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(74) Agent: **LEE, Kwang-Yeon**; LEE & KIM, 5th Floor, New-Seoul Bldg., 828-8, Yoksam 1-Dong, Kangnam-Ku, Seoul 135-935 (KR).

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(71) Applicant (*for all designated States except US*): **LG ELECTRONICS, INC.** [KR/KR]; 20, Yoido-dong, Yongdungpo-ku, Seoul 150-010 (KR).

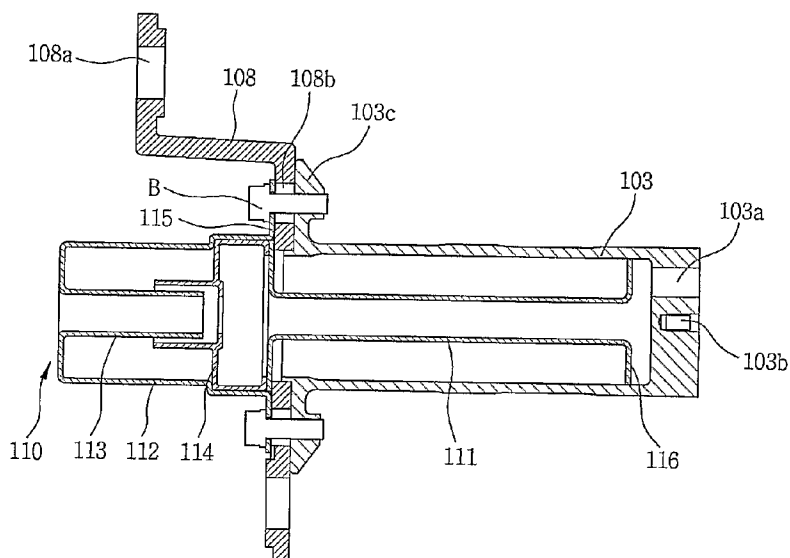
(72) Inventor; and

(75) Inventor/Applicant (*for US only*): **KANG, Yang-Jun** [KR/KR]; 209-505 Samik Apt., Sapa-dong, Changwon-shi, Gyung-sangnam-do 641-550 (KR).

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(54) Title: RECIPROCATING COMPRESSOR



(57) Abstract: The present invention relates to a reciprocating compressor wherein a moving member reciprocates linearly inside a stationary member to compress refrigerant, and more particularly, to a reciprocating compressor wherein a backflow of refrigerant is prevented before the refrigerant is introduced into a compression space. A reciprocating compressor according to the present invention includes a hollow stationary member, a moving member reciprocating linearly inside the stationary member, and having a suction hole in a blocked end so that refrigerant can be introduced therethrough, a sound attenuation duct extended lengthwise inside the moving member to guide introduced refrigerant, and a backflow prevention portion expanded from an end of the sound attenuation duct toward the moving member to prevent a backflow of the refrigerant. As the refrigerant does not flow backward before it flows into a compression space, it is possible to improve the compression efficiency.

WO 2008/082116 A2

Description

RECIPROCATING COMPRESSOR

Technical Field

- [1] The present invention relates to a reciprocating compressor wherein refrigerant is sucked into through an inner space of the moving member and compressed in a compression space defined between a stationary member and a moving member, as the moving member reciprocates linearly inside the stationary member, and more particularly, to a reciprocating compressor wherein a backflow of refrigerant is prevented in an inner space of a moving member before the refrigerant is introduced from the inner space of the moving member to a compression space.

Background Art

- [2] Generally, in a reciprocating compressor, a compression space into/from which an operation gas is sucked and discharged is defined between a piston and a cylinder, and the piston reciprocates linearly inside the cylinder to compress the refrigerant.
- [3] As the reciprocating compressor includes a component for converting a rotation force of a driving motor into a linear reciprocation force of the piston, such as a crank shaft, a large mechanical loss is caused by the motion conversion. Recently, a linear compressor has been developed to solve the above problem.
- [4] Particularly, in the linear compressor, a piston is coupled directly to a linearly-reciprocating linear motor, so that a mechanical loss caused by the motion conversion is prevented. Therefore, the linear compressor can improve the compression efficiency and simplify the configuration. In addition, power inputted to the linear motor is regulated to control an operation of the linear motor, so that noise is less generated than in the other compressors. Accordingly, the linear compressor has been mostly used in an electric home appliance installed in an indoor space, such as a refrigerator.
- [5] FIG. 1 is a view illustrating one example of a conventional reciprocating compressor, and FIG. 2 is a view illustrating one example of a refrigerant suction passage of the conventional reciprocating compressor.
- [6] Referring to FIGS. 1 and 2, in a linear compressor which is one example of the conventional reciprocating compressor, a structure composed of a frame 1, a stationary member 2, a moving member 3, a suction valve 4, a discharge valve assembly 5, a linear motor 6, a motor cover 7, a supporter 8, a main body cover 9, a buffering spring (not shown) and a muffler assembly 10 is installed inside a shell (not shown) to be elastically supported.

