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(54) ROTARY COMPRESSOR

(57) A rotary compressor (1) includes a rotating shaft (3), a rotary-type compression mechanism (4), and a muffler (10) which is disposed around the axis of the rotating shaft (3). The muffler (10) includes: a muffler body (11) for receiving a compressed refrigerant therein; and a flow passage wall (12) for forming an output flow passage (100) between the flow passage wall (12) and the rotating shaft (3) or a bearing section (6B), the output flow passage (100) having a predetermined length and allowing the refrigerant to flow to the outside of the muffler (10) in the axial direction of the rotating shaft (3). The output flow passage (100) includes: a first flow passage portion (101) located at a part in the circumferential direction (D1) of the rotating shaft (3); and a second flow passage portion (102) which is adjacent to the first flow passage portion (101) in the circumferential direction (D1). The second flow passage portion (102) has a greater dimension in the radial direction of the rotating shaft (3) than that of the first flow passage portion (101), and has a greater cross-sectional area than that of the first flow passage portion (101).

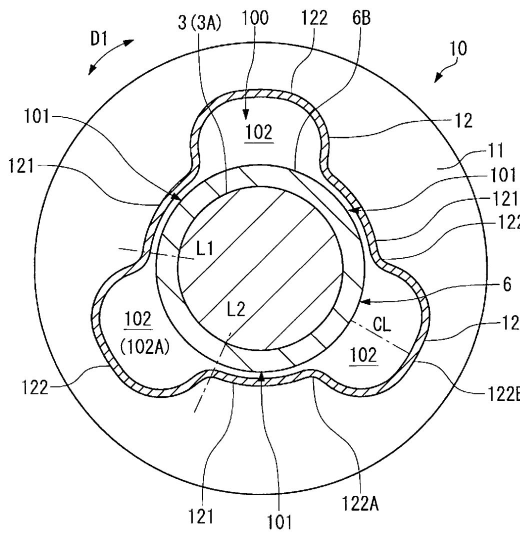

FIG. 3

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Description

Technical Field

[0001] The disclosure relates to a rotary compressor that includes a rotary-type compression mechanism and a discharging muffler.

Background Art

[0002] A rotary compressor includes a rotating shaft, a piston rotor provided on the rotating shaft, a rotary-type compression mechanism including a cylinder, a muffler configured to suppress noise caused by pulsation (pressure fluctuation) of compressed refrigerant gas, and a housing (see, for example, Patent Document 1).

[0003] The refrigerant gas compressed by the rotary-type compression mechanism is discharged into the inside of the muffler through a discharge port formed in a member that closes an opening of the cylinder, passes through the gap left between the rotating shaft and the portion of the muffler with a reduced diameter, and then is discharged into the space in the housing.

[0004] According to Patent Document 1, the gap (outlet of the muffler) formed on the outer circumference of the rotating shaft is located at a symmetrical position to the discharge port (inlet of the muffler) from the inside of the cylinder with respect to the rotating shaft as the center, and the pulsation of the refrigerant gas discharged from the inside of the cylinder into the muller is reduced by the muffler.

Citation List

Patent Document

[0005] Patent Document 1: JP 3941809 B

Summary of Invention

Problem to be Solved by the Invention

[0006] Though the muffler reduces pulsation principally with a particular frequency component, it is difficult for the same muffler to reduce pulsation with different frequency components.

[0007] When the pulsation that is not sufficiently reduced by the muffler is discharged out from the muffler and resonates within the space inside the housing, noise may be produced.

[0008] Hence, the disclosure provides a rotary compressor capable of reducing the pulsation that is not reduced sufficiently in the muffler.

Means for Solving Problem

[0009] The disclosure provides a rotary compressor including a rotating shaft configured to be rotated, a rotary-type compression mechanism including a piston rotor provided on the rotating shaft and a cylinder in which the piston rotor is disposed, and a muffler disposed around an axis of the rotating shaft, wherein the muffler includes a muffler main body configured to receive therein a fluid compressed by the compression mechanism and a flow-passage wall configured to form an output flow passage between the output flow passage and the rotating shaft or a bearing portion located around the axis of the rotating shaft, the output flow passage having a predetermined length and being configured to allow the fluid to flow, in the axial direction of the rotating shaft, out of the muffler, and the output flow passage includes a first flow passage portion located at a position in a circumferential direction of the rotating shaft, and a second flow passage portion which is adjacent to the first flow passage portion in the circumferential direction, the second flow passage portion having a larger dimension measured in a radial direction of the rotating shaft than a corresponding dimension of the first flow passage portion, and the second flow passage portion having a larger cross-sectional area than a cross-sectional area of the first flow passage portion.

[0010] The difference in the cross-sectional area between the first flow passage portion and the second flow passage portion results in a difference in the flow rate between the fluid flowing through the first flow passage portion and the fluid flowing through the second flow passage portion. Hence, the phase of the pressure fluctuation of the fluid flowed into the first flow passage portion and the phase of the pressure fluctuation of the fluid flowed into second flow passage portion shift from each other. Thus, the pressure fluctuation of the fluid flowed out of the first flow passage portion and the pressure fluctuation of the fluid flowed out of the second flow passage portion interfere with each other and cancel off each other.

[0011] In the rotary compressor of the disclosure, the output flow passage may preferably include a plurality of the second flow passage portions.

[0012] In the rotary compressor of the disclosure, one of the plurality of second flow passage portions may preferably have a different cross-sectional area from the cross-sectional area of another one of the plurality of second flow passage portions.

[0013] In the rotary compressor of the disclosure, the output flow passage may preferably be formed all around the circumference around the axis of the rotating shaft, and may preferably include a plurality of the first flow passage portions and the plurality of second flow passage portions such that the first flow passage portions and the second flow passage portions are arranged alternately in the circumferential direction.

[0014] In the rotary compressor of the disclosure, a part of the flow-passage wall for forming second flow passage portion may preferably have a cross section that is substantially C-shaped or substantially V-shaped.

[0015] The disclosure provides a rotary compressor including a rotating shaft configured to be rotated, a rotary-type compression mechanism including a piston rotor provided on the rotating shaft and a cylinder in which the piston rotor is disposed, and a muffler disposed around an axis of the rotating shaft, wherein the muffler includes a muffler main body configured to receive therein a fluid compressed by the compression mechanism and a flow-passage wall configured to form an output flow passage between the flow-passage wall and the rotating shaft or a bearing portion located around the axis of the rotating shaft, the output flow passage having a predetermined length and being configured to allow the fluid to flow, in the axial direction of the rotating shaft, out of the muffler, the output flow passage includes a first flow passage portion located at a part in a circumferential direction of the rotating shaft and a second flow passage portion having a larger cross-sectional area than a cross-sectional area of the first flow passage portion, and the first flow passage portion protrudes radially outwards from the second flow passage portion.

[0016] In the rotary compressor of the disclosure, the following equation may preferably hold: $\alpha = n (v_1/2fx_0) + 1$, where x_0 is a length of the output flow passage, v_1 is a flow rate of the fluid in the first flow passage portion, α is a flow-rate ratio of a flow rate of the fluid in the second flow passage portion in relation to v_1, f is a predetermined frequency, and n is a natural number.

Advantageous Effect of the Invention

[0017] According to the rotary compressor of the disclosure, the pulsation that is not reduced sufficiently in the muffler is also reduced, and thus the noise caused by the pulsation is also suppressed.

Brief Description of Drawings

[0018]

FIG. 1 is a vertical cross-sectional view of a rotary compressor according to a first embodiment.
FIG. 2A is an enlarged view of a portion of the rotary compressor illustrated in FIG. 1. FIG. 2B is a diagram illustrating an output flow passage of a muffler.
FIG. 3 is a plan view of the muffler illustrated in FIG. 2A.
FIG. 4A is a diagram illustrating a pulsation of a fluid flowing through a first flow passage portion of the output flow passage of the muffler, and FIG. 4B is a diagram illustrating a pulsation of a fluid flowing through a second flow passage portion of the output flow passage of the muffler.
FIG. 5 is a plan view of a muffler included in a rotary compressor according to a second embodiment.
FIG. 6 is a plan view of a muffler included in a rotary compressor according to a modified example of the disclosure.
FIG. 7 is a plan view of a muffler included in a rotary compressor according to a different modified example of the disclosure.
FIG. 8 is a plan view of a muffler included in a rotary compressor according to a modified example of the disclosure.

Best Mode for Carrying Out the Invention

[0019] An embodiment of the disclosure will be described hereinafter with reference to the appended drawings.

First Embodiment

[0020] A compressor 1 illustrated in FIG. 1 takes in gas refrigerant that is in a not-illustrated accumulator (gas-liquid separator) through piping 8 and 9, and then makes a compression mechanism 4 compresses the gas refrigerant thus taken in.

[0021] The compressor 1 and the accumulator form parts of a refrigeration device, such as an air conditioner and a chiller, and is connected to a refrigerant circuit (not illustrated) where a refrigerant circulates.

[0022] The compressor 1 includes a motor 2 serving as a power source, a rotating shaft 3 (crankshaft) configured to be rotated by a rotational driving force outputted from the motor 2, the rotary-type compression mechanism 4 driven by the rotational driving force transmitted via the rotating shaft 3, mufflers 10 and 20 disposed around the axis of the rotating shaft 3, and a housing 5.

[0023] The mufflers 10 and 20 suppress the noise caused by the pulsation of the refrigerant compressed by the compression mechanism 4.

[0024] The housing 5 accommodates the motor 2, the rotating shaft 3, the compression mechanism 4, and the mufflers 10 and 20, and is formed into a cylindrical shape.

[0025] The motor 2 includes a stator 2A fixed to an inner circumferential portion of the housing 5 and a rotor 2B disposed on an inner side of the stator 2A. The rotor 2B rotates in relation to the stator 2A when a coil 2C provided in the stator 2A is energized.

[0026] The rotating shaft 3 includes a main shaft portion 3A coupled to the rotor 2B and sticking downwards out of the rotor 2B, an upper crank pin 3B disposed eccentrically with the axial center of the main shaft portion 3A, and a lower crank pin 3C disposed also eccentrically with the axial center of the main shaft portion 3A. The direction of the eccentricity of the lower crank pin 3C is in the opposite phase (180°) to the direction of the eccentricity of the upper crank pin 3B with respect to the axial center of the rotating shaft 3.

[0027] The upper crank pin 3B is disposed in an upper cylinder 412 of the compression mechanism 4 whereas the lower crank pin 3C is disposed in a lower cylinder 422 of the compression mechanism 4.

[0028] The compression mechanism 4 (FIG. 1) will be described below.

[0029] The compression mechanism 4, which is of a so-called twin-rotary type, includes an upper compression mechanism 41, a lower compression mechanism 42, a partition plate 4A, as well as an upper bearing 6 and a lower bearing 7 that are configured to rotatably support the rotating shaft 3.

