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(72) Inventors:
• **UNE, Katsutaka**
Saitama, 360-0193 (JP)
• **SUZUKI, Kentaro**
Saitama, 360-0193 (JP)
• **TAKAHASHI, Hideyuki**
Saitama, 360-0193 (JP)

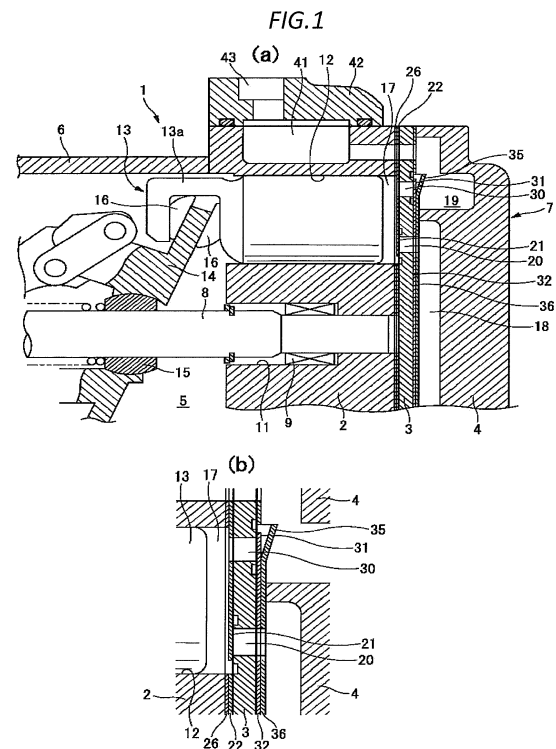
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(74) Representative: **Tran, Chi-Hai**
Valeo Systèmes Thermiques
8, rue Louis Lormand
CS 80517 La Verrière
78322 Le Mesnil Saint Denis Cedex (FR)

(71) Applicant: **Valeo Japan Co., Ltd.**
Kumagaya-shi, Saitama 360-0193 (JP)

(54) **RECIPROCATING COMPRESSOR SUCTION VALVE STRUCTURE AND RECIPROCATING COMPRESSOR**

(57) A reed valve used as a suction valve (21) of a reciprocating compressor (1) has a tongue-form arm portion (23), an outer side form of the arm portion (23) is formed of a slit portion (24) provided in a suction valve sheet (22), and an inner side form of the arm portion (23) is formed of an aperture portion (25) provided in the suction valve sheet (23). An outer side reference line (L2) that coincides with the outer side form and an inner side reference line (L3) that coincides with the inner side form are caused to incline so as to intersect with a central line (L4) of the arm portion (23) that passes through both a central point (P2) of a cylinder bore (12) and a central point (P3) of a suction port (20), whereby a width of a base side (24c) of the arm portion (23) is greater than a width of a leading end side (24a). Furthermore, an angle (R1) of inclination of the outer side reference line (L2) from the central line (L4) is a predetermined value or more greater than an angle (R2) of inclination of the inner side reference line (L3) from the central line (L4).



Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a reciprocating compressor used in, for example, a vehicle-use air conditioner refrigeration cycle, and in particular, to a suction valve structure wherein a reed valve is used as a suction valve that opens and closes a suction port.

2. Description of the Related Art

[0002] A reciprocating compressor including a cylinder block in which a cylinder bore is formed, a piston that performs a linear reciprocating motion in the cylinder bore, a cylinder head, provided on a side opposite to a side on which the piston of the cylinder block is inserted, in which a suction chamber and a discharge chamber in which a working fluid is temporarily housed are formed segregated, and a valve plate disposed between the cylinder block and the cylinder head, is publicly known, as shown in, for example, Patent Literature 1 and 2.

[0003] This kind of configuration is such that the cylinder bore communicates with each of the suction chamber and the discharge chamber via a port provided in the valve plate. A reed valve having a tongue-form arm portion, which has elasticity and excellent ease of assembly and productivity, is used as a valve body (a suction valve and a discharge valve) that opens and closes each port, as shown in, for example, Patent Literature 1 and 2. When a reed valve having a tongue-form arm portion is used as the suction valve, a working fluid such as a refrigerant gas that has passed through the suction port flows through a narrow gap between the suction valve and the valve plate, because of which a channel is limited.

[0004] As a method of reducing suction resistance when taking in this kind of working fluid, reducing spring rigidity of the suction valve by reducing width on a base side of the suction valve, or lengthening a longitudinal direction dimension of the suction valve, is mainstream, as shown in, for example, Patent Literature 2.

[0005] Meanwhile, in recent years, causing a vehicle-use variable capacity type of reciprocating compressor to operate at high speed is being demanded in order to obtain a necessary capability.

Patent Literature 1: JP-A-2000-54961

Patent Literature 2: Utility Model Registration No. 2,587,085

[0006] However, when the reciprocating compressor is caused to operate at high speed in a state wherein the suction valve spring rigidity is low when a reed valve having a tongue-form arm portion is used as the suction valve, a speed at which a leading end comes into contact with a valve seat, and by extension an impact, increases

when, for example, the suction valve moves in a direction such as to open the suction port, and a speed at which a leading end comes into contact with the valve plate, and by extension an impact, increases when the suction valve moves in a direction such as to close the suction port. Moreover, a secondary deformation after the suction valve has come into contact with the valve seat also increases. Because of this, a problem arises in that damage such as cracking of the leading end of the suction valve arm portion is liable to occur.

SUMMARY OF THE INVENTION

[0007] The invention, having been devised in order to resolve the heretofore described problem, has an object of providing a reciprocating compressor suction valve structure, and a reciprocating compressor in which the suction valve structure is used, such that reliability of the suction valve can be ensured, even when a reed valve is used as the suction valve and the reciprocating compressor is operated at high speed.

[0008] In order to achieve the heretofore described object, a reciprocating compressor suction valve structure of the invention is such that, in a reciprocating compressor that has a suction port such that an exit end opens on to a compression chamber formed in a cylinder bore and the exit end is blocked so as to be openable and closable by a suction valve, and a discharge port such that an entrance end opens on to the compression chamber and an exit end is blocked so as to be openable and closable by a discharge valve, and a reed valve is used as the suction valve, the suction valve has a tongue-form arm portion, an outer side form of the arm portion is formed by a slit portion formed of one leading end portion, one pair of base portions, and one pair of intermediate portions between the leading end portion and the base portion being provided in a suction valve sheet, an inner side form of the arm portion is formed by an aperture portion of a long hole form extending from a vicinity of a peripheral edge of the suction valve sheet toward a central point side of the cylinder bore being provided between one intermediate portion and base portion of the slit portion of the suction valve sheet and the other intermediate portion and base portion, an outer side reference line that coincides with an intermediate portion of the slit portion of the outer side form and an inner side reference line that coincides with an edge of the aperture portion of the inner side form opposing in a lateral direction are each caused to incline so as to intersect with a central line of the arm portion that passes through both a central point of the cylinder bore and a central point of the suction port, whereby a width of a base side of the arm portion is greater than a width of a leading end side, and furthermore, an angle of inclination of the outer side reference line is a predetermined value or more greater than an angle of inclination of the inner side reference line (claim 1). Herein, the base of the arm portion is a position on a reference line that passes through a side of one base portion of the

slit portion and the other base portion opposite to that of the leading end side, and is parallel to the leading end portion, and the base of an arm portion described hereafter is the same. Also, the predetermined value of a difference between the angles of inclination of the outer side reference line and the inner side reference line is, for example, 8 degrees.

