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(54) ROTARY COMPRESSOR AND AIR CONDITIONER HAVING THE SAME

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(57) **ABSTRACT**

A rotary compressor is provided which uses a synchronous reluctance motor to provide a driving force. The motor includes a rotor and a stator, each formed by a respective plurality of laminated steel plates. A plurality of magnetic flux barriers are formed on the steel plates which form the rotor, and a crystalline plastic film is disposed between the stator and a coil of the driving motor, the coil being implemented by an enamel coating layer. Accordingly, deformation of the rotor is decreased when the driving motor is assembled, and degradation of compressor performance due to slippage between the rotor and the stator is decreased, and heat emission of the rotor is decreased.

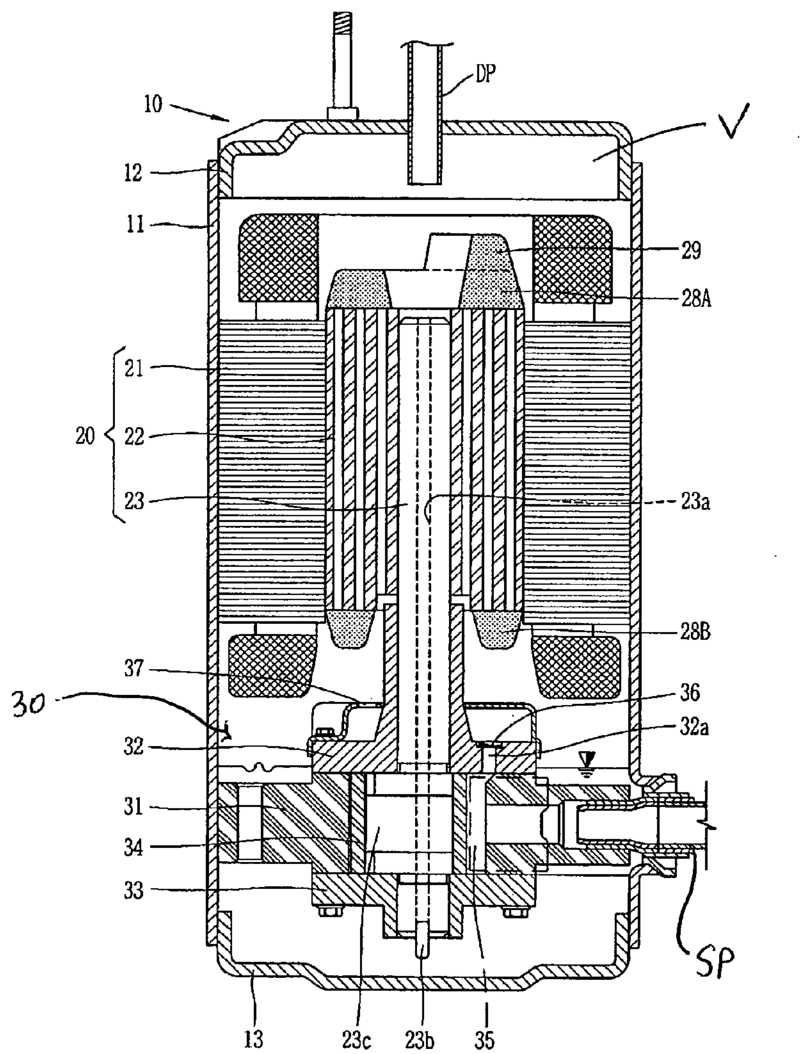
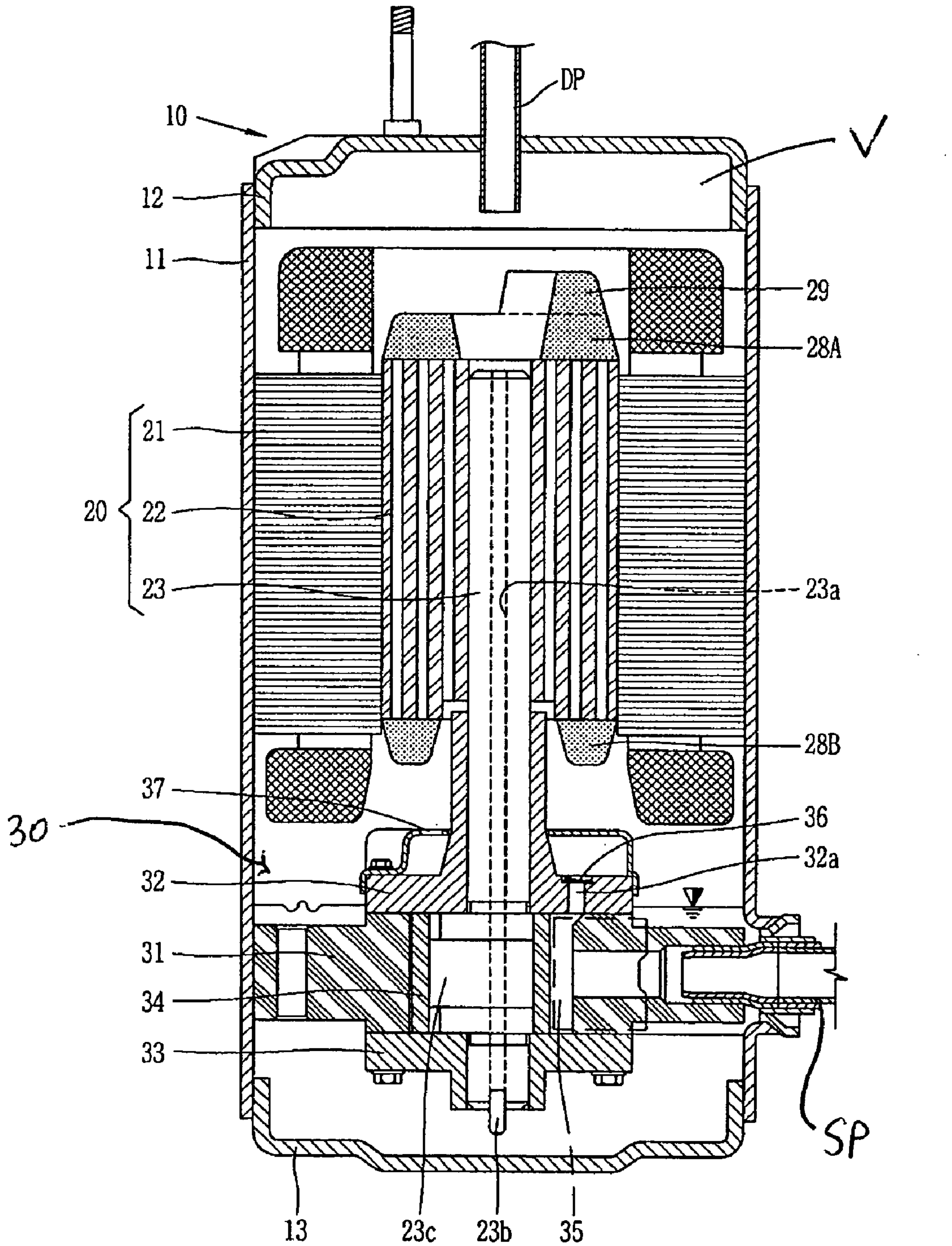


FIG. 1


DP
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V
12
11
29
28A
21
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22
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SP
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23c
23b
35