[0030] The partition plate 4A separates the inside of the cylinder 412 of the upper compression mechanism 41 from the inside of the cylinder 422 of the lower compression mechanism 42.

[0031] The upper compression mechanism 41 includes an upper piston rotor 411 disposed on the upper crank pin 3B, the upper cylinder 412 in which the upper piston rotor 411 is disposed, and the upper muffler 10 disposed around the axis of the main shaft portion 3A.

[0032] The upper piston rotor 411 fits onto the outer circumferential portion of the upper crank pin 3B, and the rotation of the upper piston rotor 411 turns the upper crank pin 3B within the upper cylinder 412.

[0033] The refrigerant is taken into the upper cylinder 412 through the piping 8.

[0034] The upper bearing 6 includes a touch portion 6A configured to touch an upper end surface of the upper cylinder 412, and also includes a cylindrical bearing portion 6B sticking upwards out of the touch portion 6A and disposed around the axis of the rotating shaft 3 (main shaft portion 3A). The touch portion 6A is fixed to an inner circumferential portion of the housing 5.

[0035] To the upper bearing 6, the upper cylinder 412, the upper muffler 10, the lower cylinder 422, and the lower muffler 20 are assembled integrally with a bolt 11B.

[0036] Once the refrigerant is taken in the upper cylinder 412, the refrigerant is compressed in a space located on the front side, in the rotational-direction, of a not-illustrated blade pressed by the outer circumferential portion of the turning upper piston rotor 411. The refrigerant thus compressed is discharged into the upper muffler 10 through the not-illustrated discharge port formed in the touch portion 6A of the upper bearing 6, then passes through an output flow passage 100 formed between the upper muffler 10 and the bearing portion 6B, and then is discharged into a space below the motor 2 within the housing 5.

[0037] Like the upper compression mechanism 41, the lower compression mechanism 42 includes a lower piston rotor 421 disposed on the lower crank pin 3C, the lower cylinder 422 in which the lower piston rotor 421 is disposed, and the lower muffler 20 disposed around the axis of the main shaft portion 3A.

[0038] The gas refrigerant is taken into the lower cylinder 422 through the piping 9.

[0039] The lower bearing 7 includes a touch portion 7A configured to touch a lower end surface of the lower cylinder 422, and also includes a cylindrical bearing portion 7B sticking downwards out of the touch portion 7A and disposed around the axis of the rotating shaft 3 (main shaft portion 3A).

[0040] Once the refrigerant is taken in the lower cylinder 422, the refrigerant is compressed by the turning of the lower piston rotor 421 and is then discharged into the lower muffler 20 through a not-illustrated discharge port formed in the touch portion 7A of the lower bearing 7. Once the refrigerant is discharged into the lower muffler 20, the refrigerant passes through the output flow passage 200 formed between the lower muffler 20 and the bearing portion 7B, and is then discharged into a space in the housing 5. After that the refrigerant passes through a cutaway 61A and a not-illustrated hole formed in the touch portion 6A of the upper bearing 6, and is then discharged into a space below the motor 2 in the housing 5.

[0041] As described above, the refrigerant having been compressed by the upper compression mechanism 41 and the refrigerant having been compressed by the lower compression mechanism 42 are discharged into the space below the motor 2 in the housing 5. Then, the refrigerant passes through the cutaways formed in the stator 2A and in the rotor 2B and flows into a space above the motor 2. After that the refrigerant is discharged into the refrigerant circuit through a discharge pipe 5A formed in an upper portion of the housing 5.

[0042] The upper compression mechanism 41 and the lower compression mechanism 42 discharge the refrigerant with pressure fluctuation (pulsation) through their respective discharge ports depending respectively on the turning cycles of the piston rotors 411 and 421. Once the refrigerant having been compressed by the upper compression mechanism 41 and the refrigerant having been compressed by the lower compression mechanism 42 are discharged respectively into the mufflers 10 and 20 through the corresponding discharge ports, the pulsation of the discharged refrigerant are reduced in the mufflers 10 and 20, respectively.

[0043] When the pulsation that is not reduced sufficiently even by the mufflers 10 and 20 are discharged out of the mufflers 10 and 20 and resonate in the space within the housing 5 below the motor 2, noise may be generated.

[0044] Thus, the compressor 1 of this embodiment reduces even the pulsation that is not reduced sufficiently in the mufflers 10 and 20 by providing an output flow passages 100 and 200 through which the refrigerant flows from the insides of the mufflers 10 and 20 out to the outsides of the mufflers 10 and 20, respectively.

[0045] First of all, a configuration of the upper muffler 10 (hereinafter, simply referred to as the "muffler 10") will be described below.

[0046] As illustrated in FIG. 2A, the muffler 10 includes a muffler main body 11 configured to form a space between itself and the touch portion 6A of the upper bearing 6, and also includes a flow-passage wall 12 configured to form the output flow passage 100 between itself and the bearing portion 6B of the upper bearing 6. The output flow passage 100 allows the refrigerant to flow out of the muffler 10. The flow-passage wall 12 is the circumferential edge of an opening 10A formed in the central portion of the flat surface of the muffler 10. The opening 10A allows the bearing portion 6B of the upper bearing 6 to pass therethrough.

[0047] The muffler main body 11 and the flow-passage wall 12 are made from a metal material such as an aluminum alloy, and are formed integrally with each other by, for example, deep drawing.

[0048] The compressed refrigerant having been compressed in the upper cylinder 412 and spouted out of the not-illustrated discharge port is allowed to enter the inside of the muffler main body 11, where the pulsation of the compressed refrigerant is reduced. For the refrigerant spouted in the muffler main body 11, the space in the muffler main body 11 serves as a resistor in accordance with the volume of the space. Hence the pulsation of the refrigerant is damped by the muffler 10.

[0049] The muffler main body 11 extends, with a predetermined diameter, outwards in the radial direction from the flow-passage wall 12, and is formed in a circular shape in plan view. The outer end portion, in the radial direction, of the muffler main body 11 is fastened to the upper bearing 6 with bolts 11B at a plurality of positions situated in the circumferential direction. No bolt 11B is illustrated in FIG. 3.

[0050] An inner-circumferential end 111 of the muffler main body 11 is located above the touch portion 6A and is contiguous to the flow-passage wall 12. The inner-circumferential end 111 of the muffler main body 11 illustrated in the drawing is contiguous to the flow-passage wall 12 via the curved portion 112, but the inner-circumferential end 111 may be contiguous directly to the flow-passage wall 12. The curved portion 112 is curved to protrude upwards relative to the inner-circumferential end 111.

[0051] The dimensions and the volume of the muffler main body 11 are defined appropriately to adapt to the main frequency component of the pulsation of the compressed refrigerant. The main frequency component is, for example, in a mid-frequency band from 500 Hz to 1 kHz, which may be more likely to cause noise.

[0052] The space in the muffler main body 11 may be divided into an inner section configured to accept, temporarily at the first stage, the refrigerant having been discharged through the discharge port, and an outer section configured to accept the refrigerant, at the second stage, coming from the inner section. Even in the case of such a two-stage muffler, similar effects to those obtainable by the muffler 10 of this embodiment are obtained by forming, as described below, the output flow passage 100 configured to allow the refrigerant to flow from the outer section to the outside of the muffler.

[0053] The flow-passage wall 12 is contiguous to the muffler main body 11 via the curved portion 112. The flow-passage wall 12 rises along the axial direction of the bearing portion 6B from the same height all around the flow-passage wall 12. The upper end of the flow-passage wall 12 has a constant height all around the flow-passage wall 12.

[0054] As illustrated in FIG. 2B, the output flow passage 100, which has a length corresponding to the height of the flow-passage wall 12, is formed along the axial direction of the rotating shaft 3 between the inner circumferential portion of the flow-passage wall 12 and the outer circumferential portion of the bearing portion 6B.

[0055] Depending upon the height of the entire muffler 10, the flow-passage wall 12 may face the outer circumferential portion of the rotating shaft 3 instead of facing the bearing portion 6B. In such cases, the output flow passage 100 is formed between the inner circumferential portion of the flow-passage wall 12 and the outer circumferential portion of the rotating shaft 3.

[0056] The lower muffler 20 (FIG. 1) is formed in a substantially similar shape to the shape of the upper muffler 10, and is disposed around the axis of the lower bearing 7 in a vertically opposite orientation to the upper muffler 10.

[0057] The lower muffler 20 includes a muffler main body 21 and a flow-passage wall 22. The output flow passage 200 is formed between the flow-passage wall 22 and the bearing portion 7B of the lower bearing 7, and is configured to allow the refrigerant to flow out of the muffler 20.

[0058] The configurations of the output flow passages 100 and 200 will be described below.

[0059] FIG. 3 illustrates the output flow passage 100 formed between the bearing portion 6B of the upper bearing 6 located around the axis of the rotating shaft 3 and the flow-passage wall 12 of the upper muffler 10. The output flow passage 100 has a predetermined passage length x_0.

[0060] The dimension of the output flow passage 100 in the radial direction of the rotating shaft 3 changes along the circumferential direction D1 of the rotating shaft 3.

[0061] The output flow passage 100 has a constant passage length x_0 (FIG. 2B) all around the output flow passage 100.

[0062] The cross-sectional area of the entire output flow passage 100, that is, the area of the image formed by projecting the output flow passage 100 in the axial direction of the rotating shaft 3, is determined by taking into account the capacity of the compressor 1 and the pulsation-reduction effects of the muffler 10.

[0063] For the lower muffler 20, no plan view of the output flow passage 200 is given here, but the output flow passage 200 may be formed in a similar manner to the output flow passage 100.

[0064] A configuration of the output flow passage 100 will be described in detail below.

[0065] The output flow passage 100 includes a first flow passage portion 101 located in a portion along the circumferential direction D1 of the rotating shaft 3, and also includes a second flow passage portion 102 located adjacently to the first flow passage portion 101 in the circumferential direction D1. When the cross-sectional area of the first flow passage portion 101 is compared with the cross-sectional area of the second flow passage portion 102, the second flow passage portion 102 has a larger cross-sectional area.

[0066] Once compressed and discharged into the muffler 10, the compressed refrigerant with pulsation flows through the first flow passage portion 101 and the second flow passage portion 102, and then flows out of the muffler 10. The pressure fluctuation of the refrigerant flowed out through the first flow passage portion 101 and the pressure fluctuation of the refrigerant flowed out through the second flow passage portion 102 interfere with each other and thus are reduced.

[0067] The output flow passage 100 preferably includes a plurality of first flow passage portions 101 and a plurality of second flow passage portions 102. The output flow passage 100 of this embodiment includes three first flow passage portions 101 and three second flow passage portions 102.

