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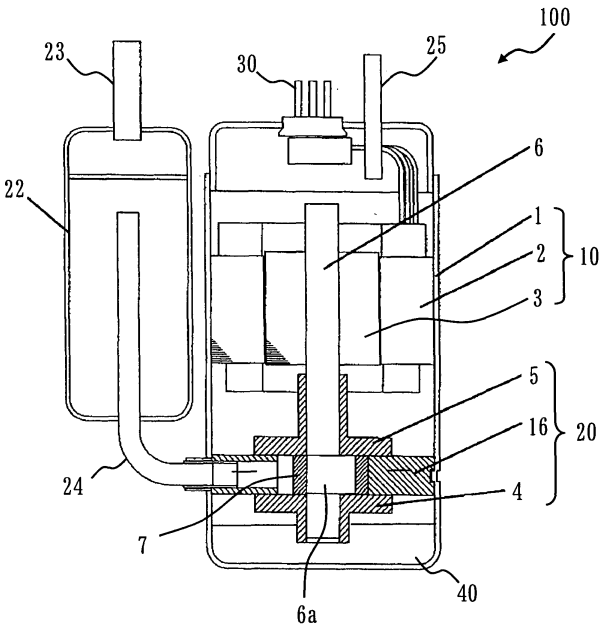
(54) A hermetic type compressor

(57) The hermetic type compressor 100 according to the present invention comprises, inside ahermetic container 1, a compressing mechanism portion 20 and an electric motor 10 for driving the compressing mechanism portion 20, and performs compression of the refrigerant continuously by dividing a compression room with a vane into a high-pressure room and a low-pressure room. The compression room is composed of a cylinder 16 that disposes therein a rolling piston 7 fitted to an eccentric axis 6a of the crankshaft 6 rotated by the electric motor 10, and a cylinder head 4 and a frame 5 that block both ends of the cylinder 16 in an axial direction. According to the hermetic type compressor 100 using the HC refrigerant, the electric motor is fitted and fixed to an inner peripheral plane of the hermetic container. An outer diameter of the electric motor is less than an outer diameter of the compressing mechanism portion. For the cylinder having an inner diameter D and a height H, D/H is set to more than 0.5 and less than 0.6.

Fig. 1



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Description

[0001] The present invention relates to, for example, a hermetic type compressor that can preferably be utilized in refrigerating apparatus, air-conditioning apparatus, and hot water supplying apparatus.

[0002] In a refrigerating cycle apparatus that uses a primary refrigerant having toxic and inflammable properties, and that uses an another secondary refrigerant, the refrigerating cycle apparatus comprises: a main refrigerant circuit connected via piping to a compressor and a pressure reducing valve, which infuses a main refrigerant inside; a use side refrigerant circuit connected via piping to an use side heat exchanger and an use side pump, which infuses a use side refrigerant inside; a heat source side refrigerant circuit connected via piping to a heat source side heat exchanger and a heat source side pump, which infuses a heat source side refrigerant inside; a use side intermediate heat exchanger connected to each of the main refrigerant circuit and the use side refrigerant circuit, which performs a heat exchange between the main refrigerant and the use side refrigerant; and a heat source side intermediate heat exchanger connected to each of the main refrigerant circuit and the heat source side refrigerant circuit, which performs a heat exchange between the main refrigerant and the heat source side refrigerant. The refrigerating cycle apparatus is proposed, in which the use side pump is driven by the same drive mechanism that drives the compressor, in an attempt to reduce a size of the device. In this refrigerating cycle apparatus, an outer diameter of the drive mechanism part is less than an outer diameter of the compressor (for example, refer to patent document 1).

[0003] As the conventional hermetic compressor, a rotary compressor having a value ranging from 1.6 to 1.7 that divides an inner diameter of the cylinder by a height of the cylinder is proposed (for example, see patent document 2).

[Patent Document 1] Japanese Unexamined Patent Publication No. 200-65431 (page 7, Fig. 2)

[Patent Document 2] Japanese Unexamined Patent Publication No. 05-302584

[0004] As the refrigerant that does not pose a threat to the ozone layer, and that has a low global warming potential value, a natural refrigerant, such as HC (hydrocarbon) refrigerant or R717 (ammonia), is receiving attention. Examples of the HC refrigerant includes: a single refrigerant, such as R170 (ethane), R1270 (propylene), R290 (propane), and R600a (isobutane) ; and combination of these refrigerants.