- [7] In detail, the stationary member 2 is formed in a hollow shape with both open ends. One end of the stationary member 2 is fitted into and fixed to the frame 1, and the other end thereof is blocked by the discharge valve assembly 5. The discharge valve assembly 5 includes a discharge valve 5a, a discharge cap 5b and a discharge valve spring 5c. After vibration and noise of refrigerant discharged from the discharge cap 5b are suppressed through a loop pipe (not shown), the refrigerant is discharged to the outside through an outflow tube (not shown) on the side of the shell.
- [8] The moving member 3 is formed in a hollow shape with one blocked end. The blocked end of the moving member 3 is inserted into the stationary member 2. A compression space P is defined between the stationary member 2 and the moving member 3. A plurality of suction holes 3a are formed in the blocked end of the moving member 3 so that refrigerant can be sucked into the compression space P therethrough. A groove 3b is formed in a center of the blocked end of the moving member 3 so that the thin suction valve 4 can be bolt-fastened B thereto. Here, the suction holes 3a may be formed eccentrically to one side of the blocked end of the moving member 3 as seen in the drawing, or may be formed in the center of the blocked end of the moving member 3. If the suction holes 3a are formed in the center, the suction valve 4 must be fixed to a rim of the moving member 3 unlike the drawing. However, as it is not easy to mechanically couple the suction valve 4 and the moving member 3, a special means such as a magnet is necessary to install the suction valve 4. Accordingly, normally, the suction holes 3a are formed eccentrically in the blocked end of the moving member 3, and the suction valve 4 is mechanically coupled to the center of the blocked end of the moving member 3 by means of a bolt or the like.
- [9] The suction valve 4 opens and closes the suction holes 3a of the moving member 3 by relative pressure variations of the compression space P caused by the linear reciprocation of the moving member 3.
- [10] The linear motor 6 includes a cylindrical inner stator 6a fixed to the outside of the stationary member 2, an outer stator 6b having a predetermined interval with the inner stator 6a in a radius direction with one end supported on the frame 1 and with the other end supported on the motor cover 7 a radius, a permanent magnet 6c installed between the inner stator 6a and the outer stator 6b with a predetermined gap, and a connection member 6d for connecting the moving member 3 to the permanent magnet 6c.
- [11] The inner stator 6a is formed by stacking laminations in a circumference direction, and the outer stator 6b is formed by mounting core blocks on a coil winding in a circumference direction at predetermined intervals. Therefore, when power is supplied

from the outside to the outer stator 6b, the inner stator 6a, the outer stator 6b and the permanent magnet 6c generate a mutual electromagnetic force, so that the permanent magnet 6c and the moving member 3 connected thereto reciprocate linearly in an axis direction.

- [12] The motor cover 7 supports the outer stator 6b in an axis direction to fix the outer stator 6b, and is bolt-fixed to the frame 1. The main body cover 9 is coupled to the motor cover 7. The supporter 8 connected to the other end of the moving member 3 is installed between the motor cover 7 and the main body cover 9 to be elastically supported by resonance springs in an axis direction.
- [13] The supporter 8 includes a supporting protrusion 8a fitted into the springs to elastically support the springs in a motion direction of the moving member 3, a bolt hole 8b bolt-fixed B to a flange 3c formed on the other end of the moving member 3, and an opening portion formed in a center to mount the muffler assembly 10 thereon.
- [14] A predetermined suction hole is formed in the main body cover 9 so that refrigerant introduced from an inflow tube on the side of the shell can pass therethrough.
- [15] In this situation, when the linear motor 6 is operated, the moving member 3 and the muffler assembly 10 connected thereto reciprocate linearly. The suction valve 4 and the discharge valve 5a are operated due to relative pressure variations of the compression space P. According to the above operation, the refrigerant is passed through the inflow tube on the side of the shell, the opening portion of the main body cover 9, the muffler assembly 10, and the suction holes 3a of the moving member 3, sucked into and compressed in the compression space P, and discharged to the outside through the discharge cap 5b, the loop pipe and the outflow tube on the side of the shell.
- [16] The muffler assembly 10 is formed to extend lengthwise in a motion direction of the moving member 3. The muffler assembly 10 not only guides a suction flow of the refrigerant but also attenuates noise generated when the refrigerant is sucked into the compression space P through the suction valve 4. As the refrigerant passes through a sound attenuation duct 11 with a relatively small diameter and a resonance chamber 14 with a relatively large diameter, noise can be attenuated according to an acoustic characteristic.
- [17] In more detail, the muffler assembly 10 includes the sound attenuation duct 11 extended lengthwise in an axis direction inside the moving member 3, a hollow outer casing 12 formed on the outside of the other end of the moving member 3, an inner extension duct 13 formed inside an inlet of the outer casing 12, the resonance chamber

