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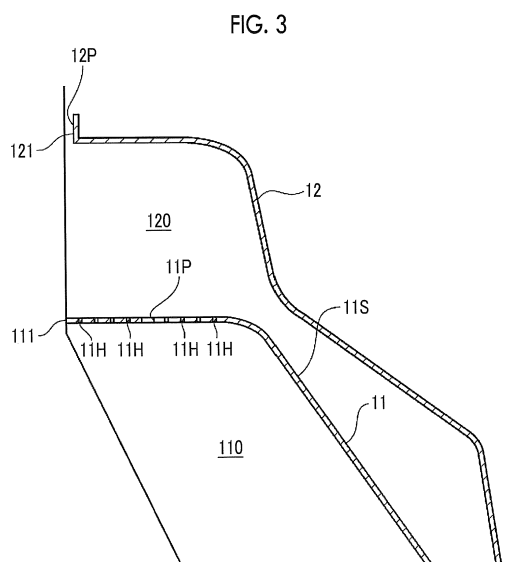
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(54) **COMPRESSOR**

(57) Provided is a compressor in which an appropriate pulsation frequency component of a fluid can be sufficiently reduced by a muffler while the performance of the compressor is ensured. A compressor 1 is provided with a compression mechanism 4 that compresses a refrigerant, and a muffler 10 that reduces pulsation of the refrigerant compressed by the compression mechanism 4. The muffler 10 is provided with: a muffler body 11 that takes refrigerant into the interior thereof from the compression mechanism; and a cover 12 that forms a cavity 120 with an outer periphery 11S of the muffler body 11, the cover 12 discharging the refrigerant taken in from the interior of the muffler body 11. A plurality of openings 11H passing through in the plate thickness direction are formed in the muffler body 11, separately from a discharge port 11P through which refrigerant passes into the cavity 120 from the interior of the muffler body 11. Due to the relationship between the speed of sound C, the cross-sectional area S of each of the openings 11H, the plate thickness L, and the volume V of the cavity 120, Helmholtz resonance arises in air masses 15 located inside the openings 11H leading into the cavity 120, whereby sound is absorbed.



Description

Technical Field

[0001] The present invention relates to a compressor having a muffler which reduces a pressure variation (pulsation) of a compressed fluid.

Background Art

[0002] A rotary compressor constituting an air conditioner or the like includes a compression mechanism which compresses a refrigerant in a cylinder by a rotation of a piston rotor and a muffler which suppresses noise caused by a pressure variation of the compressed refrigerant.

[0003] As the muffler of the rotary compressor, a two-stage muffler having a first muffler and a second muffler is adopted (for example, PTL 1). The compressed refrigerant is discharged from a discharge port of a bearing to which the cylinder is fixed into the first muffler, and is discharged from the inside of the first muffler into the second muffler through a discharge opening of the first muffler. A space in the first muffler and a space in the second muffler are operated as a resistance according to a space volume by the compressed refrigerant, and thus, the compressed refrigerant sequentially passes through the first muffler and the second muffler, and the pulsation of the refrigerant is reduced.

Citation List

Patent Literature

[0004] [PTL 1] Japanese Unexamined Patent Application Publication No. 2014-173554

Summary of Invention

Technical Problem

[0005] Even if a general muffler or a two-stage muffler is installed in a compression mechanism, it is not always possible to obtain a sufficient pulsation reduction effect with respect to a frequency component of a pulsation of a compressed refrigerant.

[0006] Particularly, in a case of the two-stage muffler, it is difficult to take a sufficient plate thickness of the muffler due to restrictions of weight or a cost and improve rigidities, and thus, pressure waves of the pulsation of the refrigerant are easily radiated to the outside of the muffler.

[0007] If an opening area of a discharge opening of the muffler is narrowed, a pressure loss is applied to the refrigerant discharged from the muffler, and thus, pulsation can be reduced. However, performance in the compressor decreases. Particularly, in the case of the two-stage muffler, the pressure loss increase, and thus, there is a

limitation in the narrowing of the opening area of the discharge opening.

[0008] Accordingly, an object of the present invention is to provide a compressor capable of sufficiently reducing an appropriate pulsation frequency component of a fluid by a muffler while securing performance of the compressor.

Solution to Problem

[0009] According to an aspect of the present invention, there is provided a compressor including: a compression mechanism which compresses a fluid; and a muffler which reduces a pulsation of the fluid compressed by the compression mechanism, in which the muffler includes a muffler body which receives the fluid from the compression mechanism into an inside of the muffler body, and a cover which forms a cavity between an outer peripheral portion of the muffler body and the cover and discharges the fluid received from the inside of the muffler body, the muffler body includes a plurality of openings which are formed to penetrate the muffler body in a plate thickness direction, separately from a discharge opening through which the fluid passes from the inside of the muffler body into the cavity, and sound is absorbed by establishing a Helmholtz resonance with respect to an air mass existing inside each opening communicating with the cavity from a relationship between a speed of sound C , a cross-sectional area S of each of the openings, a plate thickness L , and a volume V of the cavity.

[0010] In the compressor of the present invention, preferably, the compression mechanism includes a piston rotor which is provided in a rotary shaft and a cylinder in which the piston rotor is disposed, and the muffler body and the cover are disposed around an axis of the rotary shaft.

Advantageous Effects of Invention

[0011] According to the present invention, as described in detail later, a pulsation reduction effect based on the Helmholtz resonance can be obtained while the pulsation reduction effect is maintained by a two-stage muffler which repeats discharge of pulsation into a space. A movement of the air mass inside the minute opening of the muffler body generating the Helmholtz resonance does not affect a mainstream inside the muffler, and thus, the pulsation of the fluid is sufficiently reduced and the sound is absorbed while the performance of the compressor is secured, and it is possible to suppress a noise caused by a pressure variation of the fluid.