[0009] In this way, the outer side form and the inner side form of the arm portion of the suction valve are such that by setting the angle of inclination of the outer side reference line to be a predetermined value or more greater than the angle of inclination of the inner side reference line, rigidity of the base of the arm portion of the suction valve is increased, rendering the arm portion of the suction valve less likely to warp, compared with when the width between the outer side form and the inner side form does not change between the base side and the leading end side, or when the width is less than a predetermined value. Because of this, an opening and closing speed of the suction port can be reduced even when a reed valve is used as the suction valve, because of which a speed at which the leading end of the arm portion of the suction valve comes into contact with a valve plate or a valve seat, and by extension an impact, can be reduced. Furthermore, a secondary deformation after the leading end of the arm portion of the suction valve has come into contact with the valve seat can be prevented. Because of this, damage to the leading end of the arm portion of the reed valve is prevented, and reliability of the suction valve is ensured even when the reciprocating compressor is operated at high speed. Also, by the speed at which the leading end of the arm portion of the suction valve comes into contact with the valve plate or the valve seat decreasing, noise of the reciprocating compressor can also be reduced.

[0010] Also, a reciprocating compressor suction valve structure of the invention is such that, in a reciprocating compressor that has a suction port such that an exit end opens on to a compression chamber formed in a cylinder bore and the exit end is blocked so as to be openable and closable by a suction valve, and a discharge port such that an entrance end opens on to the compression chamber and an exit end is blocked so as to be openable and closable by a discharge valve, and a reed valve is used as the suction valve, the suction valve has a tongue-form arm portion, an outer side form of the arm portion is formed by a slit portion formed of one leading end portion, one pair of base portions, and one pair of intermediate portions between the leading end portion and the base portion being provided in a suction valve sheet, an inner side form of the arm portion is formed by an aperture portion of a long hole form extending from a vicinity of a peripheral edge of the suction valve sheet toward a central point side of the cylinder bore being provided between one intermediate portion and base portion of the slit portion of the suction valve sheet and the other intermediate portion and base portion, and the arm portion is such that when comparing a width direction dimension from an end

of the base portion of the slit portion on a side opposite to that of the intermediate portion to a central line of the arm portion that passes through both a central point of the cylinder bore and a central point of the suction port and a length direction dimension from a position in which a reference line that passes through ends of both base portions of the slit portion on the side opposite to that of the intermediate portion and the central line intersect to an end of the central line on a leading end side of the arm portion, the length direction dimension is greater than the width direction dimension, but approximates the width direction dimension (claim 2). Herein, a numerical value when comparing the width direction dimension and the length direction dimension of the arm portion of the suction valve is, for example, 1:1.8 or less.

[0011] By the length direction dimension of the arm portion of the suction valve being longer than, but caused to approximate, the width direction dimension in this way, the rigidity of the base of the arm portion of the suction valve is increased, rendering the arm portion of the suction valve less likely to warp, compared with when the difference in length between the length direction dimension and the width direction dimension of the arm portion of the suction valve is large. Because of this, the opening and closing speed of the suction port can be reduced even when a reed valve is used as the suction valve, because of which the speed at which the leading end of the arm portion of the suction valve comes into contact with the valve plate or the valve seat, and by extension an impact, can also be reduced. Furthermore, a secondary deformation after the leading end of the arm portion of the suction valve has come into contact with the valve seat can be prevented. Because of this, damage to the leading end of the arm portion of the suction valve is prevented, and reliability of the suction valve is ensured even when the reciprocating compressor is operated at high speed. Also, by the speed at which the leading end of the arm portion of the suction valve comes into contact with the valve plate or the valve seat decreasing, noise of the reciprocating compressor can also be reduced.

[0012] The reciprocating compressor suction valve structure according to claim 3 is characterized in that the slit portion is such that widths of lateral direction gaps of the leading end portion and the intermediate portion are formed consistently or practically consistently to a predetermined numerical value, and the base portion is formed in a circular form, because of which a width of a gap of the base portion is greater than the widths of the lateral direction gaps of the leading end portion and the intermediate portion. Herein, the predetermined numerical value is, for example, 2mm. Of course, not being limited to a case wherein a lateral direction groove width in the intermediate portion of the slit portion is consistent at, for example, 2mm while a lateral direction groove width in the leading end portion is consistent at, for example, 2mm, the lateral direction groove width in the leading end portion may be consistent in a range of 1.6mm to 1.7mm. In this case, the widths may be displaced in a

boundary region between the intermediate portion and the leading end portion of the slit portion, because of which the widths are consistent or practically consistent.

[0013] By the lateral direction groove widths of the leading end portion and the intermediate portion of the slit portion being consistent or practically consistent at widths of a predetermined numerical value in this way, dead volume due to the slit portion can be reduced in comparison with when the lateral direction groove width of the slit portion is large, because of which an improvement in compressor performance is achieved. Also, by the base portion being formed in a circular form, work of removing burr occurring in the base portion due to a shearing process becomes easier, and work of reliably removing burr using a mechanical process such as barrel polishing can be carried out. Furthermore, by the base portion of the slit portion being of a circular form, cracking occurring in the base portion can be prevented even when the arm portion of the suction valve warps, unlike a case wherein the base portion is of a form having an angle.

[0014] The reciprocating compressor suction valve structure according to claim 4 is characterized in that the arm portion is such that a position in which a reference line that passes through ends of both base portions of the slit portion on a side opposite to that of the intermediate portion and the central line intersect is in proximity to a center of the cylinder bore.

[0015] Because of this, the position of the base of the arm portion of the suction valve can be brought nearer to the center of the cylinder bore than in an existing suction valve, because of which the length direction dimension of the arm portion of the suction valve is reduced, the rigidity of the arm portion of the suction valve is further increased, and the reliability of the suction valve when the reciprocating compressor is operated at high speed can be further increased.

[0016] A reciprocating compressor according to claim 5 is characterized by having the suction valve structure according to any of claim 1 to claim 4. The reciprocating compressor is used in, for example, a refrigeration cycle of a vehicle-use air conditioner.

[0017] According to the invention, as heretofore described, an opening and closing speed of a suction port can be reduced, even when a reed valve is used as a suction valve, by increasing rigidity of a base of an arm portion of the suction valve, rendering the arm portion of the suction valve less likely to warp. Because of this, a speed at which a leading end of the arm portion of the suction valve comes into contact with a valve plate or a valve seat, and by extension an impact, can be reduced. Furthermore, a secondary deformation after the leading end of the arm portion of the suction valve has come into contact with the valve seat can be prevented. Because of this, damage to the leading end of the arm portion of the suction valve is prevented, and reliability of the suction valve is ensured even when a reciprocating compressor is operated at high speed. Further, as the speed

at which the leading end of the arm portion of the suction valve comes into contact with the valve plate or the valve seat decreases, a reduction in noise of the reciprocating compressor can also be achieved.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018]

Fig. 1A is a sectional view showing one portion of a reciprocating compressor including a suction valve structure according to the invention, and Fig. 1B is an enlarged sectional view of a suction valve and the like of the reciprocating compressor.

Fig. 2A is a drawing showing an end face on a cylinder block side of a valve plate, and Fig. 2B is a drawing showing a suction valve sheet to be superimposed on the end face on the cylinder block side of the valve plate.

Fig. 3 is a drawing showing a state wherein the suction valve sheet is superimposed on the valve plate. Fig. 4A is a drawing showing an end face on a cylinder head side of the valve plate, and Fig. 4B is a drawing showing a discharge valve sheet to be superimposed on the end face on the cylinder head side of the valve plate.

Fig. 5 is a drawing showing a state wherein the discharge valve sheet is superimposed on the valve plate.

Fig. 6 is a drawing showing a region of an arm portion of a reed valve formed in the suction valve sheet and used as the suction valve.

Fig. 7 is a drawing showing that the arm portion of the suction valve is such that a width on a base side is greater than a width on a leading end side, and moreover, that an angle of inclination of an outer side reference line from a central line is 8 degrees or more greater than an angle of inclination of an inner side reference line from the central line.

Fig. 8 is a drawing showing that a length direction dimension of the arm portion of the suction valve is greater than a width direction dimension thereof, but a ratio between the two dimensions is 1.8:1 or less.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0019] Hereafter, an embodiment of the invention will be described while referring to the attached drawings.

