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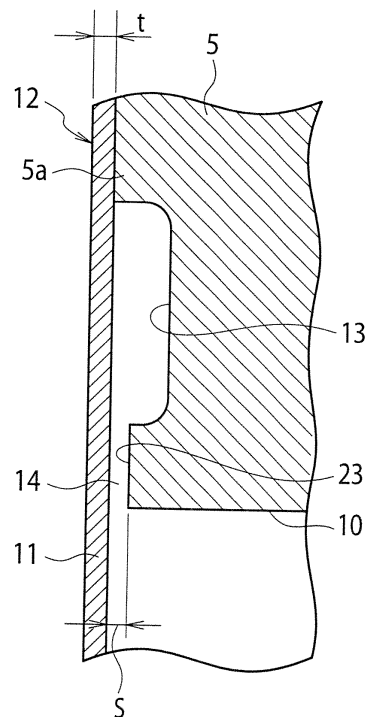
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(54) **COMPRESSOR**

(57) A compressor includes a front housing having a crank chamber therein, a cylinder block having a cylinder bore therein, a rear housing including a low-pressure chamber and a high-pressure chamber therein, a valve plate on which a suction hole for communicating the cylinder bore and the low-pressure chamber is formed, and a suction valve disk for opening and closing the suction hole. A predetermined gap width is provided between the suction valve disk and an opening edge of the suction hole, and the gap width is set to 13-15% of a thickness of the suction valve disk. By the compressor, fixation of the suction valve on the valve plate is prevented. Therefore, noise-and-vibration performance improves and thereby generation of undesired noises is prevented. Further, since the fixation of the suction valve on the valve plate is prevented, a desired volume of refrigerant is surely supplied into the cylinder bore.

FIG. 5



Description

TECHNICAL FIELD

[0001] The present invention relates to a compressor, especially, to a compressor that has a suction valve for opening and closing a suction hole of a valve plate.

BACKGROUND ART

[0002] In a Patent Document 1 listed below, a swash plate type variable capacity compressor is disclosed. In this swash plate type variable capacity compressor, a valve plate is provided between a cylinder block on which plural cylinder bores are formed and a rear housing in which a high-pressure chamber and a low-pressure chamber are formed. On the valve plate, formed are suction holes for communicating the cylinder bores with the low-pressure chamber. On a cylinder bore side of each suction hole, provided is a suction valve for opening and closing the suction hole. In addition, on the valve plate, formed are discharge holes for communicating the cylinder bores with the high-pressure chamber. On a high-pressure chamber side of each discharge hole, provided is a discharge valve for opening and closing the discharge hole.

[0003] Then, the suction valves are bent toward the cylinder bores due to a suctioning operation of pistons to open the suction holes, so that refrigerant is suctioned from the low-pressure chamber to the cylinder bores. In addition, the discharge valves are bent toward the high-pressure chamber due to a discharging operation of the pistons to open the discharge holes, so that high-pressure refrigerant in the cylinder bores is discharged to the high-pressure chamber.

[0004] A stroke displacement of the pistons changes according to a tilting angle of a swash plate, so that a capacity of refrigerant to be compressed changes. In addition, due to a rotation of the swash plate, suctioning refrigerant into the cylinder bores and compressing the refrigerant in the cylinder bores are sequentially done, and then the high-pressure refrigerant is discharged to the high-pressure chamber.

[0005] In the above-explained conventional variable capacity compressor, lubrication oil is mixed in refrigerant to keep lubricity within the compressor. Therefore, the lubrication oil infiltrates between an opening edge portion of the suction hole on the valve plate and the suction valve, so that it is concerned that the suction valve may be fixed on the valve plate. In this case, a desired volume of refrigerant cannot be suctioned into the cylinder bores upon suctioning. In addition, if the suction valve that had been fixed on the valve plate suddenly separates from the valve plate, noises may be generated.

[0006] Therefore, in a Patent Document 2, disclosed is a compressor in which suction valves are prevented from fixing on a valve plate by providing gaps between the suction valves and the valve plate.

[0007] However, in this compressor, since the gaps are provided between the suction valves and the valve plate, a use of extra parts or a complicated working process is needed and thereby its production cost may increase.

Prior Art Document

Patent Document

[0008]

Patent Document 1: Japanese Patent Application Laid-Open No. H7-103138

Patent Document 2: Japanese Patent Application Laid-Open No. 2005-42695

SUMMARY OF INVENTION

[0009] An object of the present invention is to provide a compressor that can supply a desired volume of refrigerant into a cylinder bore without a fixation of a suction vale on a valve plate and can be easily produced.

[0010] An aspect of the present invention provides a compressor that includes a front housing that has a crank chamber therein; a cylinder block that is fixed with the front housing and has a cylinder bore therein; a rear housing that is fixed with the cylinder block with interposing a valve plate therebetween and includes a low-pressure chamber and a high-pressure chamber therein; the valve plate that is provided between the cylinder block and the rear housing and on which a suction hole for communicating the cylinder bore and the low-pressure chamber is formed; and a suction valve disk that is attached on a side of the valve plate facing to the cylinder block and has a suction valve for opening and closing the suction hole, wherein a gap with a predetermined width is provided between the suction valve disk and an opening edge portion of the suction hole, and the width of the gap is set to 13 to 15% of a thickness of the suction valve disk.