FIG. 2

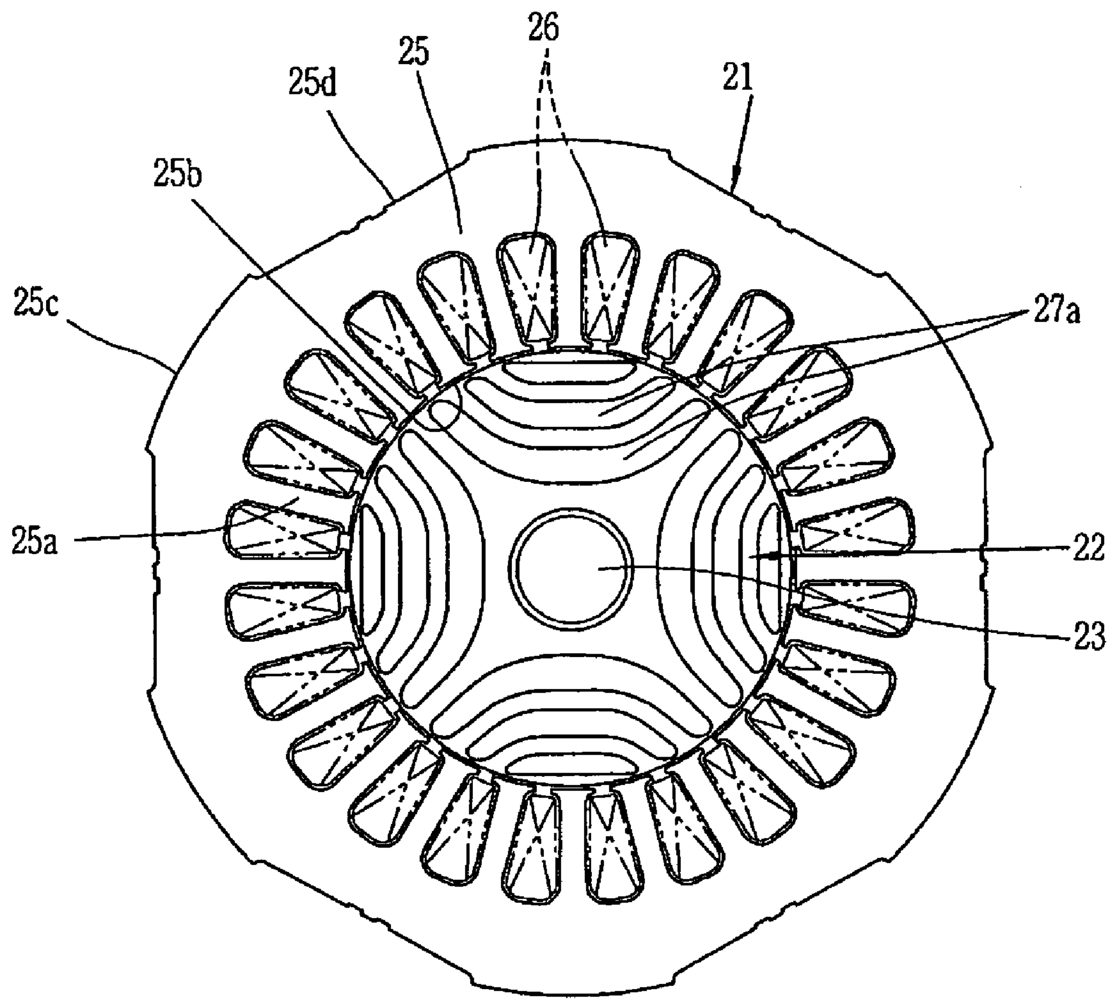


FIG. 3

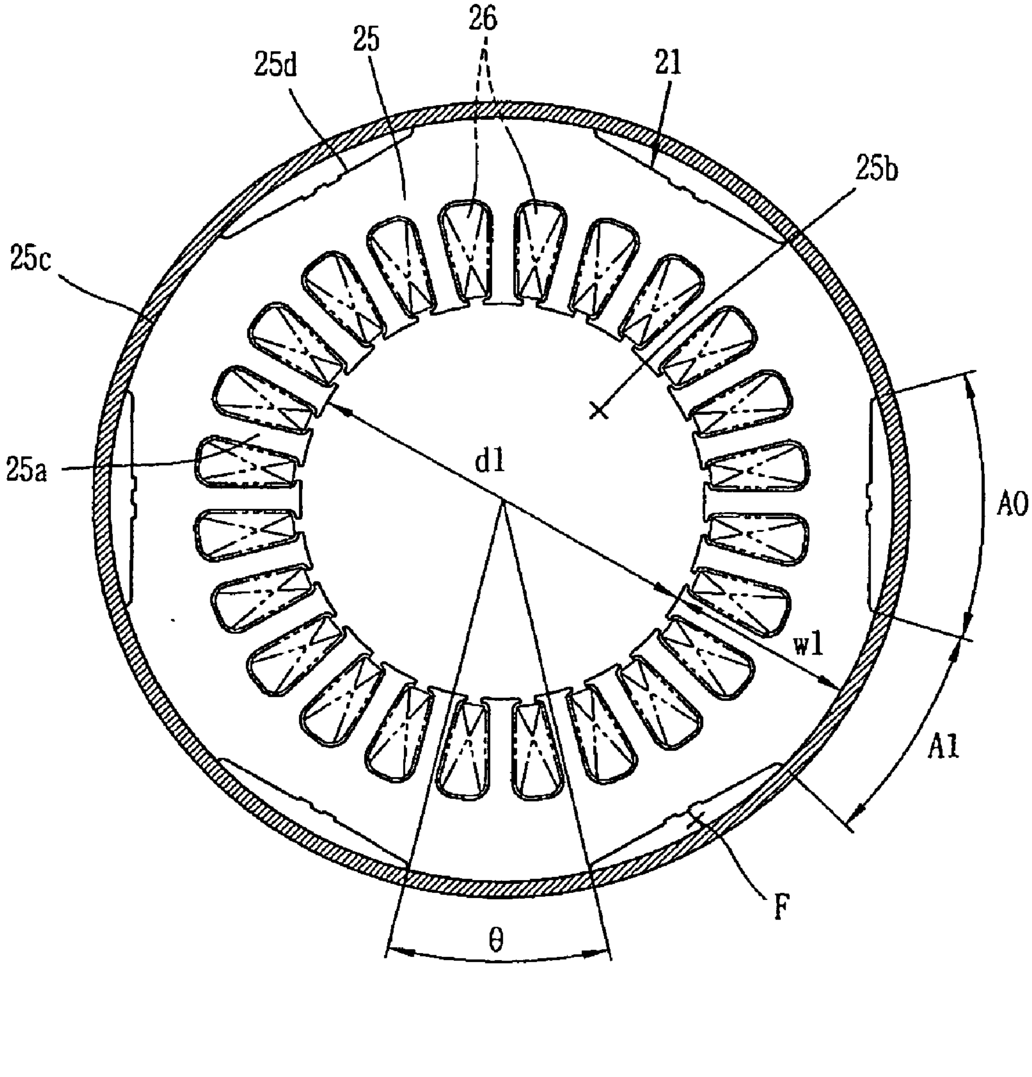


FIG. 4

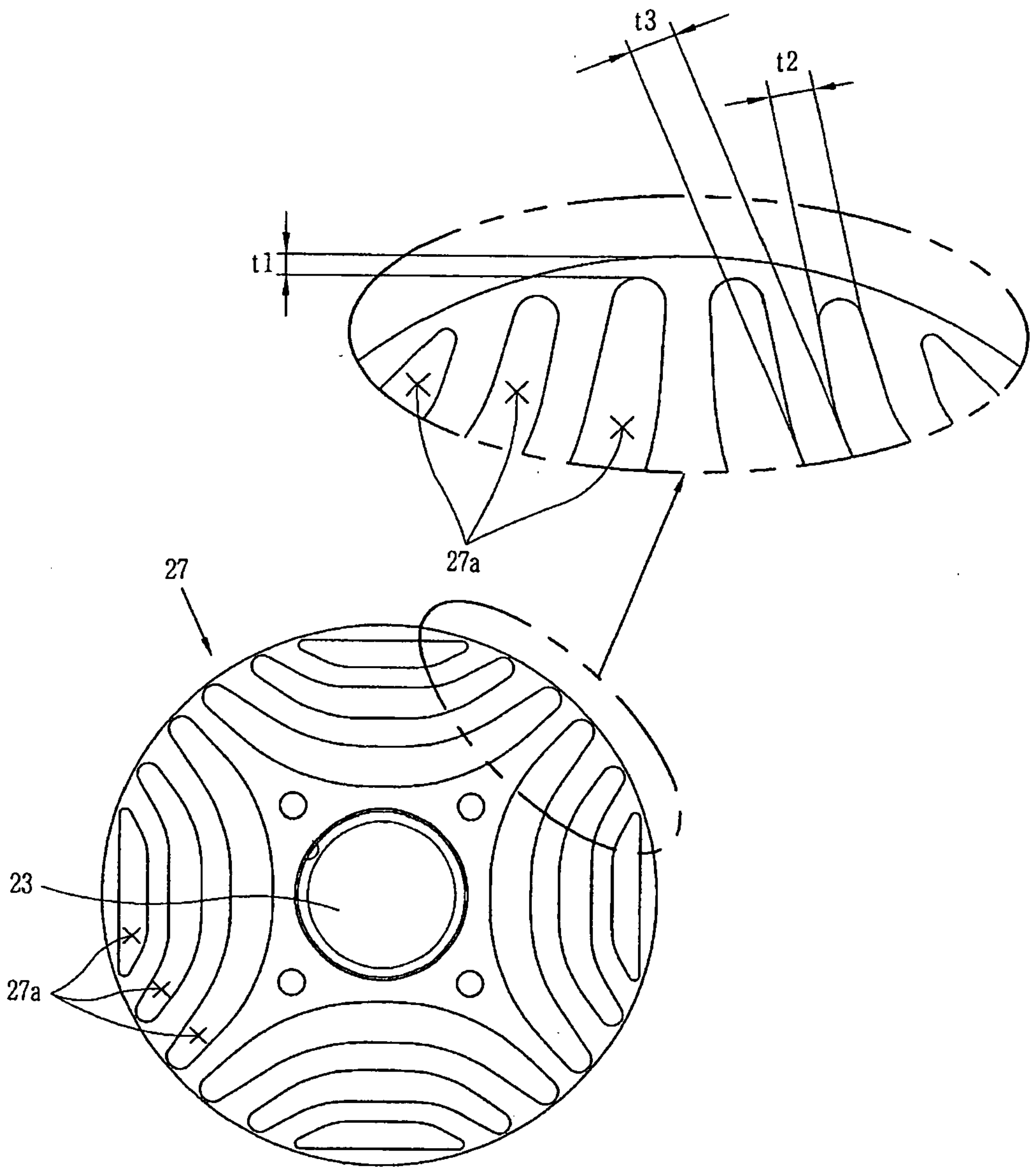


FIG. 5