[0005] In case of using the HC refrigerant to the refrigerant circuit, if the refrigerant leaks, there is a danger of fire ignition or explosion due to the inflammable property of the refrigerant. Therefore, to reduce such dangers, it is ideal to decrease an amount of the refrigerant to be infused into the refrigerant circuit. Most commonly, the hermetic type compressor being adopted in the refrigerating apparatus, the air-conditioning apparatus, the hot water supplying apparatus, or the like, is of a high-pressure type inside a hermetic container. For this reason, in order to decrease the amount of refrigerant to be infused into the refrigerant circuit, it is necessary to reduce an inner space volume of the hermetic container of the hermetic type compressor.

[0006] According to the patent document 1 which has attempted to solve this point, it faces the following problems. There is a need to drive a compressing mechanism portion of the main refrigerant circuit which uses the HC refrigerant and the heat source side pump of the heat source side refrigerant circuit, with the same electric motor. There is also a need to completely separate the main refrigerant circuit and the heat source side refrigerant circuit. For these reasons, as shown in page 7, Fig. 2 of the patent document 1, a container covering the compressing mechanism portion, a container covering the electric motor, and a container covering the heat source side pump are separately configured. Furthermore, stators and rotors disposed inside the electric motor are maintained airtight by cans.

[0007] According to this configuration, abnormal vibrations and noises are generated from the compressing mechanism portion and the electric motor, or their operation may fail in the worst case, if a coaxialty is not secured within a prescribed value, between an electric motor stator fixed to the hermetic container covering the electric motor and a rotor fixed to a drive shaft of the compressing mechanism portion which is rotably held in position to the compressing mechanism portion. For this reason, the hermetic container covering the compressing mechanism portion and the hermetic container covering the electric motor should be manufactured under a highly precise coaxial assembly technology, which prominently deteriorates the production yield, and the production cost becomes expensive.

[0008] Moreover, a rotary compressor of the patent document 2 has the following problems. R410 refrigerant has been used as the refrigerant of a conventional air-conditioning apparatus. If the HC refrigerant is used by replacing with the R410 refrigerant, given that geometric displacements of their compressing mechanism portions are identical, a refrigerating capacity declines down to about 10%, owing to the properties of the refrigerant. For example, provided that a refrigerating capacity is A when the R410A refrigerant is in use, and if a hermetic type compressor that uses the HC refrigerant is produced at the identical geometric displacement, its refrigerating capacitywill be 0.9 XA. There is a need to increase the geometric displacement by 10% in order to obtain the identical refrigerating capacity as the conventional R410A refrigerant.

[0009] Generally, a compression efficiencyof the hermetic type compressor is proportional to a value which divides an inner diameter of the cylinder by a height of the cylinder . That is, the compression efficiency will increase if the inner diameter of the cylinder is relatively greater than the height of the cylinder, that is, if a cylinder

dimension is flat. At this time, the inner diameter of the cylinder is increased if the inner diameter of the cylinder and the height of the cylinder are designed in pursue of this efficiency based on the conventional technology.

[0010] However, increasing the inner diameter of the cylinder also increases the outer diameter of the cylinder, that is, the inner diameter of the hermetic container covering the cylinder is also increased. If the inner diameter of the hermetic container is increased, an inner diameter of a bottom part of the hermetic container where a refrigerating machine oil is stored for supplying to the compressing mechanism portion is also increased. An amount of the refrigerating machine oil to be infused becomes large if attempt to secure a fixed oil level.

[0011] The HC refrigerant shows an extremely high solubility to the refrigerating machine oil that is generally being used today. The HC refrigerant readily dissolves in the refrigerating machine oil. Responding to the amount of the refrigerating machine oil inside the hermetic type compressor, the amount of refrigerant to be infused must also be infused by an extra amount of the refrigerant dissolving to the refrigerating machine oil.

[0012] In case of using the HC refrigerant to the refrigerant circuit, if the refrigerant leaks, there is a danger of fire ignition or explosion due to the inflammable property of the refrigerant. Accordingly, it is ideal to decrease the amount of refrigerant to be infused into the refrigerant circuit in order to reduce such dangers. If the amount of refrigerant to be infused is large, this also increases a chance of the danger such as fire ignition or explosion.

[0013] Moreover, when disposing the hermetic type compressor, after dismantling, the scrapes are classified into iron, aluminum and copper for recycling, however, the refrigerating machine oil has no recycle utility, therefore, it must be discarded. Hence, if the amount of refrigerating machine oil being infused is large, the amount of refrigerating machine oil to be discarded gets also large, therefore, the effect that gives on the environment is of a concern.