[0012] According to the present invention, in the muffler, the muffler itself becomes a sound source by the pulsation reduction and can suppress radiation of the sound pressure, and thus, even if a plate thickness of the muffler body or the cover is thin, it is possible to suppress the noise. Brief Description of Drawings

[0013]

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

Fig. 2 is a view schematically showing an upper muffler shown in Fig. 1.

Fig. 3 is a partially enlarged view of Fig. 2.

Figs. 4A and 4B are views for explaining a Helmholtz resonance.

Description of Embodiments

[0014] Hereinafter, an embodiment of the present invention will be described with reference to the accompanying drawings.

[0015] A rotary type compressor 1 shown in Fig. 1 sucks a gas refrigerant in an accumulator (gas-liquid separator) (not shown) through pipes 8 and 9 and compresses the gas refrigerant by a compression mechanism 4.

[0016] The compressor 1 and the accumulator constitute a refrigerating cycle device such as an air conditioner or a refrigerator and are connected to a refrigerant circuit (not shown) through which the refrigerant circulates.

[0017] The compressor 1 includes a motor 2 which is a power source, a rotary shaft 3 (crank shaft) which is rotated by a rotational driving force output from the motor 2, the rotary type compression mechanism 4 which is driven by the rotational driving force transmitted via the rotary shaft 3, mufflers 10 and 20 which are disposed around an axis of the rotary shaft 3, and a housing 5.

[0018] The mufflers 10 and 20 suppress a noise caused by a pulsation of the refrigerant compressed by the compression mechanism 4.

[0019] The housing 5 accommodates the motor 2, the rotary shaft 3, the compression mechanism 4, and the mufflers 10 and 20, and is formed in a cylindrical shape.

[0020] The motor 2 includes a stator 2A which is fixed to an inner peripheral portion of the housing 5, and a rotor 2B which is disposed inside the stator 2A. The rotor 2B rotates with respect to the stator 2A by supplying power to a coil 2C provided in the stator 2A.

[0021] The rotary shaft 3 includes a main shaft portion 3A which is connected to the rotor 2B and protrudes downward from the rotor 2B, an upper crank pin 3B which is eccentric to an axis center of the main shaft portion 3A, and a lower crank pin 3C which is eccentric to the axis center of the main shaft portion 3A similarly to the upper crank pin 3B. The lower crank pin 3C is eccentric to the axis center of the rotary shaft 3 in a direction which becomes a phase (180°) reverse to the upper crank pin 3B.

[0022] The upper crank pin 3B is disposed in an upper cylinder 412 of the compression mechanism 4, and the lower crank pin 3C is disposed in a lower cylinder 422 of the compression mechanism 4.

[0023] The compression mechanism 4 (Fig. 1) will be described.

[0024] The compression mechanism 4 which is a so-called twin rotary type mechanism includes an upper

compression mechanism 41, a lower compression mechanism 42, a partition plate 4A, and an upper bearing 6 and a lower bearing 7 which rotatably support the rotary shaft 3.

[0025] The partition plate 4A partitions an inside of a cylinder 412 of the upper compression mechanism 41 and an inside of a cylinder 422 of the lower compression mechanism 42.

[0026] The upper compression mechanism 41 is constituted so as to include an upper piston rotor 411 which is provided in the upper crank pin 3B, the upper cylinder 412 in which the upper piston rotor 411 is disposed, and the upper muffler 10 which is disposed around an axis of the main shaft portion 3A.

[0027] The upper piston rotor 411 is fitted to an outer peripheral portion of the upper crank pin 3B and is turned in the upper cylinder 412 according to a rotation of the rotary shaft 3.

[0028] The refrigerant is sucked into the upper cylinder 412 through the pipe 8.

[0029] The upper bearing 6 includes an abutment portion 6A which abuts against an upper end surface of the upper cylinder 412 and a cylindrical bearing portion 6B which protrudes upward from the abutment portion 6A and is positioned around the axis of the rotary shaft 3 (main shaft portion 3A). The abutment portion 6A is fixed to the inner peripheral portion of the housing 5.

[0030] The upper cylinder 412, the upper muffler 10, the lower cylinder 422, and the lower muffler 20 are integrally assembled to the upper bearing 6 by a bolt 113.

[0031] The refrigerant sucked into the upper cylinder 412 is pressed to an outer peripheral portion of the turning upper piston rotor 411 and is compressed in a space in front of a blade (not shown) in a rotation direction. The compressed refrigerant is discharged into the upper muffler 10 through a discharge port 6P (Fig. 2) formed in the abutment portion 6A of the upper bearing 6, and is discharged to a space in the housing 5 below the motor 2 from the inside of the upper muffler 10.

[0032] Similarly to the upper compression mechanism 41, the lower compression mechanism 42 (Fig. 1) is constituted so as to include a lower piston rotor 421 which is provided in the lower crank pin 3C, the lower cylinder 422 in which the lower piston rotor 421 is disposed, and the lower muffler 20 which is disposed around the axis of the main shaft portion 3A.

[0033] The gas refrigerant is sucked into the lower cylinder 422 through the pipe 9.

[0034] The lower bearing 7 includes an abutment portion 7A which abuts against a lower end surface of the lower cylinder 422 and a cylindrical bearing portion 7B which protrudes downward from the abutment portion 7A and is positioned around the axis of the rotary shaft 3 (main shaft portion 3A).

[0035] The refrigerant sucked into the lower cylinder 422 is compressed according to turning of the lower piston rotor 421. The compressed refrigerant is discharged into the lower muffler 20 through a discharge port (not

shown) formed in the abutment portion 7A of the lower bearing 7 and into the inner space of the housing 5, and the compressed refrigerant is discharged to the space below the motor 2 in the housing 5 through a notch 61A or an opening (not shown) formed in the abutment portion 6A of the upper bearing 6.

