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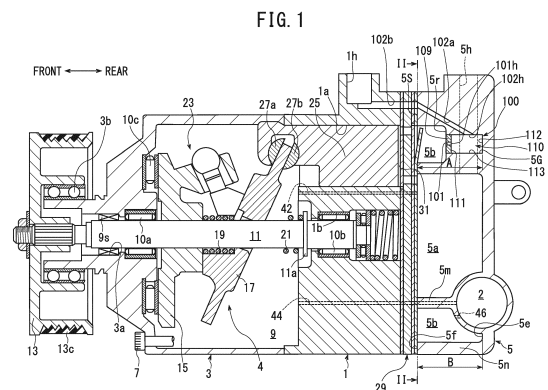
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(54) **Variable displacement compressor**

(57) Variable displacement compressor comprising: a cylinder block (1) having a plurality of cylinder bores (1a); a front housing (3) having a crank chamber (9) formed therein; a rear housing (5) having a suction chamber (5a) and a discharge chamber (5b) formed therein; a plurality of pistons (25) housed in the cylinder bores so as to reciprocate and defining a compression chamber (31); and driving means (4) provided in the crank chamber. The rear housing (5) has an annular wall (5m) that separates the suction chamber and the discharge chamber, the discharge chamber being formed between the annular wall and an outer peripheral wall of the rear housing so as to extend in the circumferential direction and annularly surround the suction chamber. A muffler (100) is provided between the discharge chamber and an outlet port (1h), the muffler having a muffler chamber (110), an inlet channel (101) and an outlet channel (102a). The muffler chamber (110) has a first end surface (111) on one end side of the muffler chamber, a second end surface (112) on the other end side of the muffler chamber, and an inner peripheral surface (113) having a cylindrical shape that is positioned between the first end surface and the second end surface and extends from the discharge chamber toward the other end side. The muffler chamber (110) is positioned between the annular wall and the outer peripheral wall, the inlet channel (101) opens in the first end surface (111), and the outlet channel (102a) opens in the inner peripheral surface (113) at a position spaced apart from the second end surface

(112).



Description

TECHNICAL FIELD

[0001] The present invention relates to a variable displacement compressor with single-head pistons.

BACKGROUND ART

[0002] Japanese Patent Laid-Open No. 9-287564 discloses a conventional variable displacement compressor with single-head pistons (referred to simply as a compressor hereinafter). The compressor comprises a cylinder block, a front housing, a rear housing, pistons and driving means. The cylinder block has a plurality of cylinder bores arranged side by side in the circumferential direction and extending in parallel with each other in the axial direction. The front housing is fixed to one end part of the cylinder block in the axial direction. The front housing has a crank chamber formed therein. The rear housing is fixed to the other end part of the cylinder block in the axial direction. The rear housing has a suction chamber and a discharge chamber formed therein. A piston is housed in each of the cylinder bores so as to reciprocate and defines a compression chamber in a rear part of each of the cylinder bores. The driving means is provided in the crank chamber. The driving means can make each of the pistons reciprocate and change strokes of each of the pistons.

[0003] The rear housing has an annular wall that separates the suction chamber and the discharge chamber from each other. The suction chamber is formed between the annular wall and the outer peripheral wall of the rear housing and extends in the circumferential direction to annularly surround the discharge chamber. The cylinder block has an outlet port through which the discharge chamber is in communication with the outside. A muffler is provided between the discharge chamber and the outlet port. The muffler is positioned at a position close to the outer peripheral surface of the cylinder block. The muffler has a muffler chamber, an inlet channel and an outlet channel. The inlet channel provides communication between the discharge chamber and the muffler chamber. The outlet channel provides communication between the muffler chamber and the outlet port.

[0004] With this compressor, the refrigerating gas at high pressure flows out of the discharge chamber into the muffler chamber through the inlet channel and then flows through the outlet channel and is discharged to the outside from the outlet port. In this process, the flow of the refrigerating gas is narrowed down in the inlet channel and then expands in the muffler chamber. In this way, the compressor is configured to reduce the discharge pulsation.

[0005] With the conventional compressor described above, the volume of the muffler chamber needs to be increased in order for the muffler to appropriately reduce the discharge pulsation, and it is difficult to arrange a less

bulky muffler in the outer peripheral part of the cylinder block. In this regard, with the conventional compressor, it is difficult to reduce the size of the compressor and appropriately reduce the discharge pulsation.

[0006] The present invention has been devised in view of the circumstances of the prior art described above, and an object to be attained of the present invention is to provide a variable displacement compressor with single-head pistons that can have a reduced size and appropriately reduce a discharge pulsation.

SUMMARY OF THE INVENTION

[0007] A variable displacement compressor with single-head pistons according to the present invention comprises:

a cylinder block having a plurality of cylinder bores that are formed side by side in a circumferential direction and extend in parallel with each other in an axial direction;

a front housing that is fixed to one end side of the cylinder block in the axial direction and has a crank chamber formed therein;

a rear housing that is fixed to the other end side of the cylinder block in the axial direction and has a suction chamber and a discharge chamber formed therein;

a plurality of pistons each housed in each of the cylinder bores so as to reciprocate and defining a compression chamber in each of the cylinder bores on the other end side; and

driving means that is provided in the crank chamber and is capable of making each of the pistons reciprocate and changing strokes of each of the pistons.

[0008] The rear housing has an annular wall that separates the suction chamber and the discharge chamber from each other.

[0009] The discharge chamber is formed between the annular wall and an outer peripheral wall of the rear housing so as to extend in the circumferential direction and annularly surround the suction chamber.

[0010] An outlet port, through which the discharge chamber is in communication with the outside, is formed in the cylinder block or the rear housing.

[0011] A muffler is provided between the discharge chamber and the outlet port.

[0012] The muffler has a muffler chamber, an inlet channel and an outlet channel. The muffler chamber is formed in the rear housing. The inlet channel provides communication between the discharge chamber and the muffler chamber. The outlet channel provides communication between the muffler chamber and the outlet port.

[0013] The muffler chamber has a first end surface, a second end surface, and an inner peripheral surface. The first end surface is positioned on the one end side of the muffler chamber. The second end surface is positioned

on the other end side of the muffler chamber. The inner peripheral surface has a cylindrical shape, is positioned between the first end surface and the second end surface and extends from the discharge chamber toward the other end side.

[0014] The muffler chamber is positioned between the annular wall and the outer peripheral wall.

[0015] The inlet channel opens in the first end surface.

[0016] The outlet channel opens in the inner peripheral surface at a position spaced apart from the second end surface.

[0017] Other aspects and advantages of the invention will be apparent from embodiments disclosed in the attached drawings, illustrations exemplified therein, and the concept of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018]

FIG. 1 is a vertical cross-sectional view of a compressor according to an embodiment 1.

FIG. 2 is a cross-sectional view of the compressor according to the embodiment 1 taken along the line II-II in FIG. 1.

FIG. 3 is a schematic perspective view of the compressor according to the embodiment 1, showing a configuration of an inlet channel, a first end surface, an inner peripheral surface, a second end surface, a muffler chamber and an outlet channel.

FIG. 4 is a partially enlarged cross-sectional view of the compressor according to the embodiment 1.

FIG. 5 is a partially enlarged cross-sectional view of a compressor according to an embodiment 2.

FIG. 6 is a schematic perspective view of the compressor according to the embodiment 2, showing a configuration of the inlet channel, the first end surface, the inner peripheral surface, an intermediate member, a first muffler chamber, the second end surface, a second muffler chamber and the outlet channel.

FIG. 7 is a partially enlarged cross-sectional view of a compressor according to an embodiment 3.