[0014] The present invention attempts to solve the problems mentioned above. The present invention is directed to provide a safe hermetic type compressor adopted in the refrigerant circuit that uses the HC refrigerant, by decreasing the amount of refrigerant to be infused, so that there is a less chance of the danger such as fire ignition or explosion occurring which may be caused by the refrigerant leakage.

[0015] A hermetic type compressor using the HC (hydrocarbon) refrigerant comprises, inside a hermetic container, a compressing mechanism portion for compressing the refrigerant and an electric motor for driving the compressing mechanism portion, and performs compression of the refrigerant continuously by dividing a compression room with a vane into a high-pressure room and a low-pressure room. The compression room is composed of a cylinder that disposes therein a rolling piston fitted to an eccentric axis of the crankshaft rotated by the electric motor and a cylinder head and a frame that block both ends of the cylinder in an axial direction. The electric motor is fitted and fixed to an inner peripheral plane of the hermetic container. An outer diameter of the electric motor is less than an outer diameter of the compressing mechanism portion. For the cylinder having an inner diameter D and a height H, D/H is set to more than 0.5 and less than 0.6.

[0016] According to one aspect of the present invention, a safe hermetic type compressor is provided by making the outer diameter of the electric motor smaller than the outer diameter of the compressing mechanism portion, and thereby decreasing the amount of refrigerant to be infused. There is a less chance of the danger such as fire ignition or explosion occurring which may be caused by the refrigerant leakage. Moreover, for a cylinder having an inner diameter D and a height H, D/H is set to more than 0.5 and less than 1.6. In this way, even in a case of increasing the geometric displacement capacity, a cylinder shape is elongated without increasing the inner diameter of the cylinder, and an inner diameter of a shell is not increased. The amount of the refrigerant to be infused is less. The refrigerating machine oil to be infused is less. Accordingly, even in the case of refrigerant leakage, there is a less chance of danger such as fire ignition or explosion occurring, and the hermetic type compressor having reduced an influence that gives to the environment upon dismantling is provided.

[0017] Further features and aspects of the present invention will become apparent from the following detailed description of exemplary embodiments with reference to the attached drawings.

[0018] The accompanying drawings, which are incorporated in and constitute apart of the specification, illustrate exemplary embodiments, features, and aspects of the invention and, together with the description, serve to explain the principles of the invention.

Fig. 1 schematically shows a longitudinal section of the hermetic type compressor 100, in accordance with the first embodiment.

Fig. 2 illustrates a longitudinal section of the essential parts of the hermetic type compressor 100, in accordance with the first embodiment.

Fig. 3 schematically shows a longitudinal section of the hermetic type compressor 100, in accordance with the second embodiment.

[0019] Various exemplary embodiments, features, and aspects of the invention will be described in detail below with reference to the drawings.

First Embodiment

[0020] Figs. 1 and 2 illustrate the first embodiment. Fig. 1 schematically shows the longitudinal section of the hermetic type compressor 100. Fig. 2 shows the longitudinal section of the essential parts of the hermetic type compressor 100.

[0021] The hermetic type compressor 100 will be described with reference to Fig. 1. The hermetic type compressor 100 is described by using the rotary compressor as one example. However, besides the rotary compressor, it is also applicable to a scroll compressor. The hermetic type compressor 100 stores a compressing mechanism portion 20 and an electric motor 10 for driving the compressing mechanism portion 20, inside the hermetic compressor 1.

[0022] The electric motor 10 includes a stator 2 and a rotor 3 that rotates at an inner side of the stator 2. An electric power is supplied to the stator 2 from a glass terminal 30. As the electric motor 10, a brushless DC motor, an induction electric motor, or the like, is normally used.

[0023] The compressingmechanismportion 20 includes a cylinder 16. An outer peripheral part of the cylinder 16 is fixed to an inner wall of the hermetic container 1. Inside the cylinder 16, there is a space in which both end faces are opened in the axial direction. A rolling piston 7 is stored in this space. The rolling piston 7 is fitted to an eccentric axis 6a of the crankshaft 6, for eccentric revolution inside the cylinder 16.

[0024] One of the opening part of the cylinder 16 (the electric motor 10 side) is blocked by a frame 5. The frame 5 is also called an upper bearing, and supports the crankshaft 6.

[0025] Another opening part of the cylinder 16 is blocked by a cylinder head 4. The cylinder head 4 is also called a lower bearing, and supports the crankshaft 6.