14 defining a space with a large inner volume inside the outer casing 12, and having an opening portion so that refrigerant can pass therethrough, and a mounting portion 15 extended in a radius direction and bolt-fixed B to the flange 3c of the moving member 3. Here, the muffler assembly 10 is bolt-fixed B to the flange 3c of the moving member 3 with the supporter 8.

[18] The refrigerant introduced through the inflow tube (not shown) of the shell is passed through the predetermined suction hole of the main body cover 9, guided to pass through the inner extension duct 13 formed inside the inlet of the outer casing 12, the resonance chamber 14 and the sound attenuation duct 11, and sucked into the compression space P through the suction valve 4. The noise generated during this operation is attenuated reversely through the sound attenuation duct 11, the resonance chamber 14, and an auxiliary resonance chamber defined by the outer casing 12 and the inner extension duct 13, and then transferred to the inside of the shell.

[19] If a length of the sound attenuation duct 11 increases, a sectional area of the sound attenuation duct 11 decreases, or an effective volume of the resonance chamber 14 increases, the noise attenuation efficiency can be improved. However, the length of the sound attenuation duct 11 is restricted by the length of the moving member 3. In addition, if an end of the sound attenuation duct 11 excessively approaches the blocked end of the moving member 3, it is difficult to guide the refrigerant passing through the sound attenuation duct 11 to the suction holes 3a. Meanwhile, if the sectional area of the sound attenuation duct 11 decreases, a suction loss of the refrigerant occurs. Further, as the muffler assembly 10 reciprocates linearly with the moving member 3 inside a space limited by the main body cover 9 and the resonance springs, there is a limit to increase the volume of the resonance chamber 14.

[20] In the meantime, as set forth above, when the sound attenuation duct 11 is positioned at the inner center of the moving member 3 and the suction holes 3a are formed eccentrically in the blocked end of the moving member 3, even though most of the refrigerant passing through the sound attenuation duct 11 is introduced into the suction holes 3a of the moving member 3, some of the refrigerant passing through the sound attenuation duct 11 collides against the blocked end of the moving member 3 and flows backward. As the refrigerant flows backward, some refrigerant flows into a space between an inner circumference of the moving member 3 and the sound attenuation duct 11, so that a flow loss of the refrigerant occurs. As a result, the compression efficiency is degraded.

Disclosure of Invention

Technical Problem

[21] The present invention is conceived to solve the aforementioned problems in the prior art. An object of the present invention is to provide a reciprocating compressor capable of reducing a backflow of refrigerant introduced from a muffler assembly to a suction hole of a moving member.

[22] Another object of the present invention is to provide a reciprocating compressor capable of reducing a flow loss of refrigerant introduced from a muffler assembly to a suction hole of a moving member.

[23] A further object of the present invention is to provide a reciprocating compressor capable of maximizing the noise attenuation efficiency of a muffler assembly by increasing a length of a sound attenuation duct of the muffler assembly as much as possible in a given condition.

Technical Solution

[24] According to the present invention for achieving the objects, there is provided a reciprocating compressor, comprising: a hollow stationary member; a moving member reciprocating linearly inside the stationary member, and having a suction hole in a blocked end so that refrigerant can be introduced therethrough; a sound attenuation duct extended lengthwise inside the moving member to guide introduced refrigerant; and a backflow prevention portion expanded from an end of the sound attenuation duct toward the moving member to prevent a backflow of the refrigerant.

[25] Here, the suction hole may be formed eccentrically in the blocked end of the moving member.

[26] Preferably, the reciprocating compressor comprises a muffler assembly including the sound attenuation duct and a resonance chamber communicating with the sound attenuation duct so as to attenuate noise generated due to the inflow of the refrigerant.

[27] More preferably, the sound attenuation duct may be formed at an inner center of the moving member to extend lengthwise in a longitudinal direction of the moving member, and the resonance chamber may be formed outside the moving member to communicate with the sound attenuation duct.