[0020] A reciprocating compressor called either a swash plate type or a piston type, used in a refrigeration cycle of a vehicle-use air conditioner that has a refrigerant as a working fluid, is shown in Fig. 1 as an example of a reciprocating compressor to which the invention is applied.

[0021] This reciprocating compressor 1 is configured to have a cylinder block 2, a cylinder head 4 installed on a rear side of the cylinder block 2 across a valve plate 3, and a front housing 6, installed so as to cover a front side

of the cylinder block 2 and defining a crank chamber 5 on the front side of the cylinder block 2. The front housing 6, the cylinder block 2, the valve plate 3, and the cylinder head 4 are fastened in an axial direction by unshown fastening bolts, thereby configuring a housing 7 of the compressor.

[0022] A drive shaft 8 disposed in the crank chamber 5 is held so as to rotate freely by the front housing 6 and the cylinder block 2 across a bearing 9 (only the cylinder block side is shown). In the embodiment, the drive shaft 8 protrudes from the front housing 6, is connected via a belt and a pulley to an unshown driving engine, and rotates by power of the driving engine being transmitted.

[0023] A support hole 11 in which the bearing 9 is housed, and a multiple of cylinder bores 12 disposed at equal intervals on a circumference centered on the support hole 11, are formed in the cylinder block 2. A single head piston 13 is inserted so as to be able to slide reciprocally in each cylinder bore 12.

[0024] A swash plate 14, which rotates in synchrony with a rotation of the drive shaft 8, is provided across a hinge ball 15 above the drive shaft 8 in the crank chamber 5. An engagement portion 13a of the single head piston 13 is anchored to a peripheral edge portion of the swash plate 14 across a pair of shoes 16 provided in front and behind.

[0025] Consequently, when the drive shaft 8 rotates, the swash plate 14 rotates in accompaniment thereto, and the rotational motion of the swash plate 14 is converted via the shoe 16 into a linear reciprocating motion of the single head piston 13, causing a capacity of a compression chamber 17 formed between the single head piston 13 and the valve plate 3 in the cylinder bore 12 to change.

[0026] A suction port 20 and a discharge port 30 corresponding to each cylinder bore 12 are formed in the valve plate 3. Furthermore, by an annular groove 28 being formed in a periphery of the suction port 20 of the valve plate 3, a valve seat 27 on which a suction valve 21 sits is formed in a circular form on a peripheral edge of an aperture of the suction port 20, and by an annular groove 38 being formed in a periphery of the discharge port 30 of the valve plate 3, a valve seat 37 on which a discharge valve 31 sits is formed in a circular form on a peripheral edge of an aperture of the discharge port 30.

[0027] Also, a suction chamber 18, which houses working fluid to be supplied to the compression chamber 17, and a discharge chamber 19, which houses working fluid that has been discharged from the compression chamber 17, are provided segregated in the cylinder head 4. In the example, the suction chamber 18 is formed in a central portion of the cylinder head 4, and the discharge chamber 19 is formed in an annular form in a periphery of the suction chamber 18.

[0028] The suction chamber 18 can communicate with the compression chamber 17 via the suction port 20, which is opened and closed by the suction valve 21, to be described hereafter. Also, the discharge chamber 19

can communicate with the compression chamber 17 via the discharge port 30, which is opened and closed by the discharge valve 31, to be described hereafter.

[0029] A suction valve sheet 22, which is superimposed on and attached to an end face on the cylinder block side of the valve plate 3 and in which the suction valve 21 is formed, and a gasket 26, which is superimposed on the suction valve sheet 22 and fixed by being gripped between the valve plate 3 and the cylinder block 2, are provided between the valve plate 3 and the cylinder block 2.

[0030] Also, a discharge valve sheet 32, which is superimposed on and attached to an end face on the cylinder head side of the valve plate 3 and in which the discharge valve 31 is formed, and a gasket 36, which is superimposed on the discharge valve sheet 32 and fixed by being gripped between the valve plate 3 and the cylinder head 4, in addition to which a retainer 35 is integrally formed in a region opposing the discharge valve 31, are provided between the valve plate 3 and the cylinder head 4.

[0031] The cylinder block 2, the gasket 26, the suction valve sheet 22, the valve plate 3, the discharge valve sheet 32, the gasket 36, and the cylinder head 4 are positioned by unshown positioning pins, and fixed in a press-fit state by the fastening bolts that fasten the components of the housing 7.

[0032] The suction chamber 18 communicates with an unshown suction aperture connected to a low pressure side (an evaporator exit side) of an external refrigerant circuit via a suction passage provided extending in a radial direction so as to penetrate the discharge chamber 19, and the discharge chamber 19 communicates with a discharge space 41 formed in a peripheral wall portion of the cylinder block 2 via a passage formed in the gasket 36, the valve plate 3, the suction valve sheet 22, the gasket 26, and the cylinder block 2. The discharge space 41 is defined by the cylinder block 2 and a cover 42 attached to the cylinder block 2, and is connected to a high pressure side (a condenser entrance side) of the external refrigerant circuit via a discharge aperture 43 formed in the cover 42.

[0033] The suction valve sheet 22 is superimposed on and attached to the end face on the cylinder block side of the valve plate 3 shown in Fig. 2A, and is formed of an assembly of a multiple of the suction valve 21 that opens and closes the suction port 20, as shown in Fig. 2B, because of which the suction valves 21 are formed at predetermined intervals in a circumferential direction in the suction valve sheet 22 in accordance with the number of cylinder bores 12, and also, a through hole for inserting a fastening bolt through, a through hole for inserting an unshown positioning pin through, and the like, are formed. Also, an aperture portion 25 that avoids interference with the discharge port 30 is formed in a base end portion of each suction valve 21.

[0034] Each suction valve 21 is configured of one portion of the suction valve sheet 22, and in the embodiment,

a reed valve is used. The suction valve 21 has a region of a leading end of an arm portion 23 as a seat portion that sits on the valve seat 27 formed in a periphery of the suction port 20 of the valve plate 3. A more detailed structure of the suction valve 21 will be described hereafter.

[0035] The gasket 26 interposed between the suction valve sheet 22 and the cylinder block 2 is such that aperture portions that avoid interference with the cylinder bore 12 are formed at predetermined intervals in a circumferential direction in accordance with the number of cylinder bores 12, and also, a through hole for inserting a fastening bolt through, a through hole for inserting a positioning pin through, and the like, are formed.

[0036] The discharge valve sheet 32 is superimposed on and attached to the end face on the cylinder head side of the valve plate 3 shown in Fig. 4A, and is configured of an assembly of a multiple of the discharge valve 31 that opens and closes the discharge port 30, as shown in Fig. 4B. The discharge valves 31 are formed at predetermined intervals in a circumferential direction in accordance with the number of cylinder bores 12. Also, an aperture portion 39 that avoids interference with the suction port 20, an unshown through hole for inserting a positioning pin through, and the like, are formed in the discharge valve sheet 32.

[0037] Each discharge valve 31 is configured of one portion of the discharge valve sheet 32, and in the embodiment, the discharge valve 31 is formed as a reed valve having an arm portion 33 extended radially in an outward direction, and has a region of a leading end of the arm portion 33 as a seat portion that sits on the valve seat 37 formed in a periphery of the discharge port 30 of the valve plate 3.

[0038] The gasket 36 interposed between the discharge valve sheet 32 and the cylinder head 4 is such that aperture portions that avoid interference with the suction port 20 are formed at predetermined intervals in a circumferential direction in accordance with the number of cylinder bores, and also, a through hole for inserting a fastening bolt through, a through hole for inserting a positioning pin through, and the like, are formed, and the retainer 35 is formed integrally in a place opposing the discharge valve 31 so as to become gradually distanced progressing from a base side toward the leading end side of the arm portion 33 of the discharge valve 31.