[0068] The output flow passage 100 is formed preferably all around the axis of the rotating shaft 3, and preferably includes the first flow passage portions 101 and the second flow passage portions 102 arranged alternately along the circumferential direction D1 of the rotating shaft 3.

[0069] The second flow passage portions 102 are preferably arranged equidistantly along the circumferential direction D1.

[0070] The flow-passage wall 12 includes a first wall portion 121 configured to form the first flow passage portion 101 between itself and the outer circumferential portion of the bearing portion 6B, and also includes a second wall portion 122 configured to form the second flow passage portion 102 between itself and the outer circumferential portion of the bearing portion 6B. The number of the first wall portion(s) 121 is the same as the number of the first flow passage portion(s) 101 whereas the number of the second wall portion(s) 122 is the same as the number of the second flow passage portion(s) 102.

[0071] The first flow passage portion 101 is formed to have a cross-sectional shape of a circular arc that is concentric with the rotating shaft 3 and the bearing portion 6B. The first wall portion 121 is formed in a similar manner.

[0072] The first wall portion 121 is disposed along the outer circumferential surface (cylindrical surface) of the bearing portion 6B with a predetermined distance left between itself and the outer circumferential surface. The distance between the first wall portion 121 and the outer circumferential surface of the bearing portion 6B, that is, the width of the first flow passage portion 101 is shorter than 1 mm, for example.

[0073] The second flow passage portion 102 has a shape bulging radially outwards from the outer circumferential surface of the bearing portion 6B. The second wall portion 122 is formed in a similar manner.

[0074] The second flow passage portion 102 has a larger dimension measured in the radial direction of the rotating shaft 3 than the corresponding dimension of the first flow passage portion 101.

[0075] The cross-sectional shape of the second wall portion 122 corresponding to the second flow passage portion 102 may be determined appropriately, and some exemplar shapes are a C-shape (or U-shape) and a V-shape. For the purpose of reducing the flow-passage loss of the flow that passes through the second flow passage portion 102, it is preferable to form a smoothly curved shape starting from a first end 122A of the second wall portion 122 (the first end 122A being contiguous to the first wall portion 121), passing by a top portion 122B (the most outwardly bulging portion), and reaching a second end 122C of the second wall portion 122.

[0076] As an example, the second wall portion 122 of this embodiment is formed to have a substantially C-shaped cross section that is symmetrical with respect to the center line CL passing through the center of the cross section in the circumferential direction D1. The second wall portion 122 may be formed to have a substantially V-shaped cross-sectional shape with the width gradually widening from the top portion 122B towards the two ends in the circumferential direction D1.

[0077] The cross-sectional shape of the first flow passage portion 101 and the cross-sectional shape of the second flow passage portion 102 are constant in the axial direction of the rotating shaft 3, which is perpendicular to the paper sheet of FIG. 3; however, the shape not limited thereto.

[0078] The output flow passage 100 is divided, in the circumferential direction D1, into the first flow passage portion 101 with a narrower flow passage and a second flow passage portion 102 with a wider flow passage than the width of the flow passage of the first flow passage portion 101. Boundary lines (e.g., L1 and L2) may be drawn in the radial direction of the rotating shaft 3 between the first flow passage portions 101 and the second flow passage portions 102. By considering each of the boundary lines as a separate line between each of the first flow passage portions 101 and the corresponding second flow passage portion 102, the cross-sectional area of each first flow passage portion 101 and the cross-sectional area of each second flow passage portion 102 may be defined.

[0079] The cross-sectional area of each first flow passage portion 101 is smaller than the cross-sectional area of each second flow passage portion 102. Hence the flow rate of the refrigerant flowing through each first flow passage portion 101 is faster than the flow rate of the refrigerant flowing through each second flow passage portion 102.

[0080] FIG. 4A illustrates the pulsation of the refrigerant flowed from the inside of the muffler main body 11 into the first flow passage portion 101, and FIG. 4B illustrates the pulsation of the refrigerant flowed from the inside of the muffler main body 11 into the second flow passage portion 102. The horizontal axis of each chart represents the distance x in the lengthwise direction of the flow passage.

[0081] As the flow rate of the refrigerant in the first flow passage portion 101 with a relatively small cross-sectional area is fast, the waveform of the pressure fluctuation p_1 in the first flow passage portion 101 illustrated in FIG. 4A is elongated in the horizontal-axis (x-axis) direction as compared to the waveform of the pressure fluctuation p_2 in the second flow passage portion 102 illustrated in FIG. 4B.

[0082] The refrigerant having been injected into the muffler main body 11 flows into the first or the second flow passage portion 101 or 102, then flows from the starting ends ($x = 0$) of the first or the second flow passage portion 101 or 102, traveling a predetermined passage length x_0 at flow rates corresponding to their respective cross-sectional areas of the first and the second flow passage portions 101 and 102, and then flows into the housing 5 at the finishing ends ($x = x_0$) of the first and the second flow passage portions 101 and 102.

[0083] The refrigerant in the muffler main body 11 that flows into the starting end ($x = 0$) of the first flow passage portion 101 and the refrigerant in the muffler main body 11 that flows into the starting end ($x = 0$) of the second flow passage portion 102 presumably have identical phases to each other. In addition, the amplitude of the pressure fluctuation p_1 of the refrigerant flowing through the first flow passage portion 101 and the amplitude of the pressure fluctuation p_2 of the second flow passage portion 102 are presumably identical to each other.

[0084] The difference in the flow rate between the refrigerant flowing through the first flow passage portion 101 and the refrigerant flowing through the second flow passage portion 102 results in the difference in the wavenumber from the starting end ($x = 0$) to the finishing end ($x = x_0$) between the pressure fluctuation p_1 and the pressure fluctuation p_2. Thus, the phases of the pressure fluctuations p_1 and p_2 are identical to each other at the positions where the refrigerant enters the first and the second flow passage portions 101 and 102, but at the finishing ends ($x = x_0$) of the first and the second flow passage portions 101 and 102, the two phases shift from each other.

[0085] Hence, the pressure wave of the refrigerant flowed out from the first flow passage portion 101 and the pressure wave of the refrigerant flowed out from the second flow passage portion 102 interfere with each other and are damped, and thus the pressure fluctuation's flowing out of the muffler 10 is suppressed sufficiently. For the purpose of allowing the pressure waves to cancel off each other by interference, it is preferable to make the phase of the pressure waveform at the finishing end ($x = x_0$) of the first flow passage portion 101 differs, by 180° (π), from the phase of the pressure waveform at the finishing end ($x = x_0$) of the second flow passage portion 102, that is, the phases of the two waveforms are opposite phases to each other.

[0086] It should be noted that FIGS. 4A and 4B illustrate just exemplar wavenumbers of the pressure fluctuations p_1 and p_2.

[0087] Accordingly, in this embodiment, to allow the pressure waves to be in the opposite phases to each other and thus to cancel off each other at the finishing ends of the first and the second flow passage portions 101 and 102, the passage length x_0 and the flow-rate ratio α between the flow rate for the first flow passage portion 101 and the flow rate for the second flow passage portion 102 are set based upon the frequency f of the pressure fluctuation as represented by Equation (I) below.

$$\alpha = n\,(v_1/2fx_0) + 1 \cdots (I)$$

where n is a natural number (1, 2, 3, ···), and the flow-rate ratio α is defined as a flow-rate ratio (v_2/v_1), where, of the flow rate v_1 of the refrigerant flowing through the first flow passage portion 101 and the flow rate v_2 of the refrigerant flowing through the second flow passage portion 102, the faster flow rate v_1 is used as the yardstick.

[0088] Another equation that is equivalent to Equation (I) may be established by using the flow-rate ratio $1/\alpha$ where the flow rate for the second flow passage portion 102 is used as the yardstick. Use of such an equivalent equation is also acceptable for designing the first and the second flow passage portions 101 and 102.

[0089] A process to obtain Equation (I) above will be described below.

[0090] As the phases at the entry into the first and the second flow passage portions 101 and 102 are identical to each other and so are the amplitudes, the waves of the pressure fluctuations p_1 and p_2 are expressed by Equation (i) below. In Equation (i), t is the time, p is the amplitude of the pressure wave, k_1 and k_2 are wavenumbers, and ω is the angular frequency. The pressure fluctuations p_1 and p_2 differ from each other only in that the wavenumbers k_1 and k_2 are different from each other.

$$p_1\,(x, t) = P \sin\,(k_1 x - \omega t)$$
$$p_2\,(x, t) = P \sin\,(k_2 x - \omega t) \cdots (i)$$

[0091] Let v_1 denote the flow rate of the refrigerant in the first flow passage portion 101, and let v_2 denote the flow rate of the refrigerant in the second flow passage portion 102,

$$v_1 = \omega/k_1 \;\; v_2 = \omega/k_2 \cdots (ii)$$

[0092] If we denote, by α, the flow-rate ratio defined by using, as the yardstick, the flow rate v_1, the relatively faster one of the two flow rates v_1 and v_1, $v_1 = \alpha v_2$ ($a > 1$)

[0093] From Equation (ii),

$$k_2 = \alpha k_1 \cdots (iii)$$

[0094] Now, solve the pressure fluctuation $p(x = x_0, t)$, which is synthesized when the flow from the finishing end of the first flow passage portion 101 and the flow from the finishing end of the second flow passage portion 102 are merged with each other. Let us refer to Equation (iii).

$$\begin{aligned} & p\,(x = x_0, t) \\ & = p_1 + p_2 = P \sin\,(k_1 x_0 - \omega t) + P \sin\,(k_2 x_0 - \omega t) \\ & = 2P \sin\,\{(1 + \alpha/2)k_1 x_0 - \omega t\} \cos\,\{(1 - \alpha/2)k_1 x_0\} \cdots (iv) \end{aligned}$$

[0095] From Equation (iv), if cos $\{(1 - \alpha/2)\, k_1 x_0\}$ is zero, the two pressure waves cancel off each other by interfering with each other (synthesis).

[0096] As the wave of $y = \cos\theta$ becomes zero, when $\theta = n(\pi/2)$ (n = 1, 2, 3···).

[Math. 1]

$$n\frac{\pi}{2} = \frac{\alpha - 1}{2} k_1 x_0 \qquad \cdots \quad (v)$$

[0097] In this case, p (x_0, t) becomes zero.

[0098] Here, a smaller value of α makes it easier to implement the output flow passage. Hence, to achieve the reduction of the pulsation with the smallest value of α, as n = 1,

[Math. 2]

$$-\frac{\pi}{2}=\frac{1-\alpha}{2}k_1 x_0 \quad \cdots \quad (v')$$

[0099] From the equation (v'), (ii), and $\omega = 2\pi f$,

[Math. 3]

$$-\frac{\pi}{2}=\frac{1-\alpha}{2}\frac{2\pi f}{v_1}x_0 \quad \cdots \quad (vi)$$

[0100] This equation is rearranged to yield Equation (I').

$$\alpha = (v_1/2fx_0) + 1 \cdots (I')$$

[0101] Equation (I') is Equation (I) above for n = 1.

