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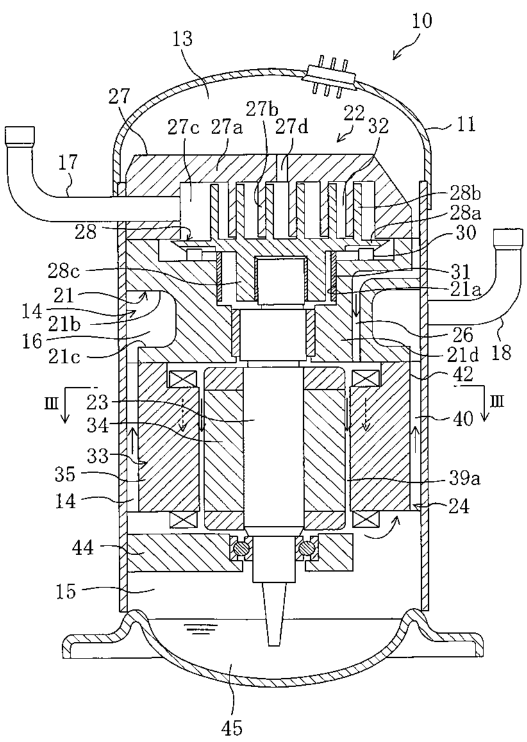
(54) COMPRESSOR

(57) A diaphragm **(42)** is provided between a frame **(21)** and a stator **(33)** of an electric motor **(24).** The diaphragm **(42)** allows a communication passage **(26)** to communicate with a gap **(39a)** and allows a gas passage **(40)** to communicate with a discharge space **(16).** Refrigerant gas discharged from a compression mechanism **(22)** flows thoroughly into the gap **(39a),** passes through a communication space **(15)** and the gas passage **(40),** and then, is discharged form a discharge pipe **(18).**

FIG. 1



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Description

Technical Field

[0001] The present invention relates to a compressor, and particularly relates to a measure for cooling an electric motor.

Background Art

[0002] Conventionally, as disclosed in Japanese Patent Application Laid Open Publication No. 5-164069A, Japanese Patent Application Laid Open Publication No. 10-22381A, and Japanese Patent Application Laid Open Publication No. 2-169887A, an electric compressor in which a compression mechanism and an electric motor for driving the compression mechanism are accommodated in a hermetic casing has been known as one type of compressors. A compressor of this kind is connected to a refrigeration circuit of a refrigerating apparatus for compressing refrigerant gas, for example. In this compressor, the compression mechanism includes a fixed scroll and a movable scroll, the fixed scroll being fixed to the casing through a housing. The electric motor is composed of a stator fixed to the casing, a rotor rotatably arranged inside the stator, and a drive shaft fixed to the rotor. The rotor rotates to rotate the drive shaft, thereby driving the compression mechanism. On the other hand, the stator of the electric motor is cut at a part of the outer peripheral portion thereof to form a gap between the casing and the stator. Refrigerant gas compressed by the compression mechanism is allowed to flow into the gap, thereby cooling the electric motor.

-Problems that the Invention is to Solve-

[0003] The conventional compressors do not control the flow of the refrigerant gas positively in the casing. For this reason, the refrigerant gas flows as it takes its natural course in the casing, and then, is discharged through a discharge pipe. The refrigerant has a nature of flowing towards a part having less resistance, and therefore, the refrigerant gas does not necessarily flow to the gap evenly and may flow ununiformly in some cases. Thus, the conventional compressors are capable of cooling the electric motor by the refrigerant gas to some degree but incapable of exhibiting efficient cooling performance to the electric motor.

[0004] For example, in a compressor in which the discharge pipe is mounted to the casing so as to communicate with a space between the compression mechanism and the electric motor, part of the refrigerant gas discharged from the compression mechanism is discharged through the discharge pipe without passing through the gap around the stator, resulting in ineffective cooling of the electric motor by the refrigerant gas.

[0005] The present invention has been made in view of the above problems and has its object of cooling an electric motor efficiently.

Summary of the Invention

[0006] To attain the above object, in the present invention, gas discharged from a compression mechanism **(22)** is made to flow from either one of a gap **(39a, 3b)** of an electric motor **(24)** and a gas passage **(40)** to the other.

[0007] Specifically, the first invention provides compressor in which a casing **(11)** accommodates a compression mechanism **(22)** and an electric motor **(24)** that has a stator **(33)** and drives the compression mechanism **(22)** and a discharge pipe **(18)** is connected to the casing **(11)** at a part between the compression mechanism **(22)** and the electric motor **(24),** the compressor including: a gas passage **(40)** formed from one end to the other end of the electric motor **(24)** between the stator **(33)** of the electric motor **(24)** and the casing **(11),** wherein the gas passage **(40)** leads at one end thereof to a gap **(39a, 39b)** extending inside the electric motor **(24)** from one end to the other end of the electric motor **(24),** and gas discharged from the compression mechanism **(22)** flows from either one of the gap **(39a, 39b)** extending inside the electric motor **(24)** from one end to the other end of the electric motor **(24)** and the gas passage **(40)** to the other, and then, flows into the discharge pipe **(18).**

[0008] The second invention provides a compressor on the premise that a casing **(11)** accommodates a compression mechanism **(22)** and an electric motor **(24)** that has a stator **(33)** and drives the compression mechanism **(22)** and a discharge pipe **(18)** is connected to the casing **(11)** at a part between the compression mechanism **(22)** and the electric motor **(24),** the compressor being characterized by including: a partition member **(21)** that defines the inside of the casing **(11)** as a first accommodation space **(13)** for the compression mechanism **(22)** and a second accommodation space **(14)** for the electric motor **(24);** a communication passage **(26)** that is formed in the partition member **(21)** for leading gas discharged from the compression mechanism **(22)** to the second accommodation space **(14);** a gas passage **(40)** which is formed between the stator **(33)** of the electric motor **(24)** and the casing **(11)** so as to extend from one end to the other end of the electric motor **(24)** and of which one end leads to a gap **(39a, 39b)** extending inside the electric motor **(24)** from one end to the other end of the electric motor **(24);** and a diaphragm **(42)** that allows the communication passage **(26)** to communicate with one end of the gap **(39a, 39b)** and allows a discharge space **(16)** communicating with the discharge pipe **(18)** to communicate with the other end of the gas passage **(40).**

[0009] In the third invention, the diaphragm **(42)** is formed between the partition member **(21)** and the stator **(33)** of the electric motor **(24)** in the second invention.

[0010] In the fourth invention, the diaphragm **(42)** is formed integrally with the partition member **(21)** in the third invention.

[0011] In the fifth invention, the diaphragm **(42)** is formed integrally with an iron core **(35)** of the stator **(33)** of the electric motor **(33)** so as to have a cylindrical shape protruding in an axial direction further than a coil **(36)** in third invention.

[0012] In the sixth invention, the diaphragm **(42)** is formed by stacking annular steel plates **(42a)** in the third invention.

[0013] In the seventh invention, the diaphragm **(42)** is composed of a cylindrical member fitted between the partition member **(21)** and the stator **(33)** of the electric motor **(24)** in the third invention.

[0014] In the eighth invention, the communication passage **(26)** has a flow outlet open towards a coil **(36)** of the stator **(33)** in the second invention.

[0015] In the ninth invention, an outer peripheral face of the stator **(33)** adheres to the casing **(11)** and the gas passage **(40)** is formed of a vertical trench **(35d)** formed in an outer peripheral portion of the stator **(33)** in any one of the first to eighth inventions.

[0016] In the tenth invention, the vertical trench **(35d)** includes a plurality of vertical trenches **(35d)** formed along a peripheral direction and the discharge pipe **(18)** is displaced in the peripheral direction from the vertical trenches **(35d)** in the ninth invention.

[0017] In the eleventh invention, the number of the vertical trench **(35d)** is one and the discharge pipe **(18)** is provided opposite the vertical trench **(35d)** with a drive shaft **(23)** of the electric motor **(24)** interposed in the ninth invention.