[28] According to one preferable aspect of the present invention, the backflow prevention portion may be formed in a flange shape to expand perpendicularly from an end of the sound attenuation duct toward an inner surface of the moving member, may be formed in a funnel shape with a diameter increased in an axis direction at an end of

the sound attenuation duct, or may be formed in a cup shape to expand from an end of the sound attenuation duct with a step difference.

[29] Preferably, the backflow prevention portion may be formed as one body with the sound attenuation duct by using a plastic material, or made of a steel material and welded to an end of the sound attenuation duct.

[30] More preferably, an end of the backflow prevention portion contacts closely to an inner surface of the moving member.

Brief Description of the Drawings

[31] FIG. 1 is a view illustrating one example of a conventional reciprocating compressor.

[32] FIG. 2 is a view illustrating one example of a refrigerant suction passage of the conventional reciprocating compressor.

[33] FIGS. 3 to 5 are views illustrating various embodiments of a refrigerant suction passage of a reciprocating compressor according to the present invention.

Mode for the Invention

[34] Hereinafter, preferred embodiments of the present invention will be described in detail with reference to the accompanying drawings.

[35] FIGS. 3 to 5 are views illustrating various embodiments of a refrigerant suction passage of a reciprocating compressor according to the present invention.

[36] Referring to FIG. 3, in a first embodiment of a refrigerant suction passage of a linear compressor that is one example of the reciprocating compressor according to the present invention, suction holes 103a are formed eccentrically in one blocked end of a moving member 103 to communicate with a compression space P defined between a stationary member (not shown) and the moving member 103, and a supporter 108 and a muffler assembly 110 are installed at the other end of the moving member 103. A sound attenuation duct 111 of the muffler assembly 110 is positioned at an inner center of the moving member 103, and a backflow prevention portion 116 is formed at an end of the sound attenuation duct 111 to expand in a radius direction.

[37] In detail, the moving member 103 is formed in a piston shape, and the suction holes 103a are formed eccentrically in the blocked end thereof. A bolt groove 103b is formed in a center of the blocked end so that a thin suction valve (not shown) for opening and closing the suction holes 103a can be bolt-fixed thereto.

[38] Here, a flange 103c is formed at the open end of the moving member 103 to expand in a radius direction, and the supporter 108 and the muffler assembly 110 are bolt-

fixed B to the flange 103c of the moving member 103.

[39] Like the prior art, the supporter 108 includes a supporting protrusion 108a and a bolt hole 108b, and the muffler assembly 110 includes the sound attenuation duct 111, an outer casing 112, an inner extension duct 113, a resonance chamber 114 and a mounting portion 115. Therefore Detailed explanations thereof are omitted.

[40] The backflow prevention portion 116 is formed in a flange shape to expand perpendicularly from the end of the sound attenuation duct 111 of the muffler assembly 110 toward the inner surface of the moving member 103, namely, in a radius direction. As the backflow prevention portion 116 serves to guide refrigerant passing through the sound attenuation duct 111 toward the suction holes 103a, the sound attenuation duct 111 of the muffler assembly 110 can be formed longer than in the prior art, namely, the sound attenuation duct 111 can be formed closer to the blocked end of the moving member 103. As a result, the sound attenuation duct 111 is relatively longer than in the prior art, thereby improving the noise attenuation characteristic.

[41] In order to prevent the refrigerant passing through the sound attenuation duct 111 of the muffler assembly 110 from colliding against the blocked end of the moving member 103 and flowing backward between an inner surface of the moving member 103 and the sound attenuation duct 111, more preferably, the backflow prevention portion 116 is expanded from the sound attenuation duct 111 of the muffler assembly 110 and contacts closely to the inner surface of the moving member 103.

[42] If the sound attenuation duct 111 is made of a plastic material, the backflow prevention portion 116 may be injection-molded with the sound attenuation duct 111 by using the plastic material. Meanwhile, if the sound attenuation duct 111 is made of a steel material, the backflow prevention portion 116 may be separately made of a steel material, and fixed to the end of the sound attenuation duct 111 by means of welding such as brazing.

[43] Accordingly, the refrigerant passing through the sound attenuation duct 111 of the muffler assembly 110 moves along the inner center of the moving member 103. Some refrigerant flows directly into the suction holes 103a of the moving member 103. Even if the other refrigerant collides against the blocked end of the moving member 103 and flows backward, the refrigerant moves along the inner surface of the moving member 103, collides against the backflow prevention portion 116, and flows toward the suction holes 103a again in a refrigerant flow direction.