[0026] A vane is slidably incorporated to a groove (not illustrated) of the cylinder 16, to separate a high-pressure side and a low-pressure side of the compression room by regularly contacting an outer periphery of the rolling piston 7.

[0027] A refrigerating machine oil 40 is collected at the bottom part of the hermetic container 1, which is to be guided to an inside of the rolling piston 7 via inside of the crankshaft 6.

[0028] Moreover, a suction muffler 22 is fixed to an outside of the hermetic container 1. A refrigerant gas (lower pressure and low temperature) is absorbed from the refrigerant circuit (not illustrated) through an absorbing pipe 23 installed at an upper part of the suction muffler 22. The absorption gas is supplied to the compression room of the compressing mechanism portion 20 via a lower connection pipe 24 installed at a lower end of the suction muffler 22.

[0029] A high temperature and high pressure discharge gas compressed at the compressing mechanism portion 20 is discharged inside the hermetic container 1, and released to the refrigerant circuit (not illustrated) from a discharge pipe 25, afterpassing through the electric motor 10.

[0030] A relationship between the inner diameter of the cylinder D and the compression efficiency, and a relationship between the height of the cylinder H and the compression efficiency are described. The compression efficiency of the hermetic type compressor 100, that is, a ratio of an actual refrigerating capacity to a theoretical refrigerating capacity declines in a compressing step of the hermetic type compressor 100. This is because the actual refrigerating capacity declines if the amount of refrigerant gas leaking from a high-pressure side to a low-pressure side increases. The amount of refrigerant leaking from the high-pressure side to the lower-pressure side in this compressing step is proportional to the height of the cylinder.

[0031] That is, if the cylinder height is low, a flow area of the refrigerant gas leaking from the high-pressure side to the low-pressure side is reduced by that amount, and the decline in the refrigerating capacity is eased. Due to this, as for the conventional compressor, in many cases, a value which divides the inner diameter D of the cylinder by the height H of the cylinder is 1.6 and more.

[0032] Hence, the inner diameter of the cylinder is increased, the inner diameter D of the bottom part of the hermetic container 1 where the refrigerating machine oil 40 is stored for supplying to the compressing mechanism portion 20 is also increased. An amount of the refrigerating machine oil to be infused becomes large if attempt to secure a fixed oil level.

[0033] The HC refrigerant shows an extremely high solubility to the refrigerating machine oil 40 that is generally being used today. The HC refrigerant readily dissolves in the refrigerating machine oil 40. Responding to the amount of the refrigerating machine oil 40 inside the hermetic type compressor 100 , the amount of refrigerant to be infused must also be infused by an extra amount of the refrigerant dissolving to the refrigerating machine oil 40.

[0034] In case of using the HC refrigerant to the refrigerant circuit, if the refrigerant leaks, there is a danger of fire ignition or explosion due to the inflammable property of the refrigerant. Accordingly, it is ideal to decrease the amount of refrigerant to be infused into the refrigerant circuit in order to reduce such dangers. If the amount of refrigerant to be infused is large, this also increases a chance of the danger such as fire ignition or explosion.

[0035] Moreover, upon disposing the hermetic type compressor 100, after dismantling, the scrapes are classified into iron, aluminum and copper for recycling, however, the refrigerating machine oil 40 has no recycle utility, therefore, it must be discarded. Hence, if the amount of refrigerating machine oil 40 to be infused is large, the amount of refrigerating machine oil 40 to be discarded gets also large, therefore, the effect that gives on the environment is intense.

[0036] In the present embodiment, for preventing such inconveniences, D/H is set to more than 0.5 and less than 1.6, which is a value that divides the inner diameter D of the cylinder 16 by the height of the cylinder. Therefore, the cylinder 16 has an elongated shape, and the inner diameter D of the cylinder is not increased, and the inner diameter of the hermetic container 1 is also not increased.

[0037] As described above, according to the present embodiment, a safe hermetic type compressor is provided, for the cylinder having the inner diameter D and the height H, D/H is set to more than 0.5 and less than 1.6. Based on this, even in a case of increasing the geometric displacement capacity, the cylinder shape is elongated without increasing the inner diameter of the cylinder, and the inner diameter D of the hermetic container 1 is not increased. The amount of the refrigerant to be infused is less. The refrigerant machine oil to be infused is also less. Accordingly, even in the case of refrigerant leakage, there is a less chance of danger such as fire ignition or explosion occurring, and the hermetic type compressor having reduced an influence that gives to the environment upon dismantling is provided.