[0018] In the twelfth invention, the stator **(33)** of the electric motor **(24)** is mounted indirectly to the casing **(11)** through the partition member **(21)** and the gas passage **(40)** is formed of a gap formed around the entirety in a peripheral direction of the stator **(33)** in any one of the second to eighth inventions.

[0019] In the thirteenth invention, the discharge space **(16)** is formed larger than a flow outlet of the gas passage **(40)** in any one of the second to twelfth inventions.

[0020] In the fourteenth invention, a coil **(36)** is wound to each of tooth parts **(35b)** of the iron core **(35)** of the stator **(33)** in the stator **(33)** of the electric motor **(24)** in any one of the first to thirteenth inventions.

-Operation-

[0021] In the first invention, the gas discharged from the compression mechanism **(22)** flows into either one of the gap **(39a, 39b)** of the electric motor **(24)** and the gas passage **(40)** to cool the electric motor **(24).** Then, the gas flowing out from the one of the gap **(39a, 39b)** of the electric motor **(24)** and the gas passage **(40)** flows into the other one of the gap **(39a, 39b)** of the electric motor **(24)** and the gas passage **(40)** to cool the electric motor **(24).** Then, the gas is discharged outside the casing **(11)** through the discharge pipe **(18).** In other words, the direction that the gas flows is restrained so that the gas flows from either one of the gap **(39a, 39b)** and the gas passage **(40)** to the other. Thus, the gas flows smoothly in the casing **(11)** to cool the electric motor **(24).**

[0022] In the second invention, the gas discharged from the compression mechanism **(22)** flows into the second accommodation space **(14)** through the communication passage **(26).** The gas then flows out from the communication passage **(26)** into the gap **(39a, 39b)** of the electric motor **(24).** The gas cools the electric motor **(24)** when flowing through the gap **(39a, 39b).** The gas flowing out from the gap **(39a, 39b)** then flows into the gas passage **(40).** This gas cools the electric motor **(24)** when flowing through the gas passage **(40).** The gas flowing out from the gas passage **(40)** passes through the discharge space **(16),** and then, is discharged outside the casing **(11)** through the discharge pipe **(18).**

[0023] In the eighth invention, the gas flowing out from the communication passage **(26)** flows towards the coil **(36)** of the stator **(33).** If the gas contains oil, the oil is trapped in the coil **(36)** to be liquefied.

[0024] In the ninth invention, the stator **(33)** of the electric motor **(24)** is fixed to the casing **(11).** The gas flows through the gas passage **(40)** that the vertical trench **(35d)** in the outer peripheral portion of the stator **(33)** and the casing **(11)** form.

[0025] In the tenth invention, the gas flow through the plurality of gas communication pipes **(40)** of the stator **(33)** which are provided along the peripheral direction. The gas flowing through the gas passages **(40)** changes its flowing direction in the peripheral direction, and then, is discharged outside the casing **(11)** through the discharge pipe **(18).**

[0026] In the eleventh invention, after the gas flows through the gas passage **(40)** of the stator **(33)** which is formed at one part, the flowing direction is changed in the peripheral direction. Then, the gas is discharged outside the casing **(11)** through the discharge pipe **(18)** located opposite the electric motor **(24)** with the drive shaft **(23)** interposed.

[0027] In the twelfth invention, the stator **(33)** is mounted indirectly to the casing (11) through the partition member **(21)** and a gap is formed around the entirety in the peripheral direction of the outer periphery of the stator **(33).** The gap forms the gas passage **(40)** and the gas discharged from the compression mechanism **(22)** flows through the gas passage **(40).**

[0028] In the thirteenth invention, the discharge space **(16)** is formed larger than the flow outlet of the gas passage **(40),** so that the flow rate of the gas flowing out from the gas passage **(40)** of the stator **(33)** decreases when the gas flowing out from the gas passage **(40)** flows into the discharge space **(16).** Then, the gas of which flow rate decreases is discharged outside the casing **(11)** through the discharge pipe **(18).**

[0029] In the fourteenth invention, a coil **(36)** is wound to each of the tooth parts **(35b)** of the iron core **(35)** of the stator **(33).** Accordingly, the gaps **(39b)** are formed between adjacent teeth **(35b).** Hence, the gas flows into the gaps **(39b)** between the teeth **(35b)** and into the gap

(39a) between the stator **(33)** and the rotor **(34).**

-Effects-

[0030] As described above, according to the first invention, the gas discharged from the compression mechanism **(22)** can flow into both the gap **(39a, 39b)** and the gas passage **(40).** Further, the direction that the gas flows is restrained, achieving smooth and thoroughgoing flow of the gas inside and outside of the electric motor **(24).** As a result, the electric motor **(24)** is cooled by the gas efficiently.

[0031] According to the second invention, the gas discharged from the compression chamber **(22)** can flow into the gap **(39a, 39b)** inside the electric motor **(24)** thoroughly and securely. Further, the gas flowing out from the gap **(39a, 39b)** can flow into the gas passage **(40)** surely, and then, be discharged outside the casing **(11).** As a result, the gas discharged from the compression mechanism **(22)** cools the electric motor **(24)** efficiently. Further, the path from the compression mechanism **(22)** to the discharge pipe **(18)** can be set long, so that a larger amount of oil in a case using gas containing oil can be separated.

[0032] In the third invention, the diaphragm **(42)** is provided between the partition member **(21)** and the stator **(33)** of the electric motor **(24),** so that the gas flowing into the second accommodation space **(14)** towards the electric motor **(24)** can be restrained surely.

[0033] In the fourth invention, the diaphragm **(42)** is formed integrally with a part of the partition member **(21)** on the electric motor side **(24),** so that the space between the partition member **(21)** and the stator **(33)** can be partitioned surely with no additional process for the stator **(33)** of the electric motor **(24)** necessitated.

[0034] In the fifth invention, the diaphragm **(42)** is formed integrally with the iron core **(35)** of the stator **(33)** so as to protrude in the axial direction further than the coil **(36).** Accordingly, the diaphragm **(42)** can be clamped between the partition member **(21)** and the iron core **(35)** of the stator **(33),** thereby surely partitioning the space between the partition member **(21)** and the stator **(33).**

[0035] In the sixth invention, the annular steel plates **(42a)** are stacked to form the diaphragm **(42).** Accordingly, the space between the partition member **(21)** and the stator **(33)** of the electric motor **(24)** can be partitioned surely in such a simple manner that only the steel plate **(42a)** are stacked, with no additional process for the partition member **(21)** necessitated.

[0036] In the seventh invention, the diaphragm **(42)** is formed of a member fitted between the partition member **(21)** and the stator **(33)** of the electric member **(24),** so that the space between the partition member **(21)** and the stator **(33)** can be partitioned surely with no additional process for the partition member **(21)** and the stator **(33)** necessitated.

[0037] In the eighth invention, the gas flowing out from the communication passage **(26)** is made to flow towards the coil **(36)** of the stator **(33),** so that oil contained in the gas is trapped by the coil **(36)** to be liquefied. Thus, the oil can be separated from the gas efficiently and is prevented from being discharged together with the gas discharged through the discharge pipe **(18).**

[0038] In the ninth invention, the stator **(33)** of the electric motor **(24)** is fixed to the casing **(11)** and the vertical trench **(35d)** to serve as the gas passage **(40)** is formed in the stator **(33).** Accordingly, the gas can flow outside the stator **(33)** while the supporting rigidity of the electric motor **(24)** is enhanced.

[0039] In the tenth invention, the plurality of gas passages **(40)** are formed along the peripheral direction and the discharge pipe **(18)** is displaced in the peripheral direction with respect to the vertical trenches **(35d),** so that cooling can be performed in a plurality of directions outside the stator **(33),** achieving efficient cooling of the electric motor **(24).** Further, the path from the compression mechanism **(22)** to the discharge pipe **(18)** can be set long, so that a larger amount of oil in a case using gas containing oil can be separated.

[0040] In the eleventh invention, the discharge pipe **(18)** is mounted on the side opposite the gas passage **(40),** so that the gas flowing path up to a part where the gas is discharged from the discharge pipe **(18)** can be set to the maximum, attaining separation of a larger amount of oil in a case using gas containing oil.