[0036] As described above, the refrigerant compressed by the upper compression mechanism 41 and the lower compression mechanism 42 is discharged to the space in the housing 5 below the motor 2. The refrigerant flows to a space above the motor 2 through a notch provided in the stator 2A or the rotor 2B and is discharged to a refrigerant circuit through a discharge pipe 5A provided on an upper portion of the housing 5.

[0037] Each of the upper compression mechanism 41 and the lower compression mechanism 42 discharges the refrigerant with a pressure variation (pulsation) from the discharge port according to a turning period of each of the piston rotors 411 and 421. The pulsation of the compressed refrigerant which are ejected to the mufflers 10 and 20 through the discharge port by the upper compression mechanism 41 and the lower compression mechanism 42 is reduced in the mufflers 10 and 20.

[0038] The compressor 1 of the present embodiment is characterized by a structure of the upper muffler 10.

[0039] First, with reference to Figs. 2 and 3, a configuration of the upper muffler 10 (hereinafter, referred to as a muffler 10) will be described.

[0040] The muffler 10 includes a muffler body 11 which forms a space 110 between the abutment portion 6A of the upper bearing 6 and the muffler body 11 and a cover 12 which forms a cavity 120 between an outer peripheral portion 11S of the muffler body 11 and the cover 12.

[0041] For example, each of the muffler body 11 and the cover 12 is formed of a metal material such as an aluminum alloy by deep drawing.

[0042] In the muffler body 11, the compressed refrigerant which is compressed in the upper cylinder 412 (Fig. 1) and ejected from the discharge port 6P is received in the inner space 110, and the pulsation of the compressed refrigerant is reduced. The inner space of the muffler body 11 is operated as a resistance according to a space volume by the refrigerant ejected into the muffler body 11, and thus, the pulsation of the refrigerant is attenuated by the muffler body 11.

[0043] The muffler body 11 is disposed around the axis of the rotary shaft 3. The bearing portion 6B supporting the rotary shaft 3 passes through an opening formed at a planar center portion of the muffler body 11. A peripheral edge portion of the opening corresponds to an inner peripheral end 111 of the muffler body 11.

[0044] The muffler body 11 extends from the inner peripheral end 111 toward a radially outer side of the rotary shaft 3 by a predetermined diameter and is formed in an approximately cylindrical shape in a plan view. An end portion on a radially outer side of the muffler body 11 is fastened to the upper bearing 6 by the bolts 113 at a plurality of locations in a circumferential direction.

[0045] A dimension or a volume of the muffler body 11 can be appropriately determined so as to conform to an audible frequency component of the pulsation of the compressed refrigerant. This is similarly applied to the cover 12.

[0046] The muffler body 11 includes a portion 11A which extends radially outward from the inner peripheral end 111 positioned above the abutment portion 6A and a portion 11B which extends downward from the portion 11A toward the abutment portion 6A and is disposed on the abutment portion 6A. The refrigerant ejected from the discharge port 6P is mainly sprayed to the portion 11A.

[0047] Shapes of the portions 11A and 11B are slightly different from those of other locations at the locations at which the muffler body 11 is fastened by the bolts 113. The muffler body 11 is not limited to the shape shown in Fig. 2 and can be formed in an appropriate shape. For example, the muffler body 11 can be formed in a dome shape. This is similarly applied to the cover 12.

[0048] In the muffler body 11, a discharge opening 11P and a plurality of openings 11H separately from the discharge opening 11P are formed.

[0049] The refrigerant passes through discharge opening 11P from the inside of the muffler body 11 to the inside of the cavity 120.

[0050] The discharge opening 11P penetrates the portion 11A of the muffler body 11 in a plate thickness direction. In addition, a plurality of discharge openings are formed at intervals in a circumferential direction of the muffler body 11.

[0051] A position of the discharge opening 11P is not particularly limited. However, preferably, the discharge opening 11P is formed at a position at which a phase angle of the discharge opening 11P is different from that of the discharge port 6P, or a position which is away from the discharge port 6P such that the compressed refrigerant ejected from the discharge port 6P is not discharged from the inside of the muffler body 11 as it is. As described later, according to this, the refrigerant is introduced into the plurality of openings 11H, and thus, a sound absorbing effect can be sufficiently obtained using a Helmholtz resonance.

[0052] The number of discharge openings 11P, an opening area of each discharge opening 11P, and a total opening area of the plurality of discharge openings 11P are determined in consideration of a balance between a pressure loss for pulsation reduction and the performance of the compressor 1. This is similarly applied to a discharge opening 12P of the cover 12.

[0053] In addition, the discharge opening 11P may be formed in an annular shape along the axis (around an axis of the bearing portion 6B of the upper bearing 6) of the rotary shaft 3.

[0054] Each of the plurality of openings 11H penetrates the muffler body 11 in the plate thickness direction. In the example shown in Fig. 2, each opening 11H is formed in the portion 11A. However, the opening 11H may be formed in the portion 11B or may be formed in both the

portions 11A and 11B.

[0055] A cross-sectional area (opening area) of the opening 11H is much smaller than a cross-sectional area of the discharge opening 11P. For example, the cross-sectional area of the opening 11H is approximately 1/500 to 1/100 of the cross-sectional area of the discharge opening 11P. As described later, in order to increase the pulsation reduction effect by the openings 11H and the cavity 120, preferably, a plurality of minute openings 11H are formed in the muffler body 11.

[0056] As shown in Fig 4A, each opening 11H can be formed in a circular round hole. However, the opening 11H is not limited to this, and the opening 11H can be appropriately constituted as long as it causes the inside and the outside of the muffler body 11 to communicate with each other.