Second Embodiment

[0038] Fig. 3 illustrates the second embodiment. Fig. 3 schematically shows a longitudinal section of the hermetic type compressor 100.

[0039] Aconfigurationof the hermetic type compressor 100 shown in Fig. 3, except for the points indicated below, is the same as the hermetic type compressor 100 of Fig. 1.

(1) An outer diameter Dm of the electric motor 10 is less than an outer diameter Dc of the compressing mechanism portion 20.

(2) Accompanied by the above point, an inner diameter of a part 1a covering the electric motor 10 of the hermetic container 1 is less than an inner diameter of a part 1b covering the compressing mechanism portion 20 of the hermetic container 1.

[0040] The electric motor 10 is fitted and fixed to the inner periphery of the hermetic container 1 by shrink fitting the electric motor 10.

[0041] An output of the electric motor 10 of the hermetic type compressor 100 is described herein. In a normal hermetic type compressor 100, even if a refrigerant in use has changed, in terms of restriction inproduction facility, the same compressing mechanism portion 20 and the electric motor 10 are used in most cases.

[0042] Conventionally, the R410A refrigerant had been used in air conditioners. If the HC refrigerant is used instead of the R410A refrigerant, given that the geometric displacement of the compressing mechanism portions 20 are identical, its refrigerating capacity declines down to about 10%, owing to the properties of the refrigerant. Herein, the geometric displacement is a geometrical volume to be displaced per 1 rotation of the hermetic type compressor 100.

[0043] For example, provided that an output of the electric motor 10 is A when the R410A refrigerant is being used, if the hermetic type compressor 100 using the HC refrigerant at the identical geometric displacement is produced, the required output generated by the electric motor 10 at that time is 10% less than the conventional output, 0.9 X A, and a difference 0.1 X A becomes an excess.

[0044] In order to decrease the excess output of this electric motor 10, the outer diameter Dm of the electric motor 10 is decreased, which is made smaller than the outer diameter Dc of the compressing mechanism portion 20. In other words,the output of the electric motor 10 is adjusted by reducing the capacity, that is, by decreasing an outer diameter of the core 2a used by the electric motor 10. In this case, a length in the axial direction of the core 2a (the core width) is fixed.

[0045] The output of the electric motor 10 is assumed to be proportional to a volume of the core 2a (all of the stators and rotors). Since the core width is fixed, if the required output generated by the electric motor 10 is 10% less than the conventional output, 0.9 X A, then the outer diameter of the electric motor 10 can be decreased to $\sqrt{0.9} \fallingdotseq 0.95$Dm. Since the outer diameter of the electric motor 10 is the same as the inner diameter of the hermetic container 1 of the part 1b covering the electric motor 10, the inner diameter of the hermetic container 1 of the part 1b covering the electric motor 10 can be decreased down to approximately 5%. In this way, the inner capacity of the hermetic container 1 is decreased.

[0046] Then, by reducing the inner space volume of the hermetic container 1, a highly-pressurized space is reduced, and the amount of refrigerant to be infused into the refrigerant circuit can be reduced.

[0047] As described above, the second embodiment has the following effects. That is, since the outer diameter Dm of the electric motor 10 is reduced with respect to the outer diameter Dc of the compressing mechanism portion 20, the space volume of the hermetic container 1 is reduced, and thereby decreasing the amount of refrigerant to be infused. Thus, even if a highly inflammable refrigerant is being used, there is a less chance of danger such as fire ignition or explosion occurring upon the refrigerant leakage, and a safe hermetic type compressor 100 is effectively obtained.

[0048] In the patent document 1, as shown in page 7, Fig. 2, the container covering the compressing mechanism portion, the container covering the electric motor, and the container covering the heat source side pump are separately configured. Furthermore, inside the electric motor, the stators are separated by the cans. The main refrigerant having the toxic and inflammable properties does not exist at a stator area. Accordingly, the amount of the main refrigerant having the toxic and inflammable properties cannot be decreased even if the electric motor is reduced.

Third Embodiment

[0049] In the second embodiment, the outer diameter Dm of the electric motor 10 is reduced with respect to the outer diameter Dc of the compressing mechanism portion 20. However, in the present embodiment, in order to reduce the excessive output of the electric motor 10,

a width of the core 2a of the electric motor 10 (the length in the axial direction) of the present embodiment is reduced with respect to a width of the core 2a of the electric motor 10 being set to the conventional refrigerant such as R410A. The output of the electric motor 10 of the present embodiment is adjusted by decreasing the volume of the core 2a, which is used by the electric motor 10. Accordingly, a height of the hermetic container 1 that covers the electric motor 10 is lowered. In this way, the inner volume of the hermetic container 1 is reduced.

