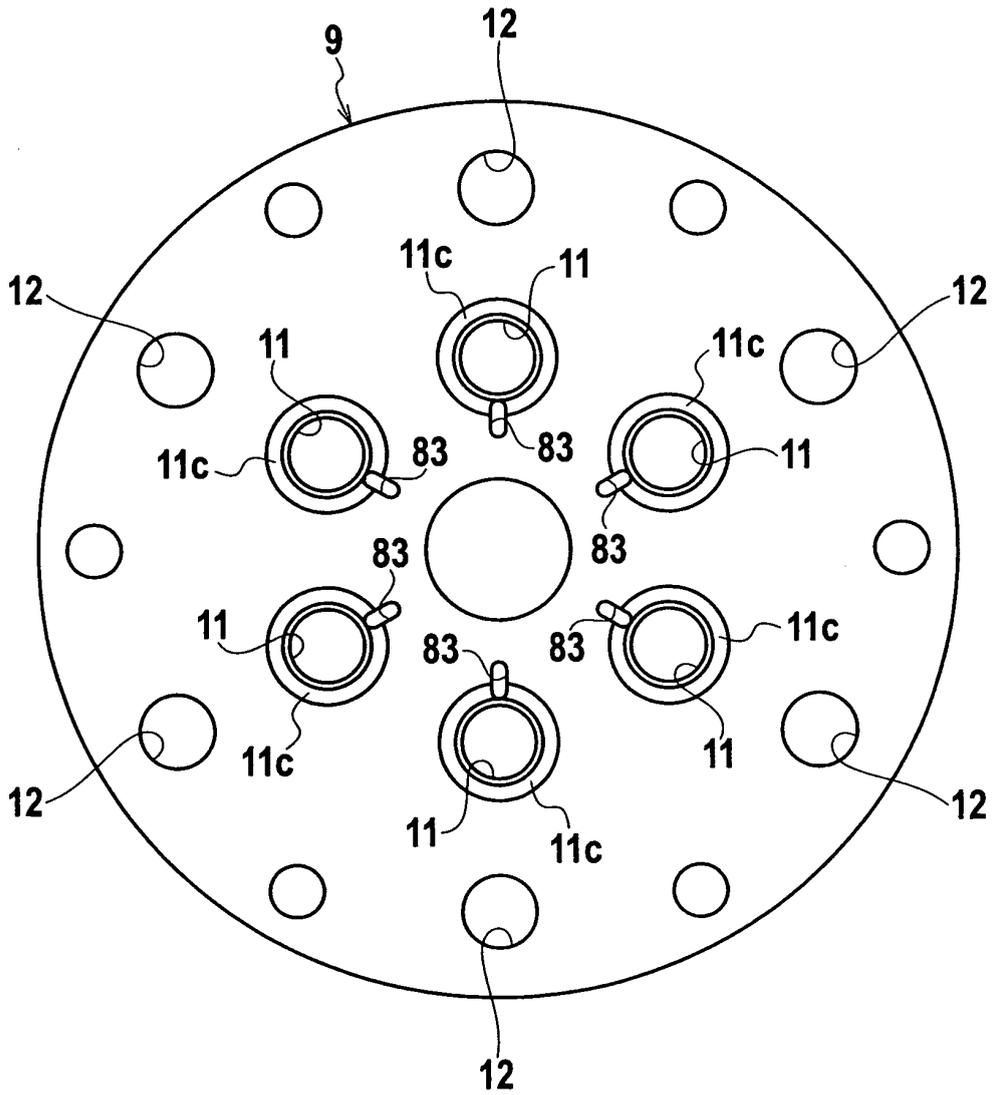
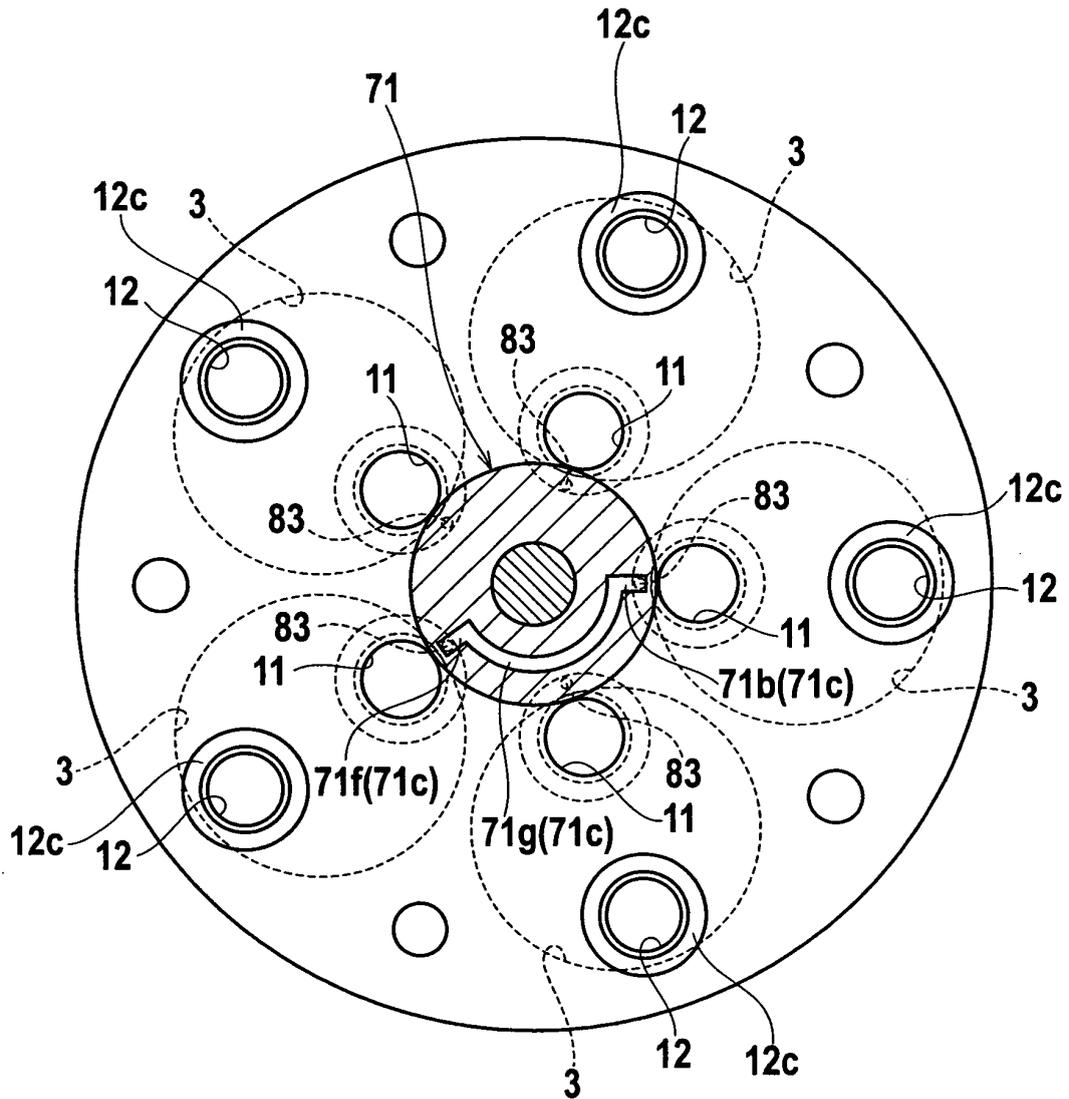