[44] That is, even if some of the refrigerant passing through the sound attenuation duct 111 of the muffler assembly 110 flows backward, as the inner surface of the moving

member 103 and the backflow prevention portion 116 contact closely to each other, it is possible to reduce a flow loss of the refrigerant.

[45] Meanwhile, referring to FIG. 4, a second embodiment of the refrigerant suction passage of the reciprocating compressor according to the present invention is identical to the first embodiment described above. However, a backflow prevention portion 117 is formed in a funnel shape with a diameter increased in a refrigerant flow direction at an end of a sound attenuation duct 111 of a muffler assembly 110, and an end of the backflow prevention portion 117 contact closely to an inner diameter of a moving member 103.

[46] As the backflow prevention portion 117 serves to guide refrigerant passing through the sound attenuation duct 111 toward suction holes 103a, the sound attenuation duct 111 of the muffler assembly 110 can be formed longer than in the prior art, namely, the sound attenuation duct 111 can be formed closer to the blocked end of the moving member 103. Accordingly, the sound attenuation duct 111 is relatively longer than in the prior art, thereby improving the noise attenuation characteristic.

[47] Although the sound attenuation duct 111 of the muffler assembly 110 is not longer than in the prior art, as the backflow prevention portion 117 is gradually expanded in a radius direction of the sound attenuation duct 111 of the muffler assembly 110 along a refrigerant flow direction, the suction holes 103a of the moving member 103 and the backflow prevention portion 117 are formed adjacent to each other.

[48] The backflow prevention portion 117 may be formed as one body with the sound attenuation duct 111 of the muffler assembly 110 by using a plastic material, or made of a steel material and welded to the sound attenuation duct 111 of the muffler assembly 110.

[49] Therefore, the refrigerant passing through the sound attenuation duct 111 of the muffler assembly 110 moves along the inner center of the moving member 103. Some refrigerant flows directly into the suction holes 103a of the moving member 103. Even if the other refrigerant collides against the blocked end of the moving member 103 and flows backward, the refrigerant is guided by the inner diameter of the moving member 103 and the backflow prevention portion 117, pins the refrigerant passing through the sound attenuation duct 111, and flows toward the suction holes 103a in a refrigerant flow direction.

[50] That is, even if some of the refrigerant passing through the sound attenuation duct 111 of the muffler assembly 110 flows backward, as the inner diameter of the moving member 103 and the backflow prevention portion 117 contact closely to each other, it

is possible to reduce a flow loss of the refrigerant.

[51] On the other hand, referring to FIG. 5, a third embodiment of the refrigerant suction passage of the reciprocating compressor according to the present invention is identical to the second embodiment described above. However, a backflow prevention portion 118 is formed in a cup shape to expand from an end of a sound attenuation duct 111 of a muffler assembly 110, and an end of the backflow prevention portion 118 contacts closely to an inner surface of a moving member 103. In case the end of the backflow prevention portion 118 does not contact closely to the inner surface of the moving member 103, preferably, the backflow prevention portion 118 is formed longer in a refrigerant flow direction, maintaining a gap therefrom.

[52] Although the sound attenuation duct 111 of the muffler assembly 110 is not longer than in the prior art, as the backflow prevention portion 118 is expanded perpendicularly in a radius direction of the sound attenuation duct 111 of the muffler assembly 110 and extended in a refrigerant flow direction, suction holes 103a of the moving member 103 and the backflow prevention portion 118 are formed adjacent to each other.

[53] The backflow prevention portion 118 may be formed as one body with the sound attenuation duct 111 of the muffler assembly 110 by using a plastic material, or made of a steel material and welded to the sound attenuation duct 111 of the muffler assembly 110.

[54] Accordingly, some of the refrigerant passing through the sound attenuation duct 111 of the muffler assembly 110 flows directly into the suction holes 103a of the moving member 103. Even if the other refrigerant collides against the blocked end of the moving member 103 and flows backward, the refrigerant is guided by the inner diameter of the moving member 103 and the backflow prevention portion 118, pins the refrigerant passing through the sound attenuation duct 111, and flows along the moving member 103 in a refrigerant flow direction.

[55] In addition, even if some of the refrigerant passing through the sound attenuation duct 111 of the muffler assembly 110 flows backward, as the inner surface of the moving member 103 and the backflow prevention portion 118 contact closely to each other, it is possible to reduce a flow loss of the refrigerant.

[56] Meanwhile, a flow rate of refrigerant flowing backward is associated closely with a structure of a refrigerant flow passage. It is represented as follows.