FIG. 8 is a perspective view of an intermediate member of the compressor according to the embodiment 3.

FIG. 9 is a partially enlarged cross-sectional view of a compressor according to an embodiment 4.

FIG. 10 is a cross-sectional view of the compressor according to the embodiment 4 taken along the line X-X in FIG. 9.

DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENTS

[0019] In the following, embodiments 1 to 4 of the present invention will be described with reference to the drawings. In the following description, the front-rear di-

rection is assumed as shown in FIG. 1.

[Embodiment 1]

[0020] As shown in FIG. 1, a variable displacement compressor with single-head pistons (referred to simply as a compressor hereinafter) according to an embodiment 1 comprises a cylinder block 1, a front housing 3, a rear housing 5, pistons 25 and driving means 4.

[0021] The cylinder block 1 has a plurality of cylinder bores 1a that are formed side by side at regular angular intervals in the circumferential direction and extend in parallel with each other. Each of the cylinder bores 1a is a cylindrical cavity that penetrates the cylinder block 1 in the front-rear direction. Each of the cylinder bores 1a houses each of the pistons 25 in such a manner that the pistons 25 can reciprocate in the front-rear direction. The front-rear direction is an example of "axial directions" according to the present invention. The front side is an example of "one end side in the axial direction", and the rear side is an example of "the other side in the axial direction".

[0022] The cylinder block 1 is held between the front housing 3 disposed in front thereof and the rear housing 5 disposed at the rear thereof, and fastened in this state with a plurality of bolts 7. In other words, the front housing 3 is fixed to the front of the cylinder block 1, and the rear housing 5 is fixed to the rear of the cylinder block 1. The front housing 3 has a crank chamber 9 formed therein. A valve unit 29 is disposed between the rear housing 5 and the cylinder block 1.

[0023] The driving means 4 comprises a drive shaft 11, a lug plate 15, a swash plate 17 and a link mechanism 23, for example.

[0024] A shaft hole 3a is formed in the front housing 3. A shaft hole 1b is formed in the cylinder block 1.

[0025] The drive shaft 11 extends in the crank chamber 9 in the front-rear direction. A front end part of the drive shaft 11 protrudes to the outside of the front housing 3 through the shaft hole 3a. In the shaft hole 3a, a shaft seal device 9s and a bearing device 10a are fitted. The shaft seal device 9s seals the gap between the drive shaft 11 and the front housing 3. A rear end part of the drive shaft 11 protrudes into the shaft hole 1b. A bearing device 10b is provided between the shaft hole 1b and the rear end part of the drive shaft 11. The drive shaft 11 is rotatably supported in the shaft holes 3a and 1b with the bearing devices 10a and 10b interposed therebetween.

[0026] The lug plate 15 is press-fitted around the drive shaft 11 in the crank chamber 9. A bearing device 10c is provided between the lug plate 15 and the front housing 3.

[0027] A pulley 13 is fixed to the front end part of the drive shaft 11. A bearing device 3b is disposed between the pulley 13 and the front housing 3. A belt 13c, which is driven by an engine or a motor of a vehicle, is wound around the pulley 13. An electromagnetic clutch may be provided instead of the pulley 13.

[0028] The swash plate 17 is penetrated by the drive

shaft 11 in the crank chamber 9. The swash plate 17 is positioned behind the lug plate 15. An inclination reducing spring 19 is provided on the circumference of the drive shaft 11 between the lug plate 15 and the swash plate 17. In the crank chamber 9, a circlip 11a is fixed to the drive shaft 11, and a return spring 21 is provided on the circumference of the drive shaft 11 between the circlip 11a and the swash plate 17.

[0029] The link mechanism 23 connects the lug plate 15 and the swash plate 17 to each other in the crank chamber 9. The link mechanism 23 supports the swash plate 17 in such a manner that the inclination angle of the swash plate 17 with respect to the lug plate 15 can be changed.

[0030] A front-rear pair of shoes 27a and 27b is provided between each of the pistons 25 and the swash plate 17. The pairs of shoes 27a and 27b each converts the rotation of the swash plate 17 into the reciprocation of the corresponding piston 25 in the front-rear direction.

[0031] In each of the cylinder bores 1a, a rear end surface of each of the pistons 25 faces the valve unit 29. With this configuration, the pistons 25 each defines a compression chamber 31 in a rear part of each of the cylinder bores 1a. The valve unit 29 operates to make the compression chambers 31 suck in a refrigerating gas from a suction chamber 5a when the pistons 25 are in a suction stroke. The valve unit 29 also operates to confine the refrigerating gas in the compression chambers 31 when the pistons are in a compression stroke, and to make the compression chambers 31 discharge the refrigerating gas to a discharge chamber 5b when the pistons 25 are in a discharge stroke.

[0032] As shown in FIGS. 1 and 2, the rear housing 5 has the suction chamber 5a, which is radially inwardly positioned, and the discharge chamber 5b, which is radially outwardly positioned. The discharge chamber 5b extends in the circumferential direction to annularly surround the suction chamber 5a. The rear housing 5 also has an inlet port 5h through which the suction chamber 5a is in communication with the outside. The suction chamber 5a is defined by an annular wall 5m formed in the rear housing 5. The discharge chamber 5b is defined by the annular wall 5m and an outer peripheral wall 5n of the rear housing 5.

[0033] As shown in FIG. 1, the crank chamber 9 and the suction chamber 5a are connected to each other by a bleed passage 42. The crank chamber 9 and the discharge chamber 5b are connected to each other by supply passages 44 and 46. The rear housing 5 houses a volume control valve 2. The volume control valve 2 is provided between the supply passages 44 and 46.

[0034] The opening of the volume control valve 2 is externally adjusted by power supply control, thereby controlling the balance between the amount of the refrigerating gas at high pressure introduced into the crank chamber 9 from the discharge chamber 5b through the supply passages 44 and 46 and the amount of the refrigerating gas introduced into the suction chamber 5a from

the crank chamber 9 through the bleed passage 42, and determining the internal pressure of the crank chamber 9. As the internal pressure of the crank chamber 9 changes, the difference in pressure between the crank chamber 9 and the compression chamber 31 changes, the inclination angle of the swash plate 17 changes, and accordingly, the strokes of the pistons 25, that is, the discharge volume of the compressor is adjusted.

[0035] An outlet port 1h, through which the discharge chamber 5b is in communication with the outside, is provided on the outer peripheral surface of the cylinder block 1. A muffler 100 is provided between the discharge chamber 5b and the outlet port 1h.

[0036] As shown in FIGS. 1 to 4, the muffler 100 has a muffler chamber 110, an inlet channel 101, and outlet channels 102a and 102b.

[0037] The rear housing 5 has a closed-end circular hole 5G that extends rearward from a rear wall surface 5r of the discharge chamber 5b. The cylindrical inner wall surface of the closed-end circular hole 5G is an inner peripheral surface 113. The circular bottom surface of the closed-end circular hole 5G is a second end surface 112 positioned at the rear end of the inner peripheral surface 113. A disk-shaped lid member 109 is press-fitted in the closed-end circular hole 5G. As shown in FIG. 4, a front surface of the lid member 109 is substantially flush with the rear wall surface 5r. The rear surface of the lid member 109 is a first end surface 111 positioned at the front end of the inner peripheral surface 113. As shown in FIG. 3, the muffler chamber 110 is a cylindrical cavity defined by the inner peripheral surface 113, the first end surface 111 and the second end surface 112.