[0057] In order to increase the pulsation reduction effect, preferably, the plurality of opening 11H are formed over the entire surface of the muffler body 11.

[0058] In the cover 12 (refer to Figs. 2 and 3), the refrigerant is received in the cavity 120 between the cover 12 and the muffler body 11 from the space 110 in the muffler body 11 and is discharged from the discharge opening 12P.

[0059] Similarly to the above-described muffler body 11, the cover 12 is disposed around the axis of the rotary shaft 3, and the bearing portion 6B passes through an opening formed at a planar center portion of the cover 12. An inner peripheral end 121 (peripheral edge portion of the opening) of the cover 12 is slightly erected along the axial direction. An annular gap between the inner peripheral end 121 and the bearing portion 6B becomes the discharge opening 12P.

[0060] Preferably, the discharge opening 12P is formed at a position away from the discharge opening 11P such that the refrigerant discharged from the discharge opening 11P of the muffler body 11 into the cover 12 is not discharged to the outside of the cover 12 as it is. The discharge opening 12P may not be formed around the axis of the bearing portion 6B and may be formed so as to penetrate the cover 12 in the plate thickness direction.

[0061] The cover 12 covers the outer peripheral portion 11S of the muffler body 11 and is fastened to the upper bearing 6 together with the muffler body 11 by the bolt 113.

[0062] The inner peripheral end 121 of the cover 12 is positioned at a position which is positioned farther away from the abutment portion 6A of the upper bearing 6 in the axial direction than where the inner peripheral end 111 of the muffler body 11 is positioned. The cover 12 includes a portion 12A which faces the portion 11A of the muffler body 11 and a portion 12B which extends downward from the portion 12A.

[0063] The cover 12 of the present embodiment covers the muffler body 11 so as to surround the entirety thereof. However, the cover 12 may cover at least a portion of the muffler body 11 as long as the cavity 120 is formed

between the cover 12 and the muffler body 11.

[0064] According to a height of the cover 12, the inner peripheral end 121 does not face the bearing portion 6B and may face an outer peripheral portion of the rotary shaft 3. In this case, the discharge opening 12P is formed between the inner peripheral end 121 and the outer peripheral portion of the rotary shaft 3.

[0065] The lower muffler 20 (Fig. 1) is formed to be approximately similar to the upper muffler 10 and is disposed around an axis of the lower bearing 7 in a direction in which the lower muffler 20 is inverted to the upper muffler 10 in a vertical direction.

[0066] Unlike the upper muffler 10, the lower muffler 20 does not have the cover and is formed of a single member. However, similarly to the upper muffler 10, the lower muffler 20 can be formed to have the muffler body and the cover.

[0067] Hereinafter, the pulsation reduction effect by the upper muffler 10 will be described.

[0068] As described above, the muffler body 11 forms the space 110 and the cover 12 forms the cavity 120. Accordingly, the refrigerant compressed by the compression mechanism 41 is ejected to the space 110 and discharged to the cavity 120 from the discharge opening 11P, and is discharged to the outside of the cover 12 through the discharge opening 12P from the cavity 120. In this way, the refrigerant sequentially passes through the inside of the muffler body 11 and the inside of the cover 12, and thus, the pulsation of the refrigerant is reduced. That is, the muffler 10 having the muffler body 11 and the cover 12 functions as a two-stage muffler which reduces the pulsation through two stages.

[0069] The muffler 10 of the present embodiment further reduces the pulsation by establishing the Helmholtz resonance by the openings 11H of the muffler body 11 and the cavity 120 while maintaining the performance of the pulsation reduction as the two-stage muffler. The openings 11H and the cavity 120 constitute a Helmholtz resonator.

[0070] As shown in Fig. 4B, the Helmholtz resonance means that when air masses 15 (air columns) existing inside the openings 11H passing through the cavity 120 move in directions of hole axes, the air masses resonate at a predetermined frequency with the surrounding air. In this case, the cavity 120 can be regarded as a spring provided in the air masses 15. If the air masses 15 vibrate in a resonance state, frictions between air and the inner peripheral portions of the openings 11H or frictions between air molecules are remarkably generated, and thus, vibration energy attenuates and a sound pressure decreases (sound is absorbed).

[0071] In order to establish the Helmholtz resonance, a cross-sectional area S (horizontal cross-sectional area) of the opening 11H, a plate thickness L of the muffler body 11, and a volume V of the cavity 120 are determined so as to be a proper relationship to each other.

[0072] A basic expression of the Helmholtz resonance is as follows. Here, f is a natural frequency of the air mass

15 and C is a speed of sound.

[Expression 1]

$$f = \frac{C}{2\pi} \sqrt{\frac{S}{VL}} \quad \cdot \cdot \cdot \quad (1)$$

[0073] Sound absorption by the Helmholtz resonance is assumed to be $LS \ll V$. That is, LS which is an inner volume of the opening 11H is very small so as to be negligible compared to the volume V of the cavity 120. For example, depending on the frequency f for reducing the pulsation, a hole diameter of the opening 11H is approximately 0.15 mm, and the plate thickness L is approximately 1.5 mm. Since each opening 11H is minute, the total LS of the plurality of openings 11H is also very small as compared with the volume V of the cavity 120.

[0074] As described above, since the cross-sectional area of the opening 11H is minute compared to the discharge opening 11P or the discharge opening 12P, the openings 11 do not affect a subject (mainstream) of a flow of the refrigerant involved in a basic pulsation reduction mechanism of the muffler 10 in which the refrigerant received in the expanding space 110 is discharged from the narrow discharge opening 11P and is received in the cavity 120 to be discharged to the discharge opening 12P.

[0075] The cross-sectional area S or the plate thickness L can be determined in consideration of an appropriate frequency f to be reduced.