[0039] Consequently, when a suction process is carried out, a refrigerant is suctioned from the suction chamber 18 into the compression chamber 17 via the suction port 20 opened and closed by the suction valve 21, and when a compression process is carried out, a compressed refrigerant is discharged from the compression chamber 17 into the discharge chamber 19 via the discharge port 30 opened and closed by the discharge valve 31.

[0040] Note that the suction valve 21 is configured to have the arm portion 23, wherein a tongue form is formed by an outer side form and an inner side form, as shown in particular in Fig. 6 to Fig. 8.

[0041] The outer side form of the arm portion 23 is formed by a U-form slit portion 24, formed of a leading end portion 24a, a pair of base portions 24c and 24c, and a pair of intermediate portions 24b and 24b between the leading end portion 24a and the base portion 24c, being provided in the suction valve sheet 22.

[0042] The pair of intermediate portions 24b and 24b of the slit portion 24 are formed consistently with a width H1 of a lateral direction gap of, for example, 2mm, and furthermore, in the embodiment, the pair of intermediate portions 24b and 24b extend linearly. In the embodiment, the leading end portion 24a of the slit portion 24 is formed consistently with a width H2 of a lateral direction gap of, for example, 1.6mm to 1.7mm. In a boundary region between the intermediate portion 24b and the leading end portion 24a, the width of one lateral direction gap gradually increases or decreases so as to become the width of the other gap. The pair of base portions 24c and 24c are formed in a circular form, whereby a width H3 of a gap passing through a central point P1 of a circular groove in the base portion 24c is greater than both the lateral direction gap widths H1 and H2 of the leading end portion 24a and the intermediate portion.

[0043] The inner side form of the arm portion 23 is formed by the aperture portion 25, which is of a long hole form extending from a vicinity of a peripheral edge of the suction valve sheet 22 toward a central point P2 side of the cylinder bore 12, being provided between one intermediate portion 24b and base portion 24c of the slit portion 24 of the suction valve sheet 22 and the other intermediate portion 24b and base portion 24c.

[0044] This kind of arm portion 23 of the suction valve 21 is such that a position of a width direction reference line L1 of the arm portion passing through ends of the pair of base portions 24c and 24c of the slit portion 24 on a side opposite to the direction in which the pair of intermediate portions 24b and 24b extend toward the leading end portion 24a forms a base of the suction valve 21, and an end on a side opposite to the base, with the central point P2 of the cylinder bore 12 in between, is a leading end.

[0045] Further, an outer side reference line L2 of the arm portion that coincides with, of the outer side form of the arm portion 23, the intermediate portion 24b of the slit portion 24, and an inner side reference line L3 of the arm portion that coincides with, of the inner side form of the arm portion 23, an edge of the aperture portion 25 opposing in a lateral direction, each incline so as to intersect with a central line L4 of the arm portion that passes through both the central point P2 of the cylinder bore 12 and a central point P3 of the suction port 20. In the embodiment, the central line L4 of the arm portion also passes through a central point P4 of the discharge port 30.

[0046] Because of this, the arm portion 23 of the suction valve 21 is such that a width on the base side is greater than a width on the leading end side. Furthermore, an angle of inclination R1 of the outer side reference line L2 from the central line L4 is greater than an

angle of inclination R2 of the inner side reference line L3 from the central line L4 by a predetermined value or greater. The predetermined value of the difference between the angles of inclination is desirably 8 degrees or greater.

[0047] Also, when comparing a width direction dimension W1 of the arm portion to the central line L4 from an end of the base portion 24c of the slit portion 24 on a side opposite to that of the intermediate portion 24b and a length direction dimension W2 of the arm portion to an end of the central line L4 on the leading end side of the arm portion 23 from a position C1 in which the reference line L1 in the width direction of the arm portion and the central line L4 intersect, the length direction dimension W2 is greater than the width direction dimension W1, but approximates the width direction dimension W1. The relationship between the width direction dimension W1 and the length direction dimension W2 of the arm portion 23 is desirably 1:1.8 or less. In accompaniment to this, a position of a base of the arm portion 23 is farther to the discharge port 30 side than the central point P2 of the cylinder bore, but is in proximity to the central point P2 of the cylinder bore, that is, nearer to the central point P2 of the cylinder bore than in an existing suction valve.

[0048] In this way, the outer side form and the inner side form of the arm portion 23 of the suction valve 21 are such that by setting the angle of inclination R1 of the outer side reference line L2 to be 8 degrees or more greater than the angle of inclination R2 of the inner side reference line L3, rigidity of the base of the arm portion 23 of the suction valve 21 can be increased, rendering the arm portion 23 less likely to warp, compared with when the width between the outer side form and the inner side form does not change between the base side and the leading end side, or when the difference between the angles of inclination R1 and R2 is smaller than 8 degrees even though the base side of the arm portion 23 is wider than the leading end side.

[0049] Further, the relationship between the length direction dimension W2 and the width direction dimension W1 of the arm portion 23 of the suction valve 21 is set to 1.8:1 or less, whereby the length direction dimension W2 of the arm portion 23 of the suction valve 21 is caused to be longer than but approximating the width direction dimension W1. For this reason too, the rigidity of the base of the arm portion 23 of the suction valve 21 can be increased, rendering the arm portion 23 less likely to warp, compared with when the relationship between the length direction dimension W2 and the width direction dimension W1 of the arm portion 23 is greater than 1.8:1.

[0050] For these reasons, by applying the structure of the suction valve 21 of the invention, an opening and closing speed of the suction port 20 can be reduced even when a reed valve is used as the suction valve, and a speed at which the leading end of the arm portion 23 of the suction valve 21 comes into contact with the valve plate 3 or the valve seat 27, and by extension an impact, can be reduced. Furthermore, a secondary deformation after the leading end of the arm portion 23 of the suction

valve 21 has come into contact with the valve seat 27 can be prevented. Because of this, damage such as cracking of the leading end of the arm portion 23 of the suction valve 21 is prevented, and reliability of the suction valve 21 can be ensured even when the reciprocating compressor 1 is operated at high speed.

Description of Reference Numerals and Signs

10 [0051]

1: reciprocating compressor

12: cylinder bore

17: compression chamber

15 18: suction chamber

19: discharge chamber

20: suction port

21: suction valve

22: suction valve sheet

20 23: arm portion

24: slit portion

24a: leading end portion

24b: intermediate portion

24c: base portion

25 25: aperture portion

30: discharge port

31: discharge valve

P2: cylinder bore central point

P3: suction port central point

30 L1: arm portion width direction reference line (arm portion base)

L2: arm portion outer side reference line

L3: arm portion inner side reference line

L4: arm portion central line

35 R1: angle of inclination of outer side reference line from central line

R2: angle of inclination of inner side reference line from central line

W1: arm portion width direction dimension

40 W2: arm portion length direction dimension

H1: width of slit portion intermediate portion lateral direction gap

H2: width of slit portion leading end portion lateral direction gap

45 H3: width of gap passing through center of slit portion base portion circular groove

Claims

- 50 1. A reciprocating compressor suction valve structure in a reciprocating compressor (1) that has a suction port (20) such that an exit end opens on to a compression chamber (17) formed in a cylinder bore (12) and the exit end is blocked so as to be openable and closable by a suction valve (21), and a discharge port (30) such that an entrance end opens on to the compression chamber (17) and an exit end is
- 55

blocked so as to be openable and closable by a discharge valve (31), and a reed valve is used as the suction valve (21), **characterized in that** the suction valve (21) has a tongue-form arm portion (23), an outer side form of the arm portion (23) is formed by a slit portion (24) formed of one leading end portion (24a), one pair of base portions (24c), and one pair of intermediate portions (24b) between the leading end portion (24a) and the base portion (24c) being provided in a suction valve sheet (22), an inner side form of the arm portion (23) is formed by an aperture portion (25) of a long hole form extending from a vicinity of a peripheral edge of the suction valve sheet (22) toward a central point (P2) side of the cylinder bore (12) being provided between one intermediate portion (24b) and base portion (24c) of the slit portion (24) of the suction valve sheet (22) and the other intermediate portion (24b) and base portion (24c), an outer side reference line (L2) that coincides with an intermediate portion (24b) of the slit portion (24) of the outer side form and an inner side reference line (L3) that coincides with an edge of the aperture portion (25) of the inner side form opposing in a lateral direction are each caused to incline so as to intersect with a central line (L4) of the arm portion (23) that passes through both a central point (P2) of the cylinder bore (12) and a central point (P3) of the suction port (20), whereby a width of a base side (24c) of the arm portion (23) is greater than a width of a leading end side (24a), and furthermore, an angle (R1) of inclination of the outer side reference line (L2) is a predetermined value or more greater than an angle (R2) of inclination of the inner side reference line (L3).