[57]

$$Q_b = \frac{\Delta P}{L} h^3$$

[58] That is, the flow rate Q_b of the refrigerant flowing backward is proportional to a pressure difference ΔP between a pressure of a space formed between the sound attenuation duct 111 and the moving member 103 and a pressure of an outlet portion of the backflow prevention portion 116, 117 or 118, and a gap h between the inner surface of the moving member 103 and the backflow prevention portion 116, 117 or 118, but inversely proportional to a flow direction length L of the sound attenuation duct 111 and the backflow prevention portion 116, 117 or 118. According to the present invention, the gap h between the inner surface of the moving member 103 and the backflow prevention portion 116, 117 or 118 is reduced as much as possible on the basis of the above formula, thereby minimizing the flow rate of the refrigerant flowing backward. That is, according to the present invention, preferably, the end of the backflow prevention portion 116, 117 or 118 is in contact with the inner surface of the moving member 103 to minimize the gap h .

[59] Moreover, the length of the sound attenuation duct 111 is increased or the refrigerant flow direction length is increased at the end of the sound attenuation duct 111 in the refrigerant flow direction so that the backflow prevention portion 116, 117 or 118 can approach the suction holes 103a of the moving member 103 as close as possible. Therefore, the refrigerant less flows backward or does not flow backward, and the flow loss of the refrigerant does not occur. Accordingly, as described above, if the length of the sound attenuation duct 111 increases, the noise attenuation efficiency can be improved.

[60] As a result, the flow rate of the refrigerant circulated in each embodiment of the reciprocating compressor according to the present invention can be increased to improve the compression efficiency and to subsequently improve an energy efficiency ratio (EER). According to a test result, as compared with the prior art, the EERS of the first to third embodiments have been improved by 0.08, 0.07 and 0.1, respectively.

[61] The present invention has been described in detail with reference to the embodiments and the attached drawings. However, the scope of the present invention is not limited to the embodiments and the drawings, but is defined by the appended claims.

Industrial Applicability

[62] According to the present invention, in a reciprocating compressor, even if a

backflow of refrigerant occurs before the refrigerant is introduced from a sound attenuation duct of a muffler assembly to a suction hole of a moving member, the refrigerant collides against a backflow prevention portion formed at an end of the sound attenuation duct of the muffler assembly, and is guided to flow again toward the suction hole of the moving member. It is thus possible to suppress the backflow of the refrigerant. Moreover, as the backflow prevention portion is attached between an inner diameter of the moving member and the sound attenuation duct of the muffler assembly, a flow loss of the refrigerant caused by the backflow is prevented before the refrigerant is introduced into a compression space. It is therefore possible to increase a flow rate of the refrigerant. Further, a length of the sound attenuation duct is increased to improve the noise attenuation efficiency and to subsequently improve the compression efficiency and the energy efficiency.