[0011] According to the aspect, the gap is provided between the opening edge portion of the suction hole and the suction valve and the width of the gap is set to 13 to 15% of the thickness of the suction valve disk, so that a fixation of the suction valve on the valve plate can be prevented. Therefore, noise-and-vibration performance can improve and thereby generation of undesired noises can be prevented. In addition, since the fixation of the suction valve on the valve plate can be prevented, a desired volume of refrigerant can be surely supplied into the cylinder bore.

[0012] Note that it is preferable that the width of the gap is 0.065 to 0.175mm when it is presented not as a relative value to the thickness of the suction valve disk but as an absolute value. According to this, the above-explained advantages can be achieved.

[0013] Here, it is preferable that a groove is provided outside the opening edge portion. According to this, the

fixation of the suction valve on the valve plate can be further prevented by introducing refrigerant gas into the groove.

[0014] Further here, it is preferable that the gap is formed by a press working. According to this, it can be easily produced without using extra parts and can reduce a production cost.

BRIEF DESCRIPTION OF DRAWINGS

[0015]

[Fig. 1] is an overall cross-sectional view of a compressor according to an embodiment.

[Fig. 2] is an enlarged cross-sectional view showing a valve plate, suction valves and discharge valves in the embodiment.

[Fig. 3] is a plan view of the valve plate and the suction valves.

[Fig. 4] (a) is a plan view of the valve plate, and (b) is an enlarged cross-sectional view taken along a line IVB-IVB shown in (a).

[Fig. 5] is an enlarged cross-sectional view of the valve plate and the suction valve.

[Fig. 6] is a graph chart showing noise-and-vibration performance and compression performance with respect to a gap width between the suction valve and an opening edge portion on the valve plate.

DESCRIPTION OF EMBODIMENTS

[0016] Hereinafter, an embodiment will be explained with reference to the drawings. As shown in Fig. 1, a compressor 100 includes a housing 1, a valve plate 5 and a suction valve disk 12. The valve plate 5 is assembled in the housing 1. The suction valve disk 12 includes suction valves 11 for opening and closing suction holes 10 that communicate with a low-pressure chamber 8. The suction holes 10 are provided closer to a center of the valve plate 5, and discharge holes 16 are provided closer to an outer circumference of the valve plate 5 (see Fig. 5).

[0017] The housing 1 is comprised of a front housing 2, a cylinder block 3 and a rear housing 4. A crank chamber 6 is formed in the front housing 2. The cylinder block 3 is fixed with the front housing 2. Plural cylinder bores 7 are arranged in the cylinder block 3. The rear housing 4 is fixed with the cylinder block 3, and includes the low-pressure chamber 8 for suctioning refrigerant and a high-pressure chamber 9 for discharging compressed refrigerant.

[0018] The six cylinder bores 7 are formed in the cylinder block 3 along its circumferential direction. The plural cylinder bores 6 are formed about a drive shaft 30 at even intervals. Pistons 31 each of which is reciprocated are accommodated in the cylinder bores 7, respectively. The pistons 31 are coupled with a swash plate 32 that rotates in the crank chamber 6.

[0019] In the rear housing 4, formed are the low-pres-

sure chamber 8 and the high-pressure chamber 9 for refrigerant gas. The low-pressure chamber 8 is connected to an outlet side of a not-shown evaporator on a refrigeration cycle. The high-pressure chamber 9 is connected to an inlet side of a not-shown condenser on the refrigeration cycle. In addition, the valve plate 5 is provided between the cylinder bores 7 and the rear housing 4.

[0020] The suction holes 10 are formed closer to the center on the valve plate 5 with associated with the six cylinder bores 7, and the suction holes 16 are formed closer to the outer circumference. As explained above, the suction holes 10 is opened and closed by the suction valves 11, and the discharge holes 11 are opened and closed by the discharge valves 17.

[0021] At an end of the front housing 2 that is not a connection end with the cylinder block 3, a drive mechanism 33 is rotatably supported. In the drive mechanism 33, a pulley 34 that receives a drive force from a not-shown engine is supported via a bearing 35, and an end of the drive shaft 30 is rotatably supported. The pulley 34 and the drive shaft 30 are engaged and disengaged by a magnetic clutch.

[0022] In a compression mechanism 36, the drive shaft 30 provides so as to penetrate the crank chamber 6. As explained above, the drive shaft 30 is rotated by receiving the drive force from the pulley 34.

[0023] A lug plate 37 is provided in the crank chamber 6, and integrally fixed with the drive shaft 30. A journal 39 to which the swash plate 32 is fixed is attached to the drive shaft 30. The lug plate 37 and the journal 39 are coupled with each other via a link mechanism 38. Due to a rotation of the drive shaft 30, the lug plate 37 transfers the drive force to the journal 39 through the link mechanism 38. The pistons 31 are coupled to a circumference of the swash plate 32 that is fixed with the journal 39, and the pistons 32 reciprocate due to the rotation of the drive shaft 30. Refrigerant is compressed by the reciprocation of the pistons 31.