2. A reciprocating compressor suction valve structure in a reciprocating compressor (1) that has a suction port (20) such that an exit end opens on to a compression chamber (17) formed in a cylinder bore (12) and the exit end is blocked so as to be openable and closable by a suction valve (21), and a discharge port (30) such that an entrance end opens on to the compression chamber (17) and an exit end is blocked so as to be openable and closable by a discharge valve (31), and a reed valve is used as the suction valve (21), **characterized in that** the suction valve (21) has a tongue-form arm portion (23), an outer side form of the arm portion (23) is formed by a slit portion (24) formed of one leading end portion (24a), one pair of base portions (24c), and one pair of intermediate portions (24b) between the leading end portion (24a) and the base portion (24c) being provided in a suction valve sheet (22), an inner side form of the arm portion (23) is formed by an aperture portion (25) of a long hole form extending from a vicinity of a peripheral edge of the suction valve sheet (22) toward a central point (P2)

side of the cylinder bore (12) being provided between one intermediate portion (24b) and base portion (24c) of the slit portion (24) of the suction valve sheet (22) and the other intermediate portion (24b) and base portion (24c), and the arm portion (23) is such that when comparing a width direction dimension (W1) from an end of the base portion (24c) of the slit portion (24) on a side opposite to that of the intermediate portion (24b) to a central line (L4) of the arm portion (23) that passes through both a central point (P2) of the cylinder bore (12) and a central point (P3) of the suction port (20) and a length direction dimension (W2) from a position in which a reference line (L1) that passes through ends of both base portions (24c) of the slit portion (24) on the side opposite to that of the intermediate portion (24b) and the central line (L1) intersect to an end of the central line (L4) on a leading end side (24a) of the arm portion (23), the length direction dimension (W2) is greater than the width direction dimension (W1), but approximates the width direction dimension (W1).

3. The reciprocating compressor suction valve structure according to claim 1 or claim 2, **characterized in that** the slit portion (24) is such that widths (H1, H2) of lateral direction gaps of the leading end portion (24a) and the intermediate portion (24b) are formed consistently or practically consistently to a predetermined numerical value, and the base portion (24c) is formed in a circular form, because of which a width (H3) of a gap of the base portion (24c) is greater than the widths (H1, H2) of the lateral direction gaps of the leading end portion (24a) and the intermediate portion (24b).
4. The reciprocating compressor suction valve structure according to any of claim 1 to claim 3, **characterized in that** the arm portion (23) is such that a position (C1) in which a reference line (L1) that passes through ends of both base portions (24c) of the slit portion (24) on a side opposite to that of the intermediate portion (24b) and the central line (L4) intersect is in proximity to a central point (P2) of the cylinder bore (12).
5. A reciprocating compressor (1) having the suction valve structure according to any of claim 1 to claim 4.