[0041] In the twelfth invention, the stator **(33)** is mounted indirectly to the casing **(11)** through the partition member **(21).** Accordingly, the gas flows around the entirety of the outer periphery of the stator **(33),** attaining further efficient cooling of the electric motor **(24)** while securely supporting the electric motor **(24).**

[0042] In the thirteenth invention, the flow rate of the gas decreases before the gas flows into the discharge pipe **(18),** so that a larger amount of oil in a case using gas containing oil can be separated.

[0043] In the fourteenth invention, the coil **(36)** of the stator **(33)** are wounded to each of the tooth parts **(35b)** of the iron core **(35),** so that the gaps **(39a, 39b)** inside the electric motor **(24)** can be set wider. As a result, the gas can flow into the gaps **(39a, 39b)** efficiently and surely, improving the cooling efficiency of the electric motor **(24).**

Brief Description of the Drawings

[0044]

FIG. **1** is a section showing a whole construction of a compressor according to Embodiment 1 of the present invention.

FIG. **2** is a section showing a construction of a stator of an electric motor in Embodiment 1 of the present invention.

FIG. **3** is a section taken along the line III-III in FIG. 1.

FIG. **4** is a section showing a whole construction of a compressor according to Embodiment 2 of the present invention.

FIG. **5** is a section showing a whole construction of a compressor according to Embodiment 3 of the present invention.

FIG. **6** is a section showing a whole construction of a compressor according to Embodiment 4 of the present invention.

FIG. **7** is a section taken along the line VII-VII in FIG. 6.

Best Mode for Carrying out the Invention

[0045] Embodiments of the present invention will be described below in detail with reference to the drawings. Wherein, the present invention is not limited to the following embodiments.

<Embodiment 1 >

[0046] Embodiment 1 of the present invention is applied to a scroll compressor for compressing refrigerant gas which is connected to a refrigeration circuit (not shown) of a refrigeration apparatus that performs a vapor compression refrigeration cycle, for example.

[0047] As shown in FIG.**1,** a compressor **(10)** according to the present embodiment includes a casing **(11)** composed of a pressure vessel. The casing **(11)** accommodates a frame **(21)** as a partition member fixed to the casing **(11),** a scroll type compression mechanism **(22)** mounted at the upper end of the frame **(21),** and an electric motor **(24)** having a drive shaft **(23)** and arranged under the frame **(21).** The frame **(21)** is arranged between the compression mechanism **(22)** and the electric motor **(24).** The inside of the casing **(11)** is defined as a first accommodation space **(13)** located upper than the frame **(21)** and accommodating the compression mechanism **(22)** and a second accommodation space **(14)** located lower than the frame **(21)** and accommodating the electric motor **(24).** The second accommodation space **(14)** is formed of a communication space **(15)** located under the electric motor **(24)** and a discharge space **(16)** ranging between the frame **(21)** and the electric motor **(24).**

[0048] To the casing **(11),** an intake pipe **(17)** and a discharge pipe **(18)** are mounted. The intake pipe **(17)** passes through the casing **(11)** and is fitted in the compression mechanism **(22).** The discharge pipe **(18)** passes through the casing **(11)** and opens at the inner end thereof to the discharge space **(16).**

[0049] The frame **(21)** adheres and is fixed at the outer peripheral face thereof to the inner peripheral face of the casing **(11)** by, for example, pressing to fit the frame **(21)** to the upward part of the casing **(11).** In the upper part of the frame **(21),** an upper face concave portion **(21a)** is formed so as to be bowed downward at the central part thereof. Further, the outer peripheral concave portion **(21b)** is formed around the entirety of the outer periphery of the frame **(21)** so as to be bowed inward. A disk-shaped flange **(21c)** extending horizontally towards the casing **(11)** is formed at the lower end of the outer peripheral concave portion **(21b)** of the frame **(21).**

[0050] The frame **(21)** is provided with a bearing portion **(21d)** under the upper face concave portion **(21a).** This bearing portion **(21d)** is composed of a sleeve bearing to support one end (upper end) of the drive shaft **(23)** of the electric motor **(24)** rotatably.

[0051] Further, a communication passage **(26)** is formed so as to pass through the frame **(21)** vertically. The communication passage **(26)** has a flow inlet formed so as to open to the first accommodation space **(13)** in a part of the upper end face of the frame **(21)** which is located further outward than a fixed scroll **(27)** and a flow outlet formed so as to open to the second accommodation space **(14)** in a part of the lower end face of the flange **(21c).**

[0052] The discharge pipe **(18)** passes through the casing **(11)** at a part between the electric motor **(24)** and the part where the frame **(21)** adheres to the casing **(11).** Further, the discharge pipe **(18)** communicates with the discharge space **(16)** between the casing **(11)** and the outer peripheral concave portion **(21b)** of the frame **(21).**

[0053] The compression mechanism **(22)** includes the fixed scroll **(27)** and a movable scroll **(28).** The fixed scroll **(27)** is mounted at the peripheral part thereof on the upper face of the frame **(21)** so as to be fixed to the frame **(21).** Each scroll **(27, 28)** is composed of a head **(27a, 28a)** and a spiral lap **(27a, 28b)** formed at the head **(27a, 28a).** The laps **(27a, 28b)** of the scrolls **(27, 28)** mesh with each other.

[0054] The movable scroll **(28)** is arranged between the fixed scroll **(27)** and the frame **(21).** A rotation inhibiting member **(30)** such as an Oldham coupling is provided between the head **(28a)** of the movable scroll **(28)** and the frame **(21)** so that the movable scroll **(28)** performs only revolution around the fixed scroll **(27).**

[0055] The space where the laps **(27b, 28b)** contact with each other between the head **(27a)** of the fixed scroll **(27)** and the head **(28a)** of the movable scroll **(28)** serves as a compression chamber **(32).** A discharge hole **(27d)** for discharging high-pressure refrigerant passes through the central part of the head **(27a)** of the fixed scroll **(27).**

[0056] The intake pipe **(17)** is fitted in the head **(27a)** of the fixed scroll **(27).** The inner end of the intake pipe **(17)** opens to a refrigerant gas intake chamber **(27c)** formed at the peripheral part of the lap **(27b).**

[0057] A cylindrically protruding boss **(28c)** is formed at the central part of the lower face of the head **(28a)** of the movable scroll **(28).** The upper end part of the drive shaft **(23)** is fitted to the boss **(28c).** The upper end part of the drive shaft **(23)** is eccentric from the axial center of the drive shaft **(23).** The bearing portion **(21d)** of the frame **(21)** supports the drive shaft **(23)** at a part just under the upper end part of the drive shaft **(23).** In other words, the electric motor **(24)** is connected to the frame **(21)** through the drive shaft **(23).**

[0058] A seal ring **(31)** is arranged around the boss

(28c) and is fitted to the upper face concave portion **(21a)** of the frame **(21)** so as to be in contact with and press the lower face of the head **(28a)** of the movable scroll **(28).** This seal ring **(31)** serves to prevent the high-pressure gas refrigerant flowing inside the upper face concave portion **(21a)** from leaking peripherally further than the seal ring **(31)** and serves to allow the movable scroll **(28)** to be in contact with and press the fixed scroll **(27)** by the high-pressure force of the high-pressure gas refrigerant.