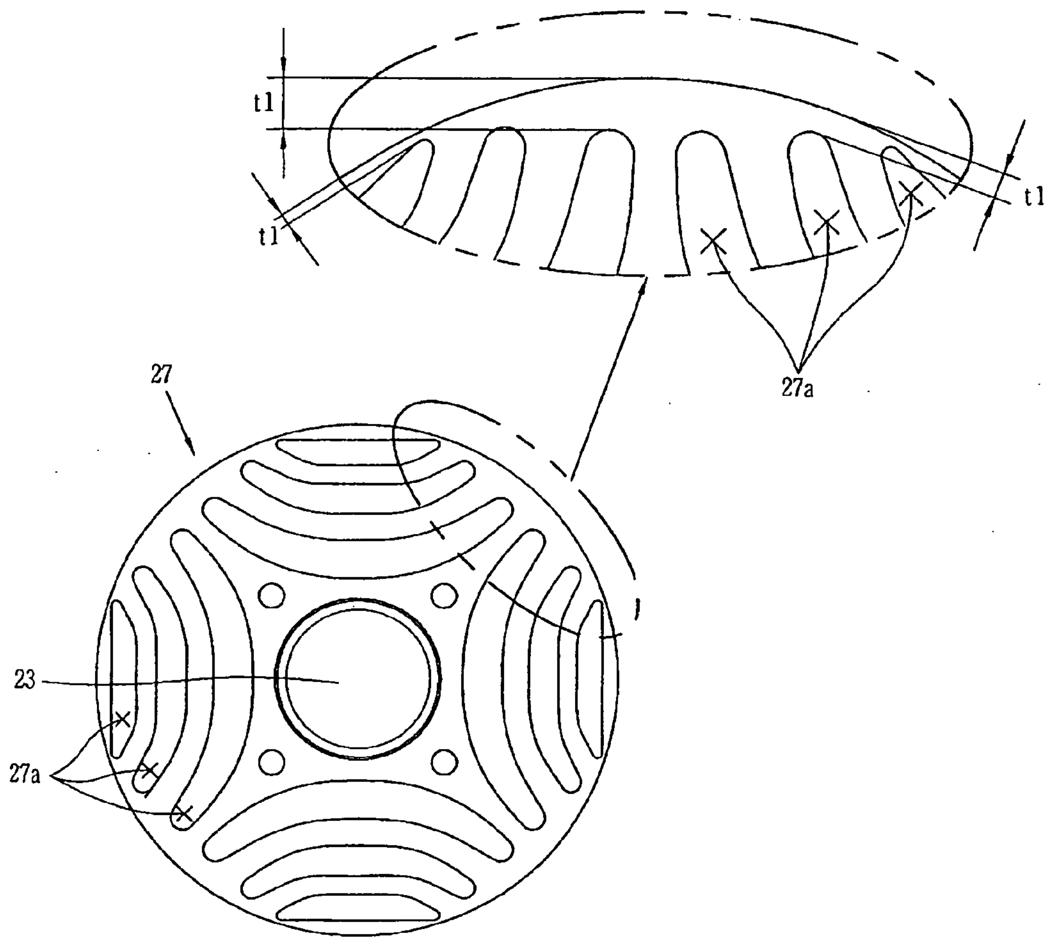


FIG. 6

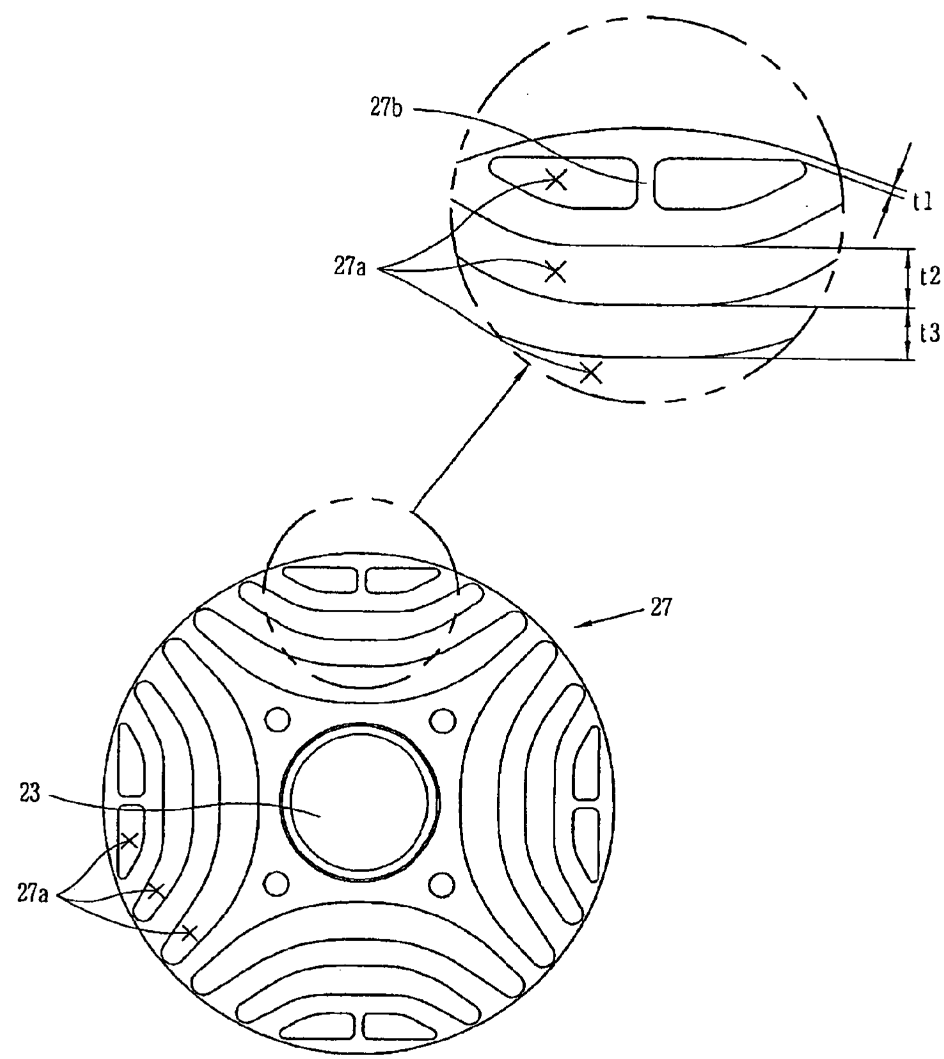


FIG. 7

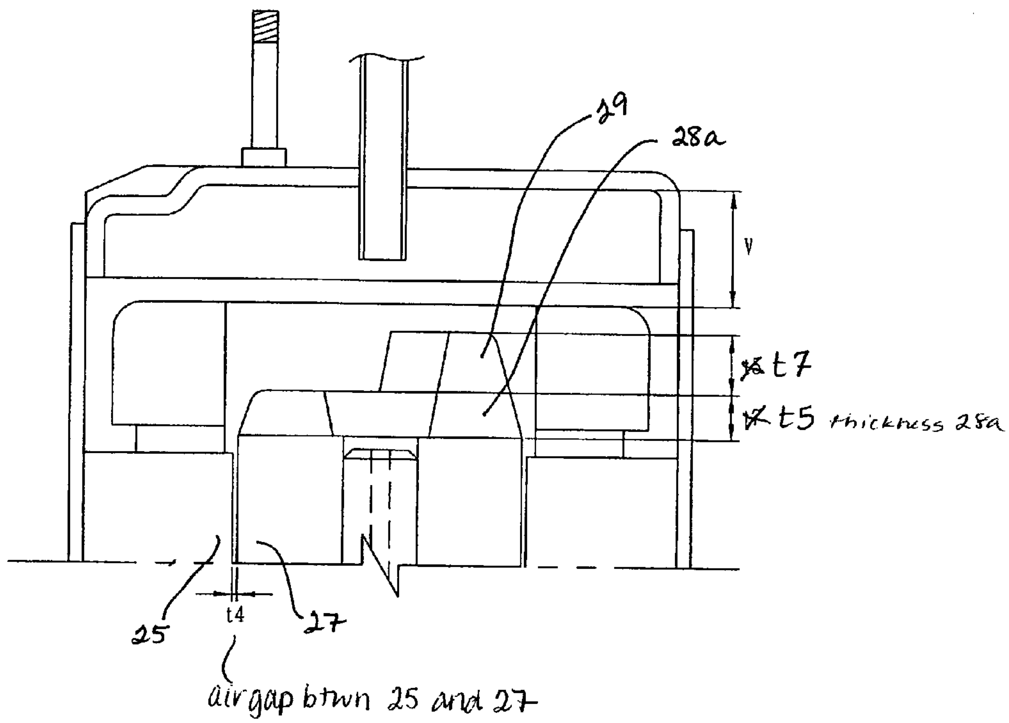


FIG. 8

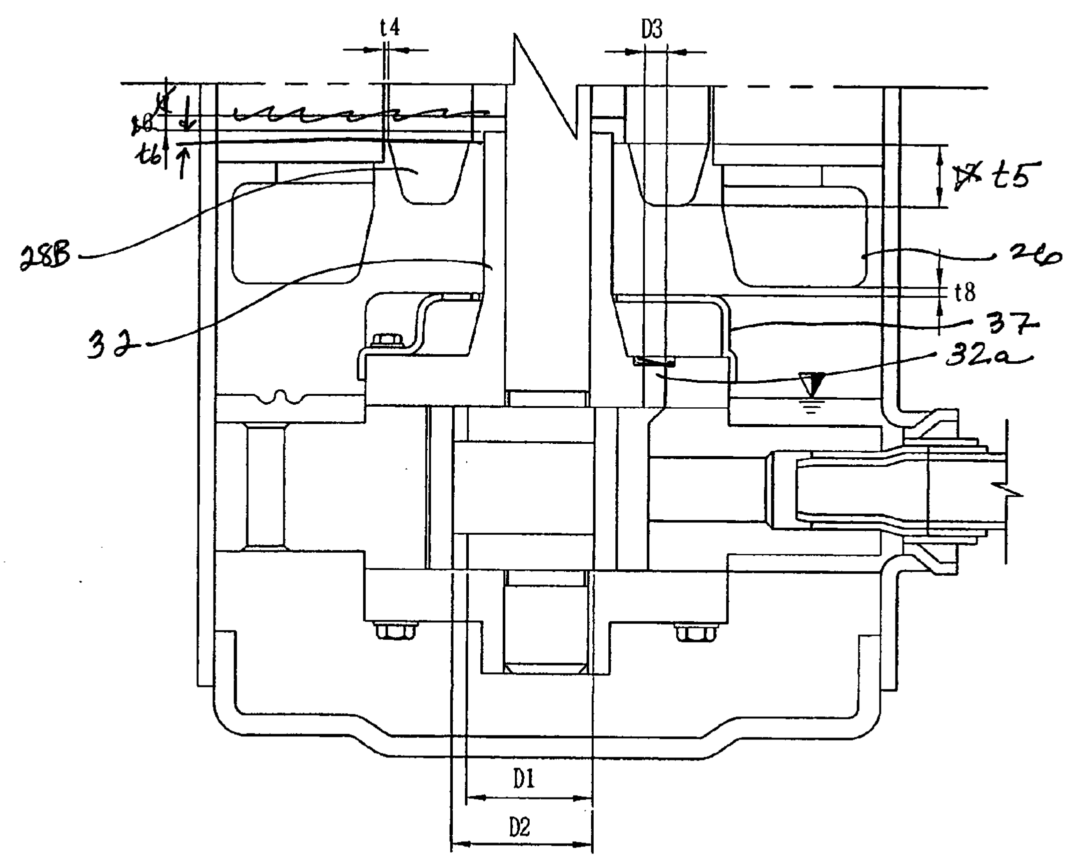


FIG. 9