[0038] As shown in FIGS. 1 and 2, in the rear housing 5, the muffler chamber 110 is positioned between the annular wall 5m and the outer peripheral wall 5n. As shown in FIG. 2, the rear housing 5 has a plurality of bolt insertion holes 6, into which the bolts 7 are inserted. In the discharge chamber 5b, the muffler chamber 110 is positioned between two bolt insertion holes 6a and 6b. As shown in FIG. 1, a distance A from a front end surface 5f of the rear housing 5 to the second end surface 112 of the muffler chamber 111 is equal to or smaller than a distance B from the front end surface 5f of the rear housing 5 to a rear end surface 5e of the discharge chamber 5b.

[0039] As shown in FIGS. 2 to 4, the inlet channel 101 is a circular hole that penetrates the lid member 109 at the center thereof in the front-rear direction. The inlet channel 101 forms an inlet opening 101h having a circular shape in the first end surface 111. That is, the lid member 109 fitted inside the front part of the inner peripheral surface 113 separates the discharge chamber 5b and the muffler chamber 110 from each other and provides the first end surface 111, the inlet channel 101 and the inlet opening 101h. The inlet channel 101 provides communication between the discharge chamber 5b and the muffler chamber 110.

[0040] As shown in FIGS. 1 and 2, the outlet channel

102a is formed in the rear housing 5. The outlet channel 102a is a hole that extends straight from a part 5S of the front surface of the rear housing 5 positioned radially outward from the discharge chamber 5b toward the inner peripheral surface 113. The outlet channel 102a is inclined with respect to the front-rear direction.

[0041] As shown in FIG. 1, the outlet channel 102b is a hole that is formed in the valve unit 29 and the cylinder block 1 and extends straight in the front-rear direction. A rear end part of the outlet channel 102b is in communication with a front end part of the outlet channel 102a. A front end part of the outlet channel 102b is in communication with the outlet port 1h.

[0042] As shown in FIGS. 1 to 4, the outlet channel 102a forms an outlet opening 102h having an elliptical shape in the inner peripheral surface 113 at a position spaced apart from the second end surface 112. As shown in FIG. 4, an inner diameter D2 of the outlet channel 102a is larger than an inner diameter D1 of the inlet channel 101.

[0043] In a vehicle air-conditioning apparatus, the discharge chamber 5b of the compressor according to the embodiment 1 configured as described above is connected to a condenser via the muffler chamber 100 and the outlet port 1h, the condenser is connected to an evaporator via an expansion valve, and the evaporator is connected to the suction chamber 5a via the inlet port 5h. When an engine or the like rotationally drives the drive shaft 11, the refrigerating gas is introduced from the suction chamber 5a into the compression chamber 31 in a discharge volume corresponding to the inclination angle of the swash plate 17 and compressed therein, and then discharged into the discharge chamber 5b.

[0044] In this process, if the opening of the volume control valve 2 is decreased, the internal pressure of the crank chamber 9 decreases. As a result, the inclination angle of the swash plate 17 increases, the strokes of the pistons 25 increases, and the discharge volume of the compressor increases. To the contrary, if the opening of the volume control valve 2 is increased, the internal pressure of the crank chamber 9 increases. As a result, the inclination angle of the swash plate 17 decreases, the strokes of the pistons 25 decreases, and the discharge volume of the compressor decreases. In this way, the discharge volume of the compressor can be changed as required.

[0045] As shown in FIGS. 3 and 4, in this compressor, the refrigerating gas at high pressure in the discharge chamber 5b flows through the inlet channel 101 into the muffler chamber 110 at the inlet opening 101h formed in the first end surface 111, flows out into the outlet channels 102a and 102b at the outlet opening 102h formed in the inner peripheral surface 113, and is discharged to the outside at the outlet port 1h. With this compressor, in this process, the flow of the refrigerating gas is narrowed down in the inlet channel 101 and then expands in the muffler chamber 110, so that the discharge pulsation can be reduced.

[0046] The muffler chamber 110 is a cylindrical cavity defined by the cylindrical inner peripheral surface 113, the first end surface 111 and the second end surface 112. The inventors have found that the amplitude of the pulsation of the pressure of the refrigerating gas flowing into the muffler chamber 110 tends to be smaller in a part close to the inner peripheral surface 113 than in a part close to the second end surface 112. Thus, the amplitude of the pulsation of the pressure of the refrigerating gas flowing from the muffler chamber 110 into the outlet channels 102a and 102b through the outlet opening 102h can be smaller in the case where the outlet channel 102a opens in the inner peripheral surface 113 at a position spaced apart from the second end surface 112 than in the case where the outlet channel 102a opens in the second end surface 112.

[0047] With this compressor, since the inner diameter D2 of the outlet channel 102a is larger than the inner diameter D1 of the inlet channel 101, the flow of the refrigerating gas introduced from the muffler chamber 110 into the outlet channel 102a through the outlet opening 102h is less likely to be narrowed down by the outlet channel 102a. Therefore, the small amplitude of the pulsation of the pressure of the refrigerating gas can be appropriately maintained until the refrigerating gas reaches the outlet port 1h.

[0048] As described above, the compressor can reduce the discharge pulsation and can accordingly reduce the volume of the muffler chamber 110. As a result, the muffler 100 disposed in the rear housing 5 of this compressor can be less bulky. In addition, since the muffler chamber 110 is positioned between the annular wall 5m and the outer peripheral wall 5n, the muffler 100 can be prevented from protruding in the radially outward direction of the rear housing 5. In addition, since the distance A from the front end surface 5f of the rear housing 5 to the second end surface 112 of the muffler chamber 110 is set to be equal to or smaller than the distance B from the front end surface 5f of the rear housing 5 to the rear end surface 5e of the discharge chamber 5b, the muffler 100 can be prevented from protruding in the axial direction of the rear housing 5.

[0049] Owing to these characteristics, the compressor according to the embodiment 1 can have a reduced size and appropriately reduce the discharge pulsation.

[0050] In addition, with this compressor, the inner peripheral surface 113 and the second end surface 112 can be easily formed by forming the closed-end circular hole 5G, which is recessed toward the rear from the discharge chamber 5b, in the rear housing 5. In addition, with this compressor, the outlet channel 102a and the outlet opening 102h can be easily formed by forming a hole that obliquely penetrates the rear housing 5 from the part 5S of the front surface of the rear housing 5 to the inner peripheral surface 113 of the muffler chamber 110. In addition, the first end surface 111, the inlet channel 101 and the inlet opening 101h can be easily formed by fitting the disk-shaped lid member 109 having an opening

formed therein inside the inner peripheral surface 113. Owing to these characteristics, the compressor can be manufactured at low cost.

[Embodiment 2]

[0051] As shown in FIGS. 5 and 6, a compressor according to an embodiment 2 differs from the compressor according to the embodiment 1 in that the muffler 100 is additionally provided with an intermediate member 230. The remainder of the configuration of the compressor according to the embodiment 2 is the same as that according to the embodiment 1. The same components as those in the embodiment 1 will be denoted by the same reference numerals as those in the embodiment 1, and descriptions thereof will be simplified or omitted.

[0052] The intermediate member 230 is fitted inside the inner peripheral surface 113 between the first end surface 111 and the second end surface 112. The intermediate member 230 comprises a main body part 232 and an extension part 231.

[0053] The main body part 232 is disk-shaped, and the outer peripheral edge thereof is partially radially inwardly recessed to form a recessed part 232a. The extension part 231 is integral with the main body part 232. The extension part 231 encloses the recessed part 232a and extends toward the front. A peripheral edge 231e of the extension part 231 is in intimate contact with the inner peripheral surface 113.