[0102] Equations (I) and (I') show the relationship between x_0 and α when the pressure waves cancel off each other.

[0103] Described below is an exemplar case of designing the flow-rate ratio α (v_2/v_1) using Equation (I').

[0104] Here, the frequency f ranges, approximately, from 50 Hz to 1 kHz (1000 Hz), and the frequency of the pressure fluctuation component that needs to be reduced is selected from this range.

[0105] The flow-passage length x_0 may be set to a value of 10 mm (0.01 m), approximately.

[0106] The flow rate v_1 is assumed to range from 0.1 m/s to 200 m/s based on, for example, the volume speed that is calculated from the displacement volume and the rotational speed of the compression mechanism 41 and also on the cross-sectional area of the entire output flow passage 100.

[0107] The values of the above-mentioned parameters are applied to Equation (I').

[0108] Based on the above-described conditions for the values, for a case where the smallest α is achieved, applying f = 1000 Hz and v_1 = 0.1 m/s yields a value of $5 \times 10^{-11} + 1$; and for a case where the largest α is achieved, applying f = 500 Hz and v_1 = 200 m/s yields a value of 20 + 1.

[0109] By selecting appropriately the flow-rate ratio α based on the frequency f of the pressure fluctuation component that needs to be reduced, the pressure waves flowing out of the first and the second flow passage portions 101 and 102 and joining together cancel off each other. Hence, the pressure fluctuation that flows out of the muffler 10 is reduced. Consequently, the resonance that would otherwise take place in a space below the motor 2 is avoided, and noise is suppressed.

[0110] From the selected flow-rate ratio and the cross-sectional area of the entire output flow passage 100, the cross-sectional area of the first flow passage portion 101 and the cross-sectional area of the second flow passage portion 102 are calculated. Then, the muffler 10 may be formed to give an appropriate cross-sectional area between the bearing portion 6B and the first wall portion 121 and an appropriate cross-sectional area between the bearing portion 6B and the second wall portion 122.

[0111] The above description was provided using the output flow passage 100 of the upper muffler 10 as an example, but the flow-rate ratio α may be calculated by using similar Equations (I) and (I') for the output flow passage 200 of the lower muffler 20, as well and thus the muffler 20 may be formed to allow the first flow passage portion 101 and the second flow passage portion 102 to have their respective cross-sectional areas that correspond to the flow-rate ratio α.

[0112] As described so far, the phase of the pressure wave that has flowed through the first flow passage portion 101 and the phase of the pressure wave that has flowed through the second flow passage portion 102 are shifted from each other, and the canceling off of two pressure waves is to be achieved when these two pressure waves join together. To this end, it is preferable: to dispose the first flow passage portion 101 and the second flow passage portion 102 adjacently to each other; and to make the refrigerant flowed out from the finishing end of the first flow passage portion 101 and the refrigerant flowed out from the finishing end of the second flow passage portion 102 join together immediately after their flowing out of their respective flow passage portions 101 and 102, thereby making their respective pressure waves interfere with each other.

[0113] Regarding this point, this embodiment provides an advantageous configuration where, as illustrated in FIG. 3, the plurality of first flow passage portions 101 and the plurality of second flow passage portions 102 are provided in the output flow passage 100 and these first and second flow passage portions 101 and 102 are arranged alternately all around the rotating shaft 3. To put it another way, all around the rotating shaft 3, there are several positions in each of which one of the first flow passage portions 101 and one of the second flow passage portions 102 are adjacent to each other in the circumferential direction D1. In every one of such positions where those two different portions 101 and 102 adjoin each other, the pressure waves interfere with each other immediately after the flowing out of the refrigerant flows from the first and the second flow passage portions 101 and 102. This results in an efficient reduction of the pulsation.

[0114] Now, suppose a case where output flow passage 100 includes only one second flow passage portion 102 (e.g., a second flow passage portion 102A) and the rest of the output flow passage 100 is the first flow passage portion 101. In this case, the pulsation-reduction effect is obtainable only in the two positions adjacent to the two end portions of the single second flow passage portion 102.

[0115] Hence, when, as in this embodiment, several positions in each of which one first flow passage portion 101 and one second flow passage portion 102 adjoin each other are distributed in the circumferential direction D1 of the rotating shaft 3, the interference of the pressure waves happens across a wider range in the circumferential direction D1. This results in an efficient reduction of the pulsation.

[0116] In this embodiment, the mufflers 10 and 20 include, respectively, the output flow passages 100 and 200 each of which includes the first and the second flow passage portions having different cross-sectional areas from each other. Hence, the pulsation propagated from the inside of the mufflers 10 and 20 into the housing 5 is reduced more sufficiently.

[0117] It should be noted that in another acceptable configuration, only one of the mufflers 10 and 20 has an output flow passage including both the first and the second flow passage portions and the other one of the mufflers 10 and 20 has an output flow passage that is formed in an annular shape around the axis of the rotating shaft 3.

Second Embodiment

[0118] Next, a second embodiment of the disclosure will be described by referring to FIG. 5.

[0119] The description given below focuses mainly on the differences from the first embodiment. Elements that are the same as those of the first embodiment will be given the same reference numerals.

[0120] An output flow passage 300 formed between a muffler 30 according to the second embodiment and a bearing portion 6B includes a plurality of second flow passage portions 302A, 302B, and 302C, as illustrated in FIG. 5.

[0121] The muffler 30 may be employed as any of a muffler included in an upper compression mechanism 41 (i.e., as the muffler 10 in FIG. 1) and a muffler included in a lower compression mechanism 42 (FIG. 1) (i.e., as the muffler 20 in FIG. 1).

[0122] The second flow passage portions 302A, 302B, and 302C have cross-sectional areas that are different from one another. The cross-sectional areas of the second flow passage portions 302A, 302B, and 302C are determined individually by taking into account the frequencies of the pulsation components that need to be reduced.

[0123] For example, the second flow passage portion 302A corresponds to a frequency of 800 Hz, the second flow passage portion 302B corresponds to a frequency of 900 Hz, and the third flow passage portion 302C corresponds to a frequency of 1 kHz.

[0124] Every one of the cross-sectional areas of the second flow passage portions 302A to 302C is set by calculating the flow-rate ratio α with respect to the adjacent first flow passage portion 101 by using Equation (I) or (I') above.

[0125] The configuration provided according to the second embodiment may handle pulsation of a wider frequency range than that in the first embodiment.

[0126] In the output flow passage 300, the second flow passage portions 302A to 302C are arranged in the circumferential direction D1 of the rotating shaft 3 so that each one of the second flow passage portions 302A to 302C alternates with one first flow passage portion 101. Hence, the pulsation is reduced efficiently at the positions in each of which one first flow passage portion 101 and any one of the second flow passage portions 302A to 302C adjoin each other.

[0127] FIG. 6 illustrates a muffler 50 according to a modified example of the disclosure.

[0128] An output flow passage 500 is formed between the muffler 50 and the bearing portion 6B, and is formed in a petaloid shape including more flow passage portions than those in the first embodiment or in the second embodiment. Here, the output flow passage 500 includes 8 first flow passage portions 501 each of which has a circular-arc cross-sectional shape, and includes also 8 second flow passage portions 502.

[0129] The muffler 50 may be employed as any of a muffler included in an upper compression mechanism 41 (i.e., as the muffler 10 in FIG. 1) and a muffler included in a lower compression mechanism 42 (i.e., as the muffler 20 in FIG. 1).

[0130] The cross-sectional area of each of the first flow passage portions 501 and the cross-sectional area of each of the second flow passage portions 502 may be set by using Equations (I) and (I') above.

[0131] A greater number of first flow passage portions 501 and a greater number of second flow passage portions 502 are provided to form a greater number of positions in each of which one first flow passage portion 501 and one second flow passage portion 502 adjoin each other in the circumferential direction D1. Hence, according to this modified example, the refrigerant flowed out from the first flow passage portions 501 and the refrigerant flowed out from the second flow passage portions 502 are made to join together and thus the pressure waves of such refrigerants interfere with each other, resulting in an efficient reduction of the pulsation.

[0132] This modified example includes two different kinds of second flow passage portions 502(A) and 502(B) with different cross-sectional areas from each other. The cross-sectional areas of these second flow passage portions 502(A) and 502(B) may be set individually to correspond to different frequencies by using Equations (I) and (I') described above.

[0133] FIG. 7 illustrates a muffler 60 according to a different modified example of the disclosure.

[0134] The muffler 60 includes a muffler main body 11 and a cylindrical flow-passage wall 62 that is concentric with the rotating shaft 3. A plurality of recessed grooves 6C extending in the axial direction is formed in the outer circumferential portion of the bearing portion 6B. These grooves 6C allows an output flow passage 600 formed between the bearing portion 6B and the flow-passage wall 62 to include both a plurality of first flow passage portions 601 each of which has a smaller cross-sectional area and a plurality of second flow passage portions 602 each of which has a larger cross-sectional area.

[0135] The cross-sectional area of each of the first flow passage portions 601 and the cross-sectional area of each of the second flow passage portions 602 may be set by using Equations (I) and (I') above.

[0136] Changing the depths and the widths of the plurality of grooves 6C gives different cross-sectional areas individually to the plurality of second flow passage portions 602, thus allowing a plurality of different frequency pulsation components to be addressed.

[0137] FIG. 8 illustrates a muffler 70 according to a still different modified example of the disclosure.

[0138] The muffler 70 includes the muffler main body 11, the substantially cylindrical flow-passage wall 72 that is concentric with the rotation shaft 3, and an output flow passage 700 formed between the flow-passage wall 72 and the bearing portion 6B. The flow-passage wall 72 includes a protruding portion 721 that protrudes outwards in the radial direction at a position in the circumferential direction, and also includes an arcuate portion 722 that is a portion other than the protruding portion 721. The plurality of protruding portions 721 and the plurality of arcuate portions 722 are disposed alternately in the circumferential direction of the flow-passage wall 72.

[0139] Each of the protruding portions 721 is formed in a folded shape with walls 721A and 721B facing each other in a close proximity. A first flow passage portion 701 of the output flow passage 700 is formed in each of the protruding portions 721.

[0140] A second flow passage portion 702 of the output flow passage 700 is formed between the inner circumferential portion of each of the arcuate portions 722 and the outer circumferential portion of the bearing portion 6B.

[0141] The distance between each of the arcuate portions 722 and the bearing portion 6B is greater than the distance between the first wall portion 121 and the bearing portion 6B in the first embodiment, so that the cross-sectional area of each of the second flow passage portions 702 is greater than the cross-sectional area of each of the first flow passage portions 701.