[0024] Next, the valve plate 5 and the suction valve disk 12 will be explained in detail with reference to Figs. 2 to 6.

[0025] As shown in Fig. 5(a), the valve plate 5 is a circular plate, and the six discharge holes 16 are formed closer to its outer circumference at even intervals along its circumferential direction. These discharge holes 16 communicate the six cylinder bores 7 in the cylinder block 3 with the high-pressure chamber 9 in the rear housing 4. In addition, the six suction holes 10 are formed, on an inward side of the six discharge holes 16, at even intervals along its circumferential direction. These suction holes 10 communicate the six cylinder bores 7 in the cylinder block 3 with the low-pressure chamber 8 in the rear housing 4.

[0026] In addition, as shown in Fig. 2, the suction valve disk 12 is provided on one side of the valve plate 5 facing to the cylinder block 3, and a discharge valve disk 22 is provided on another side of the valve plate 5 facing to

the rear housing 4. The suction valve disk 12 opens the suction hole(s) 10 when suctioning refrigerant into the cylinder bore (s) 7, and closes the suction hole(s) 10 when compressing refrigerant in the cylinder bore(s) 7. In addition, the discharge valve disk 22 opens the discharge hole (s) 16 when compressing refrigerant in the cylinder bore (s) 7, and closes the discharge hole (s) 16 when suctioning refrigerant into the cylinder bore(s) 7.

[0027] As shown in Fig. 3, the suction valve disk 12 is constituted by a circular thin plate-shaped disk base 15, the suction valves 11 provided along a circumferential direction of the disk base 15 at even intervals, and communication holes 19 that are communicated with the discharge holes 16 on the valve plate 5. The suction valve 10 is comprised of a valve body 18 provided at an inward of a U-shaped slit 20 and a pair of bridging portions 21 that connects the valve body 18 with the disk base 15 between the communication hole 19 and the slit 20.

[0028] As shown in Fig. 5, a gap 14 having a predetermined width is formed between the suction valve disk 12 and an opening edge portion 23 of the suction hole 10. The width S of this gap 14 is set to 13 to 15% of a thickness t of the suction valve disk 12. The gap 14 is formed by reducing a thickness of the opening edge portion 23 smaller than that of a base portion 5a of the valve plate 5. In addition, the gap 14 is set within a range of the predetermined width 0.065 to 0.175mm.

[0029] In addition, as shown in Figs. 2 and 4, a groove 13 surrounding the suction hole 10 is formed around the suction hole 10. The opening edge portion 23 is formed between the groove 13 and the suction hole 10. A thickness of the valve plate 5 associated with the groove 13 is smaller than the thickness of the opening edge portion 23.

[0030] The predetermined width 0.065 to 0.175mm of the gap 14 will be explained with reference to a graph chart shown in Fig. 6. Fig. 6 shows measurement results under a representative condition about noise-and-vibration performance and compressor performance with respect to the width S of the gap 14. Its horizontal axis refers to the width S of the gap 14, its vertical right axis refers to noise-and-vibration performance as pulsation (ΔP_s), and its vertical left axis refers to compressor performance (Gr). A line A indicates a criterion for noise-and-vibration performance, and a line B indicates a criterion for compressor performance. In addition, a line C indicates a measurement result of noise-and-vibration performance of the suction valve 11, and a line D indicates a measurement result of compressor performance.

[0031] A portion of the line C beyond the noise-and-vibration performance criterion A doesn't meet the performance criterion, so that generated noises and vibrations may become problems. In addition, a portion of the line C below the noise-and-vibration performance criterion A meets the performance criterion, so that generated noises and vibrations may not become problems. Therefore, where the line C runs above the noise-and-vibration performance criterion A, i.e. when the width S is less than

0.065mm, the noise-and-vibration performance may have problems. But, when the width S is not less than 0.065mm, the noise-and-vibration performance may not have problems. As a result, a minimum value for the width S of the gap 14 is determined, so that the minimum width S of the gap 14 between the suction valve 11 and the opening edge portion 23 is set to 0.065mm.

[0032] Meanwhile, a portion of the line D located beyond the compressor performance criterion B meets the performance criterion, so that a desired volume of refrigerant can be supplied into the cylinder bores 7. In addition, a portion of the line D below the compressor performance criterion B doesn't meet the performance criterion, so that the desired volume of refrigerant cannot be supplied into the cylinder bores 7. Therefore, where the line C runs under the compressor performance criterion B, i.e. when the width S is more than 0.175mm, the compressor performance may have problems. But, when the width S is not more than 0.175mm, the compressor performance may not have problems. As a result, a maximum value for the width S of the gap 14 is determined, so that the maximum width S of the gap 14 between the suction valve 11 and the opening edge portion 23 is set to 0.175mm.