[0054] The main body part 232 and the extension part 231 of the intermediate member 230 divide the muffler chamber 110 into a first muffler chamber 210a positioned to the front and a second muffler chamber 210b positioned to the rear.

[0055] In the intermediate member 230, a first opening 231h, a second opening 232h, and an intermediate flow channel 233 are formed. The first opening 231h is a circular hole formed in a front part of the extension part 231. The first opening 231h penetrates the extension part 231 in the radial direction and opens into the first muffler chamber 210a. The second opening 232h is a clearance formed in a rear surface of the main body part 232 between the recessed part 232a and the inner peripheral surface 113, and opens into the second muffler chamber 210b. The intermediate flow channel 233 is a cavity formed between the extension part 231 and the main body part 232 of the intermediate member 230 and the inner peripheral surface 113, and intermediate flow channel 233 extends in the front-rear direction. The extension part 231 is in communication with the first opening 231h at the front thereof and is in communication with the second opening 232h at the rear thereof.

[0056] The first opening 231h is formed in the front part of the extension part 231 so as to penetrate the extension part 231 in the radial direction. Alternatively, however, the first opening 231h may be formed in the front part of the extension part 231 at a position opposed to the first end surface 111 so as to penetrate the extension part

231 in the axial direction.

[0057] As shown in FIG. 5, an inner diameter D3 of the first opening 231h is smaller than the inner diameter D2 of the outlet channel 102a. The inner diameter D3 of the first opening 231h is slightly larger than the inner diameter D1 of the inlet channel 101.

[0058] With the compressor according to the embodiment 2 configured as described above, the refrigerating gas at high pressure in the discharge chamber 5b flows into the first muffler chamber 210a through the inlet channel 101 at the inlet opening 101h, and then flows into the second muffler chamber 210b through the first opening 231h, the intermediate flow channel 233 and the second opening 232h. The refrigerating gas then flows out into the outlet channels 102a and 102b through the outlet opening 102h and is discharged to the outside through the outlet port 1h. In this process, this compressor can further reduce the discharge pulsation, because the flow of the refrigerating gas is once narrowed down by the inlet channel 101 and then expanded in the first muffler chamber 210a, and then narrowed down again by the intermediate flow channel 233 and then expanded in the second muffler chamber 210b.

[0059] In addition, in this compressor, the first muffler chamber 210a is a substantially cylindrical cavity defined by the cylindrical inner peripheral surface 113, the first end surface 111 positioned to the front, the main body part 232 positioned to the rear of the first end surface 111, and the extension part 231 that is integral with the main body part 232 and extends toward the front. The amplitude of the pulsation of the pressure of the refrigerating gas flowing into the first muffler chamber 210a tends to be smaller in a part close to the front of the extension part 231 than in a part close to the main body part 232. Thus, the amplitude of the pulsation of the pressure of the refrigerating gas flowing into the second muffler chamber 210b through the first opening 231h, the intermediate flow channel 233 and the second opening 232h can be smaller in the case where the first opening 231h opens in the front part of the extension part 231 than in the case where the first opening 231h opens in the main body part 232.

[0060] The second muffler chamber 210b is a cylindrical cavity defined by the cylindrical inner peripheral surface 113, the second end surface 112 positioned to the rear, and the main body part 232 positioned to the front of the second end surface 112. The amplitude of the pulsation of the pressure of the refrigerating gas flowing from the first muffler chamber 210a into the second muffler chamber 210b through the first opening 231h, the intermediate flow channel 233 and the second opening 232h tends to be smaller in a part close to the inner peripheral surface 113 than in a part close to the second end surface 112. Thus, the amplitude of the pulsation of the pressure of the refrigerating gas flowing out of the second muffler chamber 210b into the outlet channels 102a and 102b can be smaller in the case where the flow channel 102a has the outlet opening 102h in the inner peripheral sur-

face 113 than in the case where the outlet channel 102a opens in the second end surface 112.

[0061] Owing to these characteristics, the compressor according to the embodiment 2 can have a reduced size and appropriately reduce the discharge pulsation, as with the compressor according to the embodiment 1.

[Embodiment 3]

[0062] As shown in FIGS. 7 and 8, a compressor according to an embodiment 3 differs from the compressor according to the embodiment 1 in that the muffler 100 is additionally provided with three intermediate members 330. The remainder of the configuration of the compressor according to the embodiment 3 is the same as that according to the embodiment 1. The same components as those in the embodiment 1 will be denoted by the same reference numerals as those in the embodiment 1, and descriptions thereof will be simplified or omitted.

[0063] The three intermediate members 330 are disk-shaped members having the same shape. Each intermediate member 330 is fitted inside the inner peripheral surface 113 side by side in the front-rear direction between the first end surface 111 and the second end surface 2. The intermediate members 330 divide the muffler chamber 110 into four muffler chamber sections 310a, 310b, 310c and 310d. With respect to any one of the intermediate members 330, each muffler chamber section 310a - 310c positioned to the front of that intermediate member 330 is an example of the "first muffler chamber" according to the present invention, and each muffler chamber section 310b - 310d positioned to the rear of that intermediate member 330 is an example of the "second muffler chamber" according to the present invention.

[0064] A plurality of sets of a first opening 331, a second opening 332 and an intermediate flow channel 333 are formed in each intermediate member 330. The first opening 331, the second opening 332 and the intermediate flow channel 333 are parts of a perforated substantially funnel-shaped part protruding toward the front formed by piercing the intermediate member 330 with a sharp-pointed needle-like tool. The first opening 331 opens into the muffler chamber section 310a - 310c positioned to the front. The second opening 332 opens into the muffler chamber section 310b - 310d positioned to the rear. The intermediate flow channel 333 provides communication between the first opening 331 and the second opening 332.

[0065] As shown in FIG. 7, when viewed in the front-rear direction, the sets of the first opening 331, the second opening 332 and the intermediate flow channel 333 formed in one of adjacent two intermediate members 330 are displaced from the sets of the first opening 331, the second opening 332 and the intermediate flow channel 333 formed in the other of the adjacent two intermediate members 330.

[0066] With the compressor according to the embodiment 3 configured as described above, the refrigerating

gas flowing into the muffler chamber 110 sequentially passes through the muffler chamber sections 310a to 310d. In this process, the flow of the refrigerating gas is narrowed down by the set of the first opening 331, the second opening 332 and the intermediate flow channel 333 formed in each intermediate member 330 and then expands. In addition, the refrigerating gas is agitated as the refrigerating gas flows in a serpentine path since the sets of the first opening 331, the second opening 332 and the intermediate flow channel 333 are displaced from each other when viewed in the front-rear direction. As a result, the amplitude of the pulsation of the pressure of the refrigerating gas is reduced.

[0067] Owing to these characteristics, the compressor according to the embodiment 3 can have a reduced size and appropriately reduce the discharge pulsation, as with the compressors according to the embodiments 1 and 2.

[Embodiment 4]

[0068] As shown in FIGS. 9 and 10, a compressor according to an embodiment 4 differs from the compressor according to the embodiment 1 in that the muffler 100 is additionally provided with an agitating member 440. The remainder of the configuration of the compressor according to the embodiment 4 is the same as that according to the embodiment 1. The same components as those in the embodiment 1 will be denoted by the same reference numerals as those in the embodiment 1, and descriptions thereof will be simplified or omitted.

[0069] The agitating member 440 is inserted in the muffler chamber 110. The agitating member 440 has a plurality of minute reflecting surface elements 441 whose reflecting surfaces intersect with the front-rear direction. The reflecting surface elements 441 are dispersed in the muffler chamber 110 by fixing the reflecting surface elements 441 onto a wire coil (not shown) at intervals and placing the coil wire in the muffler chamber 110, for example. Alternatively, the reflecting surface elements 441 may be parts of a stainless steel scourer made of spiral-shaped chips produced in lathe machining of a stainless steel material, for example.