[0142] The cross-sectional area of the first flow passage portion 701 and the cross-sectional area of the second flow passage portion 702 are set by using Equations (I) and (I') above. Hence, the refrigerant flowed out from the first flow passage portions 701 and the refrigerant flowed out from the second flow passage portions 702 are made to join together and thus the pressure waves of such refrigerants interfere with each other, resulting in an efficient reduction of the pulsation.

[0143] Changing the individual protruding lengths of the plurality of protruding portions 721 and the individual distances between the walls 721A and 721B gives different cross-sectional areas individually to the plurality of second flow passage portions 702, thus allowing a plurality of different frequency pulsation components to be addressed.

[0144] Besides the above-described embodiments, as long as there is no departure from the spirit and scope of the disclosure, configurations explained in the above-described embodiments can be selected as desired, or can be changed to other configurations as necessary.

[0145] The first flow passage portion of the output flow passage according to the disclosure does not have to be formed in an arcuate shape that is concentric with the rotating shaft 3. In addition, the cross-sectional areas of the plurality of first flow passage portions may be different from one another. What is necessary for forming the first flow passage portion is a narrower interstice between the flow-passage wall and the rotating shaft 3 or the bearing portion 6B than the interstice for the second flow passage portion.

[0146] In addition, in the circumferential direction D1 of the rotating shaft 3, the first flow passage portions and the second flow passage portions do not have to be arranged alternately with each other. For example, in the configuration illustrated in FIG. 6, the second flow passage portion 502A may be adjacent to another second flow passage portion 502B with a different cross-sectional area from the cross-sectional area of the second flow passage portion 502A.

[0147] Furthermore, the cross-sectional area and/or the arrangement for each of the first flow passage portion and the second flow passage portion of the output flow passage may be set appropriately by using Equations (I) and (I') based on the frequency f to be reduced, the passage length x_0, the capacity of the compressor, the desired pulsation-reduction effect, and other factors.

[0148] The output flow passage according to the disclosure does not have to be contiguous all around in the circumference direction D1 of the rotating shaft 3. The flow-passage wall 12 of the muffler may be in contact with the outer circumferential portion of the bearing portion 6B at a position in the circumferential direction D1.

[0149] In addition, a partition may be disposed at the border between a first flow passage portion and a second flow passage portion. In this case, the first flow passage portion and the second flow passage portion adjoin each other with the partition disposed in between. Also in this case, the cross-sectional area of each of the first and the second flow passage portions divided by the partition may be set by using Equations (I) and (I').

[0150] In particular, in a case that a relatively great number of second flow passage portions are provided as in the configuration illustrated in FIG. 6, providing the partitions facilitates the forming of the second flow passage portions.

[0151] The compression mechanism to be mounted in the compressor of the disclosure is not limited to a twin-rotary-type compression mechanism 4, but may be a single-rotary-type compression mechanism that includes a set of one cylinder and one piston rotor as well as a muffler.

[0152] In addition, not only a motor but also, for example, an engine or the like sources may be used as the power source for the compressor of the disclosure.

Reference Signs List

[0153]

1 Compressor
2 Motor
2A Stator
2B Rotor
2C Coil
3 Rotating shaft
3A Main shaft portion
3B Upper crank pin
3C Lower crank pin
4 Compression mechanism 4A Partition plate
5 Housing
5A Discharge pipe
6 Upper bearing
6A Touch portion
6B Bearing portion
6C Groove
7 Lower bearing
7A Touch portion
7B Bearing portion
8, 9 Piping
10 Upper muffler
10A Opening
11 Muffler main body
11B Bolt
12 Flow-passage wall
20 Lower muffler
21 Muffler main body
22 Flow-passage wall
30 Muffler
302A, 302B, 302C Second flow passage portion
41 Upper compression mechanism
42 Lower compression mechanism
50 Muffler
501 First flow passage portion
502, 502A, 502B Second flow passage portion
60 Muffler

62 Flow-passage wall
70 Muffler
72 Flow-passage wall
100 Output flow passage
101 First flow passage portion
102 Second flow passage portion
111 Inner-circumferential end
112 Curved portion
121 First wall portion
122 Second wall portion
122A First end
122B Top portion
122C Second end
200 Output flow passage
411 Upper piston rotor
412 Upper cylinder
421 Lower piston rotor
422 Lower cylinder
500 Output flow passage
600 Output flow passage
601 First flow passage portion
602 Second flow passage portion
700 Output flow passage
701 First flow passage portion
702 Second flow passage portion
721 Protruding portion
722 Arcuate portion
D1 Circumferential direction of rotating shaft

Claims

1. A rotary compressor comprising:

a rotating shaft configured to be rotated;
a rotary-type compression mechanism including a piston rotor provided on the rotating shaft and a cylinder in which the piston rotor is disposed; and
a muffler disposed around an axis of the rotating shaft,
wherein the muffler includes:

a muffler main body configured to receive therein a fluid compressed by the compression mechanism; and
a flow-passage wall configured to form an output flow passage between the flow-passage wall and the rotating shaft or a bearing portion located around the axis of the rotating shaft, the output flow passage having a predetermined length and being configured to allow the fluid to flow, in the axial direction of the rotating shaft, out of the muffler, and

the output flow passage includes:

a first flow passage portion located at a part in a circumferential direction of the rotating shaft; and
a second flow passage portion which is adjacent to the first flow passage portion in the circumferential direction, the second flow passage portion having a larger dimension measured in a radial direction of the rotating shaft than a corresponding dimension of the first flow passage portion, and the second flow passage portion having a larger cross-sectional area than a cross-sectional area of the first flow passage portion.

2. The rotary compressor according to claim 1, wherein the output flow passage includes a plurality of the second flow passage portions.

3. The rotary compressor according to claim 2, wherein a cross-sectional area of one of the plurality of second flow passage portions is different from a cross-sectional area of another one of the plurality of second flow passage portions.

4. The rotary compressor according to claim 2, wherein
the output flow passage is formed all around a circumference around the axis of the rotating shaft, and
the output flow passage includes a plurality of the first flow passage portions and the plurality of second flow passage portions, the first flow passage portions and the second flow passage portions being arranged alternately in the circumferential direction.

5. The rotary compressor according to claim 3, wherein
the output flow passage is formed all around a circumference around the axis of the rotating shaft, and
the output flow passage includes a plurality of the first flow passage portions and the plurality of second flow passage portions, the first flow passage portions and the second flow passage portions being arranged alternately in the circumferential direction.

6. The rotary compressor according to any one of claims 1 to 5, wherein a part of the flow-passage wall for forming the second flow passage portion is formed to have a cross section that is substantially C-shaped or substantially V-shaped.

7. A rotary compressor comprising:

a rotating shaft configured to be rotated;
a rotary-type compression mechanism including a piston rotor provided on the rotating shaft and a cylinder in which the piston rotor is disposed; and
a muffler disposed around an axis of the rotating shaft,
wherein the muffler includes:

a muffler main body configured to receive therein a fluid compressed by the compression mechanism; and
a flow-passage wall configured to form an output flow passage between the flow-passage wall and the rotating shaft or a bearing portion located around the axis of the rotating shaft, the output flow passage having a predetermined length and being configured to allow the fluid to flow, in the axial direction of the rotating shaft, out of the muffler,

the output flow passage includes:

a first flow passage portion located at a part in a circumferential direction of the rotating shaft; and
a second flow passage portion having a larger cross-sectional area than a cross-sectional area of the first flow passage portion, and

the first flow passage portion protrudes radially outwards from the second flow passage portion.

8. The rotary compressor according to any one of claims 1 to 5 and 7, wherein
an equation holds: $\alpha = n (v_1/2fx_0) + 1$
where
x_0 is a length of the output flow passage,
v_1 is a flow rate of the fluid in the first flow passage portion,
α is a flow-rate ratio of a flow rate of the fluid in the second flow passage portion in relation to v_1,
f is a predetermined frequency, and
n is a natural number.

9. The rotary compressor according to claim 6, wherein
an equation holds: $\alpha = n (v_1/2fx_0) + 1$
where
x_0 is a length of the output flow passage,
v_1 is a flow rate of the fluid in the first flow passage portion,
α is a flow-rate ratio of a flow rate of the fluid in the second flow passage portion in relation to v_1,
f is a predetermined frequency, and
n is a natural number.

10. The rotary compressor according to any one of claims 1 to 5 and 7, wherein pressure fluctuation of the fluid flowed out of the first flow passage portion and pressure fluctuation of the fluid flowed out of the second flow passage portion interfere with each other and cancel off each other.

11. The rotary compressor according to claim 6, wherein pressure fluctuation of the fluid flowed out of the first flow passage portion and pressure fluctuation of the fluid flowed out of the second flow passage portion interfere with each other and cancel off each other.

12. The rotary compressor according to claim 9, wherein pressure fluctuation of the fluid flowed out of the first flow passage portion and pressure fluctuation of the fluid flowed out of the second flow passage portion interfere with each other and cancel off each other.

Amended claims under Art. 19.1 PCT

1. [Amended]
A rotary compressor comprising:

a rotating shaft configured to be rotated;
a rotary-type compression mechanism including a piston rotor provided on the rotating shaft and a cylinder in which the piston rotor is disposed; and
a muffler disposed around an axis of the rotating shaft,
wherein the muffler includes:

a muffler main body configured to receive therein a fluid compressed by the compression mechanism; and
a flow-passage wall configured to form an output flow passage between the flow-passage wall and the rotating shaft or a bearing portion located around the axis of the rotating shaft, the output flow passage having a predetermined length and being configured to allow the fluid to flow, in the axial direction of the rotating shaft, out of the muffler,

the output flow passage includes:

a first flow passage portion located at a part in a circumferential direction of the rotating shaft; and
a second flow passage portion which is adjacent to the first flow passage portion in the circumferential direction, the second flow passage portion having a larger dimension measured in a radial direction of the rotating shaft than a corresponding dimension of the first flow passage portion, and the second flow passage portion having a larger cross-sectional area than a cross-sectional area of the first flow passage portion, and

pressure fluctuation of the fluid flowed out of the first flow passage portion and pressure fluctuation of the fluid flowed out of the second flow passage portion interfere with each other and cancel off each other.

2. The rotary compressor according to claim 1, wherein the output flow passage includes a plurality of the second flow passage portions.

3. The rotary compressor according to claim 2, wherein a cross-sectional area of one of the plurality of second flow passage portions is different from a cross-sectional area of another one of the plurality of second flow passage portions.

4. The rotary compressor according to claim 2, wherein
the output flow passage is formed all around a circumference around the axis of the rotating shaft, and
the output flow passage includes a plurality of the first flow passage portions and the plurality of second flow passage portions, the first flow passage portions and the second flow passage portions being arranged alternately in the circumferential direction.