[0050] An output of the electric motor 10 is assumed to be proportional to the volume of the core 2a (all of the stators and rotors). Since the outer diameter of the electric motor 10 is fixed, if the required output generated by the electric motor 10 is 10% less than the conventional output, 0.9 X A, then a core width H of the electric motor 10 can also be decreased to 0.9H.

[0051] Then, by reducing the inner space volume of the hermetic container 1, the highly-pressurized space is reduced, and the amount of refrigerant to be infused into the refrigerant circuit can be decreased.

[0052] According to the present embodiment, the following effects will be exhibited. That is, the width of the core 2a of the electric motor 10 is reduced with respect to the width of the core 2a of the electric motor 10 set for the conventional refrigerant such as R410A. Therefore, a space volume inside of the hermetic container 1 can be reduced, and thereby decreasing the amount of refrigerant to be infused. Thus, even if a highly inflammable refrigerant is being used, there is a less chance of the danger such as fire ignition or explosion occurring upon the refrigerant leakage, and a safe hermetic compressor 100 is effectively obtained.

[0053] Further, the hermetic type compressor 100 can be configured by combining the first, second and third embodiments.

[0054] While the present invention has been described with reference to exemplary embodiments, it is to be understood that the invention is not limited to the disclosed exemplary embodiments. The scope of the following claims is to be accorded the broadest interpretation so as to encompass all modifications, equivalent structures, and functions.

Claims

1. A hermetic type compressor using the HC (hydrocarbon) refrigerant comprising, in a hermetic container (1), a compressing mechanism portion (20) for compressing the refrigerant and an electric motor (10) for driving the compressing mechanism portion (20), and performing compression of the refrigerant continuously by dividing a compression room with a vane into a high-pressure room and a low-pressure room;
wherein the compression room is composed of a cylinder (16) that disposes therein a rolling piston (7) fitted to an eccentric axis of the crankshaft (6) rotated by the electric motor (10) and a cylinder head (4) and a frame (5) that block both ends of the cylinder (16) in an axial direction;
wherein the electric motor (10) is fitted and fixed to an inner peripheral plane of the hermetic container (1);
wherein an outer diameter of the electric motor (10) is less than an outer diameter of the compressing mechanism portion (20); and
wherein an inner diameter D of the cylinder/a height H of the cylinder (16) (D/H) is set to more than 0.5 and less than 0.6.