[0059] The electric motor **(24)** is arranged immediately below the bearing portion **(21d)** of the frame **(21).** The electric motor **(24)** is composed of a blushless DC motor, for example, and includes a stator **(33)** and a rotor **(34)** arranged inside the stator **(33).** The drive shaft **(23)** is connected to the rotor **(34)** so as to rotate integrally with the rotor **(34).**

[0060] The stator **(33)** is composed of a stator iron core **(35)** and coils **(36)** fitted to the stator iron core **(35),** as shown in FIG. **2** and FIG. **3.** The stator iron core **(35)** includes an annular iron core body **(35a)** fixed to and pressed in the casing **(11)** and teeth **(35b)** as tooth parts formed so as to protrude inward of the iron core body **(35a).**

[0061] The stator iron core **(35)** is composed such that multiple electromagnetic steel plates **(35c)** punched out by sheet metal stamping are stacked, as shown in FIG. **2.** Each of the electromagnetic steel plates **(35c)** includes an annular portion serving as the annular iron core body **(35a)** and substantially rectangular portions serving as the teeth **(35b).**

[0062] The teeth **(35b)** of plural in number (6 in the present embodiment) are formed along the peripheral direction. Each tip end of the teeth **(35b)** forms an arc so that a cylindrical space is formed further inside than the tip ends of the teeth **(35b).**

[0063] The rotor **(34)** is composed such that a permanent magnet **(34b)** is embedded in a cylindrical rotor iron core **(34a)** formed by stacking electromagnetic plates punched out by metal stamping. The rotor **(34)** is arranged so that a gap **(39a)** having a predetermined width between the rotor **(34)** and the teeth **(35b)** is formed in the space formed further inside than the teeth **(35b).**

[0064] The stator **(33)** employs concentrated winding (series winding) for winding the coils **(36).** Namely, the coils **(36)** are wound individually to the teeth **(35b)** of the stator iron core **(35).** A gap **(39b)** having a predetermined width is formed between each pair of adjacent teeth **(35b).**

[0065] The gaps **(39a, 39b)** are formed from the upper end to the lower end of the electric motor **(24).** The lower ends of the gaps **(39a, 39b)** open to the communication space **(15)** under the electric motor **(24).**

[0066] Vertical trenches **(35d)** are formed by cutting out parts of the outer peripheral portion along the peripheral direction of the iron core body **(35a)** of the stator iron core **(5).** The vertical trenches **(35d)** are formed correspondingly to the teeth **(35b)** so as to be long and narrow in the peripheral direction and so as to extend across the entirety in the axial direction. The vertical trenches **(35d)** and the casing **(11)** form gas passages **(40)** that allow the refrigerant gas to flow therethrough. Namely, the gas passages **(40)** are formed from one end to the other end of the electric motor **(24).** Each lower end of the gas passages **(40)** opens to the communication space **(15),** so that the gas passages **(40)** leads at the lower end thereof to the gaps **(39a, 39b).**

[0067] The discharge pipe **(18)** is displaced in the peripheral direction from the vertical trenches **(35d).** In other words, the discharge pipe **(18)** is located immediately above a part between one pair of adjacent vertical trenches **(35d).**

[0068] In the second accommodation space **(14),** a diaphragm **(42)** is formed as shown in FIG. **1** and FIG. **2.** The diaphragm **(42)** is in a cylindrical shape and arranged so as to connect the flange **(21c)** of the frame **(21)** and the iron core body **(35a)** of the stator iron core **(35).** Whereby, the space between the frame **(21)** and the stator **(33)** is defined as inside and outside spaces. The diaphragm **(42)** is composed such that a predetermined number of the annular electromagnetic steel plates **(42a)** not having parts forming the teeth **(35b),** namely, composing only the iron core body **(35a)** are stacked. The diaphragm **(42)** is made longer than the length of a part of the coils **(36)** which protrudes in the axial direction from the end in the axial direction of the stator iron core **(35).** The predetermined number of electromagnetic steel plates **(42a)** are stacked on the stacked body of the electromagnetic steel plates **(35c)** composing the stator iron core **(35),** so that the upper end of the diaphragm **(42)** is in contact with the lower end of the flange **(21c)** of the frame **(12).**

[0069] To the space inside the diaphragm **(42),** the flow outlet of the communication passage **(26)** of the frame **(21)** opens and the upper ends of the gaps **(39a, 39b)** open as flow inlets. On the other hand, to the space outside the diaphragm **(42),** the upper ends of the gas passages **(40)** open as flow outlets and communicate with the discharge space **(16).** Namely, the diaphragm **(42)** sets the communication passage **(26)** to communicate with the upper ends of the gaps **(39a, 39b)** while setting the discharge space **(16)** and the gas passages **(40)** to communicate with each other.

[0070] In the communication space **(15),** a bearing plate **(44)** and an oil reservoir **(45)** are provided. The bearing plate **(44)** is fixed to the casing **(11)** and supports the lower end of the drive shaft **(23)** rotatably. Oil reserved in the oil reservoir **(45)** is supplied to each of sliding parts such as the compression mechanism **(22),** the bearing portion **(21d),** and the like through an oil supply passage (not shown) formed inside the drive shaft **(23).**

-Operation-

[0071] The operation of the compressor **(10)** according to the present embodiment will be described next. First, when the electric motor **(24)** starts operating, the rotor **(34)** rotates relative to the stator **(33)** to rotate the drive shaft **(23).** In association with the rotation of the drive shaft **(23),** the movable scroll **(28)** revolves around the fixed scroll **(27)** without rotation. This makes a low-pressure refrigerant to be sucked into the compression chamber **(32)** from the intake pipe **(17)** to change the volume of the compression chamber **(32),** thereby compressing the refrigerant. This refrigerant becomes high in pressure by the compression, and then, is discharged to the first accommodation space **(13)** from the discharge hole **(27d).** The refrigerant gas contains oil. Namely, part of the oil supplied from the oil reservoir **(45)** to the compression mechanism **(22)** is discharged to the first accommodation space **(13)** together with the refrigerant gas.

[0072] The refrigerant gas filled up in the first accommodation space **(13)** is lead to the second accommodation space **(14)** through the communication passage **(26).** At that time, the refrigerant flowing out from the communication passage **(26)** flows thoroughly into the space inside the diaphragm **(42)** towards the coils **(36)** of the electric motor **(24)** in the presence of the diaphragm **(42).** Accordingly, part of the oil contained in the refrigerant gas is trapped by the coils **(36)** to be liquefied. This means that the liquefied oil is separated from the refrigerant gas. Thereafter, the refrigerant gas flows into the gaps **(39a, 39b)** of the electric motor **(24).**

[0073] Part of the refrigerant gas flows downward through the gap **(39a)** between the stator **(33)** and the rotor **(34)** while the other part of the refrigerant gas flows downward through the gaps **(39b)** between the teeth **(35b).** At this time, the refrigerant gas cools the electric motor **(24)** while flowing through the gaps **(39a, 39b).** The refrigerant gas flows out into the communication space **(15)** from the lower ends of the gaps **(39a, 39b).** The communication space **(15)** has a passage area larger than the total passage area of the gaps **(39a, 39b),** so that the flow rate of the refrigerant gas decreases in the communication space **(15).** Accordingly, part of the oil contained in the refrigerant gas is separated also in the communication space **(15).**

[0074] Thereafter, the refrigerant gas flows upward into the gas passages **(40).** At this time, the refrigerant gas cools the electric motor **(24)** while flowing through the gas passages **(40).** Namely, the refrigerant gas flows downward through the gaps **(39a, 39b)** and flows upward through the gas passages **(40).** This means restraint of the direction that the refrigerant gas flows in the casing **(11).**

[0075] The refrigerant gas flowing out from the gas passages **(40)** passes through the outside of the diaphragm **(42)** and flows into the discharge space **(16).** The discharge space **(16)** is enlarged wider than the flow outlets of the gas passages **(40)** to decrease the flow rate of the refrigerant gas in the discharge space **(16).** Accordingly, part of the oil contained in the refrigerant gas is separated also in the discharge space **(16).** Subsequently, the refrigerant gas changes in its flowing direction in the discharge space **(16),** and then, is discharged outside the casing **(11)** through the discharge pipe **(18).**

-Effects in Embodiment 1-

[0076] As described above, according to the compressor **(10)** in Embodiment 1, the refrigerant gas discharged from the compression mechanism **(22)** is made to thoroughly flow into either the gaps **(39a, 39b)** of the electric motor **(24)** and the gas passages **(40).** Further, the diaphragm **(42)** restricts the direction that the refrigerant gas flows to make the refrigerant gas flowing out from the communication passage **(26)** to flow thoroughly into the gaps **(39a, 39b)** surely. As a result, the refrigerant gas cools the electric motor **(24)** efficiently.

[0077] Further, in Embodiment 1, the refrigerant gas flows from the gaps **(39a, 39b)** to the gas passages **(40)** and the refrigerant gas flowing out from the gas passages **(40)** is discharged through the discharge pipe **(18).** Accordingly, the discharge pipe **(18)** is only required to communicate at the inner end thereof with the discharge space **(16),** simplifying the construction thereof.