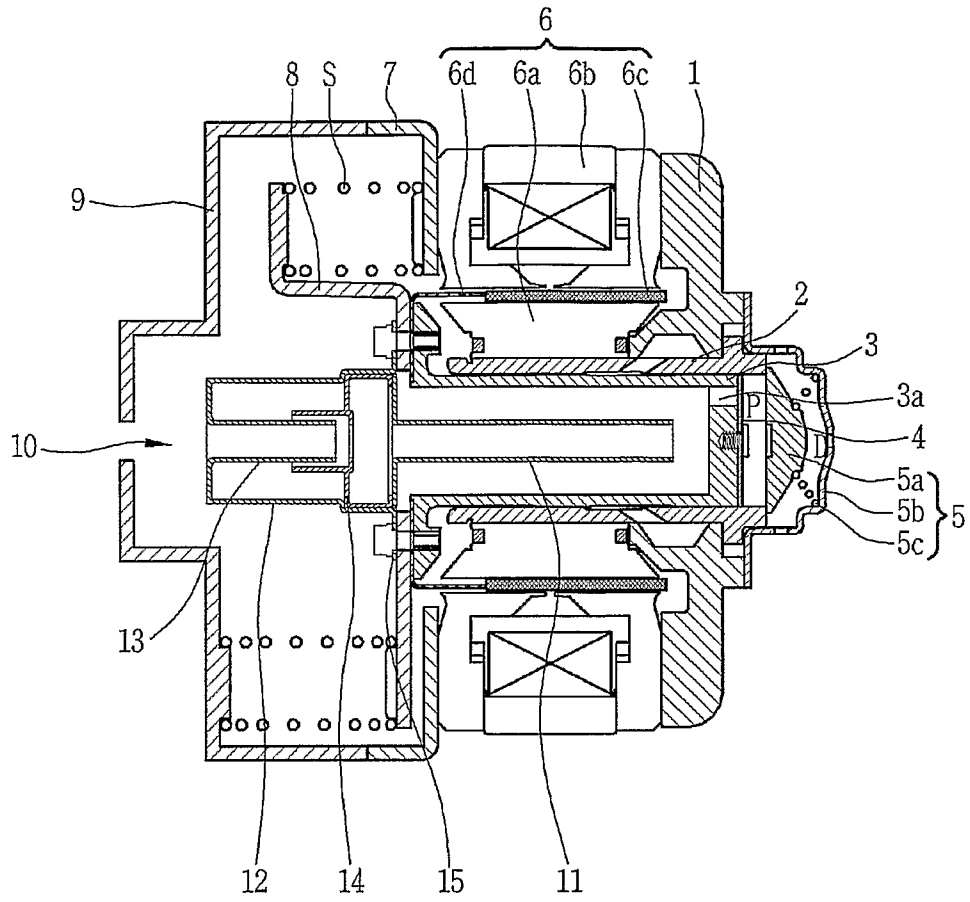
Claims

- [1] A reciprocating compressor, comprising:
a hollow stationary member;
a moving member reciprocating linearly inside the stationary member, and
having a suction hole in a blocked end so that refrigerant can be introduced therethrough;
a sound attenuation duct extended lengthwise inside the moving member to guide introduced refrigerant; and
a backflow prevention portion expanded from an end of the sound attenuation duct toward the moving member to prevent a backflow of the refrigerant.
- [2] The reciprocating compressor of claim 1, wherein the suction hole is formed eccentrically in the blocked end of the moving member.
- [3] The reciprocating compressor of claim 2, comprising a muffler assembly including the sound attenuation duct and a resonance chamber communicating with the sound attenuation duct so as to attenuate noise generated due to the inflow of the refrigerant.
- [4] The reciprocating compressor of claim 3, wherein the sound attenuation duct is formed at an inner center of the moving member to extend lengthwise in a longitudinal direction of the moving member, and the resonance chamber is formed outside the moving member to communicate with the sound attenuation duct.
- [5] The reciprocating compressor of any one of claims 1 to 4, wherein the backflow prevention portion is formed in a flange shape to expand perpendicularly from an end of the sound attenuation duct toward an inner surface of the moving member.
- [6] The reciprocating compressor of any one of claims 1 to 4, wherein the backflow prevention portion is formed in a funnel shape with a diameter increased in an axis direction at an end of the sound attenuation duct.
- [7] The reciprocating compressor of any one of claims 1 to 4, wherein the backflow prevention portion is formed in a cup shape to expand from an end of the sound attenuation duct with a step difference.
- [8] The reciprocating compressor of any one of claims 1 to 4, wherein the backflow prevention portion is formed as one body with the sound attenuation duct by using a plastic material.
- [9] The reciprocating compressor of any one of claims 1 to 4, wherein the backflow

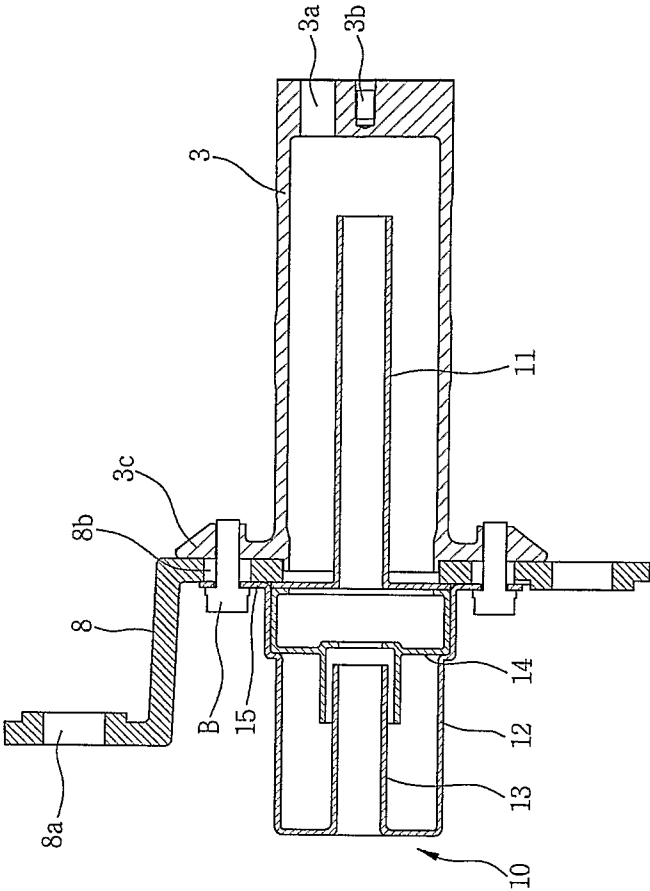
prevention portion is made of a steel material and welded to an end of the sound attenuation duct.