Fig. 1

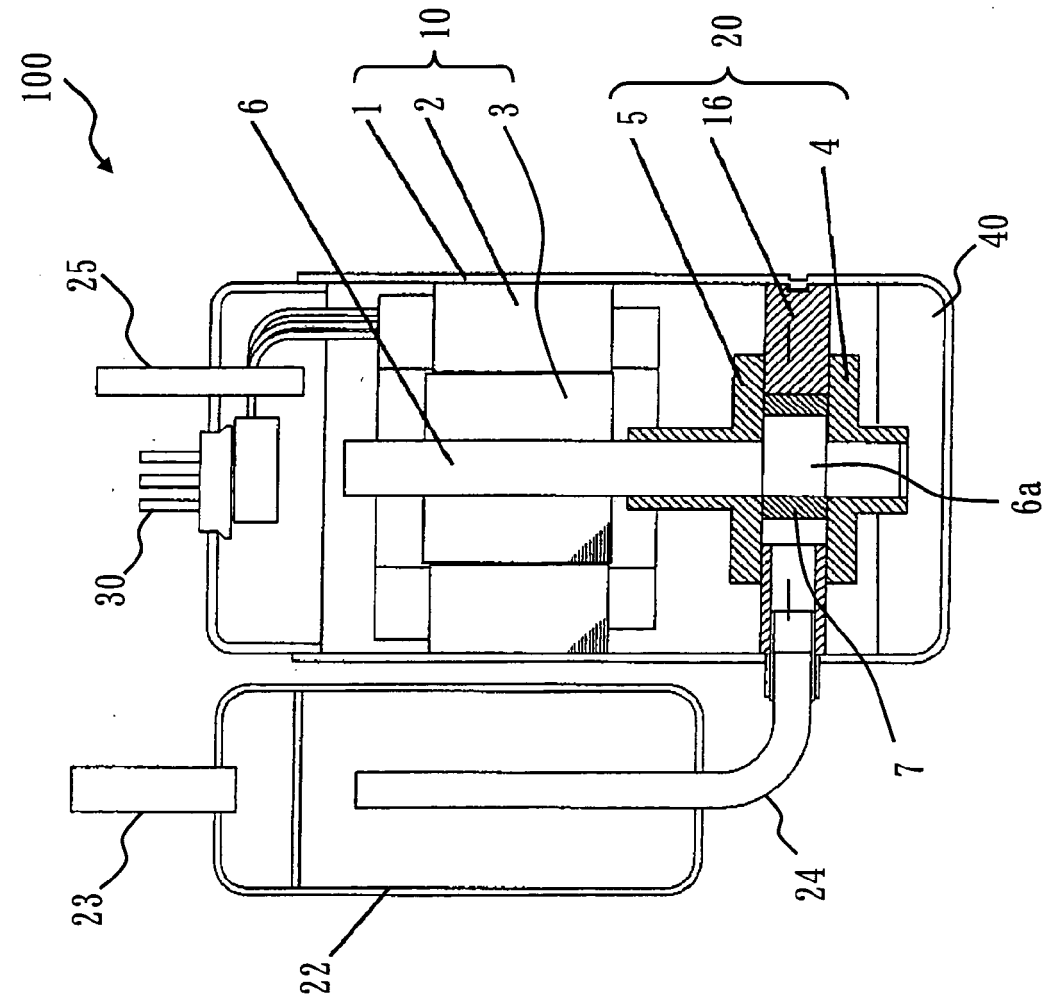


Fig. 2

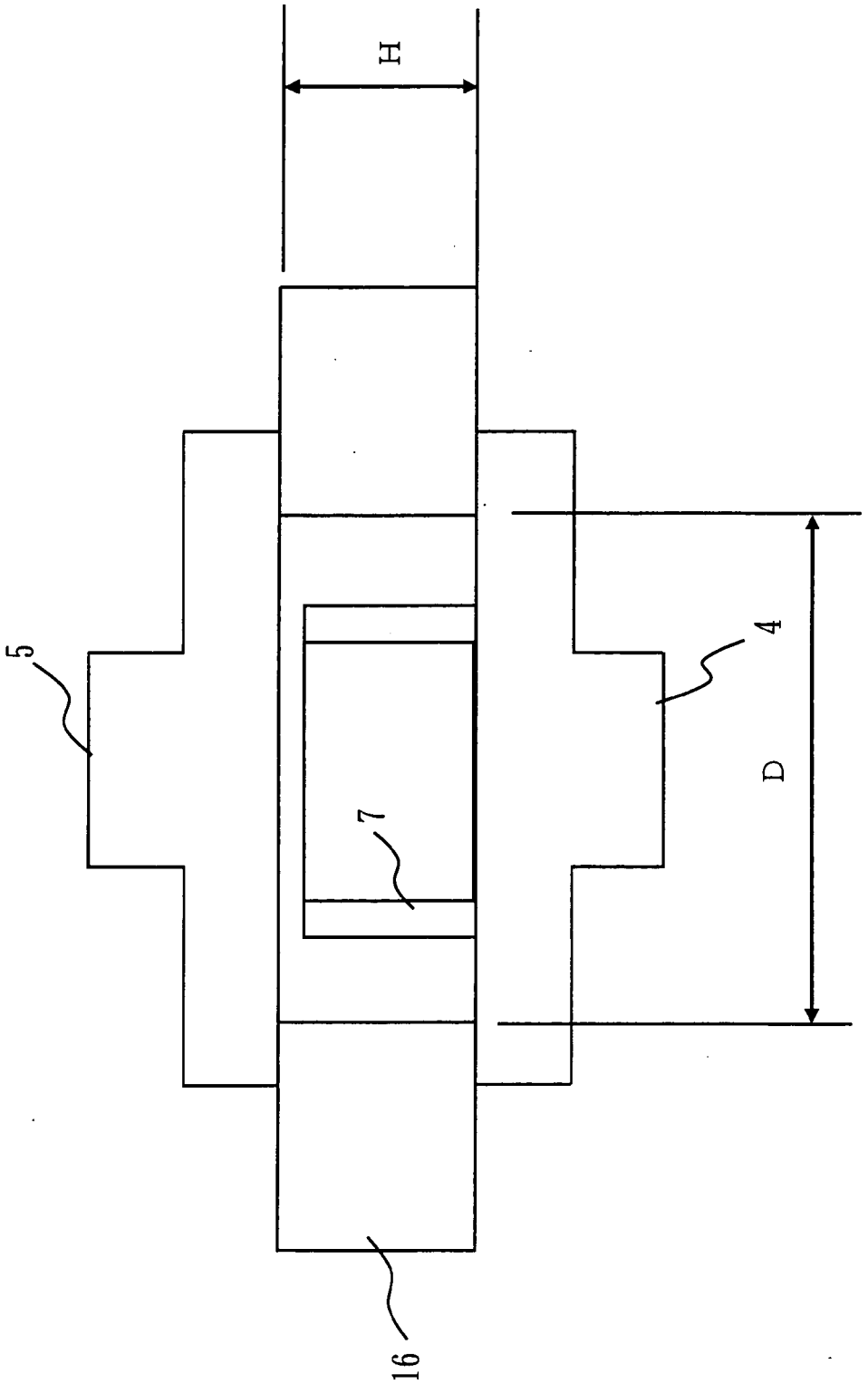