[0070] With the compressor according to the embodiment 4 configured as described above, the refrigerating gas flowing into the muffler chamber 110 is agitated by the plurality of minute reflecting surface elements 441 of the agitating member 440, so that the amplitude of the pulsation of the pressure of the refrigerating gas is reduced.

[0071] Owing to these characteristics, the compressor according to the embodiment 4 can have a reduced size and appropriately reduce the discharge pulsation, as with the compressors according to the embodiments 1 to 3.

[0072] Although the embodiments 1 to 4 of the present invention have been described above, of course, the present invention is not limited to the embodiments 1 to 4, and various changes can be made to the embodiments as required without departing from the spirit of the present

invention.

[0073] For example, in the embodiments 1 to 4, the outlet opening 102h is formed in the inner peripheral surface 113 at a position that is spaced apart from the second end surface 112 toward the first end surface 111 and is closer to the second end surface 112 than the first end surface 111. Alternatively, however, the outlet opening 102h may be formed in the inner peripheral surface 113 at a position that is spaced apart from the second end surface 112 toward the first end surface 111 and is closer to the first end surface 111 than the second end surface 112.

[0074] Furthermore, in the embodiments 1 to 4, the inner diameter D2 of the outlet channel 102a is larger than the inner diameter D1 of the inlet channel 101. Alternatively, however, the inner diameter D2 may be smaller than or equal to the inner diameter D1.

[0075] Furthermore, in the embodiments 1 to 4, the distance A from the front end surface 5f of the rear housing 5 to the second end surface 112 of the muffler chamber 110 is equal to or smaller than the distance B from the front end surface 5f of the rear housing 5 to the rear end surface 5e of the discharge chamber 5b. Alternatively, however, the muffler chamber 110 may be configured so that the distance A is longer than the distance B.

Claims

1. A variable displacement compressor with single-head pistons, comprising:

a cylinder block having a plurality of cylinder bores that are formed side by side in a circumferential direction and extend in parallel with each other in an axial direction;
 a front housing that is fixed to one end side of the cylinder block in the axial direction and has a crank chamber formed therein;
 a rear housing that is fixed to the other end side of the cylinder block in the axial direction and has a suction chamber and a discharge chamber formed therein;
 a plurality of pistons each housed in each of the cylinder bores so as to reciprocate and defining a compression chamber in each of the cylinder bores on the other end side; and
 driving means that is provided in the crank chamber and is capable of making each of the pistons reciprocate and changing strokes of each of the pistons,
 the rear housing having an annular wall that separates the suction chamber and the discharge chamber from each other,
 the discharge chamber being formed between the annular wall and an outer peripheral wall of the rear housing so as to extend in the circumferential direction and annularly surround the

suction chamber,
 an outlet port, through which the discharge chamber is in communication with the outside, being formed in the cylinder block or the rear housing,
 a muffler being provided between the discharge chamber and the outlet port,
 the muffler having a muffler chamber, an inlet channel and an outlet channel, and
 the muffler chamber being formed in the rear housing, the inlet channel providing communication between the discharge chamber and the muffler chamber, and the outlet channel providing communication between the muffler chamber and the outlet port,
 wherein the muffler chamber has:

a first end surface positioned on the one end side of the muffler chamber;
 a second end surface positioned on the other end side of the muffler chamber; and
 an inner peripheral surface having a cylindrical shape that is positioned between the first end surface and the second end surface and extends from the discharge chamber toward the other end side,
 the muffler chamber is positioned between the annular wall and the outer peripheral wall,
 the inlet channel opens in the first end surface, and
 the outlet channel opens in the inner peripheral surface at a position spaced apart from the second end surface.

2. The variable displacement compressor with single-head pistons according to claim 1, wherein the inner peripheral surface, the second end surface and the outlet channel are formed in the rear housing, the first end surface is formed by a disk-shaped lid member that is fitted inside the inner peripheral surface and separates the discharge chamber and the muffler chamber from each other, and the inlet channel is formed in the lid member.
3. The variable displacement compressor with single-head pistons according to claim 2, wherein the inner peripheral surface and the second end surface form a closed-end circular hole that is recessed in the discharge chamber toward the other end side, and the outlet channel is a straight hole that penetrates the rear housing from the one end side to the inner peripheral surface.
4. The variable displacement compressor with single-head pistons according to any one of claims 1 to 3, wherein an inner diameter of the outlet channel is larger than an inner diameter of the inlet channel.

5. The variable displacement compressor with single-head pistons according to any one of claims 1 to 4, wherein an intermediate member is fitted inside the inner peripheral surface, the intermediate member dividing the muffler chamber into a first muffler chamber positioned on the one end side and a second muffler chamber positioned on the other end side, a first opening, a second opening and an intermediate flow channel are formed in the intermediate member, and
the first opening opens into the first muffler chamber, the second opening opens into the second muffler chamber, and the intermediate flow channel provides communication between the first opening and the second opening.
6. The variable displacement compressor with single-head pistons according to claim 5, wherein the intermediate member includes a disk-shaped main body part and an extension part that is integral with the main body part and extends toward the one end side, the first opening is formed in the extension part at a position on the one end side, the second opening is formed in the main body part at a position on the other end side, and the intermediate flow channel is formed between the extension part and the main body part of the intermediate member and the inner peripheral surface.
7. The variable displacement compressor with single-head pistons according to claim 5, wherein a plurality of the intermediate members arranged side by side in the axial direction are fitted inside the inner peripheral surface, and the first opening, the second opening and the intermediate flow channel formed in one of adjacent two of the intermediate members are displaced from the first opening, the second opening and the intermediate flow channel formed in the other of the adjacent two of the intermediate members when viewed in the axial direction.
8. The variable displacement compressor with single-head pistons according to any one of claims 1 to 7, wherein an agitating member is inserted in the muffler chamber, the agitating member having a plurality of reflecting surface elements whose reflecting surfaces intersect with the axial direction.