5. The rotary compressor according to claim 3, wherein
the output flow passage is formed all around a circumference around the axis of the rotating shaft, and
the output flow passage includes a plurality of the first flow passage portions and the plurality of second flow passage portions, the first flow passage portions and the second flow passage portions being arranged alternately in the

circumferential direction.

6. The rotary compressor according to any one of claims 1 to 5, wherein a part of the flow-passage wall for forming the second flow passage portion is formed to have a cross section that is substantially C-shaped or substantially V-shaped.

7. A rotary compressor comprising:

a rotating shaft configured to be rotated;
a rotary-type compression mechanism including a piston rotor provided on the rotating shaft and a cylinder in which the piston rotor is disposed; and
a muffler disposed around an axis of the rotating shaft,
wherein the muffler includes:

a muffler main body configured to receive therein a fluid compressed by the compression mechanism; and
a flow-passage wall configured to form an output flow passage between the flow-passage wall and the rotating shaft or a bearing portion located around the axis of the rotating shaft, the output flow passage having a predetermined length and being configured to allow the fluid to flow, in the axial direction of the rotating shaft, out of the muffler,

the output flow passage includes:

a first flow passage portion located at a part in a circumferential direction of the rotating shaft; and
a second flow passage portion having a larger cross-sectional area than a cross-sectional area of the first flow passage portion, and

the first flow passage portion protrudes radially outwards from the second flow passage portion.

8. The rotary compressor according to any one of claims 1 to 5 and 7, wherein
an equation holds: $\alpha = n (v_1/2fx_0) + 1$
where
x_0 is a length of the output flow passage,
v_1 is a flow rate of the fluid in the first flow passage portion,
α is a flow-rate ratio of a flow rate of the fluid in the second flow passage portion in relation to v_1,
f is a predetermined frequency, and
n is a natural number.

9. The rotary compressor according to claim 6, wherein
an equation holds: $\alpha = n(v_1/2fx_0) + 1$
where
x_0 is a length of the output flow passage,
v_1 is a flow rate of the fluid in the first flow passage portion,
α is a flow-rate ratio of a flow rate of the fluid in the second flow passage portion in relation to v_1,
f is a predetermined frequency, and
n is a natural number.

10. [Amended]
The rotary compressor according to claim 7, wherein pressure fluctuation of the fluid flowed out of the first flow passage portion and pressure fluctuation of the fluid flowed out of the second flow passage portion interfere with each other and cancel off each other.

11. The rotary compressor according to claim 6, wherein pressure fluctuation of the fluid flowed out of the first flow passage portion and pressure fluctuation of the fluid flowed out of the second flow passage portion interfere with each other and cancel off each other.

12. The rotary compressor according to claim 9, wherein pressure fluctuation of the fluid flowed out of the first flow passage portion and pressure fluctuation of the fluid flowed out of the second flow passage portion interfere with each other and cancel off each other.

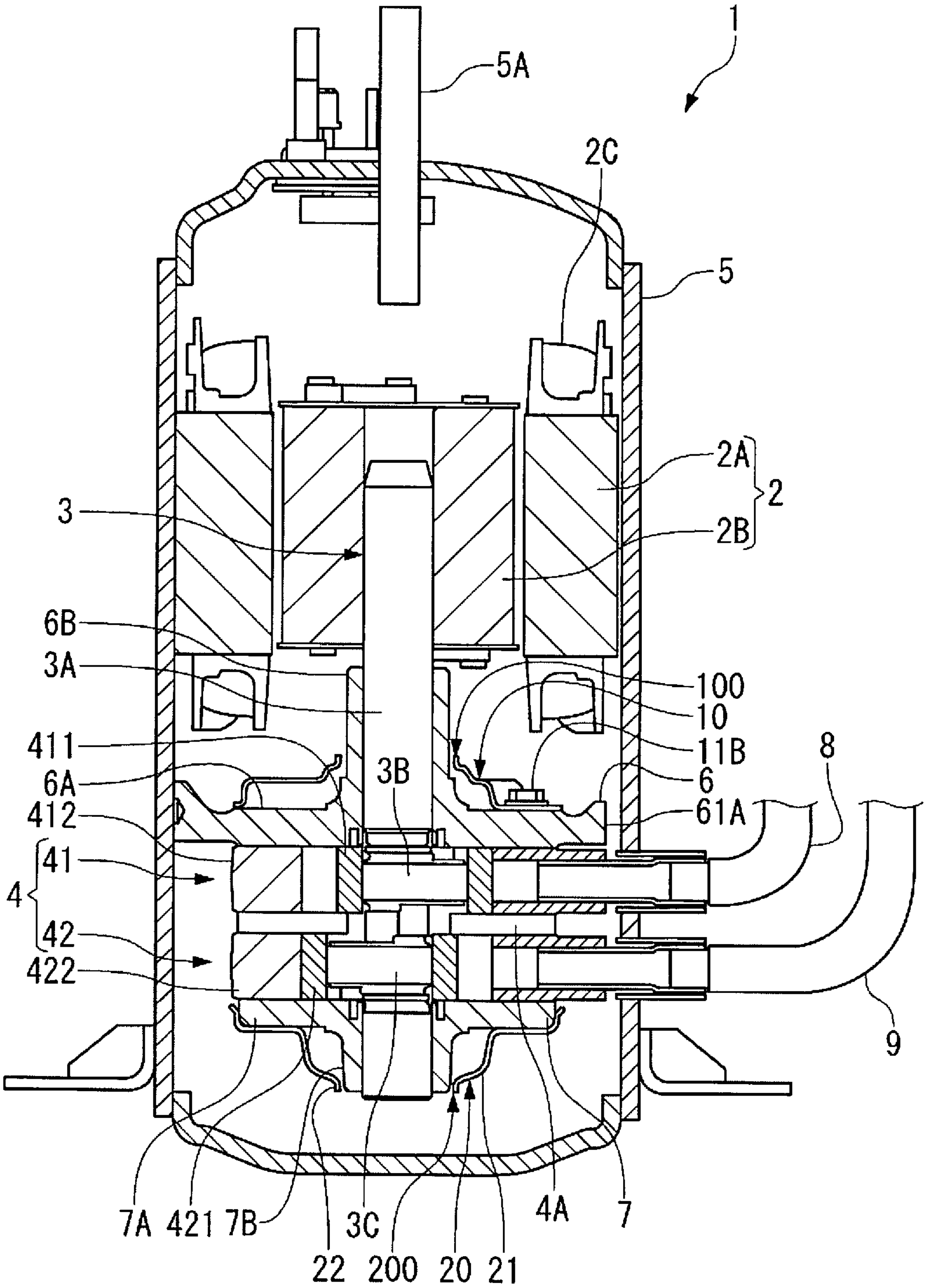

1
5A
2C
5
2A
2
3
2B
6B
3A
100
10
411
11B
8
3B
6A
6
412
61A
41
4
42
422
9
7A
421
7B
3C
4A
7
22
200
20
21

FIG. 1

FIG. 2A

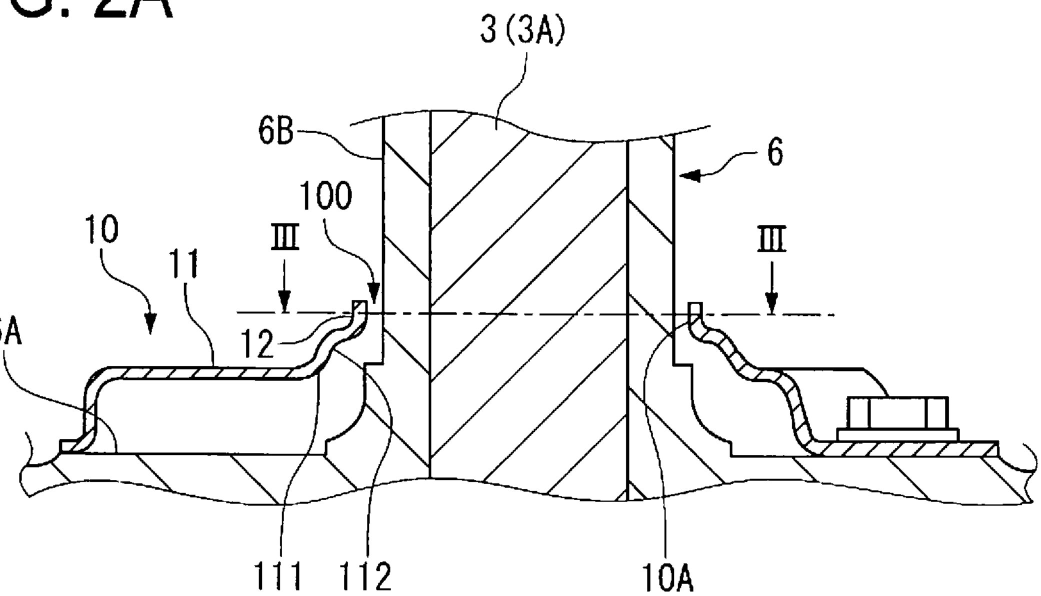
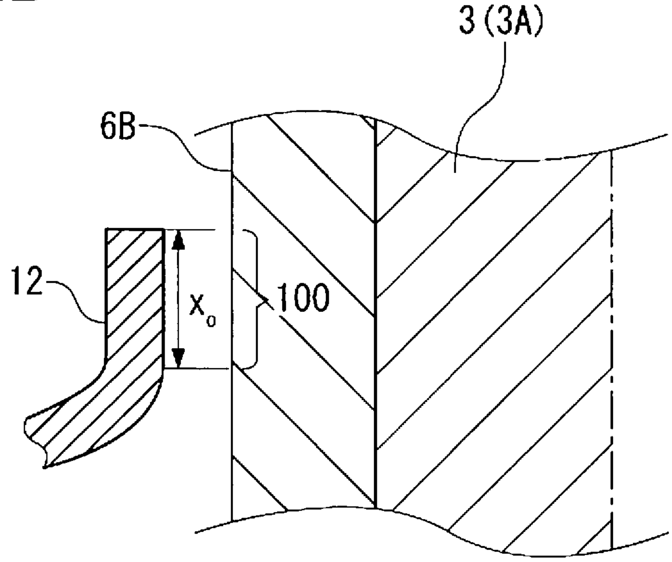