FIG.1

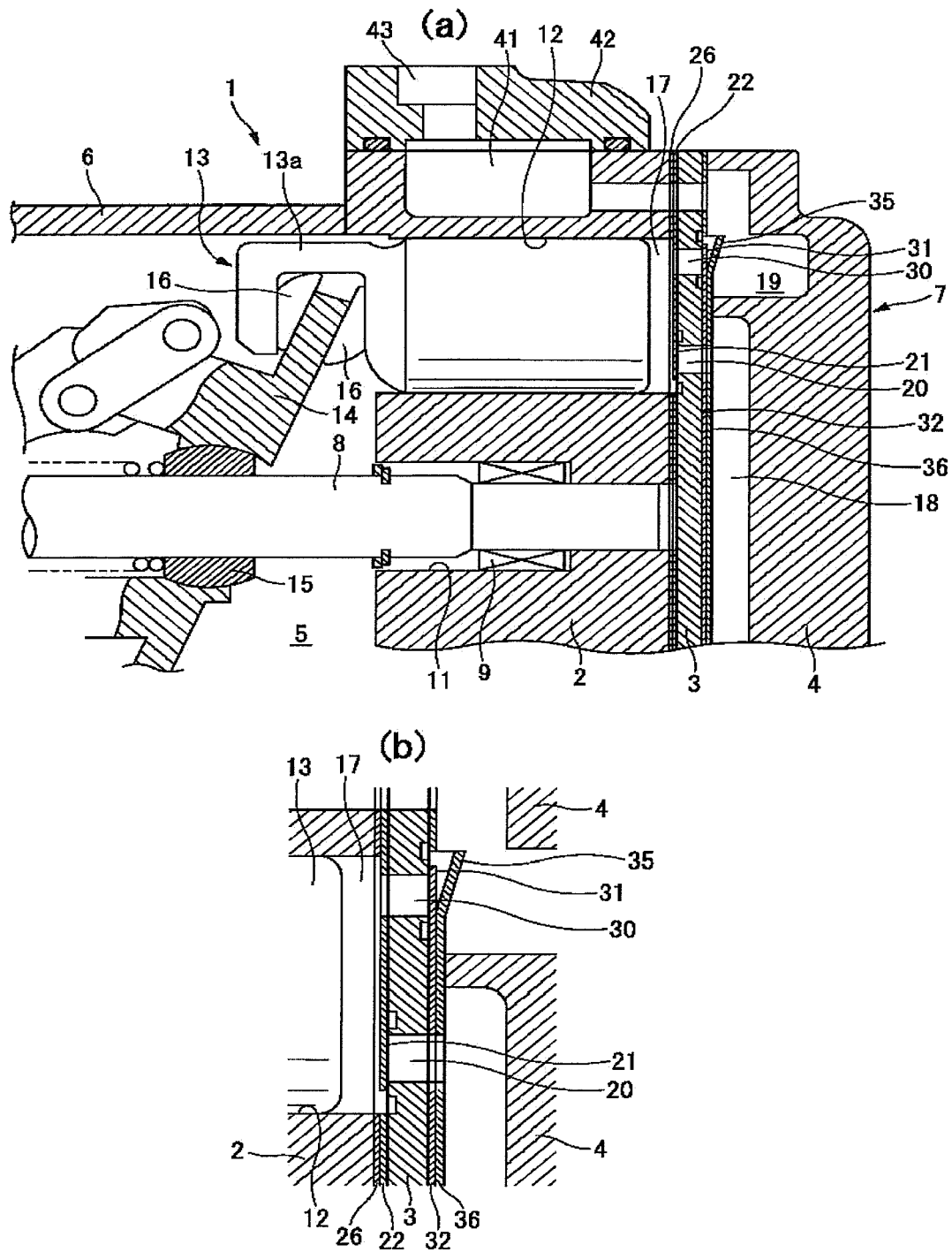


FIG.2

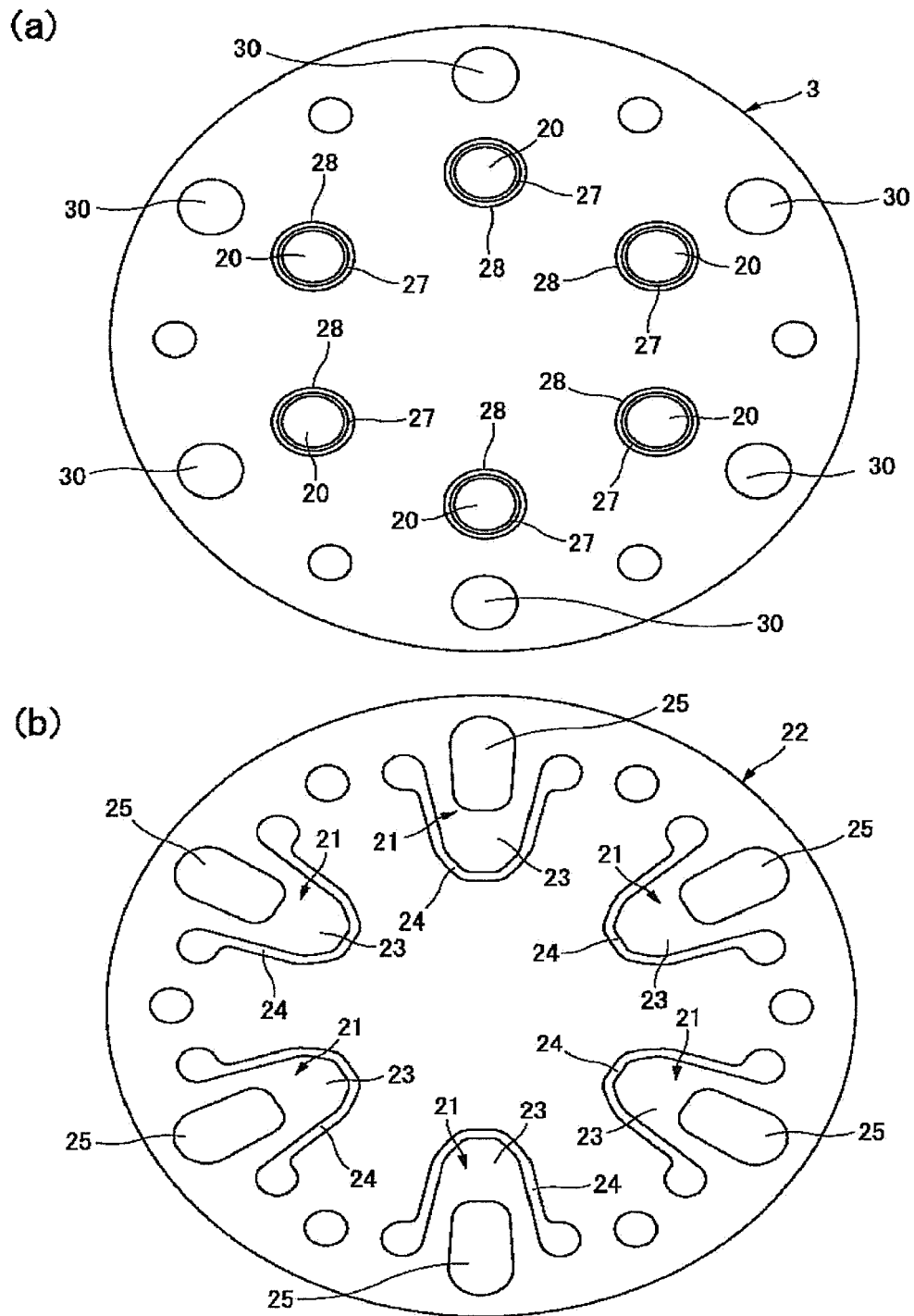


FIG.3

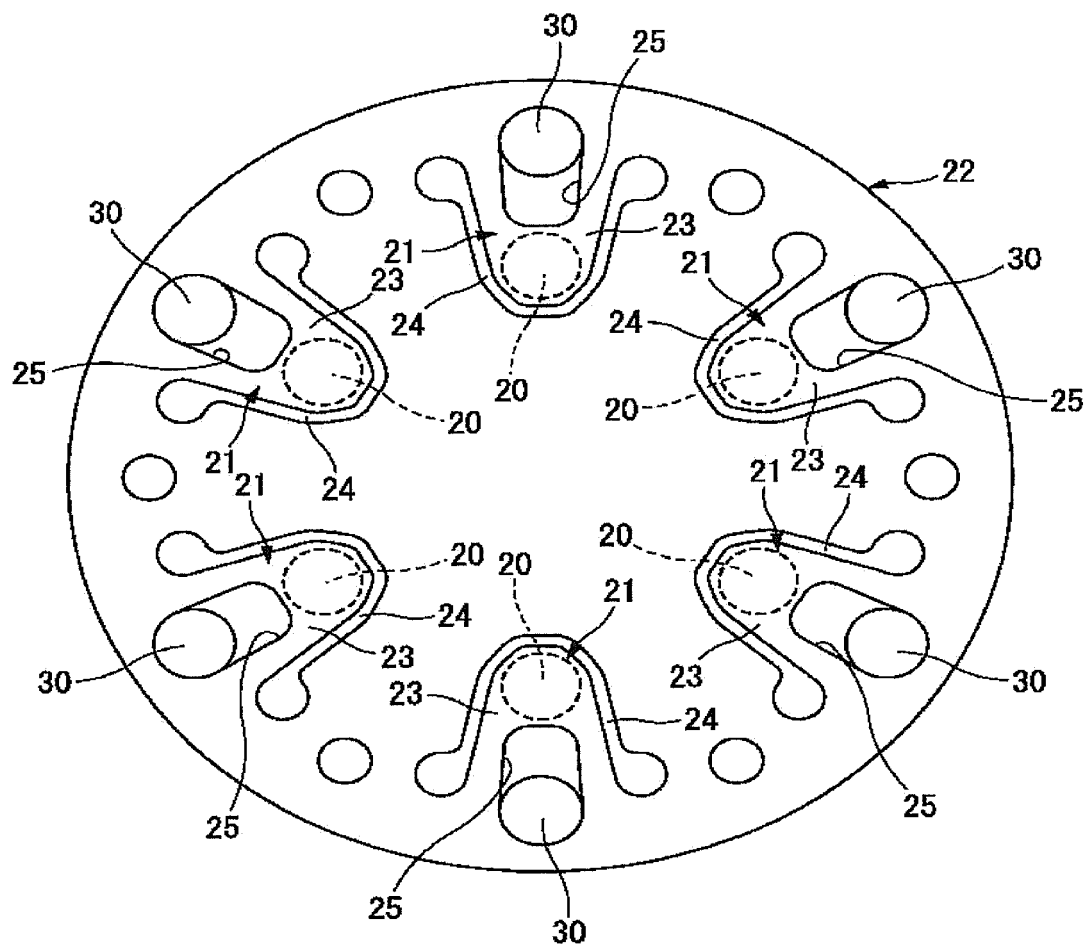
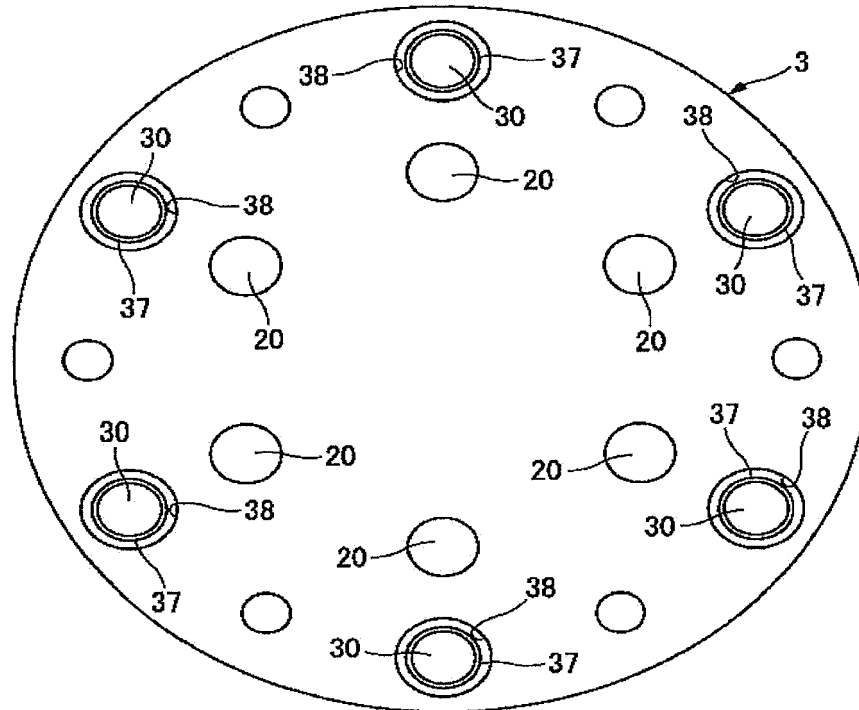