[0033] Therefore, the predetermined width S of the gap 14 is set within a range of 0.065 to 0.175mm, the noise-and-vibration performance and the compressor performance can be met and the fixation of the suction valves 11 on the valve plate 5 can be prevented.

[0034] Next, explained will be a case where the predetermined width S of the gap 14 is presented by a ratio to a thickness t of the valve plate 5 (13 to 15% in the present embodiment).

[0035] The range of the predetermined width S of the gap 14 is set in the range within 0.065 to 0.175mm as explained above. A minimum value of the thickness t of the valve plate 5 (i.e. a minimum thickness required for functioning as the valve plate 5) is generally 0.3mm. In addition, a maximum value of the thickness t of the valve plate 5 (i.e. a maximum thickness capable of being installed in a compressor) is considered 0.5mm as a common sense. Therefore, a ratio (S/t) of the minimum value 0.065mm of the predetermined width S to the maximum value 0.5mm of the thickness t is about 13%. In addition, a ratio (S/t) of the maximum value 0.175mm of the predetermined width S to the minimum value 0.3mm of the thickness t is about 50%.

[0036] As a result, the width S of this gap 14 between the suction valve disk 12 and the opening edge portion 23 of the suction hole 10 on the valve plate 5 is set to 13 to 15% of the thickness t of the suction valve disk 12.

[0037] Next, operations of the compressor according to the present embodiment will be explained (see Fig. 1).

[0038] In a state where the piston 31 doesn't reciprocate in the cylinder bore 7 (i.e. a state where a suction/discharge operation is not done: a state where the piston is positions at its TDC or BDC or a state where the swash plate 32 is not substantially tilted), the suction hole 10

is closed by the suction valve 11 on the side of valve plate 5 facing to the cylinder block 3. Mean while, the discharge hole 16 is closed by the discharge valve 17 on the other side facing to the rear housing 4.

[0039] When the piston 31 starts its compression process in the cylinder bore 7 from the above state, compressed high-pressure refrigerant elastically bends the discharge valve 17 to open the discharge hole 16, and then is discharged from the cylinder bore 7 to the high-pressure chamber 9. When the compression of refrigerant finishes, the discharge valve 17 reverts back to its normal shape to close the discharge hole 16. Subsequently, when the piston 31 starts its suction process in the cylinder bore 7, to-be-suctioned low-pressure refrigerant elastically bends the bridging portions 21 of the suction valve 11 to open the suction hole 10, and then is suctioned from the low-pressure chamber 8 to the cylinder bore 7.

[0040] According to the present embodiment, the gap 14 is provided between the opening edge portion 23 of the suction hole 10 and the suction valve 11 and the gap 14 is set with the range of 13 to 15% of the thickness of the suction valve disk 12 (0.065 to 0.175mm), so that the fixation of the suction valve 11 on the valve plate 5 can be prevented. Therefore, noise-and-vibration performance can improve and thereby generation of undesired noises can be prevented. In addition, since the fixation of the suction valve 11 on the valve plate 5 can be prevented, the desired volume of refrigerant can be surely supplied into the cylinder bores 7.

[0041] In addition, since the groove 13 is provided outside the opening edge portion 23, the fixation of the suction valve 11 on the valve plate 5 can be further prevented by introducing refrigerant gas into the groove 13.

[0042] Further, since the gap 14 is formed by a press working, it can be easily produced without using extra parts and can reduce a production cost. In this case, since the groove 13 can become a space for receiving an extruded volume upon forming the gap 14 by a press working, the extruded volume can be prevented from heaving on a valve seat surface by forming the groove 13.

[0043] Note that, the groove 13 is provided on the side of the valve plate 5 facing to the suction valve 11 and the gap 14 is provided at the opening edge portion 23 between the suction hole 10 and the groove 13, as explained above. Similarly, an opening edge portion and a groove may be provided on the other side of the valve plate 5 facing to the discharge valve 17 (see Fig. 2).

[0044] In addition, the six cylinder bores 7 are formed in the cylinder block 3 in the present embodiment, the number of them may not be six. The number of the cylinder bores 7 may be five, seven or the other.

a front housing that has a crank chamber therein;

a cylinder block that is fixed with the front housing and has a cylinder bore therein;

a rear housing that is fixed with the cylinder block with interposing a valve plate therebetween and includes a low-pressure chamber and a high-pressure chamber therein;

the valve plate that is provided between the cylinder block and the rear housing and on which a suction hole for communicating the cylinder bore and the low-pressure chamber is formed; and

a suction valve disk that is attached on a side of the valve plate facing to the cylinder block and has a suction valve for opening and closing the suction hole, wherein

a gap with a predetermined width is provided between the suction valve disk and an opening edge portion of the suction hole, and the width of the gap is set to 13 to 15% of a thickness of the suction valve disk.

2. The compressor according to claim 1, wherein the width of the gap is 0.065 to 0.175mm.
3. The compressor according to claim 1 or 2, wherein a groove is provided outside the opening edge portion.
4. The compressor according to any one of claims 1 to 3, wherein the gap is formed by a press working.