- [10] The reciprocating compressor of any one of claims 1 to 4, wherein an end of the backflow prevention portion contact closely to an inner surface of the moving member.

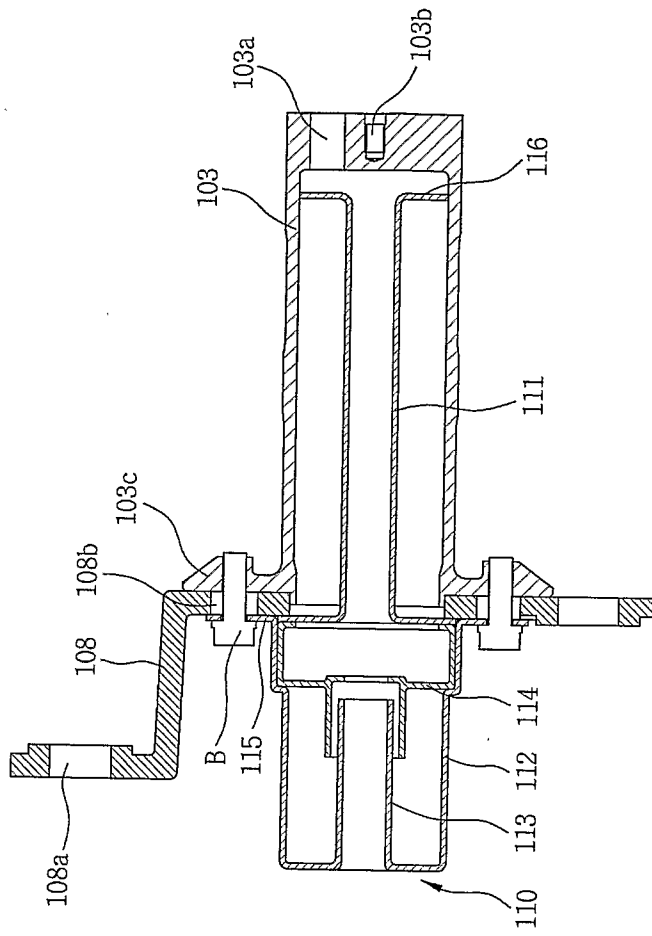
[Fig. 1]



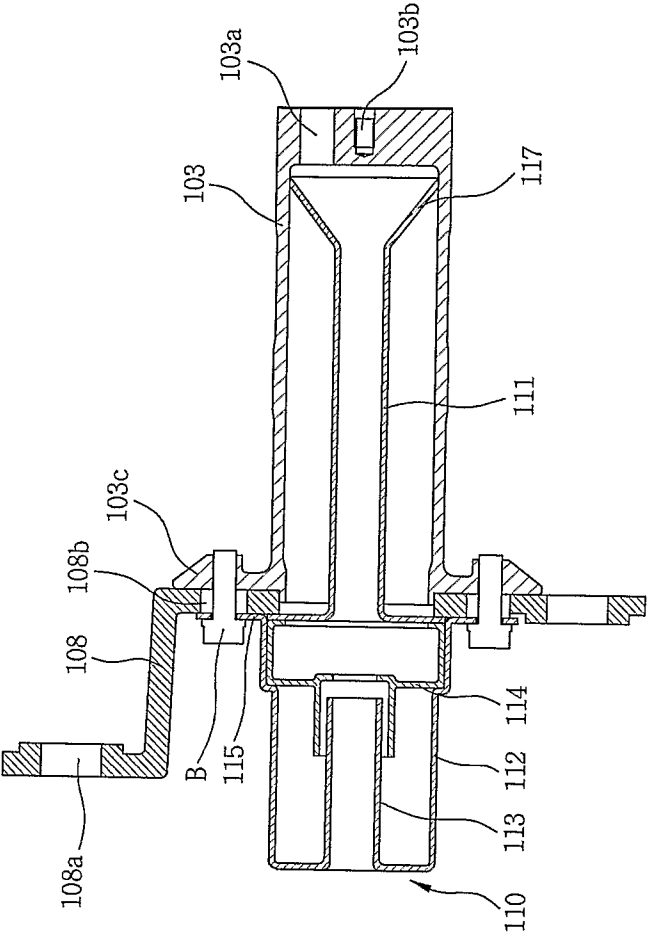
[Fig. 2]



[Fig. 3]



[Fig. 4]



[Fig. 5]