FIG. 4

(a)



(b)

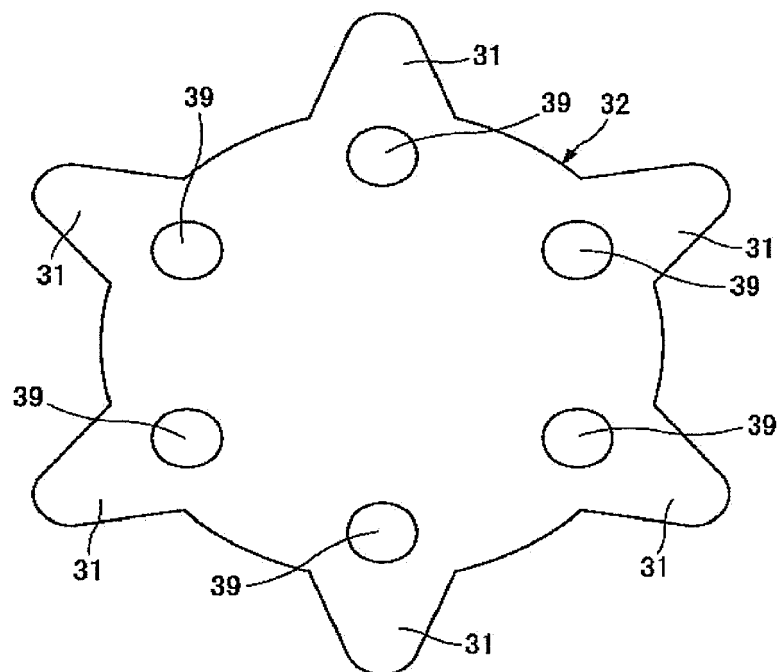


FIG.5

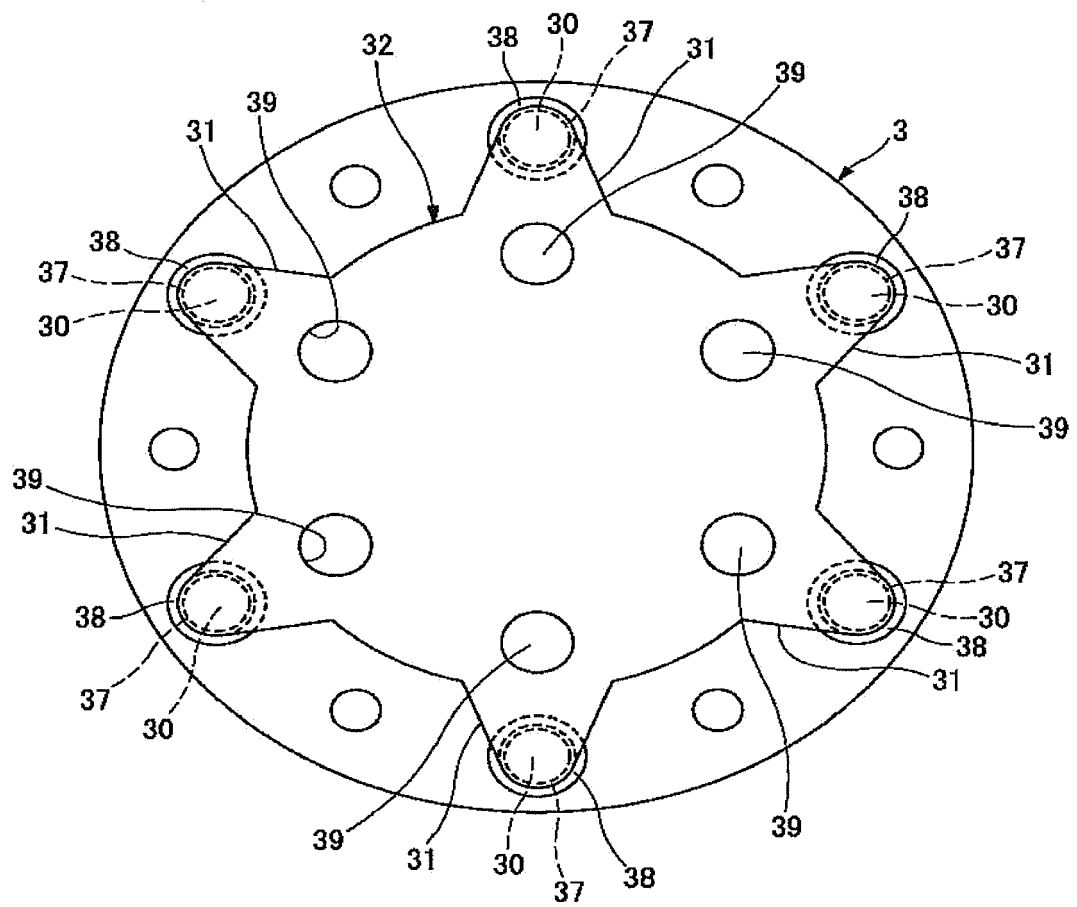


FIG.6

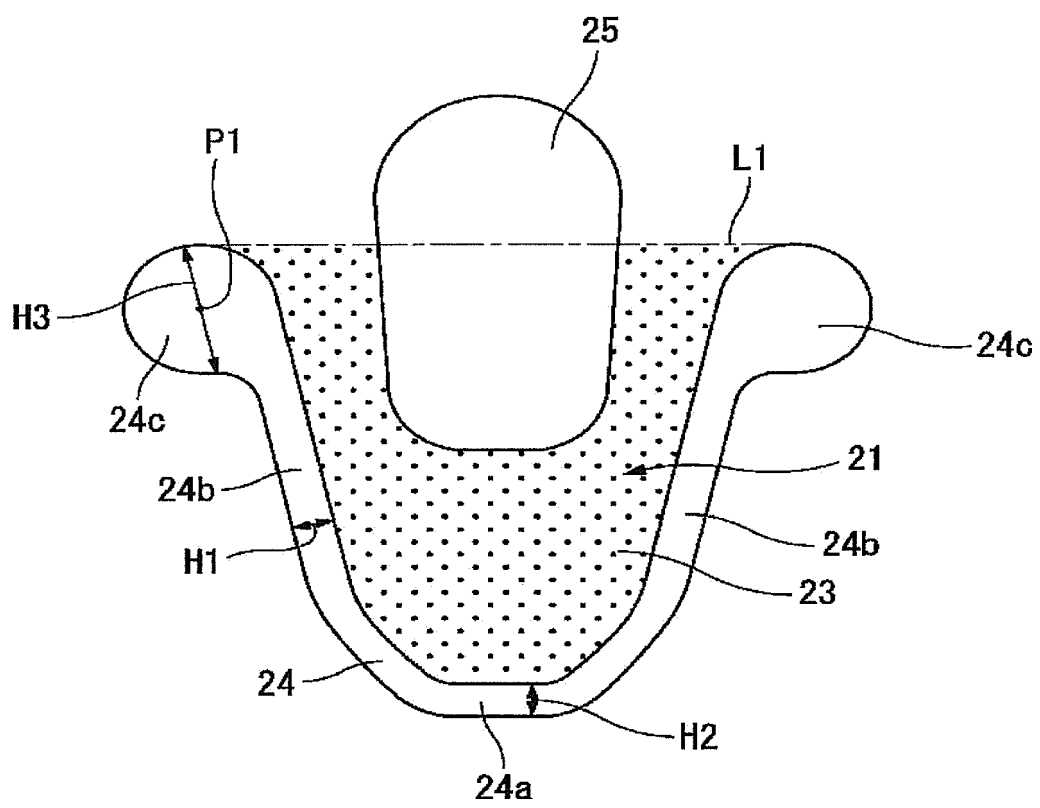


FIG. 7