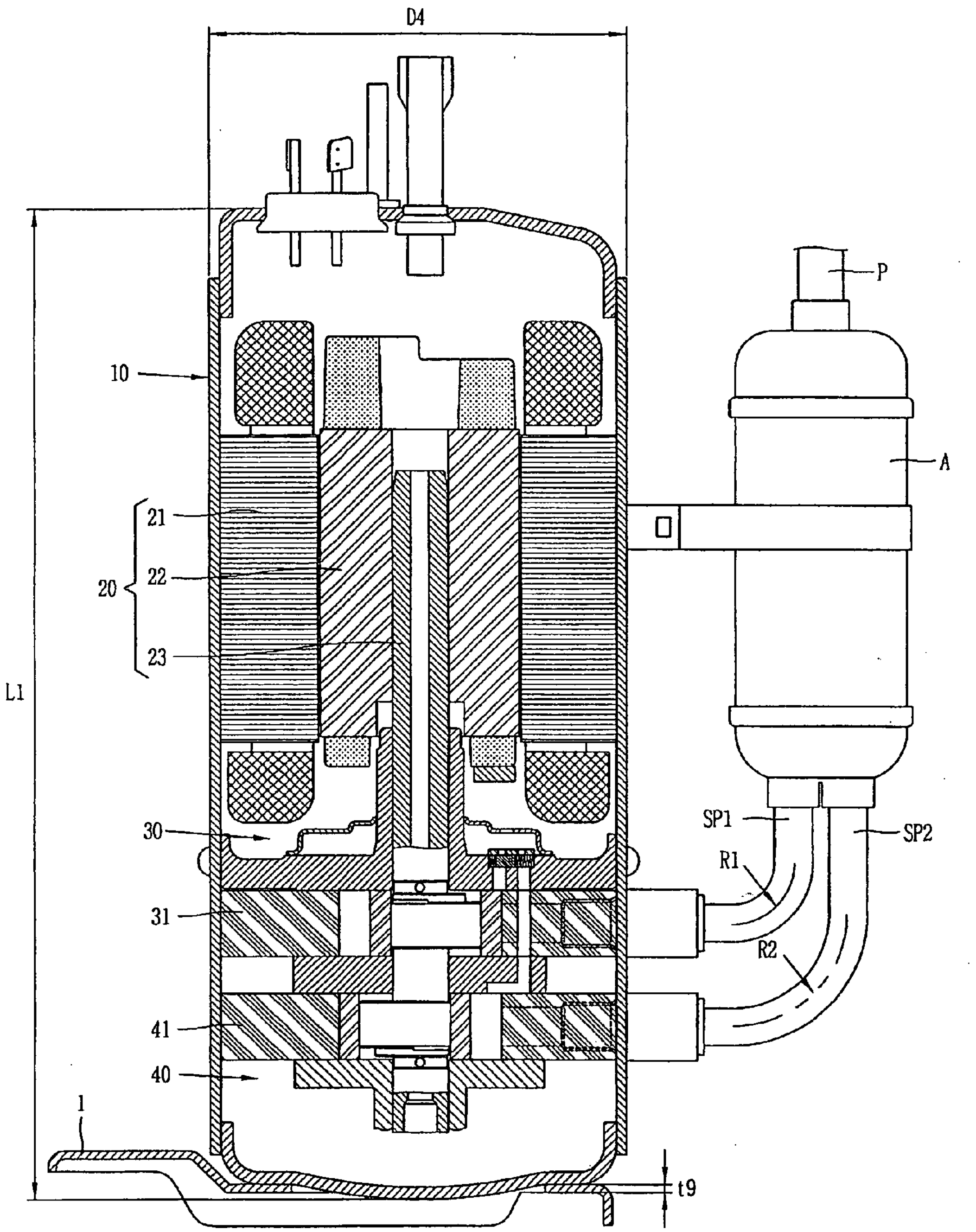
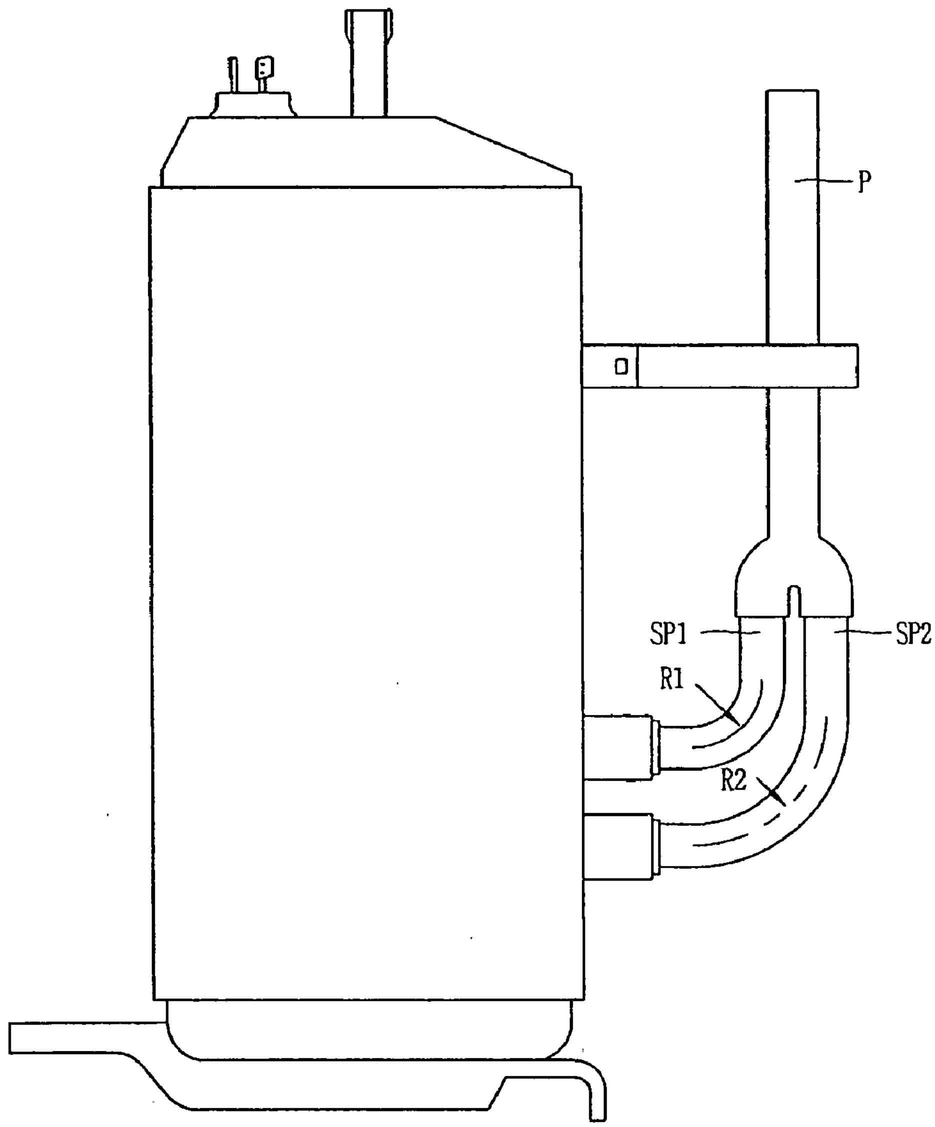


FIG. 10



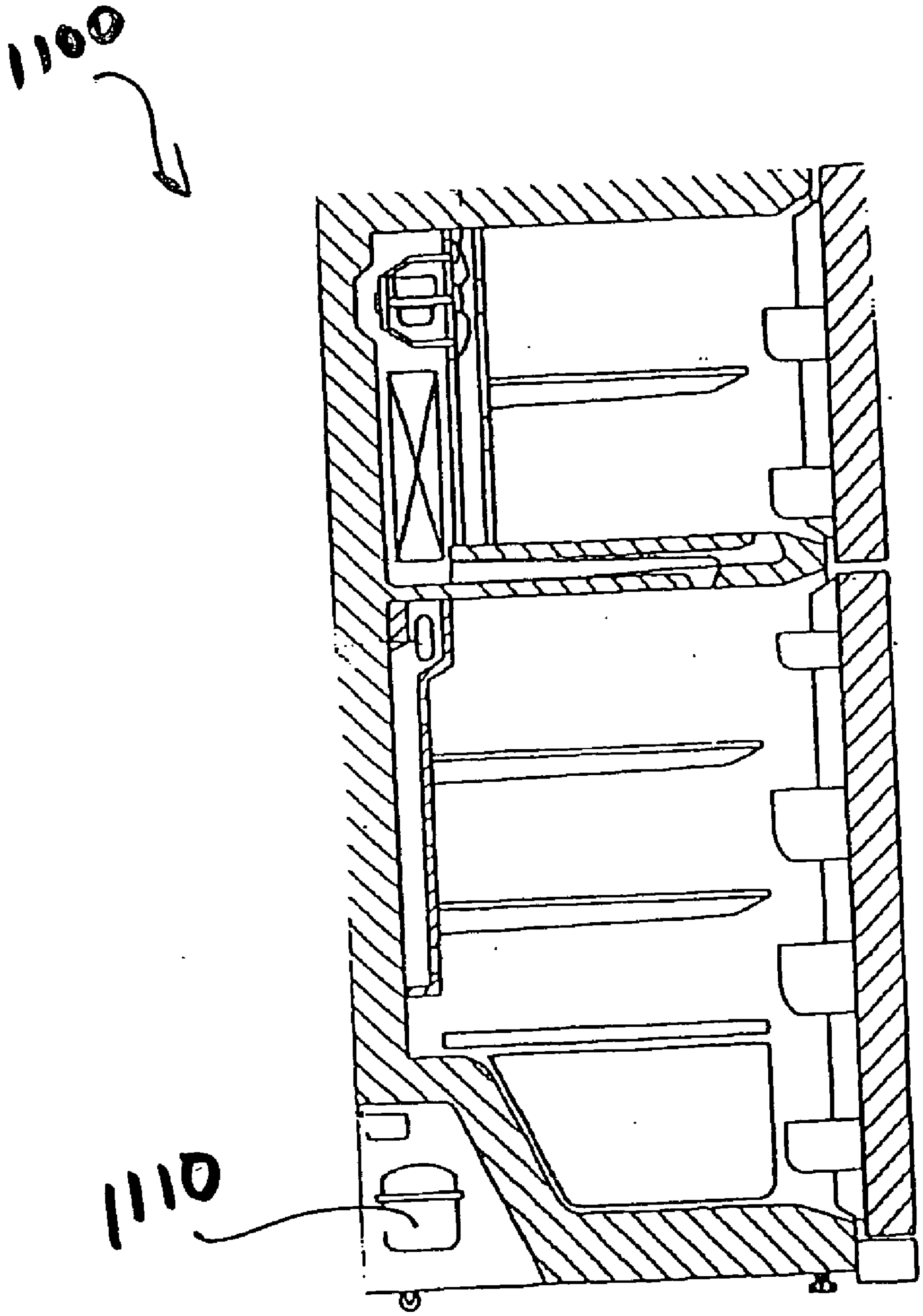
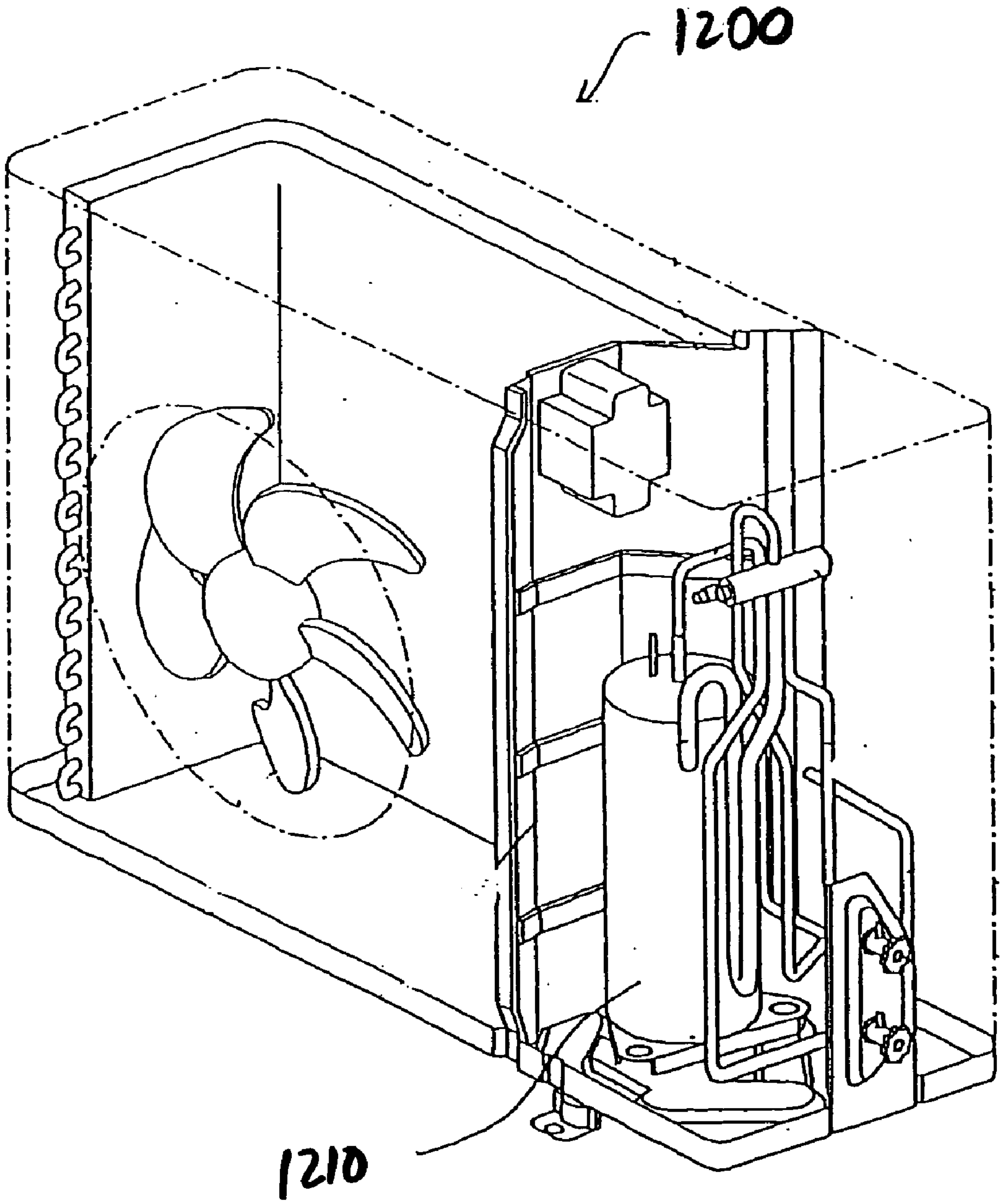