FIG. 11



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2007/064486

A. CLASSIFICATION OF SUBJECT MATTER F04B27/08(2006.01)i, F04B39/10(2006.01)i, F04B39/12(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) F04B27/08, F04B39/10, F04B39/12		
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 1996-2007 Kokai Jitsuyo Shinan Koho 1971-2007 Toroku Jitsuyo Shinan Koho 1994-2007		
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 2002-81381 A (Zexel Valeo Climate Control Corp.), 22 March, 2002 (22.03.02), Par. Nos. [0033], [0034], [0040] to [0042], [0049] to [0051]; Figs. 4 to 5 & US 2003/0091451 A1 & EP 1298322 A1 & WO 2001/098657 A1	1, 4
Y	JP 8-61239 A (Toyoda Automatic Loom Works, Ltd.), 08 March, 1996 (08.03.96), Par. Nos. [0025] to [0029], [0041]; Figs. 2 to 3 & US 5562425 A & DE 19530127 A1	1, 4
<input checked="" type="checkbox"/> Further documents are listed in the continuation of Box C. <input type="checkbox"/> See patent family annex.		
* Special categories of cited documents:		
"A" document defining the general state of the art which is not considered to be of particular relevance	"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	
"E" earlier application or patent but published on or after the international filing date	"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	
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"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	
"O" document referring to an oral disclosure, use, exhibition or other means	"&" document member of the same patent family	
"P" document published prior to the international filing date but later than the priority date claimed		
Date of the actual completion of the international search 20 August, 2007 (20.08.07)	Date of mailing of the international search report 04 September, 2007 (04.09.07)	
Name and mailing address of the ISA/ Japanese Patent Office	Authorized officer	
Facsimile No.	Telephone No.	

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2007/064486

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 5-231310 A (Toyoda Automatic Loom Works, Ltd.), 07 September, 1993 (07.09.93), Full text; Figs. 1 to 8 (Family: none)	1-5

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

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 2005163714 A [0002] [0043] [0044]