[0076] For example, when the natural frequency (resonance frequency) of air mass 15 is 250 Hz, the hole diameter of the opening 11H can be set to 0.15 mm, the plate thickness of the muffler body 11 to 1.5 mm, and the volume V of the cavity 120 to 200 mm³.

[0077] Here, in order to obtain a pulsation reduction effect (sound absorbing effect), it is necessary that the hole diameter of the opening 11 H is sufficiently small, and an upper limit of a sum of the cross-sectional areas S of the plurality of openings 11H is 1% of the surface area of the muffler body 11.

[0078] Since the air mass 15 in the opening 11H moves so as to draw the surrounding air, it is necessary to correct the length (plate thickness L) of the air mass 15 according to the shape around the opening 11H (opening portion correction). For example, if a radius of the opening 11H is defined as a, L' obtained from $L + 1.7a = L'$ can be applied to the Expression (1).

[0079] According to the compressor 1 of the present embodiment, the pulsation of the refrigerant compressed by the upper compression mechanism 41 and the lower compression mechanism 42 can be sufficiently reduced by the mufflers 10 and 20. As described above, according to the muffler 10, the pulsation reduction effect based on the Helmholtz resonance can be obtained while the pulsation reduction effect of the two-stage muffler which re-

peats the discharge of pulsation into the space is maintained. The movement of the air mass 15 inside the minute opening 11H does not affect the mainstream inside the muffler.

[0080] Therefore, according to the present embodiment, the pulsation of the refrigerant is sufficiently reduced while the performance of the compressor 1 is secured, and thus, it is possible to suppress a noise caused by the pressure variation of the refrigerant.

[0081] In the muffler 10, the muffler 10 itself becomes a sound source by the pulsation reduction and can suppress radiation of the sound pressure, and thus, even if the plate thickness of the muffler body 11 or the cover 12 is thin, it is possible to suppress the noise.

[0082] In addition, as long as the gist of the present invention is not deviated, it is possible to select configurations described in the embodiment or to appropriately change the configurations to other configurations.

[0083] The compression mechanism mounted on the compressor of the present invention is not limited to the twin rotary type compression mechanism 4. That is, the compression mechanism may be a single rotary type compression mechanism having a pair of cylinder and piston rotor and a muffler.

[0084] The compressor of the present invention is not limited to the rotary compressor and may be a scroll compressor. In this case, the configuration of the present invention may be applied to the muffler (also referred to as a discharge cover) which receives the compressed refrigerant discharged from the scroll type compression mechanism. That is, the discharge cover (muffler) includes a muffler body and a cover, and the minute opening 11H may be formed in the muffler body.

[0085] As the power source of the compressor of the present invention, in addition to the motor, for example, an engine or the like may be used.

Reference Signs List

[0086]

- 1: compressor
- 2: motor
- 2A: stator
- 2B: rotor
- 2C: coil
- 3: rotary 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: abutment portion
- 6B: bearing portion
- 6P: discharge port

7:	lower bearing	
7A:	abutment portion	
7B:	bearing portion	
8, 9:	pipe	
10:	upper muffler	5
11:	muffler body	
11A:	portion	
11B:	portion	
11P:	discharge opening	
11H:	opening	10
11S:	outer peripheral portion	
12:	cover	
12A:	portion	
12B:	portion	
12P:	discharge opening	15
15:	air mass	
20:	lower muffler	
41:	upper compression mechanism	
42:	lower compression mechanism	
61A:	notch	20
110:	space	
111:	inner peripheral end	
113:	bolt	
120:	cavity	
121:	inner peripheral end	25
411:	upper piston rotor	
412:	upper cylinder	
421:	lower piston rotor	
422:	lower cylinder	
L:	plate thickness	30
S:	cross-sectional area	
V:	volume	

existing inside each opening communicating with the cavity from a relationship between a speed of sound C, a cross-sectional area S of each of the openings, a plate thickness L, and a volume V of the cavity.

2. The compressor according to claim 1, wherein the compression mechanism includes a piston rotor which is provided in a rotary shaft and a cylinder in which the piston rotor is disposed, and wherein the muffler body and the cover are disposed around an axis of the rotary shaft.

Claims 35

1. A compressor comprising:

a compression mechanism which compresses a fluid; and 40

a muffler which reduces a pulsation of the fluid compressed by the compression mechanism, wherein the muffler includes

a muffler body which receives the fluid from the compression mechanism into an inside of the muffler body, and 45

a cover which forms a cavity between an outer peripheral portion of the muffler body and the cover and discharges the fluid received from the inside of the muffler body, 50

wherein the muffler body includes a plurality of openings which are formed to penetrate the muffler body in a plate thickness direction, separately from a discharge opening through which the fluid passes from the inside of the muffler body into the cavity, and 55

wherein sound is absorbed by establishing a Helmholtz resonance with respect to an air mass