FIG. 1

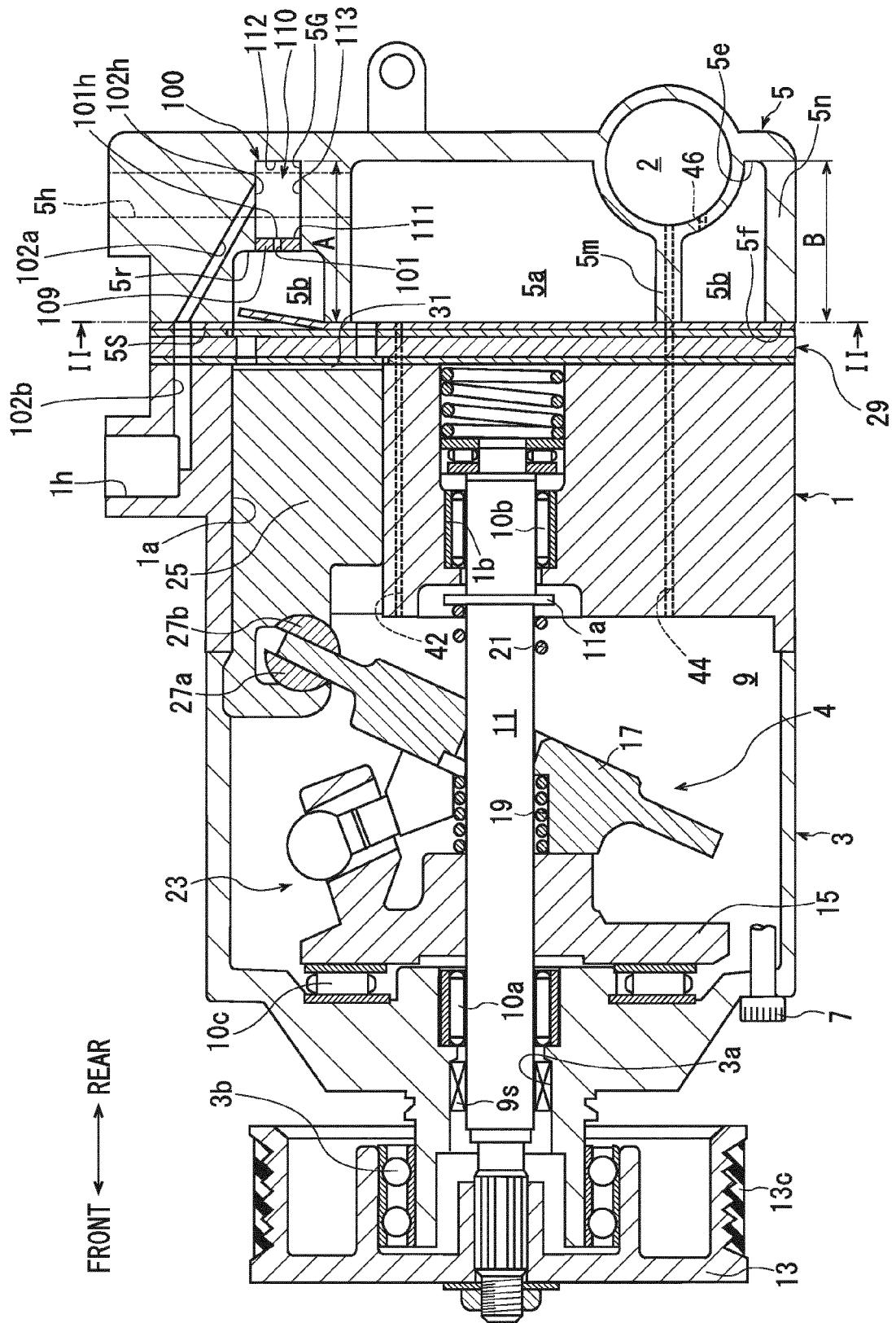


FIG. 2

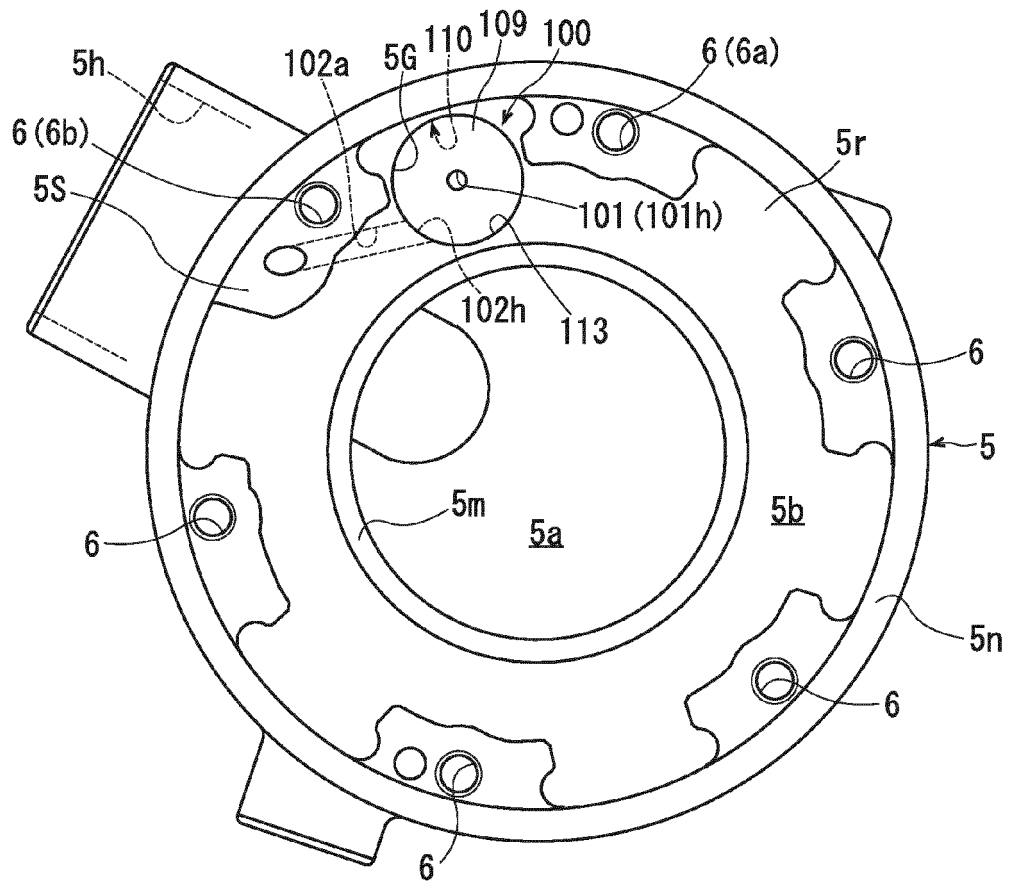


FIG. 3

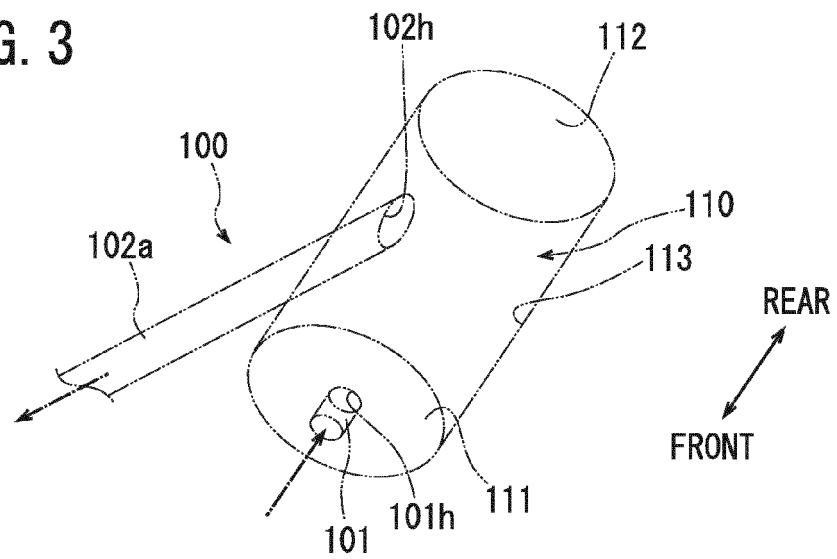


FIG. 4

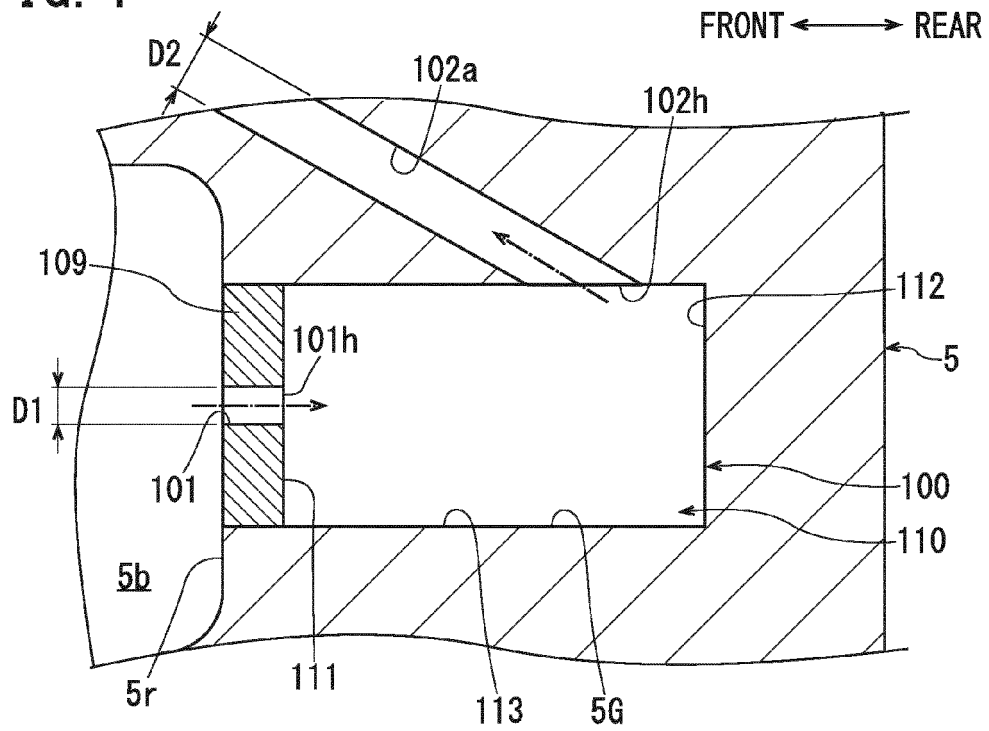