[0078] Furthermore, in Embodiment 1, the diaphragm **(42)** is composed of the predetermined number of electromagnetic steel plates **(42a)** stacked on the stator iron core **(35).** This simple scheme of stacking the electromagnetic steel plates **(42a)** enables sure partitioning between the frame **(21)** and the stator **(33)** with no additional process for the frame **(21)** necessitated. Also, the diaphragm **(42)** protrudes in the axial direction further than the coils **(36),** being clamped between the frame **(21)** and the stator iron core **(35).** This enables sure partitioning of the space between the frame **(21)** and the stator **(33).**

[0079] Moreover, in Embodiment 1, the flow outlet of the communication passage **(26)** opens towards the coils **(36)** of the stator **(33),** so that the refrigerant gas flowing out from the communication passage **(26)** flows towards the coils **(36).** Accordingly, the coils **(36)** traps oil contained in the refrigerant gas to liquefy it, resulting in efficient separation of oil from the refrigerant gas. This suppresses discharge of oil from the discharge pipe **(18)** together with the gas.

[0080] Further, in Embodiment 1, the stator **(33)** of the electric motor **(24)** is inserted by pressing in the casing **(11)** and the vertical trenches **(35d)** are formed by cutting out parts of the outer peripheral portions of the stator **(33),** thereby forming the gas passages **(40)** of the gaps between the vertical trenches **(35d)** and the casing **(11).** Hence, the refrigerant gas can flow outside the stator **(33)** surely while the supporting rigidity of the electric motor **(24)** increases.

[0081] Furthermore, in Embodiment 1, the discharge pipe **(18)** is displaced in the peripheral direction from the vertical trenches **(35d),** so that the refrigerant gas changes its flowing direction in the peripheral direction after flowing upward through the gas passages **(40)** formed along the peripheral direction. This means cooling in the plural directions from the outside of the stator **(33),** resulting in efficient cooling of the electric motor **(24).** Further, a larger amount of oil contained in the refrigerant gas can be separated because the refrigerant path up to the part where it is discharged from the discharge pipe **(18)** can be set longer.

[0082] Moreover, in Embodiment 1, the discharge space **(16)** is enlarged wider than the flow outlets of the gas passages **(40)** of the stator **(33),** so that the flow rate of the refrigerant gas decreases when the refrigerant gas flowing from the gas passages **(40)** flows into the discharge space **(16).** Then, the refrigerant gas of which flow rate decreases is discharged outside the casing **(11)** through the discharge pipe **(18).** Thus, the decrease in flow rate of the refrigerant gas before flowing into the discharge pipe **(18)** attains separation of a larger amount of oil contained in the refrigerant gas before it flows into the discharge pipe **(18).**

[0083] In addition, in Embodiment 1, the concentrated winding is employed for the coils **(36)** so that the coils **(36)** are wound individually to the teeth **(35b)** of the stator iron core **(35),** and accordingly, the gaps **(36b)** are formed between adjacent teeth **(35b).** This increases the area of the passages through which the refrigerant gas flows, resulting in efficient and sure flow of the refrigerant gas into the gaps **(39a, 39b)** and in increase in cooling efficiency of the electric motor **(24).**

<Embodiment 2>

[0084] FIG. **4** shows Embodiment 2 of the present invention. Wherein, the same reference numerals are assigned to the same constitutional elements as those in Embodiment 1 and the detailed description thereof is omitted.

[0085] In Embodiment 2, the diaphragm **(42)** is formed of a part of the frame **(21).** Specifically, the flange **(21c)** of the frame **(21)** is in the disk shape, as described above, and extends at the outer peripheral end thereof downward to form the diaphragm **(42).** Namely, the diaphragm **(42)** is integrally formed with a part of the frame **(21)** on the electric motor **(24)** side. The diaphragm **(42)** is in a cylindrical shape concentric with the drive shaft **(23)** and has a length in the axial direction longer than the length of a part of the coils **(36)** of the electric motor **(24)** which protrudes from the end face in the axial direction of the stator iron core **(35).** Further, the lower end of the diaphragm **(42)** is in contact with the upper end of the iron core body **(35a)** of the stator iron core **(35).**

[0086] Hence, according to Embodiment 2, the space between the frame **(21)** and the stator **(33)** can be partitioned surely with no additional process for the stator **(33)** of the electric motor **(24)** necessitated. The other constitution, operations, and effects of the present embodiment are the same as those in Embodiment 1.

<Embodiment 3>

[0087] FIG. **5** shows Embodiment 3 of the present invention. Wherein, the same reference numerals are assigned to the same constitutional elements as those in Embodiment 1 and the detailed description thereof is omitted.

[0088] In Embodiment 3, the diaphragm **(42)** is composed of a cylindrical member separately from the frame **(21)** and the stator **(33b)** of the electric motor **(23).** This diaphragm **(42)** is set longer than the length of a part of the coils **(36)** of the electric motor **(23)** which protrudes in the axial direction from the end face in the axial direction of the stator iron core **(35).** Further, the diaphragm **(42)** is fitted between the flange **(21c)** of the frame **(21)** and the stator **(33)** of the electric motor **(24)** so as to be concentric with the drive shaft **(23).** The upper end of the diaphragm **(42)** is in contact with the lower end of the flange **(21c)** while the lower end thereof is in contact with the upper end of the iron core body **(35a)** of the stator iron core **(35).**

[0089] Hence, according to Embodiment 3, the space between the frame **(21)** and the stator **(33)** can be partitioned surely with no additional process for the frame **(21)** and the stator **(33)** necessitated. The other constitution, operations, and effects of the present embodiment are the same as those in Embodiment 1.

<Embodiment 4>

[0090] FIG. **6** shows Embodiment 4 of the present invention. Wherein, the same reference numerals are assigned to the same constitutional elements as those in Embodiment 1 and the detailed description thereof is omitted.

[0091] In Embodiment 4, the stator **(33)** of the electric motor **(24)** is fixed indirectly to the casing **(11)** through the frame **(21).** Specifically, the stator iron core **(35)** of the stator **(33)** has an outer diameter smaller than the inner diameter of the casing **(11),** and is arranged a distance left from the inner face of the casing **(11).** A through hole **(35e)** is formed in the iron core body **(35a)** of the stator iron core **(35)** for allowing a bolt **(51)** to pass therethrough. The stator **(33)** is arranged such that the diaphragm **(42)** is clamped between the stator **(33)** and the frame **(21),** and is fastened and fixed to the flange **(21c)** of the frame **(21)** by means of the bolt **(51)** inserted in the through hole **(33f)**

[0092] A gap formed between the casing **(11)** and the stator **(33)** so as to have a predetermined width forms a gas passage **(40).** Namely, as described above, the outer diameter of the stator iron core **(35)** is smaller than the inner diameter of the casing **(11)** to form the gap between the casing **(11)** and the stator **(33)** around the entirety in the peripheral direction of the stator **(33).** This gap forms the gas passage **(40)** through which the refrigerant gas is allowed to flow. Wherein, the vertical trenches **(35d)** are not formed in the outer peripheral part of the stator

(33) in Embodiment 4.

[0093] Hence, in Embodiment 4, the refrigerant gas flows around the entirety of the outer periphery of the stator **(33),** so that efficient cooling of the electric motor **(24)** is attained while the electric motor **(24)** is supported firmly. The other constitution, operations, and effects of the present embodiment are the same as those in Embodiment 1.

<Other Embodiments of the Invention>

[0094] In Embodiments 1 to 3, a plural number of gas passages **(40)** are formed along the peripheral direction of the stator **(33).** Instead, only one gas passage **(40)** may be formed. In this case, it is preferable to arrange the discharge pipe **(18)** opposite the gas passage **(40)** with the drive shaft **(23)** interposed. By doing so, the refrigerant gas flowing path up to the part where the refrigerant gas is discharged from the discharge pipe **(18)** can be set to the maximum, enabling separation of a larger amount of oil contained in the refrigerant gas.