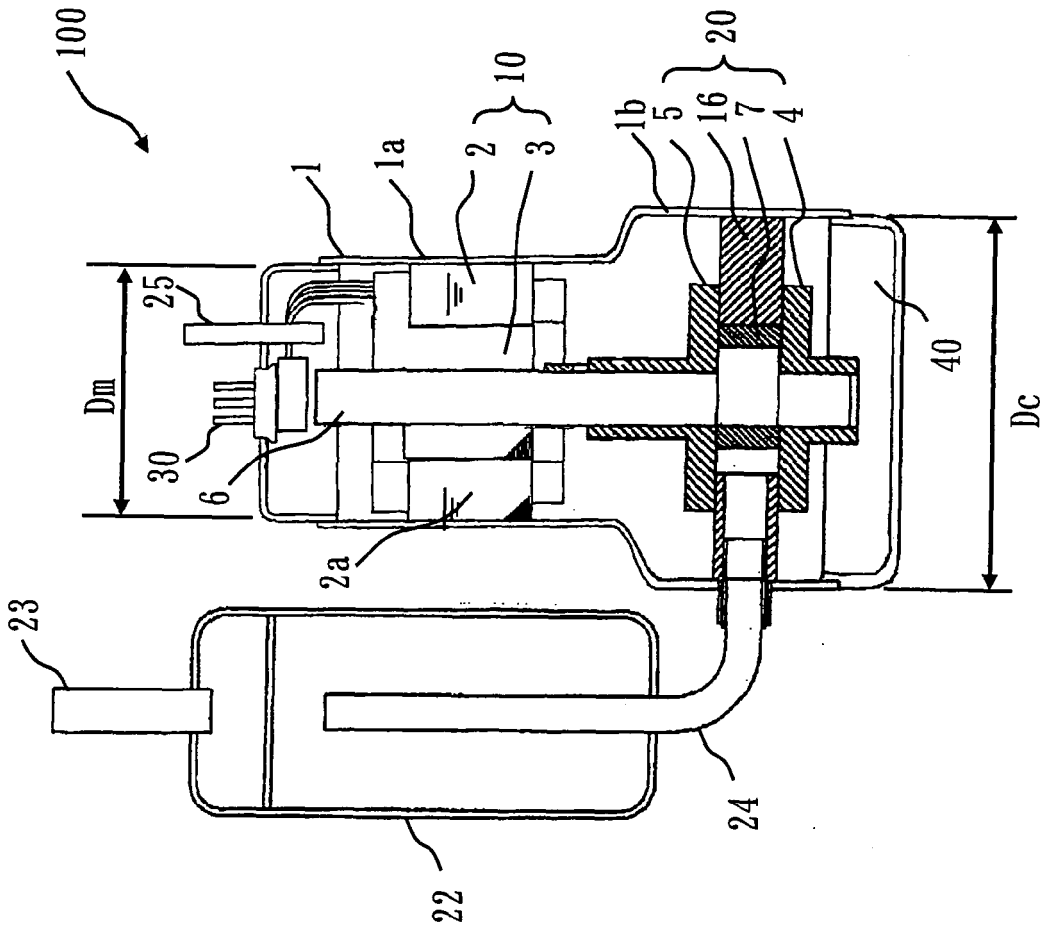


Fig. 3



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