FIG. 5

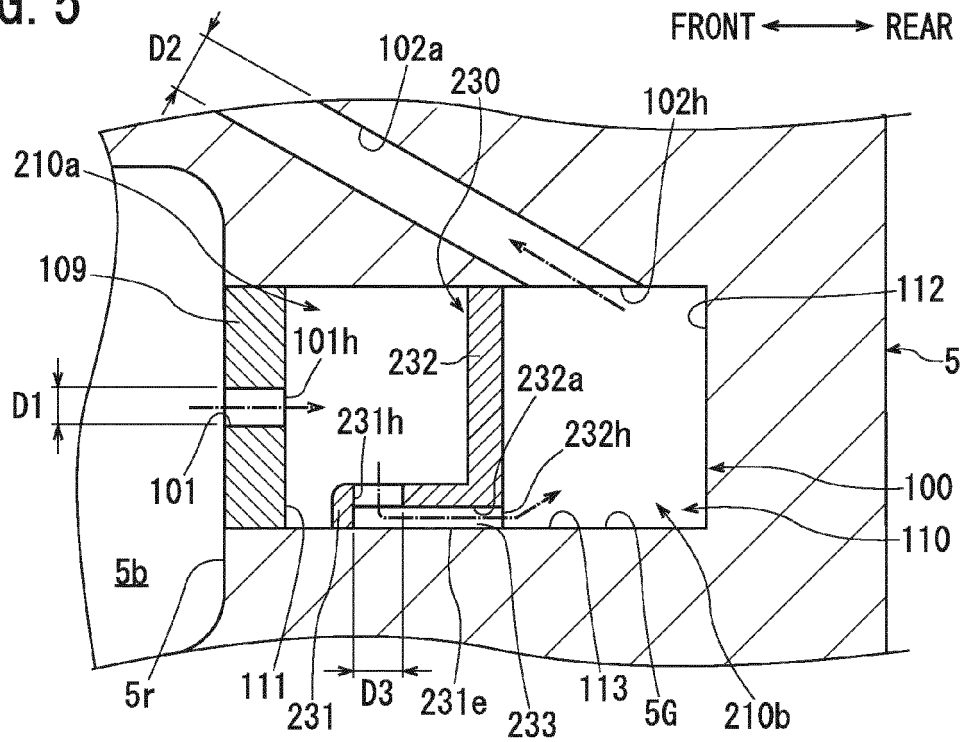


FIG. 6

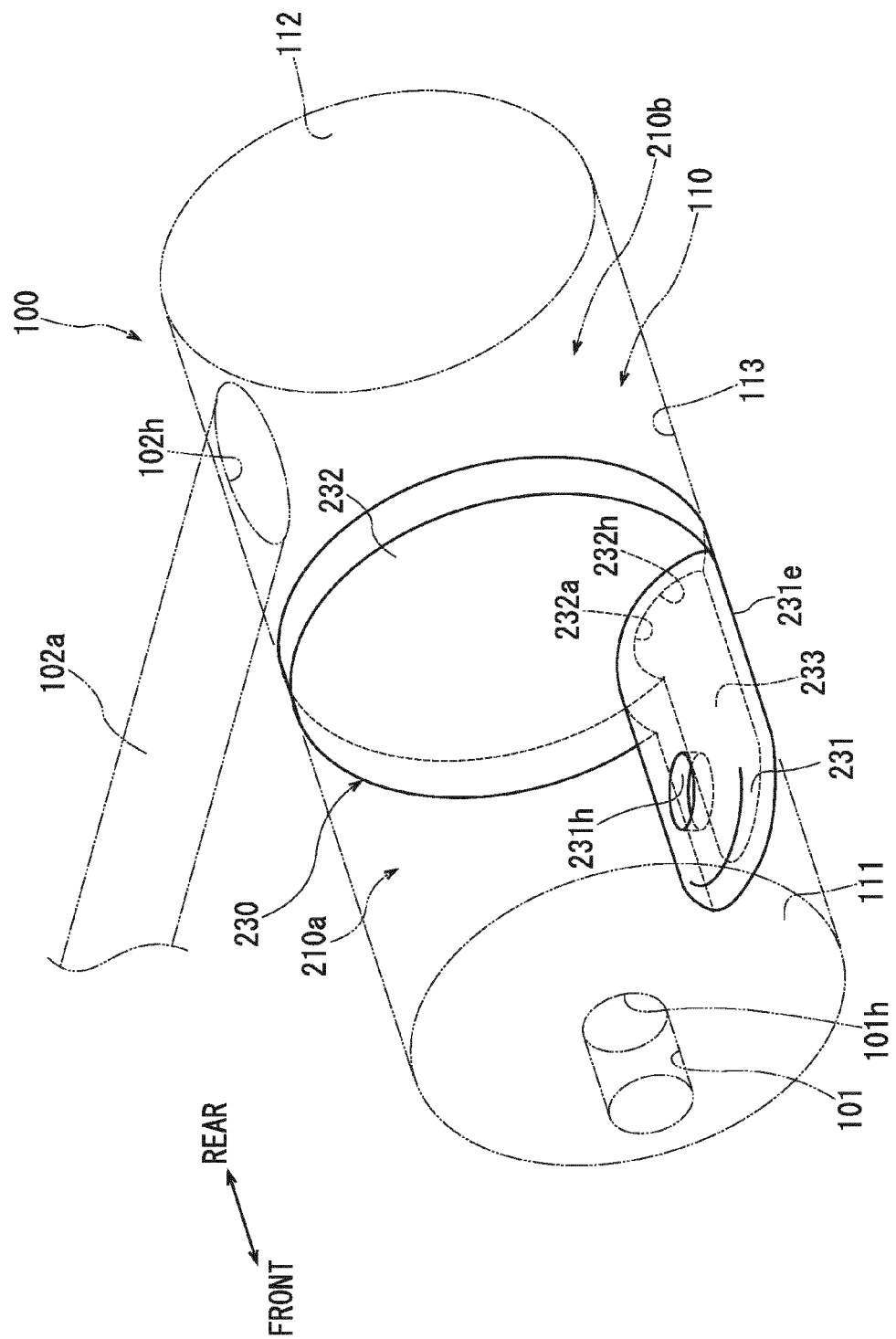


FIG. 7

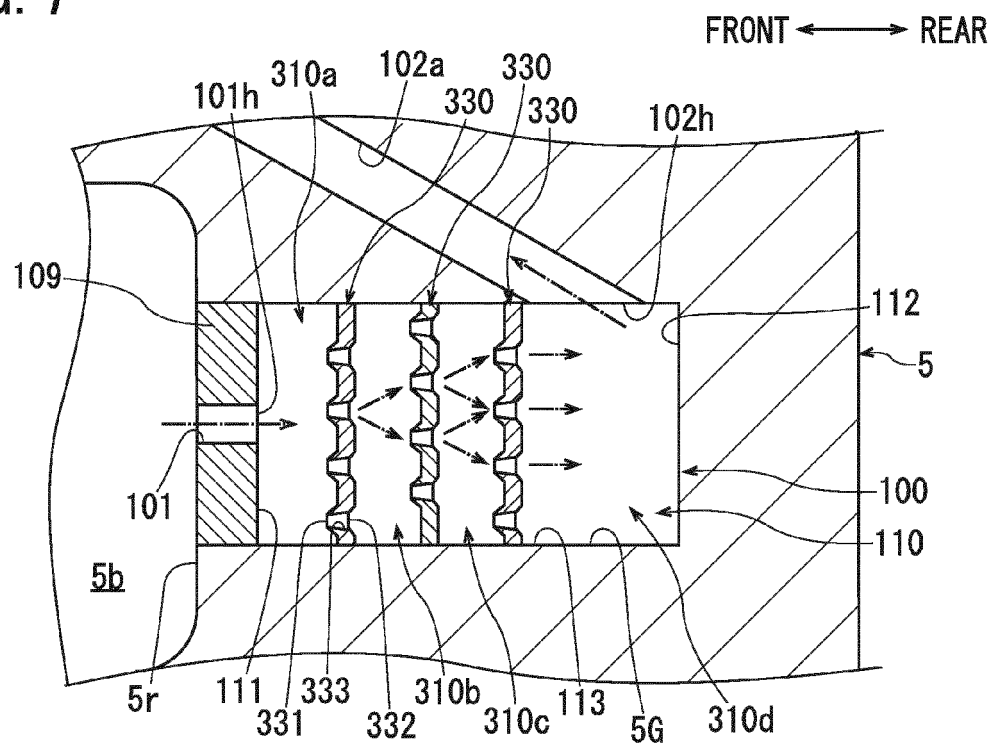


FIG. 8

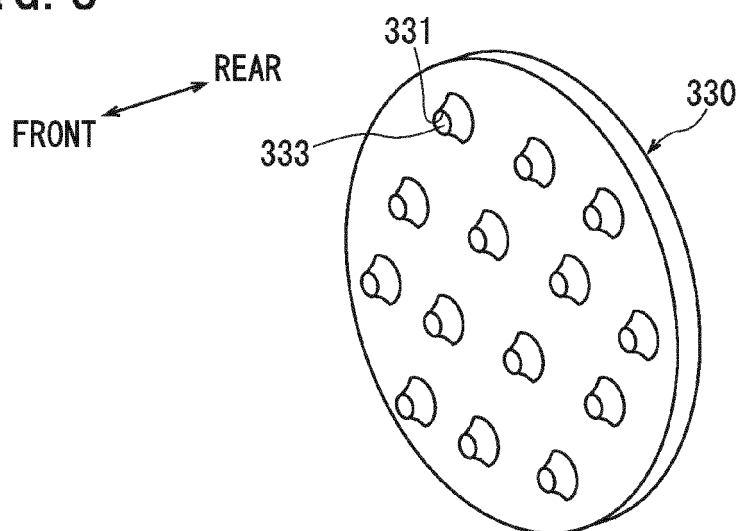


FIG. 9