[0095] Further, in each of the above embodiments, the stator iron core **(35)** of the electric motor **(24)** is composed of stacked layers of the electromagnetic steel plates **(35c).** However, the present invention is not limited to this composition and the stator iron core **(35)** may be composed of an integral member formed of a dust iron core, for example.

[0096] Moreover, the diaphragm **(42)** is composed of stacked layers of the predetermined number of electromagnetic plates **(42a)** on the upper face of the stator iron core **(35)** in Embodiment 1, but may be formed cylindrically and integrally with the stator iron core **(35).** For example, the stator iron core **(35)** and the diaphragm **(42)** may be integrally formed of a dust iron core or the like. In this constitution, also, the diaphragm **(42)** is required to protrude in the axial direction further than the coils **(36).**

[0097] In each of the embodiments, the generally-called concentrated winding is employed for the stator **(33)** of the electric motor **(24).** Instead, there may be employed a generally-called distributed winding in which a coil **(36)** is wound to a plurality of teeth **(35b).**

[0098] Referring to Embodiment 4, the diaphragm **(42)** may be composed of a part of the frame **(21)** which extends downward from the flange **(21c)** or may be composed of a cylindrical member separately from the frame **(18)** and the stator **(33).**

[0099] Furthermore, in each of the embodiments, the refrigerant gas flowing out from the communication passage **(26)** flows through the gaps **(39a, 39b),** and then, flows through the gas passages **(40)** to be discharged from the discharge pipe **(18).** On the contrary, the refrigerant gas flowing out from the communication passage **(26)** may flow through the gas passages **(40),** and then, flow through the gaps **(39a, 39b)** to be discharged from the discharge pipe **(18).**

[0100] In addition, the scroll compressor **(10)** is employed in each of the embodiments, but the compressor is not limited to the scroll type and may be of rotary piston type.

Industrial Applicability

[0101] As described above, the present invention is useful for compressors of which casing accommodates a compression mechanism and an electric motor.

Claims

1. A compressor in which a casing **(11)** accommodates a compression mechanism **(22)** and an electric motor **(24)** that has a stator **(33)** and drives the compression mechanism **(22)** and a discharge pipe **(18)** is connected to the casing **(11)** at a part between the compression mechanism **(22)** and the electric motor **(24),** the compressor comprising:

a gas passage **(40)** formed from one end to the other end of the electric motor **(24)** between the stator **(33)** of the electric motor **(24)** and the casing **(11),**
wherein the gas passage **(40)** leads at one end thereof to a gap **(39a, 39b)** extending inside the electric motor (24) from one end to the other end of the electric motor **(24),** and
gas discharged from the compression mechanism **(22)** flows from either one of the gap **(39a, 39b)** extending inside the electric motor **(24)** from one end to the other end of the electric motor **(24)** and the gas passage **(40)** to the other, and then, flows into the discharge pipe **(18).**

2. A compressor in which a casing **(11)** accommodates a compression mechanism **(22)** and an electric motor **(24)** that has a stator **(33)** and drives the compression mechanism **(22)** and a discharge pipe **(18)** is connected to the casing **(11)** at a part between the compression mechanism **(22)** and the electric motor **(24),** the compressor comprising:

a partition member **(21)** that defines the inside of the casing **(11)** as a first accommodation space **(13)** for the compression mechanism **(22)** and a second accommodation space **(14)** for the electric motor **(24);**
a communication passage **(26)** that is formed in the partition member **(21)** for leading gas discharged from the compression mechanism **(22)** to the second accommodation space **(14);**
a gas passage **(40)** which is formed between the stator **(33)** of the electric motor **(24)** and the casing **(11)** so as to extend from one end to the other end of the electric motor **(24)** and of which one end leads to a gap **(39a, 39b)** extending inside the electric motor **(24)** from one end to

the other end of the electric motor **(24);** and a diaphragm **(42)** that allows the communication passage **(26)** to communicate with one end of the gap **(39a, 39b)** and allows a discharge space **(16)** communicating with the discharge pipe **(18)** to communicate with the other end of the gas passage **(40).**

3. The compressor of Claim 2, wherein the diaphragm **(42)** is formed between the partition member **(21)** and the stator **(33)** of the electric motor **(24).**

4. The compressor of Claim 3, wherein the diaphragm **(42)** is formed integrally with the partition member **(21).**

5. The compressor of Claim 3, wherein the diaphragm **(42)** is formed integrally with an iron core **(35)** of the stator **(33)** of the electric motor **(33)** so as to have a cylindrical shape protruding in an axial direction further than a coil **(36).**

6. The compressor of Claim 3, wherein the diaphragm **(42)** is formed by stacking annular steel plates **(42a).**

7. The compressor of Claim 3, wherein the diaphragm **(42)** is composed of a cylindrical member fitted between the partition member **(21)** and the stator **(33)** of the electric motor **(24).**

8. The compressor of Claim 2, wherein the communication passage **(26)** has a flow outlet open towards a coil **(36)** of the stator **(33)**.

9. The compressor of any one of Claims 1 to 8, wherein an outer peripheral face of the stator **(33)** adheres to the casing **(11),** and the gas passage **(40)** is formed of a vertical trench **(35d)** formed in an outer peripheral portion of the stator **(33).**

10. The compressor of Claim **9,** wherein the vertical trench **(35d)** includes a plurality of vertical trenches **(35d)** formed along a peripheral direction, and the discharge pipe **(18)** is displaced in the peripheral direction from the vertical trenches **(35d).**

11. The compressor of Claim 9, wherein the number of the vertical trench **(35d)** is one, and the discharge pipe **(18)** is provided opposite the vertical trench **(35d)** with a drive shaft **(23)** of the electric motor **(24)** interposed.

12. The compressor of any one of Claims 2 to 8, wherein the stator **(33)** of the electric motor **(24)** is mounted indirectly to the casing **(11)** through the partition member **(21),** and the gas passage **(40)** is formed of a gap formed around the entirety in a peripheral direction of the stator **(33).**

13. The compressor of any one of Claims 2 to 12, wherein the discharge space **(16)** is formed larger than a flow outlet of the gas passage **(40).**

14. The compressor of any one of Claims 1 to 13, wherein in the stator **(33)** of the electric motor **(24),** a coil **(36)** is wound to each of tooth parts **(35b)** of the iron core **(35)** of the stator **(33).**