FIG. 11

FIG. 12



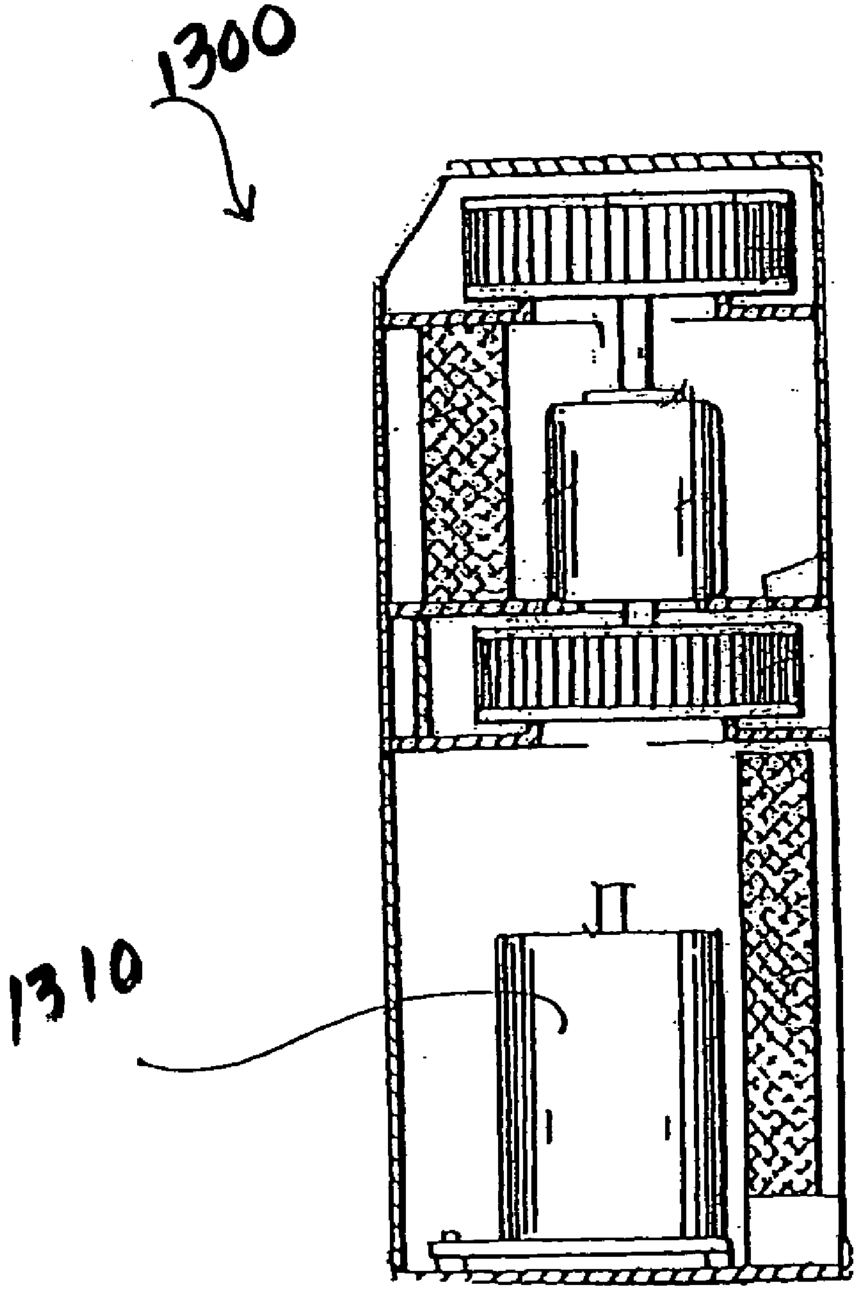


FIG. 13

ROTARY COMPRESSOR AND AIR CONDITIONER HAVING THE SAME

BACKGROUND

[0001] 1. Field

[0002] The field relates to a compressor, and more particularly, to a rotary compressor and an air conditioner having the same.

[0003] 2. Background

[0004] In general, a compressor converts mechanical energy into compressive energy. Compressors may typically be categorized into a reciprocating type, a scroll type, a centrifugal type, a rotary type and a vane type. A rotary compressor may be used to, for example, drive a refrigerating cycle such as, for example, in an air conditioner. A rotary compressor may include a driving motor which drives a compression part to compress fluid. The driving motor may be, for example, an induction motor, which has a simple structure, low cost, and is easily handled. However, slippage between the stator and the rotor of a motor can degrade performance in an induction motor. Further, induction current flow into the rotor generates heat, which lowers efficiency due to thermal loss.

[0005] Descriptions of rotary compressors and operation thereof can be found, for example, in U.S. Pat. Nos. 6,336,800, 6,312,233, and 6,250,899, which are subject to an obligation of assignment to the same entity, and the entirety of which is incorporated herein by reference.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] The embodiments will be described in detail with reference to the following drawings in which like reference numerals refer to like elements wherein:

[0007] FIG. **1** is a cross-sectional view of an exemplary rotary compressor having a synchronous reluctance motor as embodied and broadly descried herein;

[0008] FIG. **2** is a cross-sectional view of a synchronous reluctance motor which may be applied to the exemplary rotary compressor shown in FIG. **1**, in accordance with embodiments as broadly described herein;

[0009] FIG. **3** is a cross-sectional view of a stator of synchronous reluctance motor which may be applied to the exemplary rotary compressor shown in FIG. **1**, in accordance with embodiments as broadly described herein;

[0010] FIGS. **4** to **6** are plane views of a rotor of a driving motor which may be applied to the exemplary rotary compressor shown in FIG. **1**, in accordance with embodiments as broadly described herein;

[0011] FIG. **7** is a schematic view of an upper portion of the exemplary rotary compressor shown in FIG. **1**, in accordance with embodiments as broadly described herein;

[0012] FIG. **8** is a schematic view of a lower portion of the rotary compressor shown in FIG. **1**, in accordance with embodiments as broadly described herein;

[0013] FIG. **9** is a cross-sectional view of an exemplary double-type rotary compressor having a synchronous reluctance motor, in accordance with embodiments as broadly described herein;

[0014] FIG. **10** is a front view of a modification of an accumulator of the double-type rotary compressor shown in FIG. **9**, in accordance with embodiments as broadly described herein; and

[0015] FIGS. **11-13** illustrate exemplary installations of a compressor as broadly described herein.

DETAILED DESCRIPTION

[0016] A rotary compressor and components thereof in accordance with embodiments as broadly described herein are shown in FIGS. **1-8**. Although a rotary compressor is presented for ease of discussion, it is well understood that a motor as embodied and broadly described herein may be applied to other types of compressors and/or other applications.

[0017] Some rotary compressors have used a chlorofluorocarbon (CFC)-based refrigerant such as for example, CFC **11**, CFC **12**, CFC **113**, CFC **114**, and CFC **115**. However, the use of these CFC-based refrigerants has been restricted worldwide, and thus HFC-based refrigerants, such as, for example, CFC **134***a* (1,1,1-tetrafluoroethane, CH_2FCF_3) has replaced many of the earlier CFC-based refrigerants. However, since HFC-based refrigerants have different chemical structure, they are not as easily mixed with lubrication fluids, such as, for example, oil, and have inferior abrasion resistance. Accordingly, when an HFC-based refrigerant is used in a compressor, performance of the compressor is degraded.

[0018] The exemplary rotary compressor shown in FIG. **1** includes a hermetic casing **10** to which a refrigerant suction pipe (SP) and a refrigerant discharge pipe (DP) are connected, a driving motor **20** disposed at an upper portion of the casing **10**, and a compression part **30** disposed at a lower portion of the casing **10**. In order to ensure a continuous, adequate supply to oil to friction components of the compressor, oil should be filled in the casting up to a height above a cylinder **31**.

[0019] The casing **10** includes a body **11** having a substantially cylindrical shape, with a driving motor **20** and a compression part **30** provided at upper and lower portions of the casing, and an upper cap **12** and a lower cap **13** which cover upper and lower ends of the body **11**, respectively. A volume (V) from an upper end of the inner circumferential surface of the upper cap **12** to an upper end of the stator of the driving motor **20** is preferably formed to be more than 5000 mm^3, thereby minimizing oil leakage.

[0020] As shown in FIGS. **1** and **2**, the driving motor **20** includes a stator **21** fixed to an inner portion of the casing **10** which receives power from an external source. A rotor **22** is disposed in the stator **21**, with a gap therebetween, and a rotation shaft **23** is coupled to the rotor **22** so as to transmit a rotational force from the driving motor **20** to the compression part **30**. The rotation shaft **23** may be coupled to the rotor **22** by pressfit, shrinkage fit, or other coupling methods as appropriate.