FIG. 1

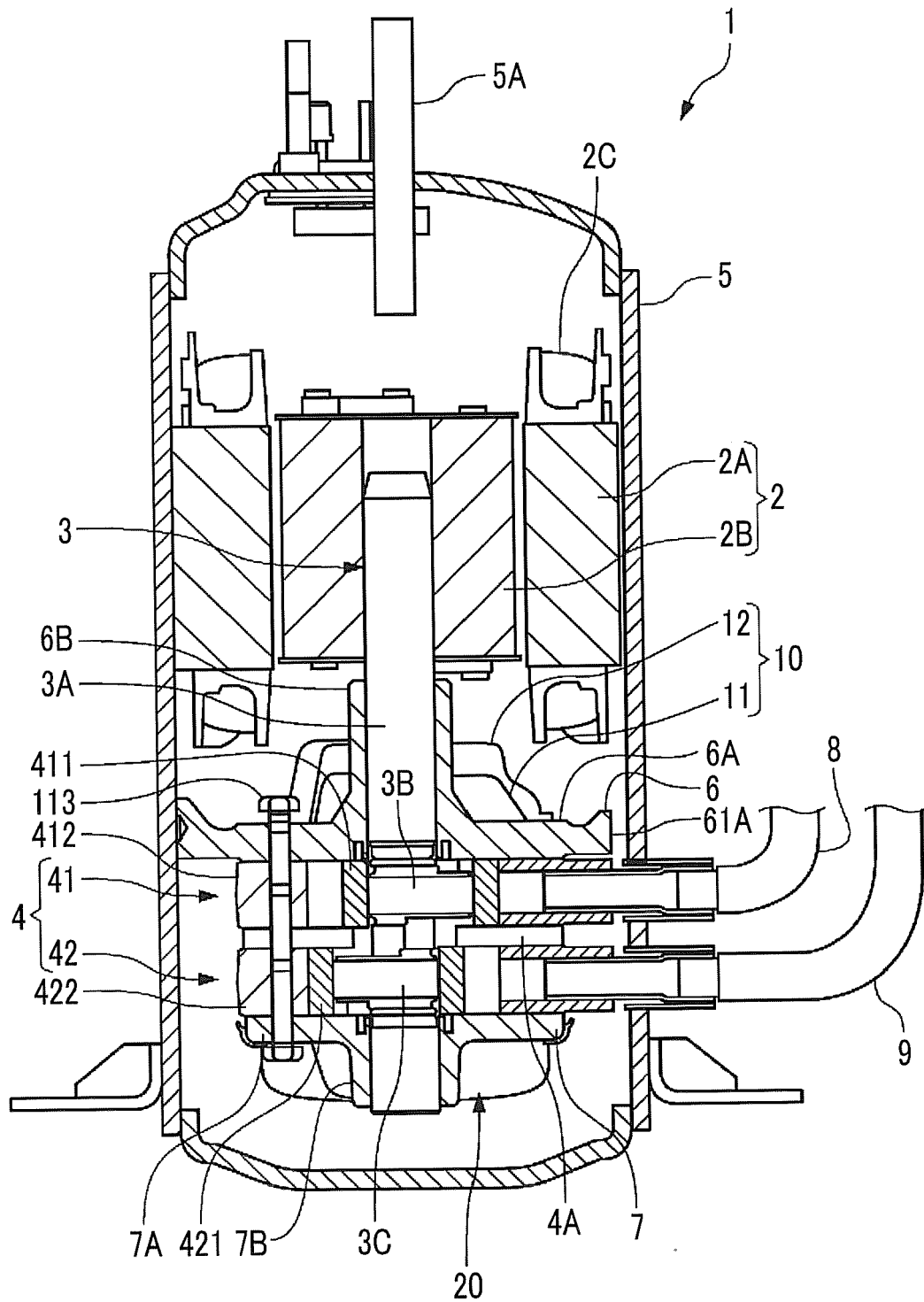


FIG. 2

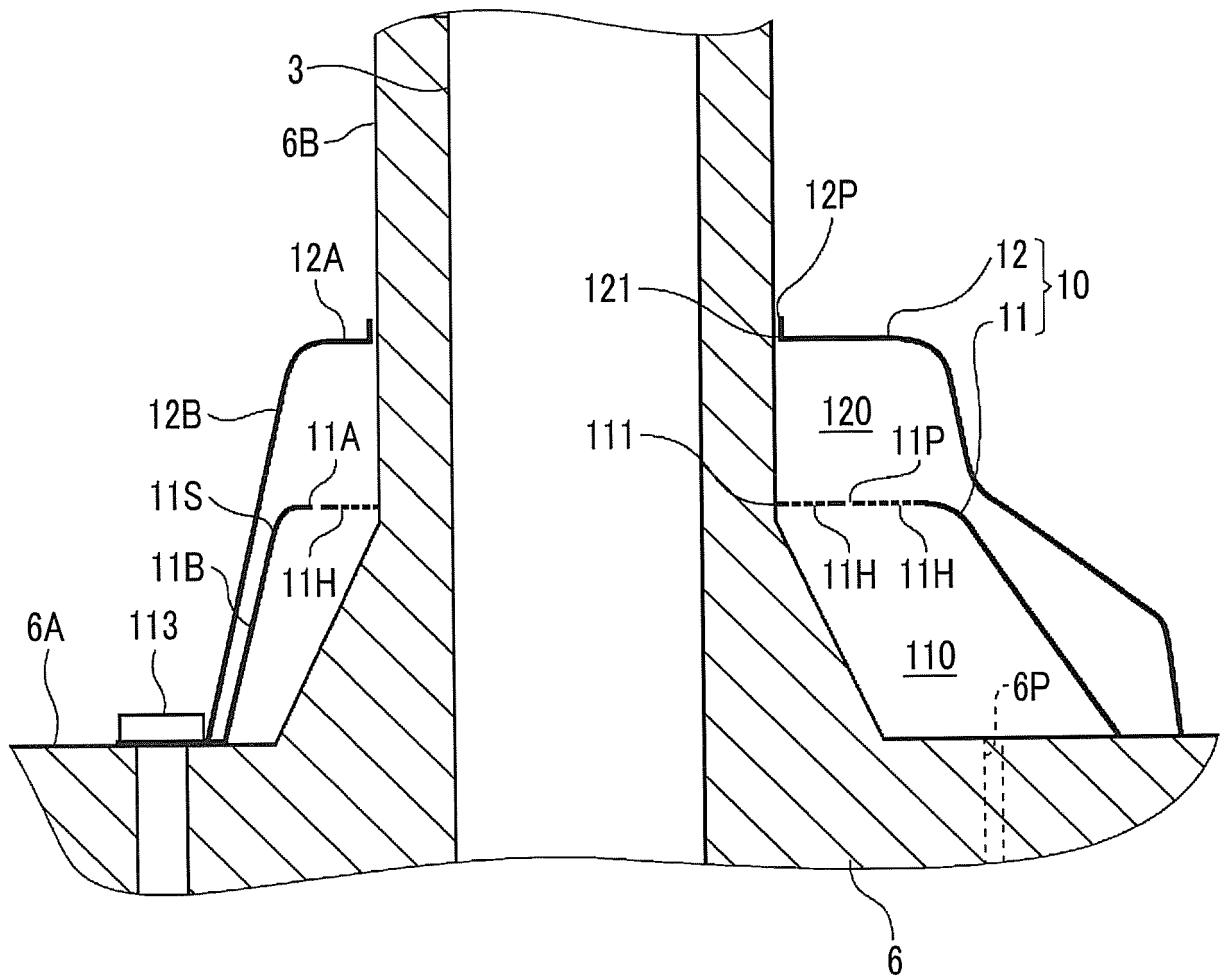


FIG. 3

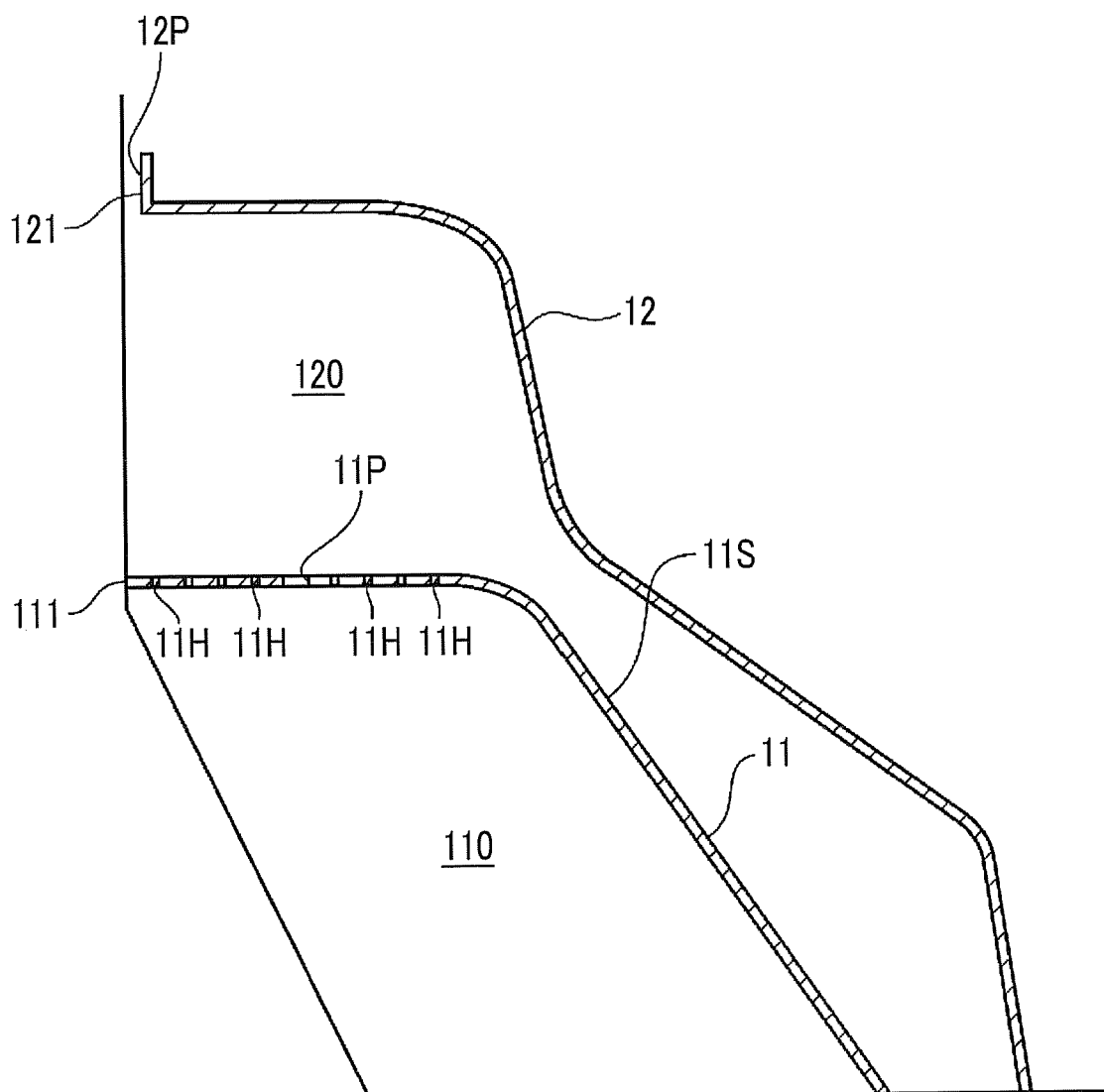


FIG. 4A

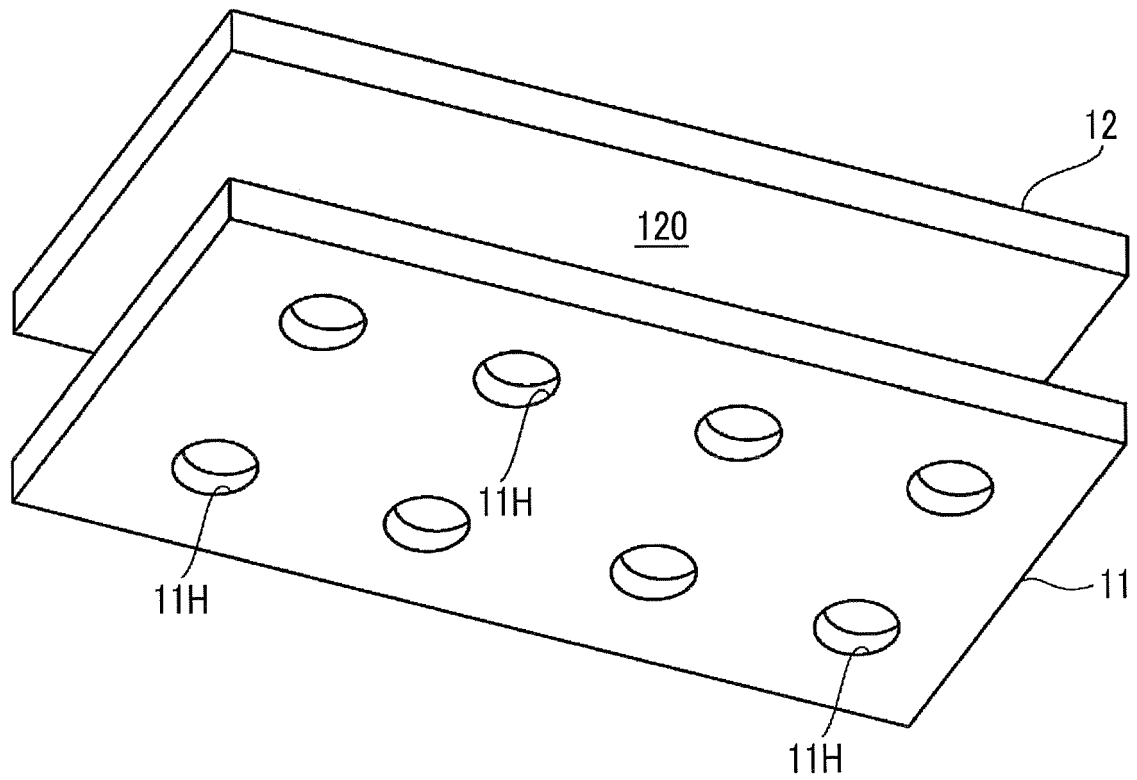
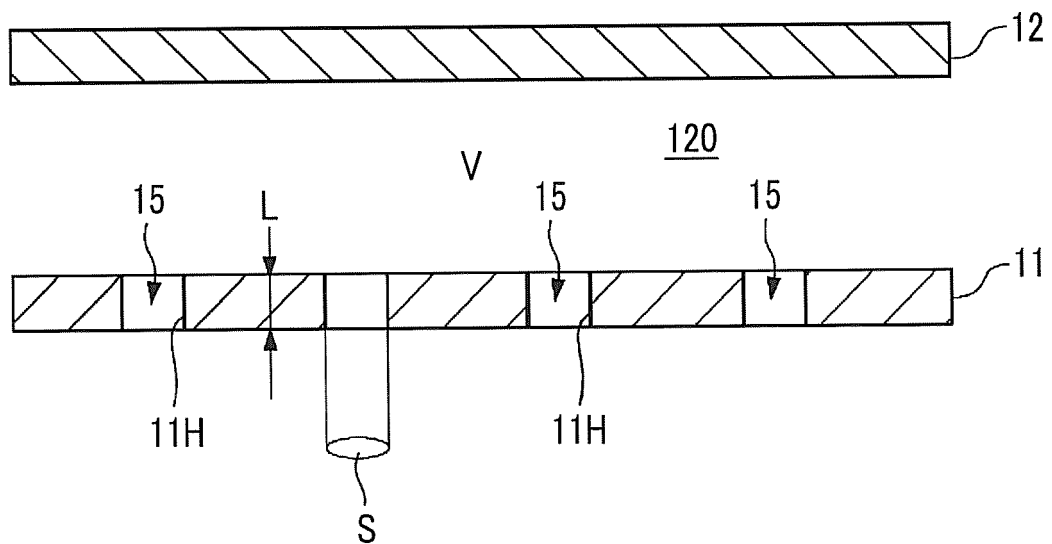


FIG. 4B



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2017/028710

A. CLASSIFICATION OF SUBJECT MATTER

F04C29/06(2006.01)i, F04B39/00(2006.01)i, F04C23/00(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, F04B39/00, F04C23/00

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

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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.