FIG. 2B



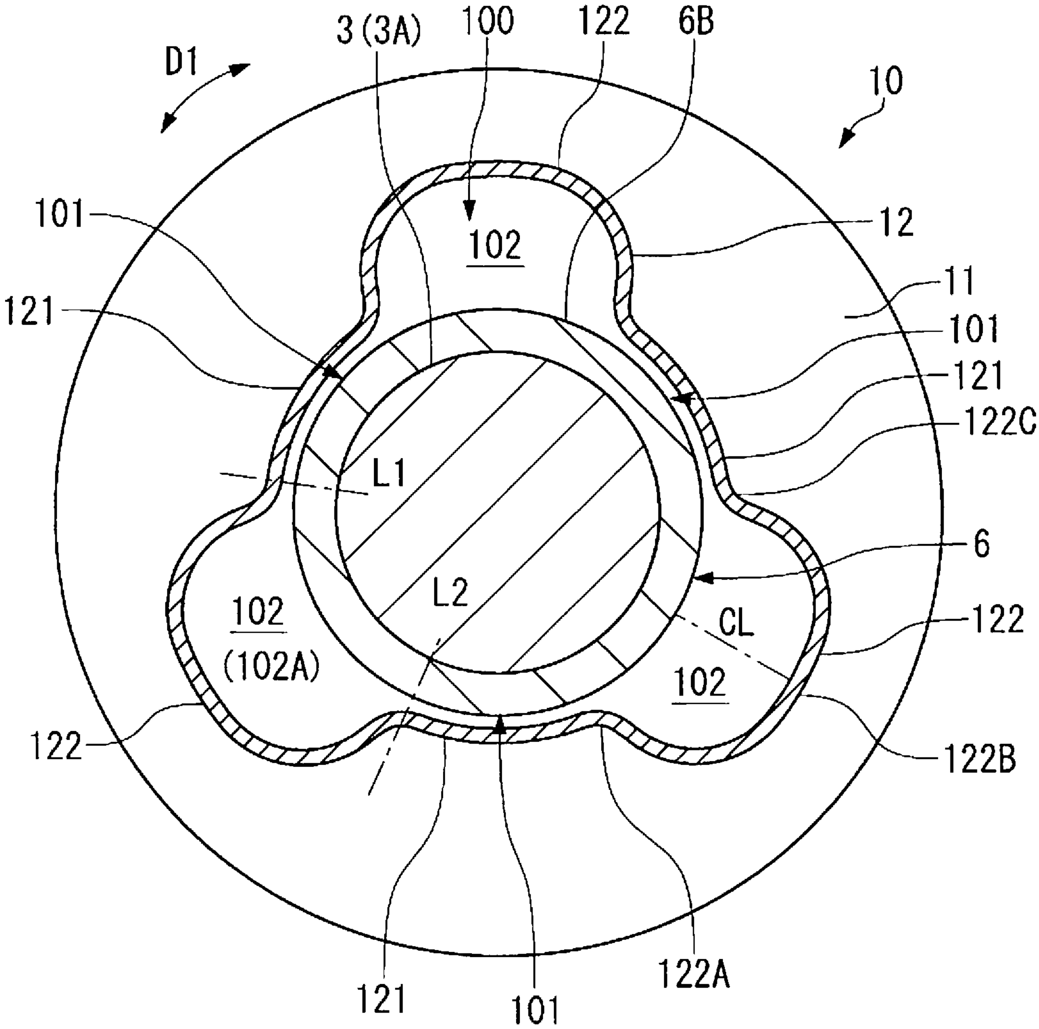

D1
3 (3A)
100
122
6B
10
101
102
12
11
121
101
121
122C
L1
6
L2
CL
102
(102A)
102
122
122
122B
121
101
122A

FIG. 3

FIG. 4A

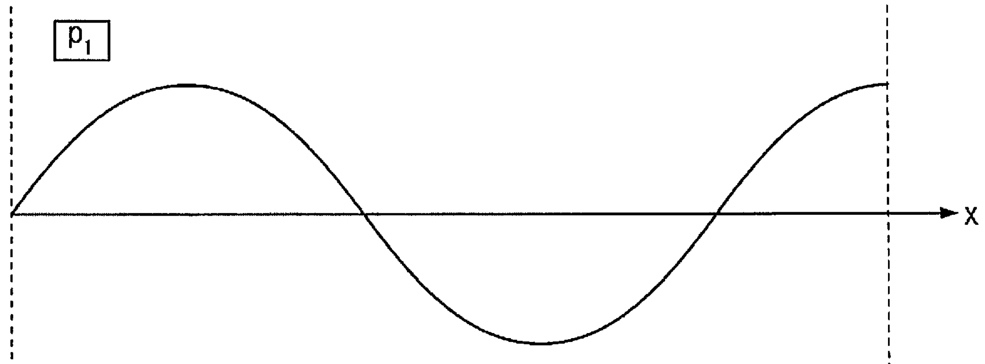
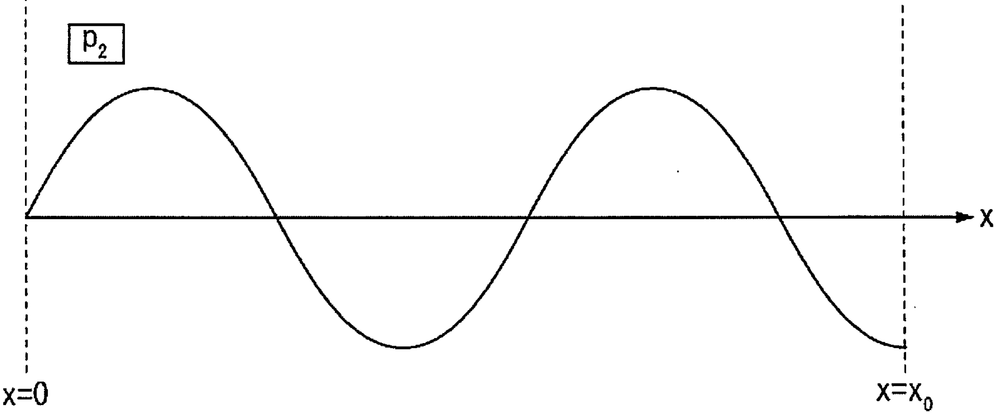