FIG. 1

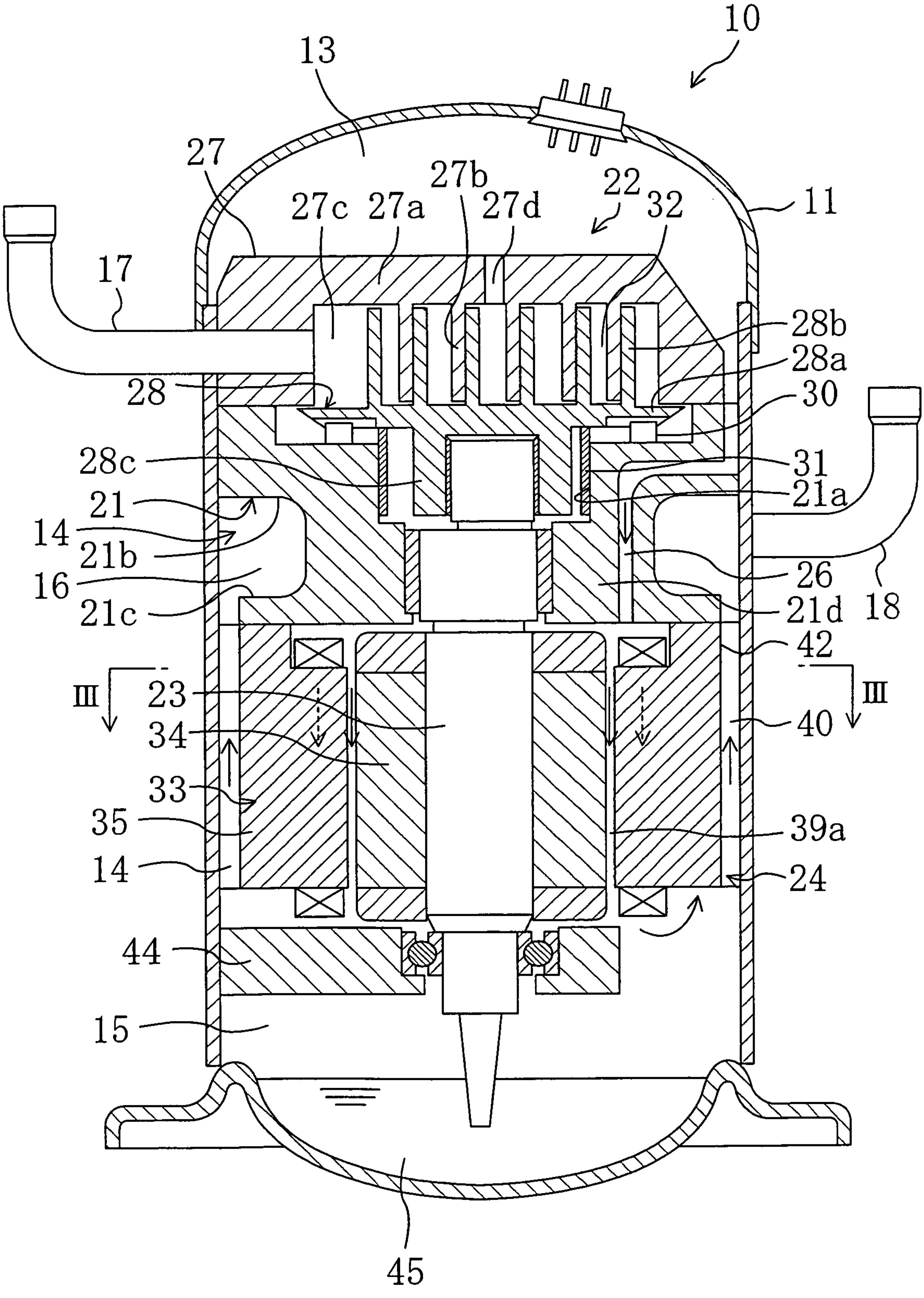
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FIG. 2

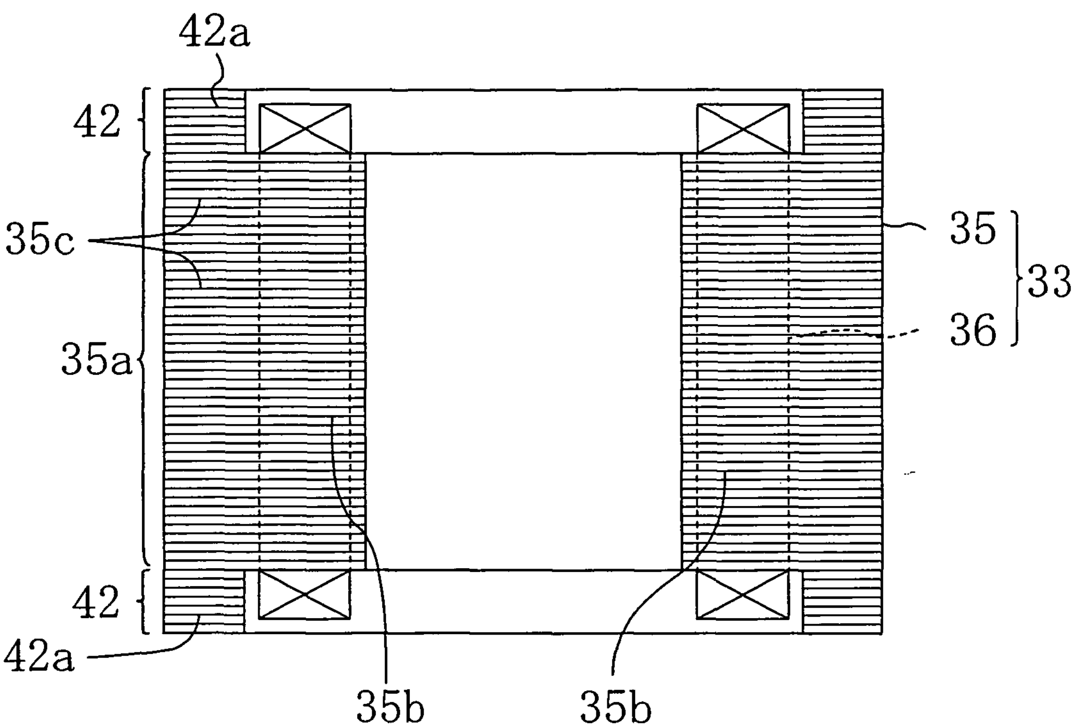

FIG. 3

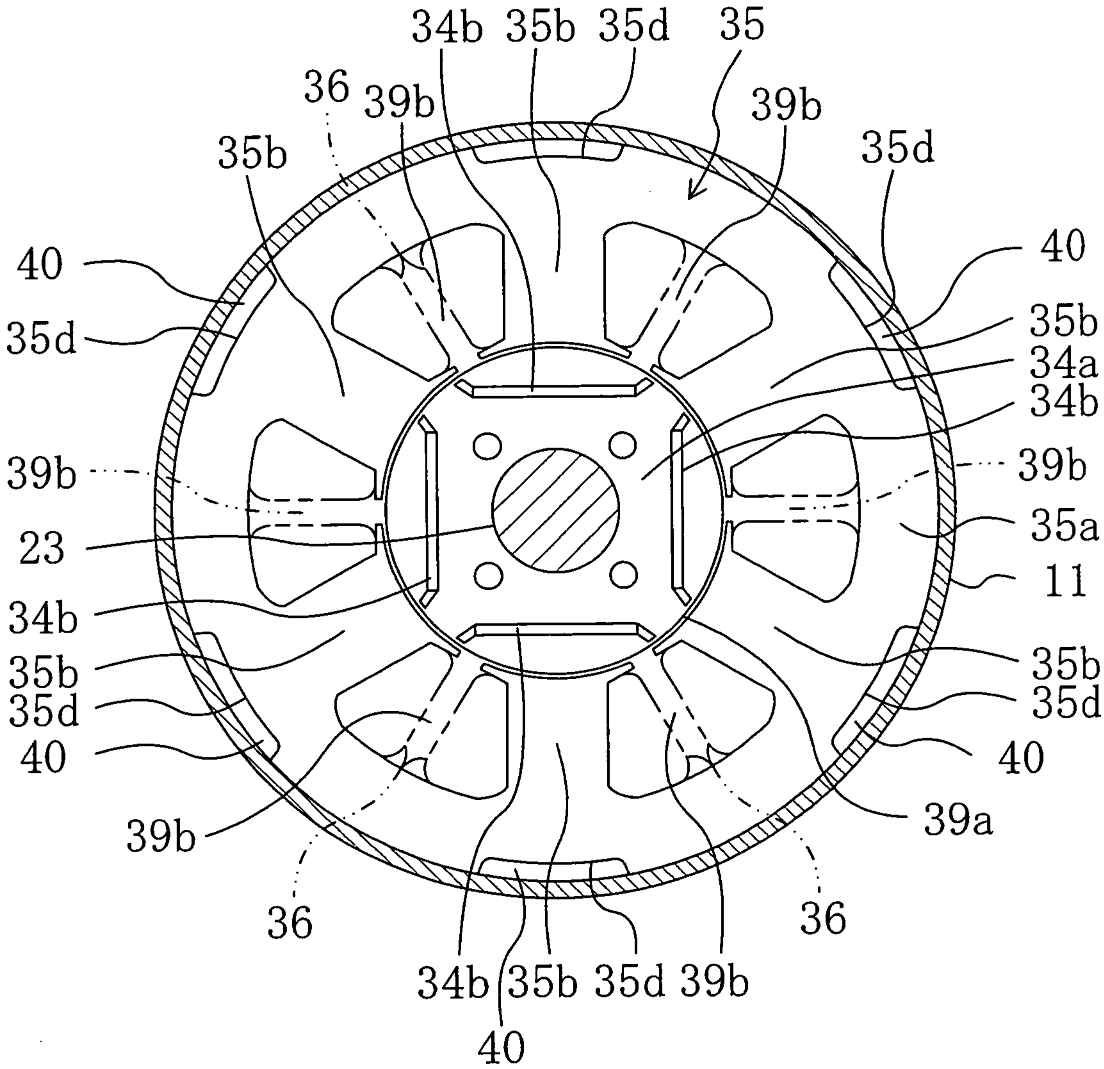
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FIG. 4