[0021] The stator **21** includes a stator laminator **25** which has a cylindrical shape so as to rotatably position the rotor **22** at the center thereof. A coil **26** is wound on the stator laminator **25** and connected to an external power source. The stator laminator **25** may form a ring shaped magnetic path, with a plurality of protruding poles **25***a* extending from an inner circumferential surface of the magnetic path at equal intervals. In certain embodiments, a distance between an upper end of the stator laminator **25** to a lower surface of an upper bearing plate, or main bearing **32** is approximately 110~140 mm. In certain embodiments, a height difference between a center of a rotor laminator **27** in a shaft direction and a center of the stator laminator **25** in a shaft direction is within the range of −2~3 mm, thereby preventing physical interference between the stator **21** and the rotor **22** due to an eccentric load on the rotation shaft **23**.

[0022] The stator laminator **25** may include a rotor insertion hole **25***b* having a substantially circular shape at its center, with a plurality of protruding fixing portions **25***c* and cut-passages **25***d* alternately formed along an outer circumferential surface of the stator laminator **25** so as to form a gas passage F with the casing **10**. In certain embodiments, the protruding fixing portions **25***c* and the cut-passages **25***d* may be symmetrical with each other, with the same interval therebetween. For example, a circumferential length between the protruding fixing portions **25***c* may be equal to a circumferential length between the cut-passages **25***d* so as to minimize any deformation of the stator laminator **25**.

[0023] As shown in FIG. **3**, a ratio (d**1**/w**1**) between a diameter (d**1**) of the rotor insertion hole **25***b* and a width (w**1**) of the stator laminator **25** may be greater than or equal to 2. Additionally, an angle θ formed between both ends of the protruding fixing portion **25***c* and a center of the stator **21** may be 15°~35°. In certain embodiments, at least two cut-passages **25***d* are formed so that a ratio (QA_0/QA_1) between a sum (QA_0) of a circumferential length of each cut-passage **25***d* and a sum (QA_1) of a circumferential length of each protruding fixing portion **25***c* is 0.2~0.8.

[0024] The coil **26** may be successively wound on each of the protruding poles **25***a* of the stator laminator **25**. The coil **26** may be implemented by forming an enamel coating layer having a separation transition temperature more than approximately 120° C. on an outer circumferential surface of a copper wire. An insulation film formed of, for example, a crystalline plastic film having a separation transition temperature more than approximately 50° C., may be interposed between an outer circumferential surface of the coil **26** and an inner circumferential surface of the stator laminator **25** contacting the coil **26**.

[0025] The rotor **22** includes a rotor laminator **27**. In certain embodiments, the rotor laminator **27** may be formed from a plurality of thin steel plates laminated in a shaft direction, with an upper end plate **28**A and a lower end plate **28**B disposed at upper and lower ends of the rotor laminator **27**, respectively. Each steel plate of the rotor laminator **27** is provided with a shaft hole for insertion of the rotation shaft **23**. In the embodiment shown in FIG. **4**, each steel plate may be provided with a plurality of magnetic flux barriers **27***a* formed in a circumferential direction and a radius direction, each having a substantially circular shape. A width (t**1**) from an outer circumferential surface of the steel plate to each end of the magnetic flux barriers **27***a* is uniform. A width (t**2**) of the magnetic flux barrier **27***a* in the radius direction, and a width (t**3**) between adjacent magnetic flux barriers **27***a* in the radius direction each increase towards the center of the steel plate. As shown in FIGS. **7** and **8**, a gap (t**4**) of approximately 0.4~0.8 mm may be formed between an inner circumferential surface of the stator laminator **25** and an outer circumferential surface of the rotor laminator **27** so as to improve efficiency of the motor **22**. The upper and lower end plates **28***a*, **28***b* are respectively formed to have a thickness (t**5**) of approximately 1~4 mm. Also, a gap (t**6**) between the lower end plate **28**B and an upper end of the main bearing **32** may be 2~6 mm so as to reduce an overall length of the rotor **22** and prevent interference between the stator **21** and the rotor **22** due to an eccentric load on the rotation shaft **23**.

[0026] A balance weight **29** eccentric at a certain angle in a circumferential direction is formed on the upper end plate **28**A, either integrally or at a later point in fabrication. A thickness (t**7**) of the balance weight **29** may be less than two times the thickness (t**5**) of the upper end plate **28**A so as to enhance reliability of the motor **20**.

[0027] The upper and lower end plates **28**A and **28**B may either completely or partially cover the magnetic flux barriers **22***a* of the rotor **22** so as to form a path through the rotor **22** in the upper and lower directions.

[0028] The rotation shaft **23** may have a substantially circular section so as to fit into the shaft hole of the rotor **22**. An oil hole **23***a* penetrates the length of the shaft **23**, with an oil feeder **23***b* disposed at the lowest end of the oil hole **23***a* for drawing oil in from the casing **10**. The rotation shaft **23** may be coupled to the shaft hole of the rotor **22** by numerous methods including, for example shrinkage fit of an outer diameter or shrinkage fit of an inner diameter. Deformation of the outer circumferential surface of the rotor **22**, which in some instances is relatively weak, can be minimized by shrinkage fit of an inner diameter.

[0029] The rotation shaft **23** may include an eccentric portion **23***c* coupled to a rolling piston **34** at a lower outer circumferential surface thereof. In certain embodiments, the eccentric portion **23***c* is formed so that a ratio between a diameter (D**1**) of the shaft without the eccentric portion **23***c* and a diameter (D**2**) of the shaft **23** with the eccentric portion **23***c* can be 16:20~18:30. In certain embodiments, the eccentric portion **23***c* is formed so that an eccentric amount thereof can be within a range of 1.5~5 mm.

[0030] As shown in FIGS. **1** and **8**, the compression part **30** includes a cylinder **31** disposed in the casing **10** and having a ring shape, a main bearing **32** and a sub bearing **33** which cover upper and lower ends of the cylinder **31** to define a compression space and support the rotation shaft **23**, and a rolling piston **34** rotatably coupled to the eccentric portion **23***c* of the rotation shaft **23** so as to compress a refrigerant within the compression space. The compression part **30** also includes a vane **35** coupled to the cylinder **31** so as to be movable in a radius direction of the cylinder **31** and contact an outer circumferential surface of the rolling piston **34**. The vane **35** divides the compression space of the cylinder **31** into a suction chamber and a compression chamber. A discharge valve **36** is coupled to an end of a discharge port **32***a* provided at a middle portion of the main bearing **32** so as to control the flow of refrigerant discharged from the compression chamber, and a muffler **37** is provided on an upper surface of the main bearing **32**.

[0031] In certain embodiments, the cylinder **31** has a ring shape with open upper and lower sides. The main bearing **32** and the sub bearing **33** each include a shaft hole for supporting the rotation shaft **23**, and may have a disc shape to cover the open upper and lower sides of the cylinder **31**. In certain embodiments, the cylinder **31**, the main bearing **32**, and the sub bearing **33** may be formed of gray pig iron, the rolling piston **34** may be formed of an alloy of molybdenum, nickel, and chrome, and the vane **35** may be formed of a high speed steel having undergone a nitriding process, thereby minimizing abrasion of the compression part. Other materials for these components may also be appropriate.

[0032] In certain embodiments, a diameter (D**3**) of the discharge port **32***a* may be approximately 5 mm when a volume of the compression chamber of the cylinder **31** is approximately 6 cc, and approximately 8 mm when the volume of the compression space is approximately 9 cc, thereby allowing for stable discharge of refrigerant. The muffler **37** may be coupled to an upper surface of the main bearing **32** by a bolt or other suitable fastener. For stability, a gap (t**8**) between an upper surface of the muffler **37** and a lower surface of the coil **26** is greater than 3.2 mm.

[0033] Operation of a rotary compressor as embodied and broadly described herein will now be explained.

[0034] When power is supplied to the stator **21** of the driving motor **20** and the rotor **22** is rotated, the rotation shaft **23** rotates to transmit a rotation force to the compression part **30**. The rolling piston **34** rotates eccentrically in the cylinder **31**, and refrigerant is drawn into a suction chamber through a refrigerant suction pipe SP connected to the cylinder **31**. Then, the refrigerant is compressed and discharged into the casing **10** through the discharge port **32***a*.

[0035] In certain embodiments, the driving motor **20** is a synchronous reluctance motor which generates a rotation force by being synchronously rotated by a reluctance torque in a direction such that magnetic resistance is minimized. Accordingly, slippage between the stator **21** and the rotor **22** may be greatly reduced. Additionally, when an induction current flows into the rotor **22**, thermal loss from the rotor **22** may be reduced to enhance efficiency of the motor **20**.

[0036] Oil having acceptable mixture characteristics with a given refrigerant may be used, thereby preventing a 'double-separation' phenomenon in which the refrigerant and the oil are separated from each other at a sliding or friction portion of the compression part **30**. Accordingly, frictional losses and abrasion of the compression part **30** can be reduced.

[0037] In order to ensure a continuous supply of oil to the compression part **30**, oil is filled in the casing **10** to a height higher than the cylinder **31**. An upper space of the casing **10** is established so that the refrigerant and oil discharged from the compression part **30** is not leaked to any portion of the refrigerating cycle after being separated in the inner space of the casing **10**. Accordingly, abrasion of the compression part **30** due to oil leakage can be prevented.

[0038] Further, by minimizing the length of the rotor by sizing the various components and gaps therebetween as discussed above, interference between the stator **21** and the rotor **22** due to an eccentric load the rotation shaft **23** can be prevented.

[0039] In order to ensure that contraction of the stator laminator **25** in the radius direction is uniform if the stator **21** is shrinkage fit into the casing **10**, the stator laminator **25** may be symmetrically formed, and a width of the stator laminator **25** and a length of the protruding fixing portion **25***c* may be sized to maintain a certain strength. Accordingly, the rotor insertion hole **25***b* of the stator laminator **25** maintains a substantially circular shape, and an air gap (t**4**) between the stator **21** and the rotor **22** is uniformly maintained, thereby preventing interference between the rotor **22** and the stator **21**, and enhancing reliability of the driving motor **20** and the compressor.

[0040] The coil **26** may be implemented by forming an enamel coating layer on an outer circumferential surface of a copper wire, thereby preventing a voltage loss due to a hydrolysis, crack, softening, expansion, and breakdown. Also, an insulation film formed of a crystalline plastic film may be interposed between the coil **26** and an inner circumferential surface of the protruding pole **25***a* of the stator **21**, thereby preventing any lowering in strength, tensile characteristics, or electrical insulating characteristics and enhancing reliability of the driving motor **20**.

[0041] As discussed above, in certain embodiments, the rotor laminator **27** has a plurality of steel plates, and each of the magnetic flux barriers **27***a* has the same width (t**1**) from each end thereof to an outer circumferential surface of the steel plate, thereby facilitating fabrication.

[0042] Further, a width (t**2**) of the magnetic flux barrier **27***a* in the radius direction, and a width (t**3**) between adjacent magnetic flux barriers **27***a* in the radius direction are increased towards the center, thereby minimizing deformation of the steel plate when the rotation shaft **23** is shrinkage fit.

[0043] The rotor of the rotary compressor in accordance with another embodiment will now be explained.