Claims

1. A compressor comprising:

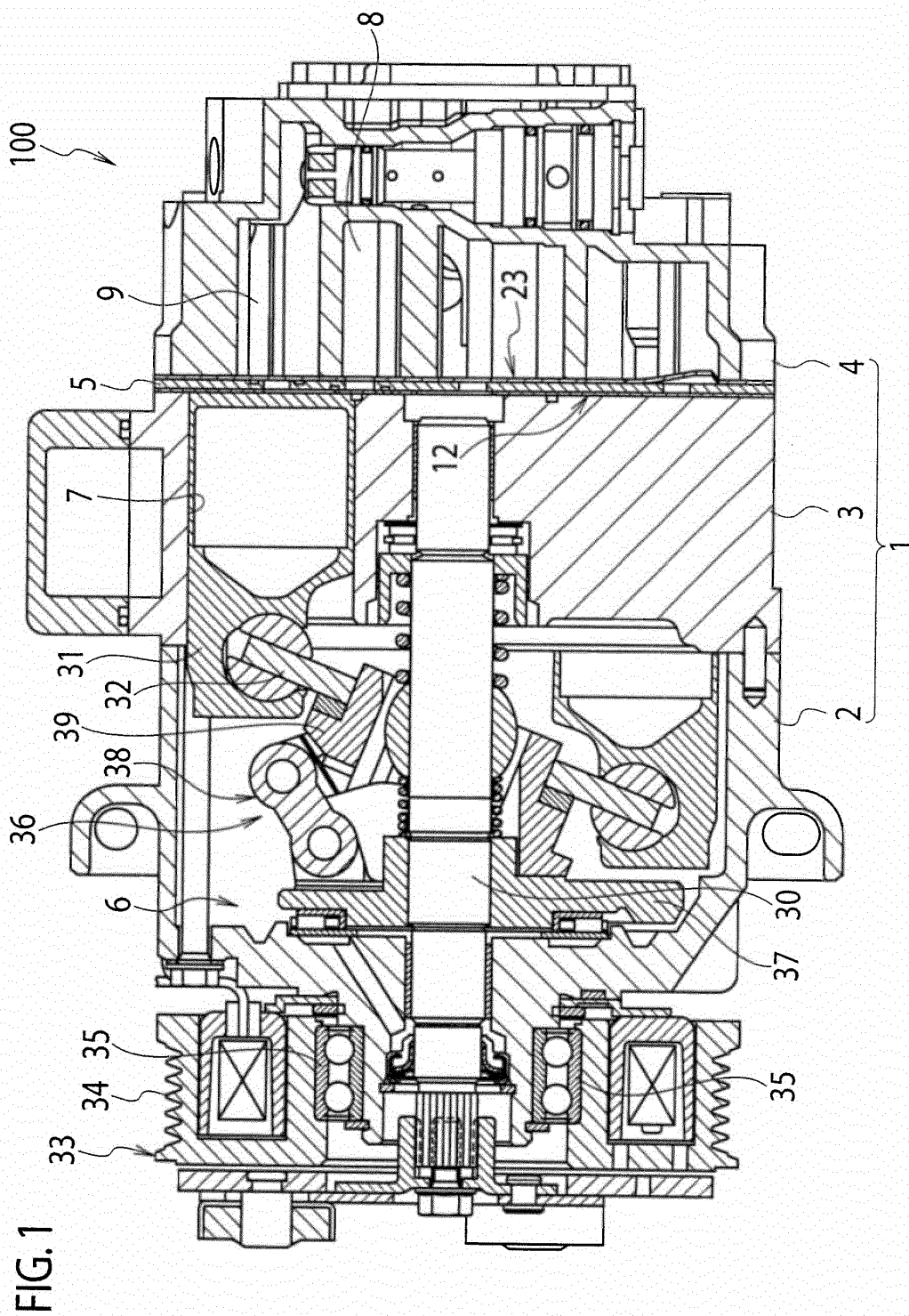


FIG. 2

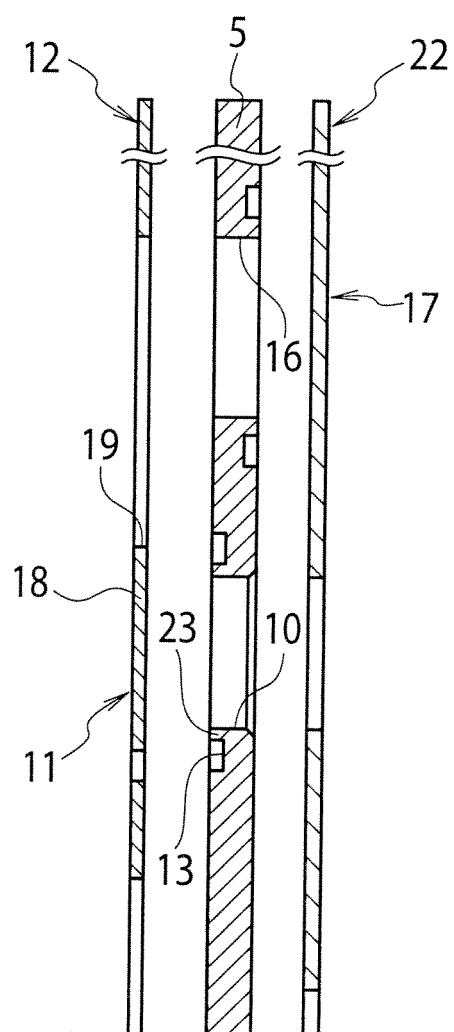


FIG. 3

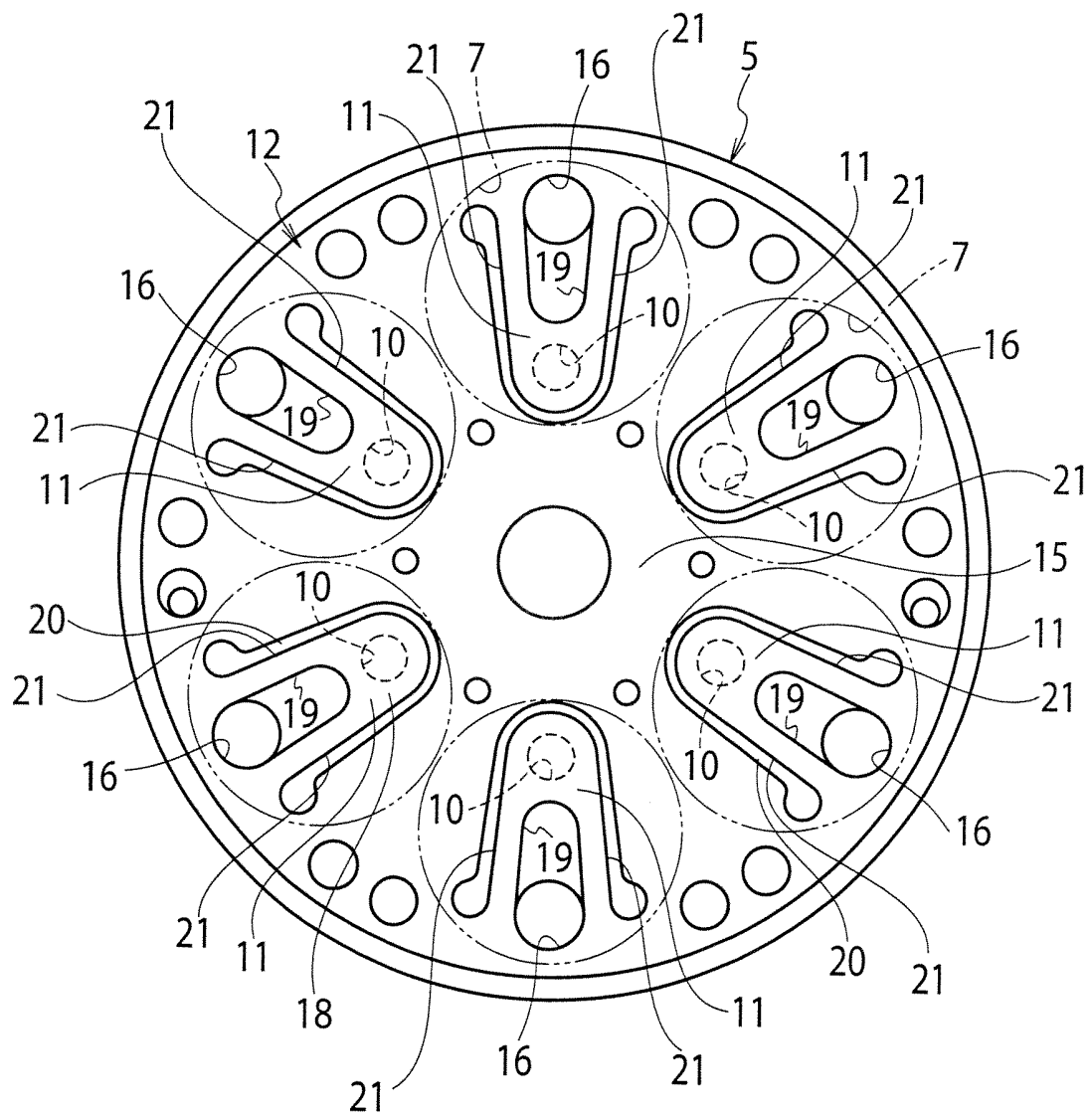


FIG. 4

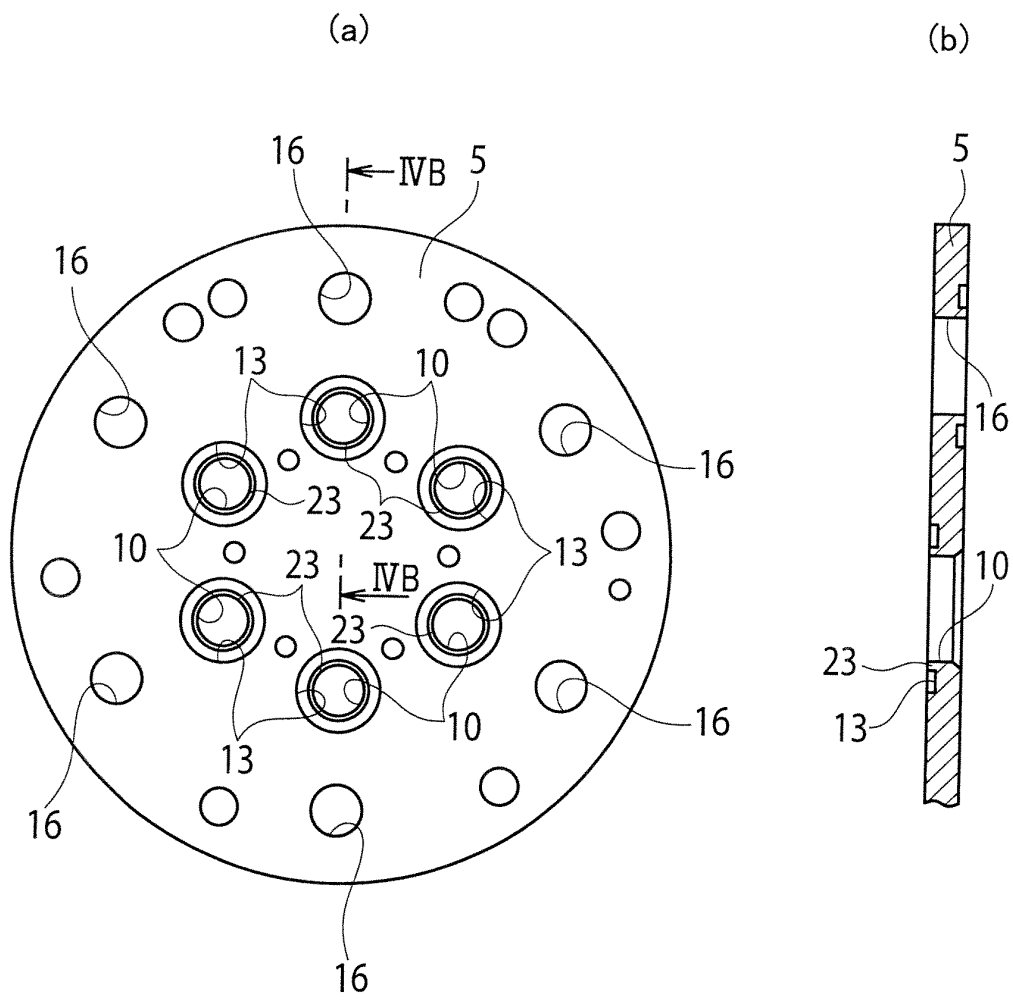


FIG. 5

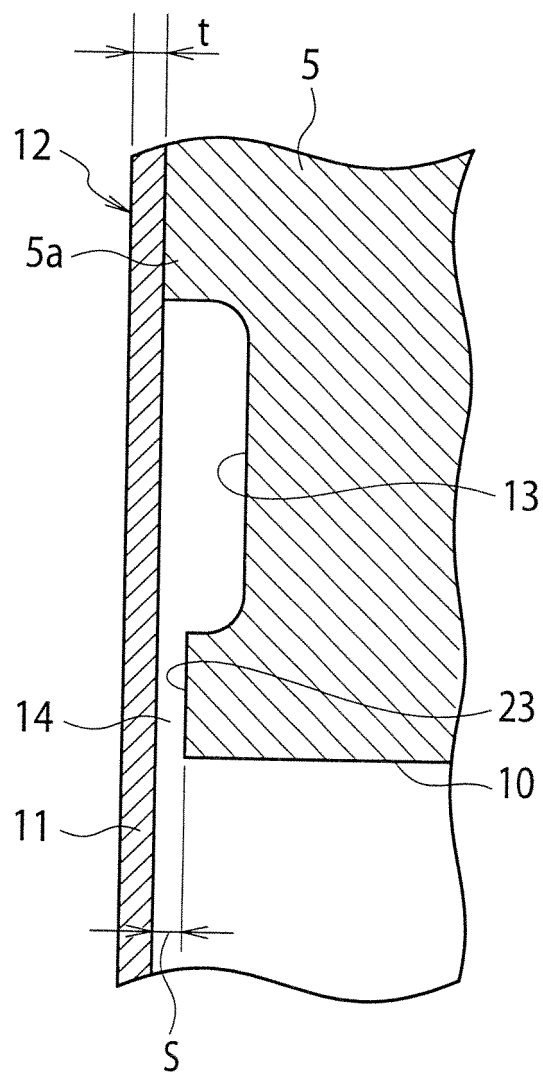
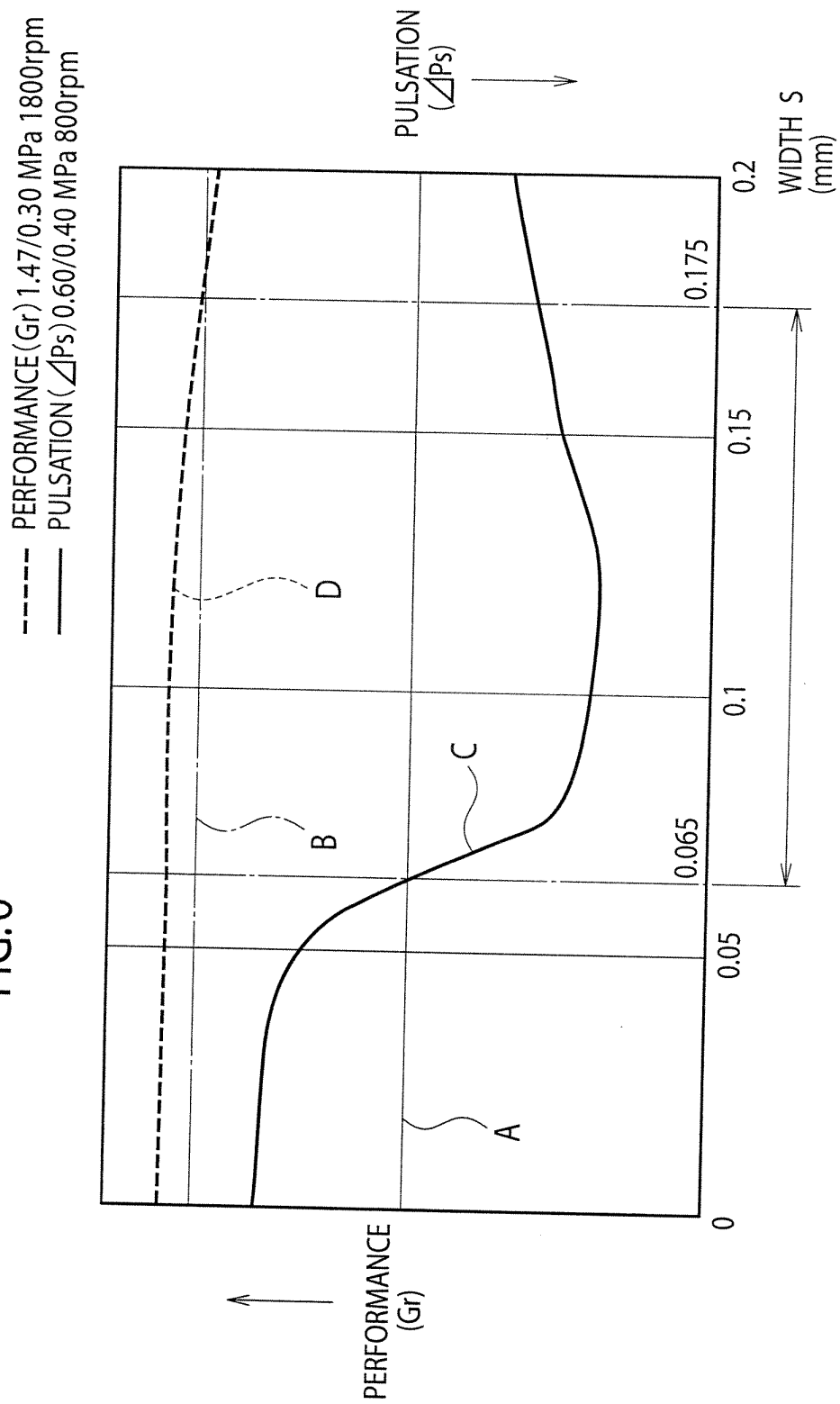


FIG. 6



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2010/067854

A. CLASSIFICATION OF SUBJECT MATTER <i>F04B39/10</i> (2006.01) i, <i>F04B27/08</i> (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) <i>F04B39/10</i> , <i>F04B27/08</i> 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 1996-2011 Kokai Jitsuyo Shinan Koho 1971-2011 Toroku Jitsuyo Shinan Koho 1994-2011 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 2005-42695 A (Calsonic Kansei Corp.), 17 February 2005 (17.02.2005), paragraphs [0034], [0035], [0061] to [0064]; fig. 2, 8 & US 2006/0280617 A1 & WO 2005/033510 A1 & KR 10-2006-0096003 A & CN 1860295 A	1-4
Y	JP 2008-95522 A (Sanden Corp.), 24 April 2008 (24.04.2008), paragraph [0026]; fig. 4, 5 (Family: none)	1-4
Y	JP 2000-27760 A (Career Corp.), 25 January 2000 (25.01.2000), paragraphs [0025] to [0028]; fig. 1 to 3 & US 6565336 B1 & EP 955463 A2	1-4
☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.		
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Date of the actual completion of the international search 04 January, 2011 (04.01.11)		Date of mailing of the international search report 18 January, 2011 (18.01.11)
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INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2010/067854

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 2005-291031 A (Calsonic Kansei Corp.), 20 October 2005 (20.10.2005), entire text; all drawings (Family: none)	1-4

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REFERENCES CITED IN THE DESCRIPTION

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