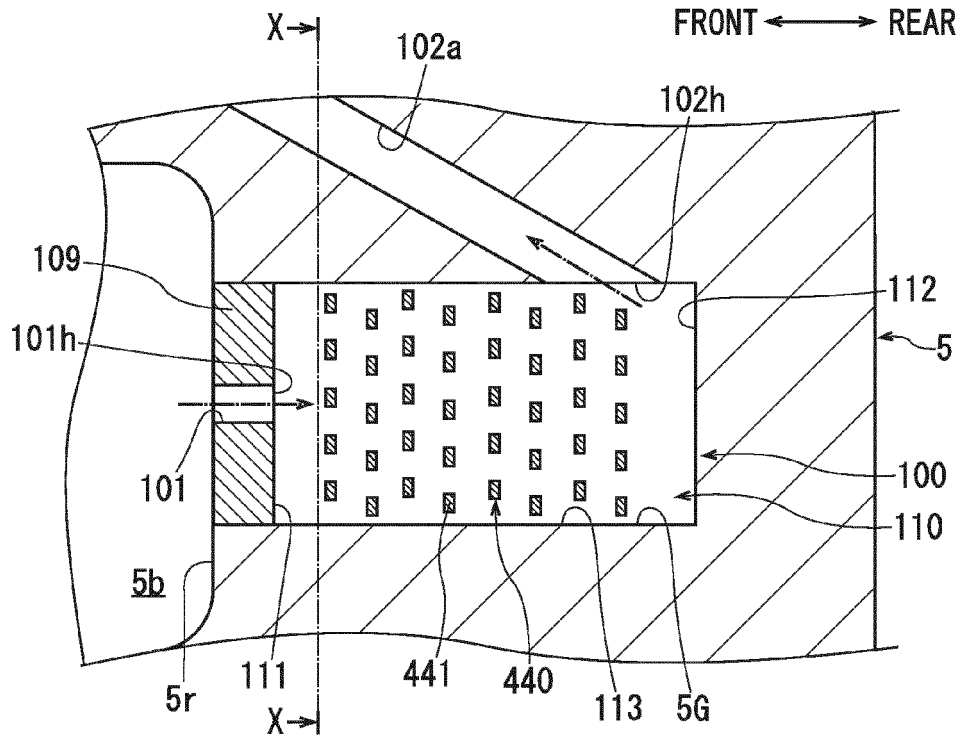
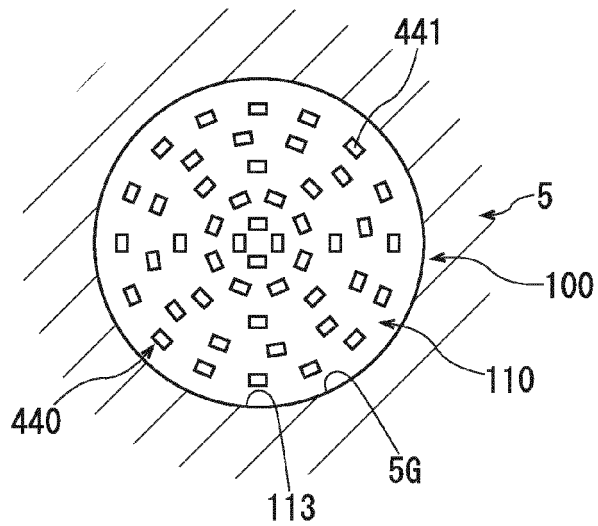


FIG. 10



REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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