[0044] In the aforementioned embodiment shown in FIG. **4**, the width (t**1**) from each end of the magnetic flux barriers **27***a* to an outer circumferential surface of the steel plate is uniform. However, in the embodiment shown in FIG. **5**, the width (t**1**) from each end of the magnetic flux barriers **27***a* to an outer circumferential surface of the steel plate is increased towards the center.

[0045] The rotor of a rotary compressor in accordance with another embodiment will now be explained.

[0046] In the aforementioned embodiments shown in FIGS. **4** and **5**, each of the magnetic flux barriers **27***a* is formed as one through hole. However, in the embodiment shown in FIG. **6**, a bridge **27***b* for connecting an inner surface and an outer surface of the magnetic flux barrier **27***a* in the radius direction is provided. Herein, the width (t**1**) between an end of each of the magnetic flux barriers **27***a* and an outer circumferential surface of the steel plate can be uniform as shown in FIG. **4**, or can be different from each other as shown in FIG. **5**.

[0047] The casing **10**, the driving motor **20**, and the compression part **30** according to the second and third embodiments are similar to those of the first embodiment, and thus their details will be omitted.

[0048] When the width (t**1**) between an end of each of the magnetic flux barriers **27***a* and an outer circumferential surface of the steel plate is increased towards the center as shown in FIG. **5**, or when a bridge **27***b* is formed at a middle portion of each of the magnetic flux barriers **27***a* as shown in FIG. **6**, the strength of the steel plate is enhanced, thus preventing thermal deformation of the steel plate.

[0049] In the preceding discussion, the aforementioned embodiments have been applied to a single rotary compressor having one cylinder. However, these embodiments may also be applied to a double-type rotary compressor as shown, for example, in FIG. **9**. This compressor includes a first cylinder **31** and a second cylinder **41** which may have a first compression part **30** and a second compression part **40**, respectively. Gas suction pipes SP**1** and SP**2** coupled to inlets of the cylinders **31** and **41** may be connected to a refrigeration connection pipe P of the refrigerating cycle through one accumulator A. Alternatively, as shown in FIG. **10**, the gas suction pipes SP**1** and SP**2** may be directly connected to the refrigeration connection pipe P without the accumulator A.

[0050] Each middle portion of the gas suction pipes SP**1** and SP**2** may be bent with different curvatures R**1** and R**2** so as to connect the cylinders **31** and **41** of the compression parts **30** and **40**. In certain embodiments, the curvature R**2** of the second gas suction pipe SP**2** connected to the second compression part **40** far from the accumulator A is greater than the curvature R**1** of the first gas suction pipe SP**1**, thereby enhancing reliability of the gas suction pipe SP**2**.

[0051] In the double-type rotary compressor, the length of the casing **10** may be longer than that of the single rotary compressor. Accordingly, a thickness (t**9**) of the base plate **1** for supporting the casing **10** on an installation surface may be increased. For instance, if a length L**1** of the casing **10** is more than two times of an outer diameter (D**4**), the thickness (t**9**) of the base plate **1** may be 2.6~4.0 mm to lend stability to the compressor.

[0052] When the rotary compressor in accordance with embodiments as broadly described herein is applied to an air conditioner, a thermal loss due to slippage of the driving motor is decreased, thus enhancing the function of the rotary compressor and the air conditioner. Furthermore, losses due to emissions are decreased, thus enhancing the function of the rotary compressor and the air conditioner having the same.

[0053] Further, when an eco-friendly refrigerant is used, oil easily mixed with the eco-friendly refrigerant has improved abrasion resistance and lubricating characteristics. Accordingly, reliability, durability and capacity of the rotary compressor and the air conditioner having the same is improved.

[0054] A compressor having a motor as embodied and broadly described herein has numerous applications in which compression of fluids is required, and in different types of compressors. Such applications may include, for example, air conditioning and refrigeration applications. One such exemplary application is shown in FIG. **11**, in which a compressor **1110** having a motor as embodied and broadly described herein is installed in a refrigerator/freezer **1100**. Installation and functionality of a compressor in a refrigerator is discussed in detail in U.S. Pat. Nos. 7,082,776, 6,955,064, 7,114,345, 7,055,338 and 6,772,601, the entirety of which are incorporated herein by reference.

[0055] Another such exemplary application is shown in FIG. **12**, in which a compressor **1210** having a motor as embodied and broadly described herein is installed in an outdoor unit of an air conditioner **1200**. Installation and functionality of a compressor in a refrigerator is discussed in detail in U.S. Pat. Nos. 7,121,106, 6,868,681, 5,775,120, 6,374,492, 6,962,058, 6,951,628 and 5,947,373, the entirety of which are incorporated herein by reference.

[0056] Another such exemplary application is shown in FIG. **13**, in which a compressor **1300** having a motor as embodied and broadly described herein is installed in a single, integrated air conditioning unit **1300**. Installation and functionality of a compressor in a refrigerator is discussed in detail in U.S. Pat. Nos. 7,032,404, 6,412,298, 7,036,331, 6,588,228, 6,182,460 and 5,775,123, the entirety of which are incorporated herein by reference.

[0057] Likewise, the motor as embodied and broadly described herein is not limited to installation in compressors. Rather, the motor as embodied and broadly described herein may be applied in any situation in which this type of driving force is required and/or advantageous.

[0058] An object is to provide a rotary compressor having a driving motor with high efficiency that is capable of generating less slip between a stator and a rotor, and generating less thermal loss at the rotor, and an air conditioner having the same.

[0059] Another object is to provide a rotary compressor capable of enhancing a function thereof by using an eco-friendly refrigerant and a driving motor of a high efficiency, and an air conditioner having the same.

[0060] Still another object is to provide a rotary compressor capable of enhancing a reliability thereof by using an eco-friendly refrigerant, by using oil easily mixed with the eco-friendly refrigerant, having an excellent abrasion resistance and lubricating characteristic, and not badly influencing on an insulating material, a drying material, etc., by using a driving motor suitable for the eco-friendly refrigerant and the oil, and an air conditioner having the same.

[0061] To achieve these and other advantages and in accordance with embodiments broadly described herein, there is provided a rotary compressor, including a casing having a hermetic inner space for filling a certain amount of oil, and to which gas suction pipe and a gas discharge pipe are connected, a driving motor installed at the inner space of the casing, and synchronously rotated by a reluctance torque in a direction that a magnetic resistance is minimized, at least one cylinder fixed at the inner space of the casing so as to be positioned at one side of the driving motor in a shaft direction, and to which the gas suction pipe is directly connected, for compressing a refrigerant, a plurality of bearing plates covering the cylinder thereby forming a compression space, for supporting a rotation shaft of the driving motor, at least one rolling piston orbit-motioned in the compression space of the cylinder, coupled to an eccentric portion of the rotation shaft, and linearly-contacting an inner circumferential surface of the cylinder, for flowing a refrigerant, and at least one vane contacting the rolling piston, for dividing the compression space into a suction chamber and a compression chamber, wherein a hydro-fluorocarbon (HFC) or hydro-chlorofluorocarbon (HCFC)-based refrigerant is used, wherein fatty acid-ester oil is used in the even of the HFC-based refrigerant, and fatty acid-mineral oil is used in the event of the HCFC-based refrigerant, the fatty-acid ester oil having a viscosity of 2~70 cSt at a temperature of 40° C., having a viscosity of 1~9 cSt at a temperature of 100° C., and ester-coupled in a molecule at least two times, the fatty-acid mineral oil having a viscosity of 32~68 cSt at a temperature of 40° C. and ester-coupled in a molecule at least two times, wherein the driving motor includes a stator formed accordingly as a plurality of steel plates are laminated thus to be inserted into an inner circumferential surface of the casing, the steel plate having a plurality of protruding poles on which a field coil is wound, a rotor formed accordingly as a plurality of steel plates are laminated thus to be rotatably disposed in the stator, the steel plate having a plurality of magnetic flux barriers penetratingly formed in a shaft direction, in which a width of the magnetic flux barrier in a radius direction and a width between the magnetic flux barriers in the radius direction are increased towards the center of the driving motor, and a rotation shaft coupled to the center of the rotor by shrinkage fit thus to be supported by a frame, one end of the rotation shaft is coupled to the orbit scroll, wherein an insulation film formed of a crystalline plastic film having a separation transition temperature more than 50° C. is disposed between the stator of the driving motor and the field coil, and wherein the field coil is implemented by forming an enamel coating layer having a separation transition temperature more than 120° C.

[0062] Any reference in this specification to "one embodiment," "an exemplary," "example embodiment," "certain embodiment," "alternative embodiment," and the like means that a particular feature, structure, or characteristic described in connection with the embodiment is included in at least one embodiment as broadly described herein. The appearances of such phrases in various places in the specification are not necessarily all referring to the same embodiment. Further, when a particular feature, structure, or characteristic is described in connection with any embodiment, it is submitted that it is within the purview of one skilled in the art to effect such feature, structure, or characteristic in connection with other ones of the embodiments.

[0063] Although embodiments have been described with reference to a number of illustrative embodiments thereof, it should be understood that numerous other modifications and embodiments can be devised by those skilled in the art that will fall within the spirit and scope of the principles of this disclosure. More particularly, numerous variations and modifications are possible in the component parts and/or arrangements of the subject combination arrangement within the scope of the disclosure, the drawings and the appended claims. In addition to variations and modifications in the component parts and/or arrangements, alternative uses will also be apparent to those skilled in the art.

What is claimed is:

1. A rotary compressor, comprising:

a casing which defines an inner space, wherein a suction pipe and a discharge pipe are each coupled to the casing;

a driving motor installed in the inner space of the casing;

at least one cylinder provided in the inner space of the casing;

a plurality of bearing plates coupled to the cylinder so as to form a compression space with the cylinder, wherein the plurality of bearing plates are configured to support a rotation shaft of the driving motor;

at least one rolling piston coupled to an eccentric portion of the rotation shaft and in linear contact with an inner circumferential surface of the cylinder; and

at least one vane in contact with the rolling piston and configured to divide the compression space into a suction chamber and a compression chamber,

wherein the driving motor includes:

a stator comprising a plurality of stator plates laminated together and configured to be inserted into an inner circumferential surface of the casing, each stator plate having a plurality of protruding poles on which a coil is wound;

a rotor comprising a plurality of rotor plates laminated together and configured to be rotatably disposed in the stator, wherein each rotor plate comprises a plurality of magnetic flux barriers formed therein, and wherein a width of each magnetic flux barrier in a radius direction and a width between adjacent magnetic flux barriers in the radius direction each increase towards the center of the driving motor; and

a rotation shaft coupled to the center of the rotor and.