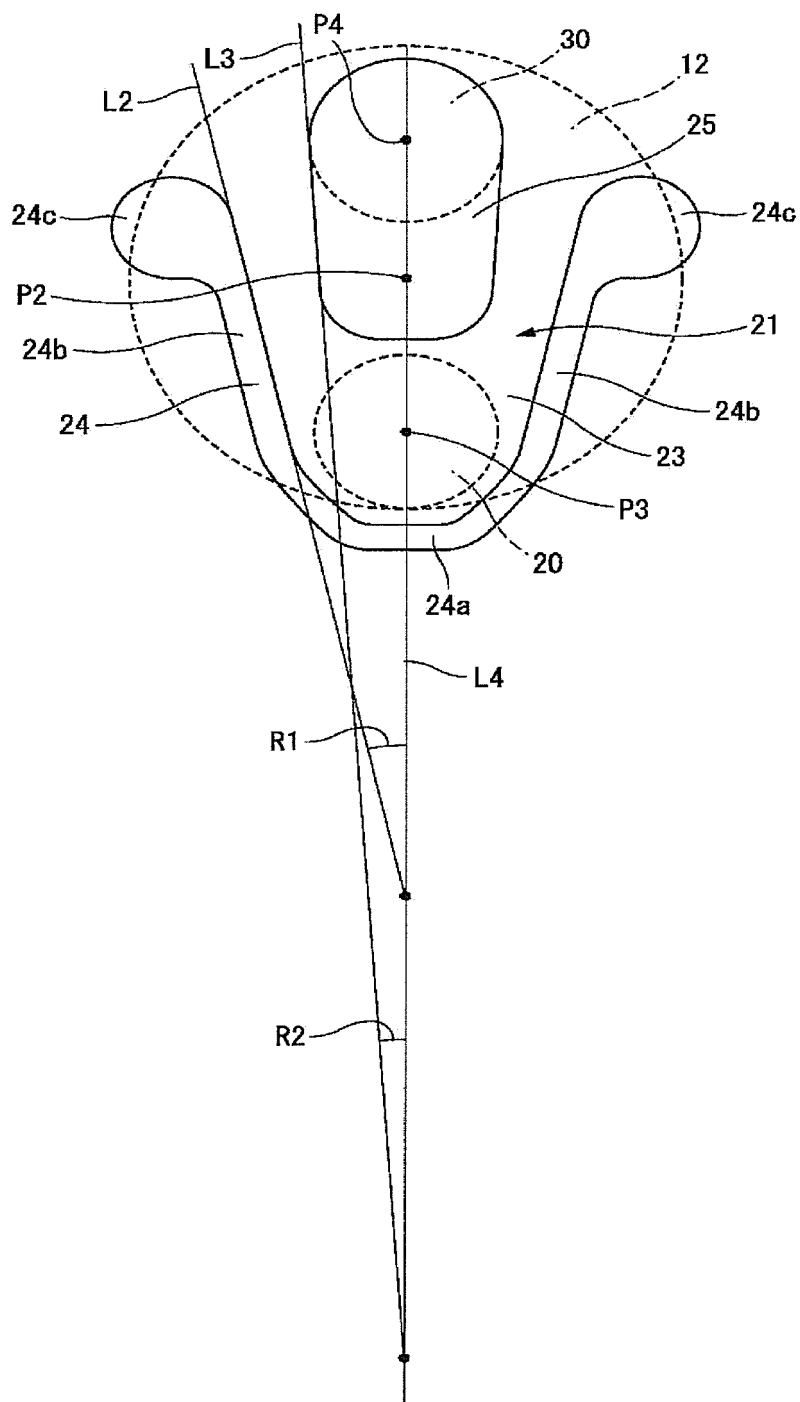
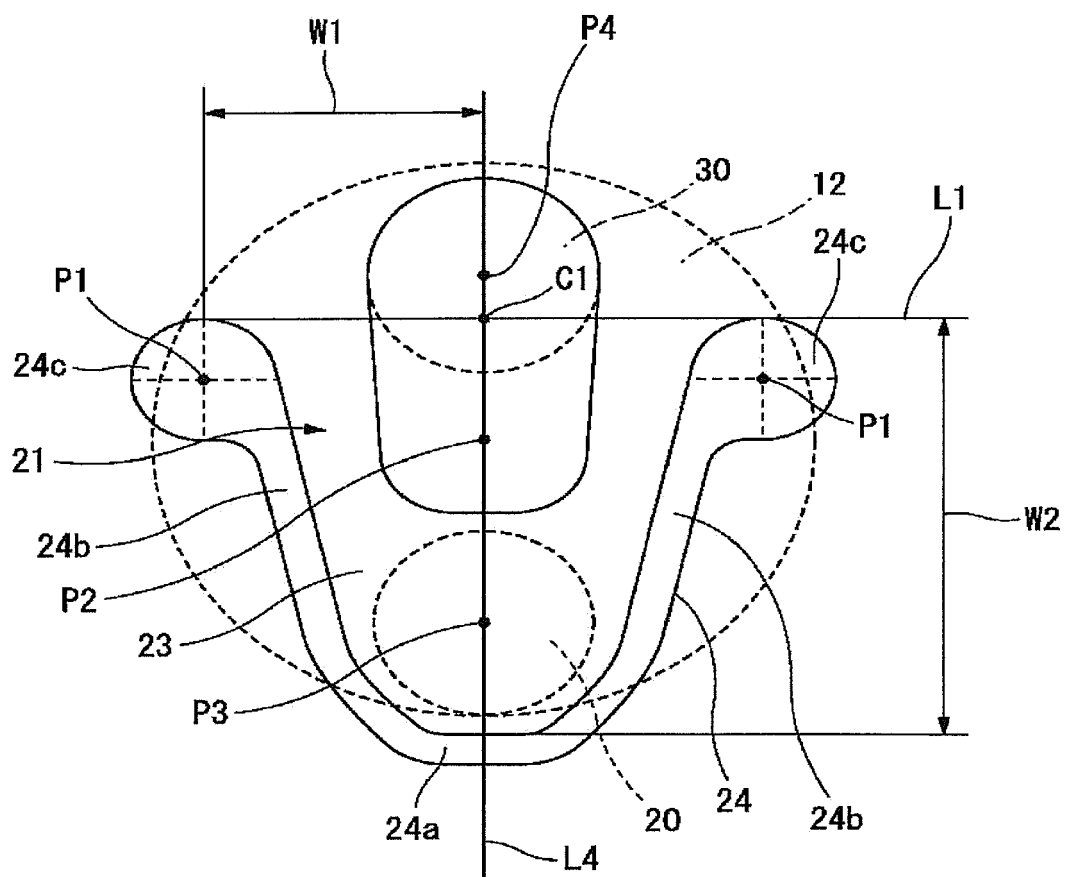


FIG.8



REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2000054961 A [0005]
- WO 2587085 A [0005]