A	WO 2013/168194 A1 (Mitsubishi Electric Corp.), 14 November 2013 (14.11.2013), paragraphs [0020] to [0024]; fig. 1 to 3 & CN 104379937 A	1-2
A	JP 4-159490 A (Daikin Industries, Ltd.), 02 June 1992 (02.06.1992), page 3, lower left column, line 5 to page 4, upper left column, line 16; fig. 1 to 3 (Family: none)	1-2
A	JP 11-210660 A (Mitsubishi Electric Corp.), 03 August 1999 (03.08.1999), paragraph [0013]; fig. 2 (Family: none)	1-2

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

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Date of the actual completion of the international search
28 September 2017 (28.09.17)Date of mailing of the international search report
10 October 2017 (10.10.17)Name and mailing address of the ISA/
Japan Patent Office
3-4-3, Kasumigaseki, Chiyoda-ku,
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INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2017/028710

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2005-195013 A (LG Electronics Inc.), 21 July 2005 (21.07.2005), paragraph [0013]; fig. 6 & US 2005/0142002 A1 paragraph [0017]; fig. 2 & CN 1648453 A	1-2
A	JP 8-151918 A (Osaka Yakin Kogyo Co., Ltd.), 11 June 1996 (11.06.1996), paragraphs [0020] to [0023]; fig. 1 to 4 (Family: none)	1-2

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2014173554 A [0004]