FIG. 4B



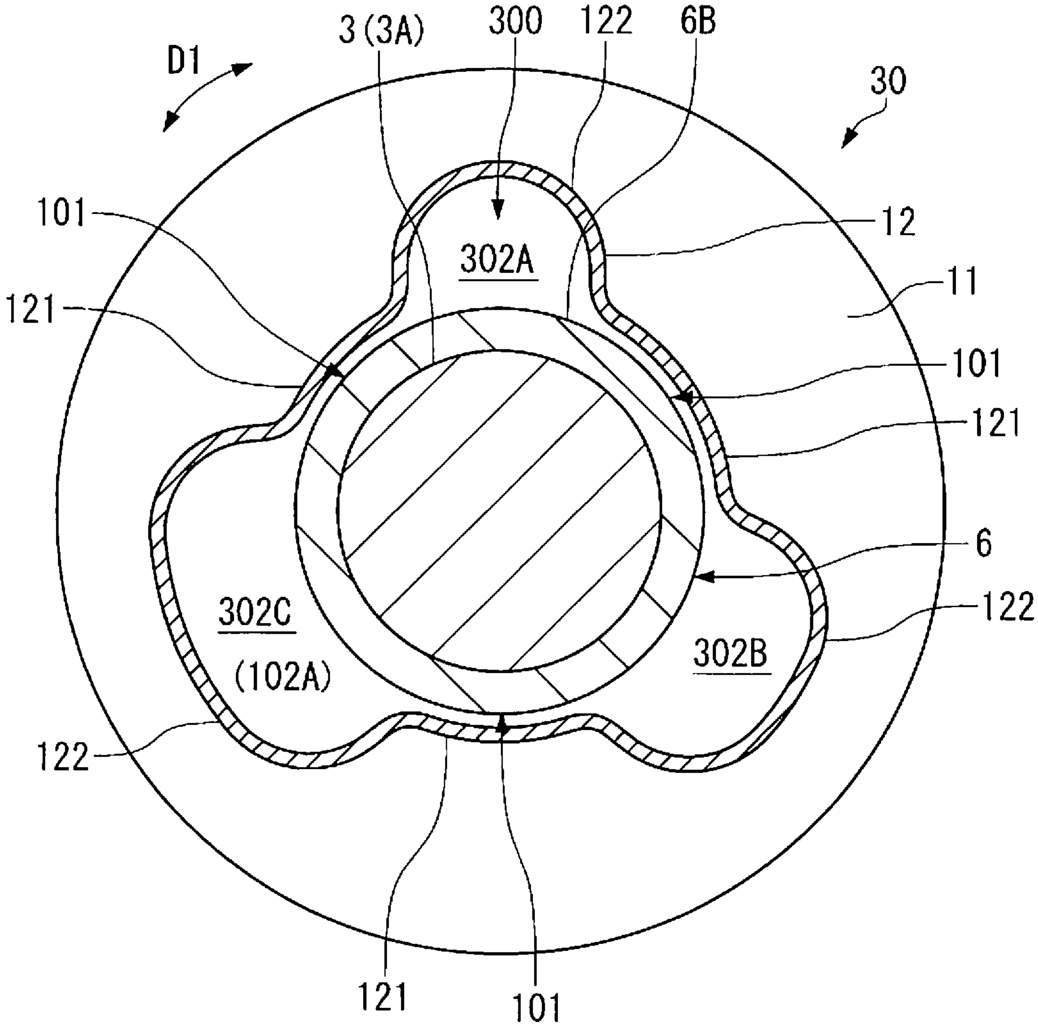

D1
3 (3A)
300
122
6B
30
101
302A
12
11
121
101
121
6
302C
(102A)
302B
122
122
121
101

FIG. 5

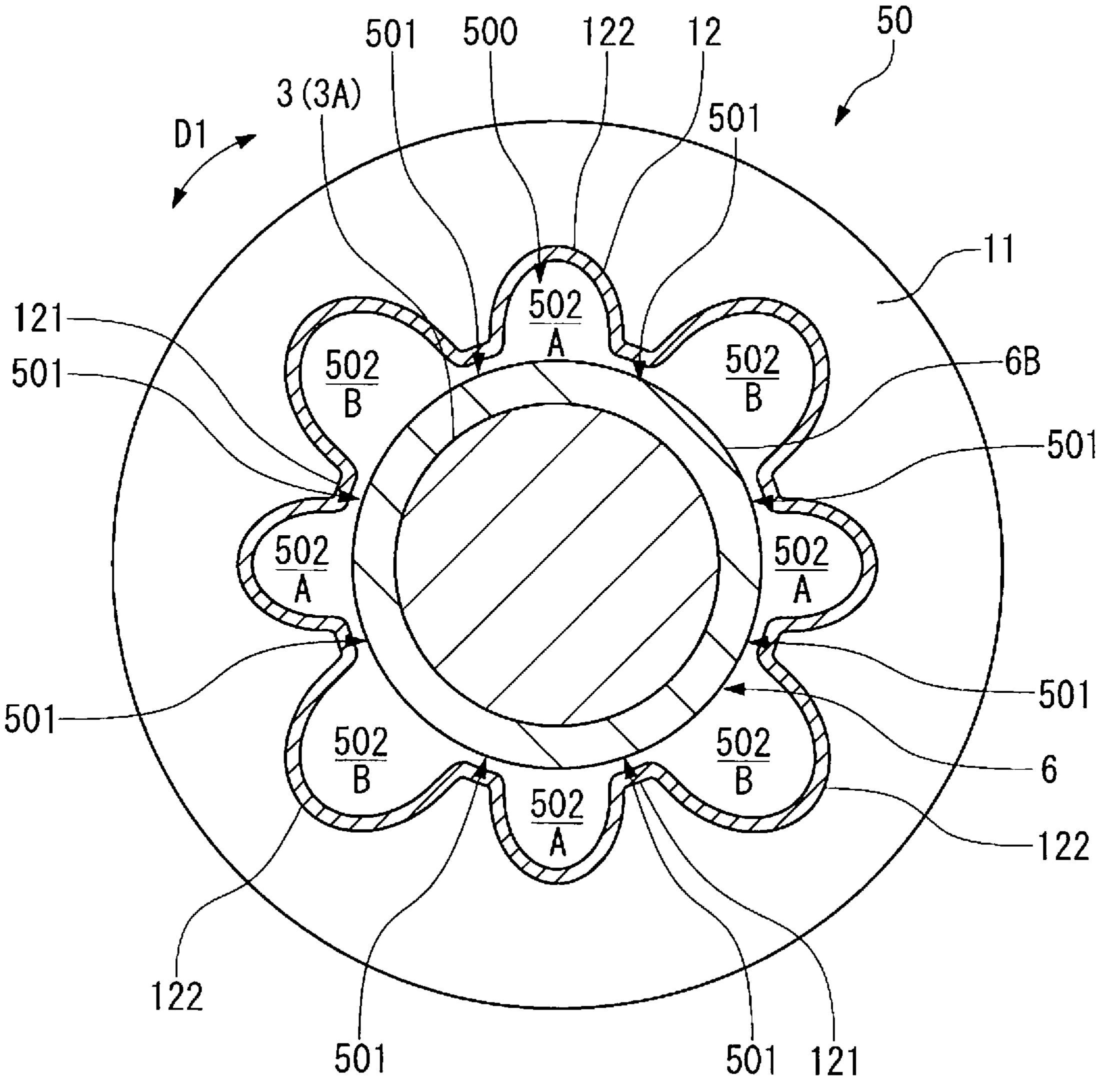

501
500
122
12
50
3 (3A)
D1
501
11
121
502
A
502
B
502
B
6B
501
501
501
502
A
502
A
501
501
6
502
B
502
B
502
A
122
122
501
501
121

FIG. 6

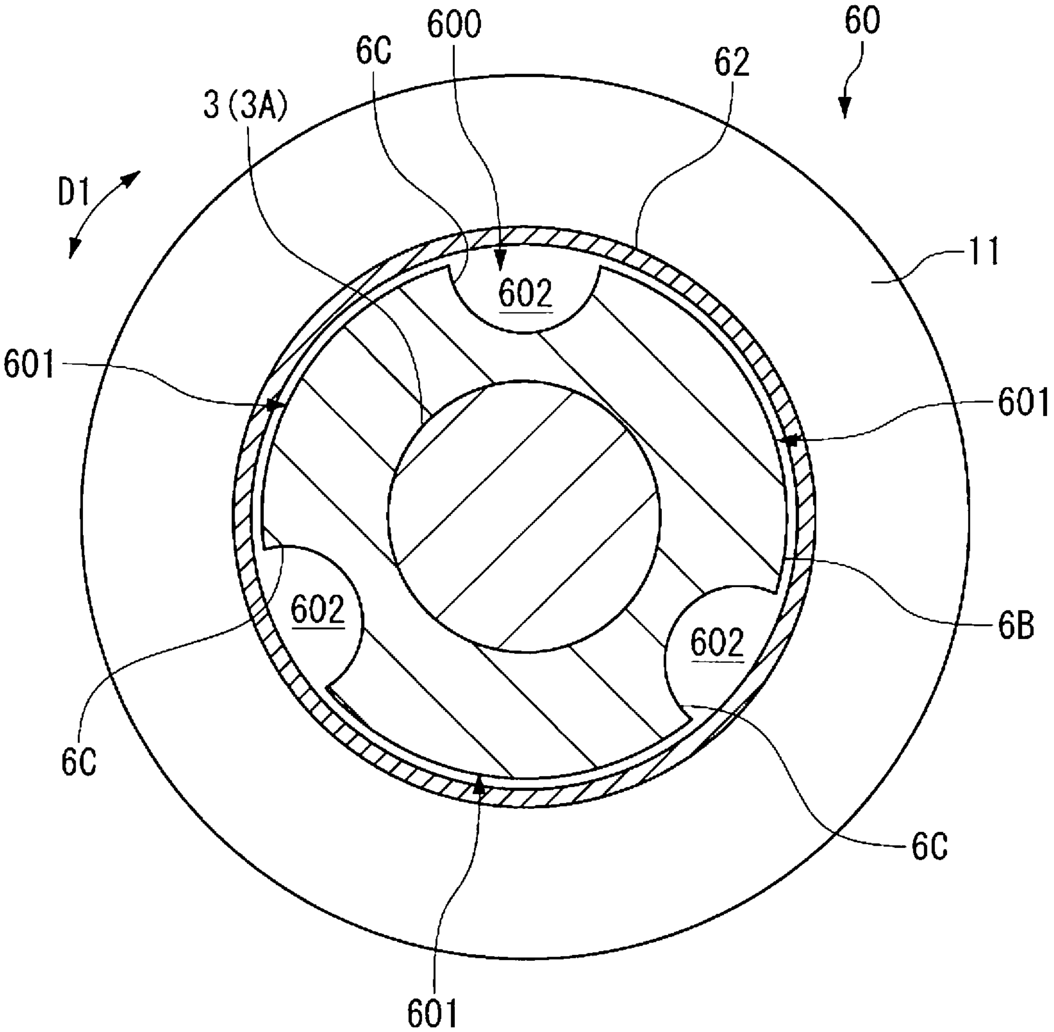


FIG. 7

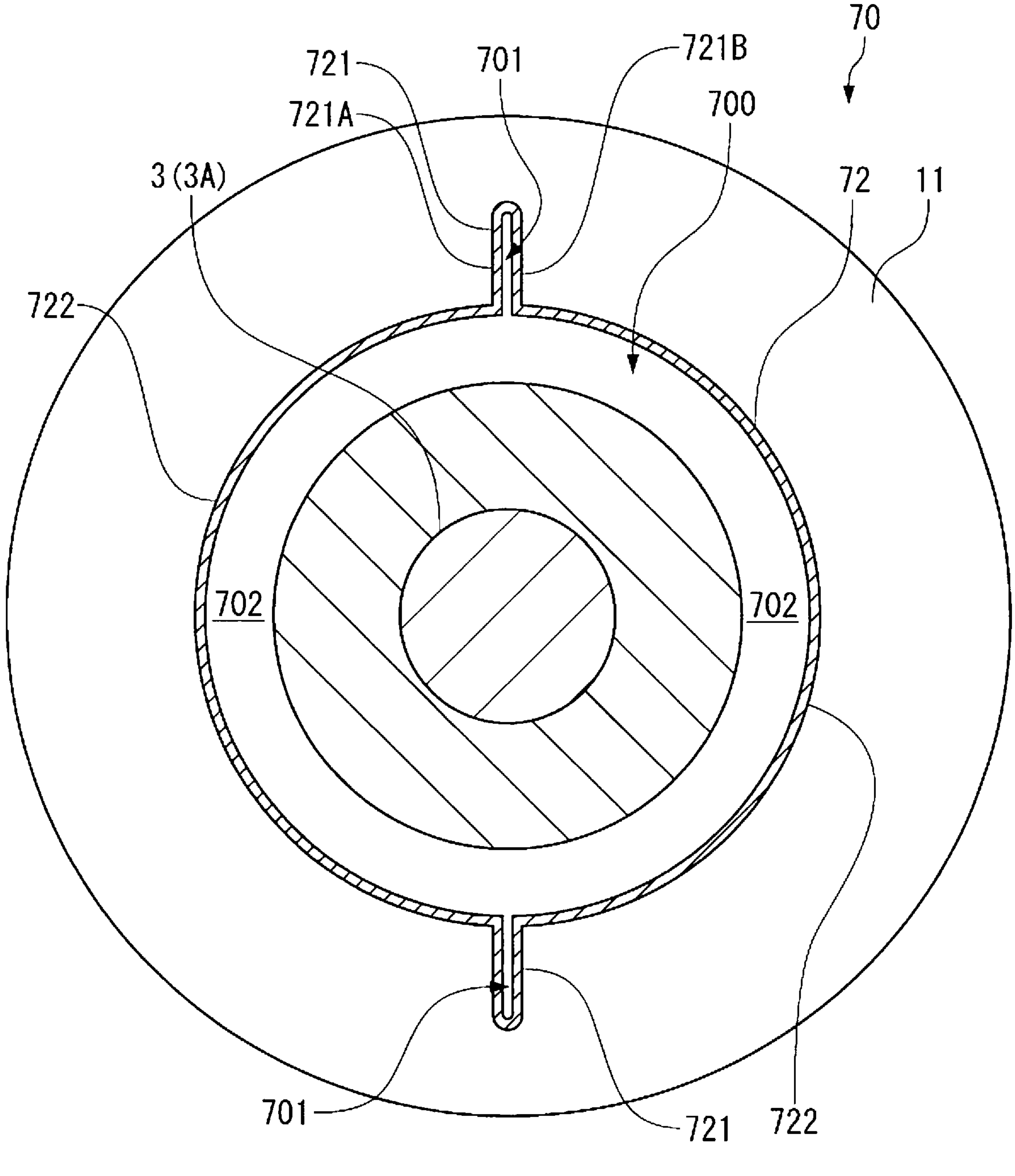


FIG. 8

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2017/010498

A. CLASSIFICATION OF SUBJECT MATTER
F04C29/06(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)
F04C29/06

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	1996-2017
Kokai Jitsuyo Shinan Koho	1971-2017	Toroku Jitsuyo Shinan Koho	1994-2017

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.
X A	JP 10-176691 A (Daikin Industries, Ltd.), 30 June 1998 (30.06.1998), paragraphs [0019] to [0029]; fig. 1 to 4 (Family: none)	1-6 7-12
X A	JP 2006-214376 A (Daikin Industries, Ltd.), 17 August 2006 (17.08.2006), paragraphs [0014] to [0052]; fig. 1, 5 (Family: none)	1 2-12

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search
27 April 2017 (27.04.17)

Date of mailing of the international search report
16 May 2017 (16.05.17)

Name and mailing address of the ISA/
Japan Patent Office
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Authorized officer

Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

REFERENCES CITED IN THE DESCRIPTION

Patent documents cited in the description

- JP 3941809 B **[0005]**