2. The rotary compressor of claim **1**, wherein the stator of the driving motor comprises:

a rotor insertion hole into which the rotor is inserted;

a plurality of protruding fixing portions extending from an outer circumferential surface of the stator in a circumferential direction and configured to be fixed to an inner circumferential surface of the casing; and

a plurality of cut-passages formed between the protruding fixing portions in a circumferential direction so as to form a gap with an inner circumferential surface of the casing, wherein a ratio (d**1**/w**1**) between a diameter (d**1**) of the rotor insertion hole and a width (w**1**) of the protrusion fixing portion is greater than or equal to 2.1.

3. The rotary compressor of claim **2**, wherein the protruding fixing portion is formed so that an angle between both ends thereof and the center of the stator is 20°~30°.

4. The rotary compressor of claim **2**, wherein the cut-passage is formed so that a ratio (QA_0/QA_1) between a sum (QA_0) of a circumferential length of each cut-passage and a sum (QA_1) of a circumferential length of each protruding fixing portion is 0.3~0.7.

5. The rotary compressor of claim **1**, wherein the rotor of the driving motor is formed so that a distance from an outer circumferential surface thereof to an end of each of the magnetic flux barriers is uniform.

6. The rotary compressor of claim **5**, wherein each of the plurality of magnetic flux barriers includes at least one bridge configured to connect an inner surface and an outer surface thereof.

7. The rotary compressor of claim **1**, wherein a distance from an outer circumferential surface of the rotor to an end of each magnetic flux barrier varies based on the respective magnetic flux barrier.

8. The rotary compressor of claim **7**, wherein at least one of the magnetic flux barriers includes at least one bridge configured to connect an inner surface and an outer surface thereof.

9. The rotary compressor of claim **1**, wherein the casing is configured to receive oil therein, and wherein oil is filled in the casing to a level higher than an upper side of the cylinder.

10. The rotary compressor of claim **1**, wherein a volume between an upper end of the stator and an inner a lower surface of an upper end of the casing is greater than 5000 mm^3.

11. The rotary compressor of claim **1**, wherein a muffler configured to attenuate noise is installed at an uppermost bearing plate of the plurality of bearing plates, and wherein a gap between an upper end of the muffler and the coil which extends downward from the stator is greater than 3.2 mm.

12. The rotary compressor of claim **1**, wherein a refrigerant connection pipe of a refrigerating cycle is directly connected to an inlet of the suction pipe.

13. The rotary compressor of claim **1**, wherein the at least one cylinder comprises a plurality of cylinders, and wherein the suction pipe comprises a corresponding plurality of gas suction pipes respectively connected to the plurality of cylinders, wherein the plurality of suction pipes are connected to one refrigerant connection pipe.

14. The rotary compressor of claim **1**, wherein a ratio between a diameter of the rotation shaft excluding the eccentric portion and a diameter of the eccentric portion is between 16:20~18:30.

15. The rotary compressor of claim **1**, wherein an eccentric amount of the eccentric portion of the rotation shaft is within a range of 1.5~5 mm.

16. The rotary compressor of claim **1**, wherein the at least one cylinder and the plurality of bearing plates are formed of gray pig iron, the rolling piston is formed of an alloy of molybdenum, nickel and chrome, and the vane is formed of a high speed steel having undergone a nitriding process.

17. The rotary compressor of claim **1**, wherein an upper bearing plate of the plurality of bearing plates includes a discharge port configured to discharge a fluid compressed in the compression space, wherein a diameter of the discharge port is 5 mm when a volume of the compression space is 6 cc, and the diameter of the discharge port is 8 mm when the volume of the compression space is 9 cc.

18. The rotary compressor of claim **1**, wherein the at least one cylinder comprises a plurality of cylinders which have different capacities.

19. The rotary compressor of claim **1**, wherein the at least one cylinder comprises a plurality of cylinders, and wherein if a length of the casing is greater than two times an outer diameter of the casing, a thickness of a base plate which supports the casing on an installation surface is between 2.6~4.0 mm.

20. The rotary compressor of claim **1**, wherein the stator and the rotor of the driving motor have a gap of 0.4~0.8 mm therebetween.

21. The rotary compressor of claim **1**, wherein upper and lower end plates positioned at upper and lower ends of the rotor, respectively, have a thickness of approximately 1~4 mm, and wherein a gap between a lower surface of the lower end plate and an upper end surface of an uppermost bearing plate is between 2~6 mm.

22. The rotary compressor of claim **21**, wherein a balance weight eccentric at a certain angle in a circumferential direction is integrally formed on an outer surface of at least one of the upper or lower end plate, wherein a thickness of the balance weight is less than two times a thickness of the respective end plate.

23. The rotary compressor of claim **21**, wherein a balance weight eccentric at a certain angle in a circumferential direction is coupled to at least one of the upper or lower end plate during a post-assembling process, and wherein a thickness of the balance weight is less than two times a thickness of the respective end plate.

24. The rotary compressor of claim **21**, wherein one of the end plates is configured to completely cover the plurality of magnetic flux barriers.

25. The rotary compressor of claim **21**, wherein one of the end plates is configured to partially cover the plurality of magnetic flux barriers so as to form a path in the rotor in upper and lower directions.

26. The rotary compressor of claim **1**, wherein a vertical distance between the center of the rotor and the center of the stator is between −2~3 mm.

27. The rotary compressor of claim **1**, wherein a length from an upper end of the stator to a lower surface of an uppermost bearing plate of the plurality of bearing plates is approximately 110~140 mm.

28. The rotary compressor of claim **1**, wherein the rotation shaft is coupled to the rotor by shrinkage fit.

29. The rotary compressor of claim **1**, wherein the suction pipe comprises a plurality of suction pipes respectively connected to a plurality of cylinders, and wherein the plurality of suction pipes are connected to one accumulator.

30. The rotary compressor of claim **29**, wherein the plurality of suction pipes have different curvatures.

31. The rotary compressor of claim **1**, wherein the at least one cylinder comprises a plurality of cylinders, and wherein the suction pipe is respectively connected to the plurality of cylinders at one end thereof, and to one refrigerant connection pipe connected to an outlet of an evaporator at another end thereof.

32. The rotary compressor of claim **31**, wherein the suction pipe comprises a plurality of suction pipes having different curvatures and being respectively connected to the plurality of cylinders.

33. The rotary compressor of claim **1**, wherein the driving motor is configured to be synchronously rotated by a reluctance torque in a direction in which magnetic resistance is minimized.

34. The rotary compressor of claim **1**, wherein the at least one rolling piston is configured to perform an orbiting motion within the compression space.

35. The rotary compressor of claim **1**, wherein the at least one cylinder is directly connected to a suction pipe which provides fluid to be compressed in the compression space.

36. The rotary compressor of claim **1**, wherein a fluid to be compressed in the compression space is a hydro-fluorocarbon (HFC) or a hydro-chlorofluorocarbon (HCFC)-based refrigerant, and wherein a fatty acid-ester oil is used for lubrication if the HFC-based refrigerant is used, and a fatty acid-mineral oil is used for lubrication if the HCFC-based refrigerant is used.

37. The rotary compressor of claim **36**, wherein the fatty-acid ester oil has a viscosity of 2~70 cSt at a temperature of 40° C., and a viscosity of 1~9 cSt at a temperature of 100° C., and is ester-coupled in a molecule at least two times, and wherein the fatty-acid mineral oil has a viscosity of 32~68 cSt at a temperature of 40° C. and is ester-coupled in a molecule at least two times.

38. The rotary compressor of claim **1**, wherein the plurality of magnetic flux barriers penetrate the respective rotor plate in which they are formed.

39. The rotary compressor of claim **1**, wherein an insulation film formed of a crystalline plastic film having a separation transition temperature greater than 50° C. is disposed between the stator and the coil.

40. The rotary compressor of claim **1**, wherein the coil comprises an enamel coating layer having a separation transition temperature greater than 120° C.

41. The rotary compressor of claim **2**, wherein the protruding fixing portions each have substantially the same shape and area, and the plurality of cut passages each have substantially the same shape and area and are spaced apart from each other at substantially equal intervals.

42. A rotary compressor, comprising:

a hermetic casing having an inner space to which a suction pipe and a discharge pipe are connected;

a motor installed in the inner space of the casing, wherein the motor is configured to be synchronously rotated by a reluctance torque;

at least one cylinder installed in the inner space, wherein the suction pipe is directly connected to the cylinder for compression of a fluid;

a plurality of bearing plates coupled to the at least one cylinder so as to form a compression space and to support arotation shaft of the motor;

at least one rolling piston coupled to an eccentric portion of the rotation shaft and in linear contact with an inner circumferential surface of the cylinder; and

at least one vane in contact with the rolling piston and configured to divide the compression space into a suction chamber and a compression chamber, wherein the driving motor includes:

a stator comprising a plurality of steel stator plates laminated together and configured to be inserted into an inner circumferential surface of the casing, each of the steel stator plates having a plurality of protruding poles on which a coil is wound;

a rotor comprising a plurality of steel rotor plates laminated together and configured to be rotatably disposed in the stator, each of the plurality of steel rotor plates having a plurality of magnetic flux barriers formed therein, wherein a width of each magnetic flux barrier in a radius direction and a width between adjacent magnetic flux barriers in the radius direction each towards the center of the motor, and further comprising at least one bridge configured to connect an inner surface and an outer surface of at least one of the plurality of magnetic flux barriers; and

a rotation shaft coupled to the center of the rotor and supported by a frame.

43. A rotary compressor, comprising:

a hermetic casing having an inner space to which a suction pipe and a gas discharge pipe are connected;

a motor installed in the inner space and configured to be synchronously rotated by a reluctance torque;

at least one cylinder provided in the inner space, at one side of the motor, wherein the suction pipe is directly connected to the cylinder so as to compress a fluid therein;

a plurality of bearing plates coupled to the cylinder so as to form a compression space, wherein the plurality of bearing plates are configured to support a rotation shaft of the motor;

at least one rolling piston positioned in the compression space of the cylinder, coupled to an eccentric portion of the rotation shaft and in linear contact with an inner circumferential surface of the cylinder; and

at least one vane in contact with the rolling piston and configured to divide the compression space into a suction chamber and a compression chamber, wherein the motor includes:

a stator comprising a plurality of steel stator plates laminated together and configured to be inserted into an inner circumferential surface of the casing, each of the plurality of steel stator plates having a plurality of protruding poles on which a coil is wound;

a rotor comprising a plurality of steel rotor plates laminated together and configured to be rotatably disposed in the stator, the plurality of steel rotor plates having a plurality of magnetic flux barriers formed therein, wherein a width of each magnetic flux barrier in a radius direction and a width between adjacent magnetic flux barriers in the radius direction each increase towards the center of the motor, and wherein a width from an outer circumferential surface of each steel rotor plate to an end of each of the magnetic flux barriers is different; and

a rotation shaft coupled to the center of the rotor by shrinkage fit and supported by a frame.

44. An air conditioner comprising the rotary compressor of claim **1**.

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