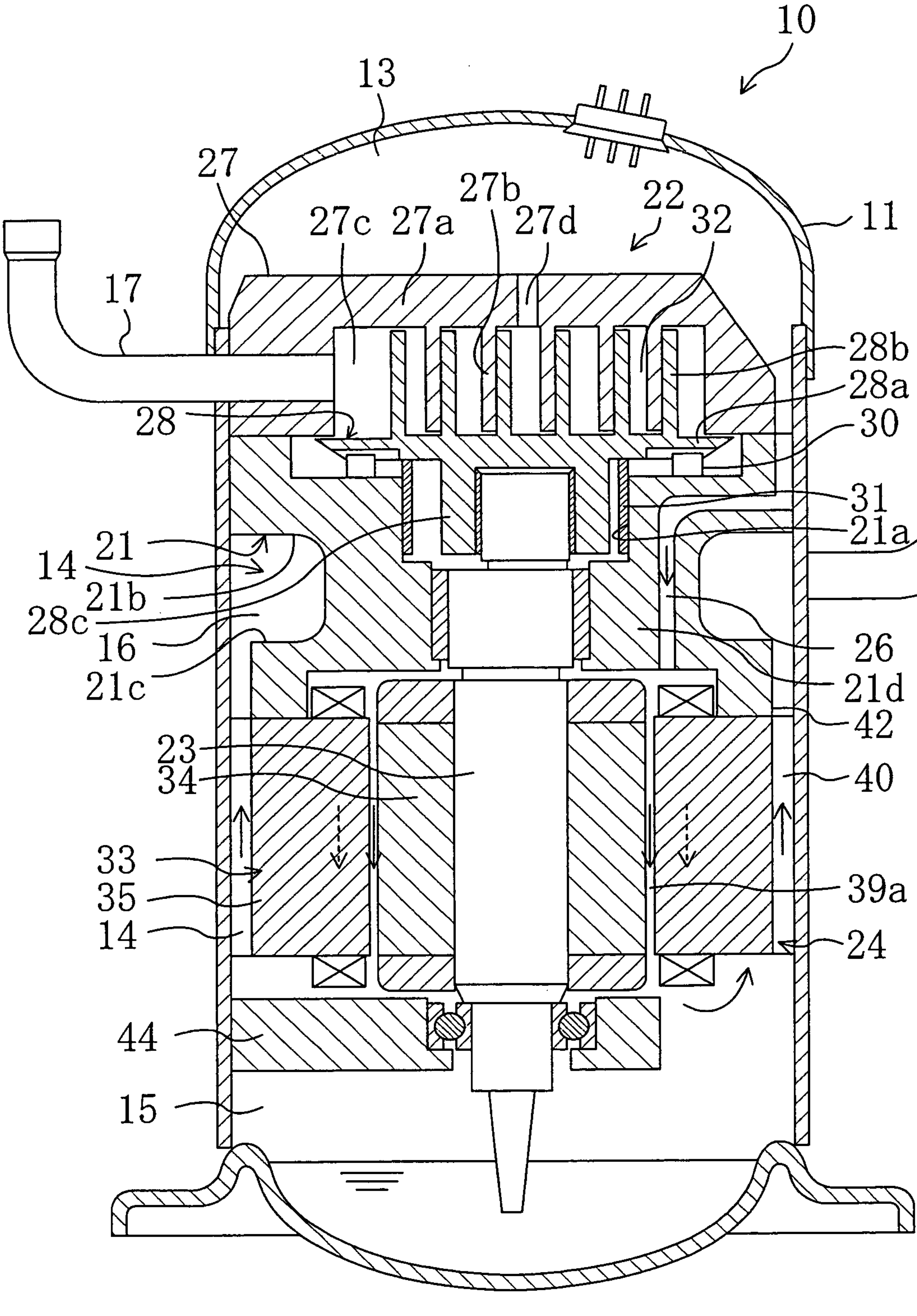
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FIG. 5

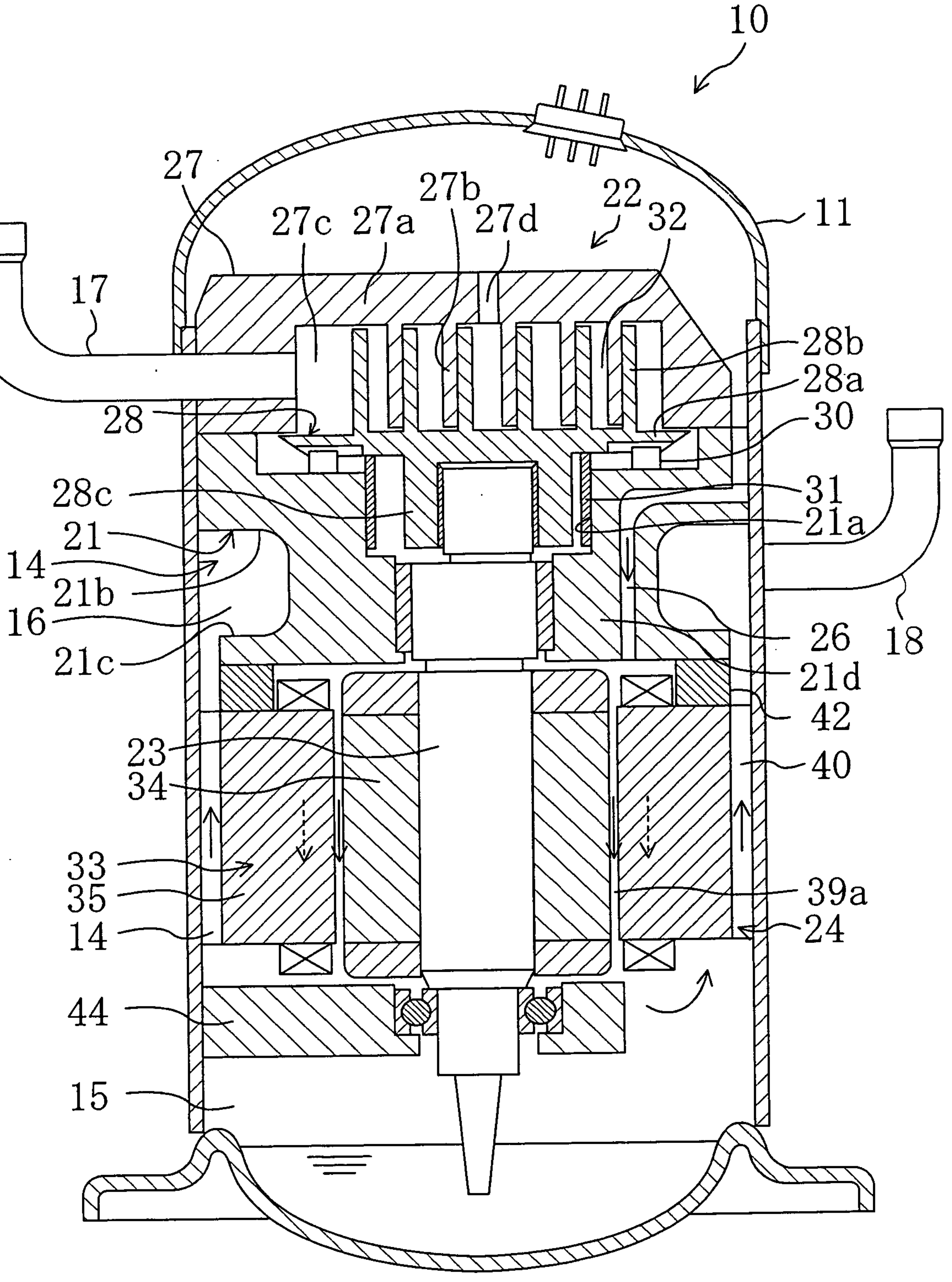
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FIG. 6

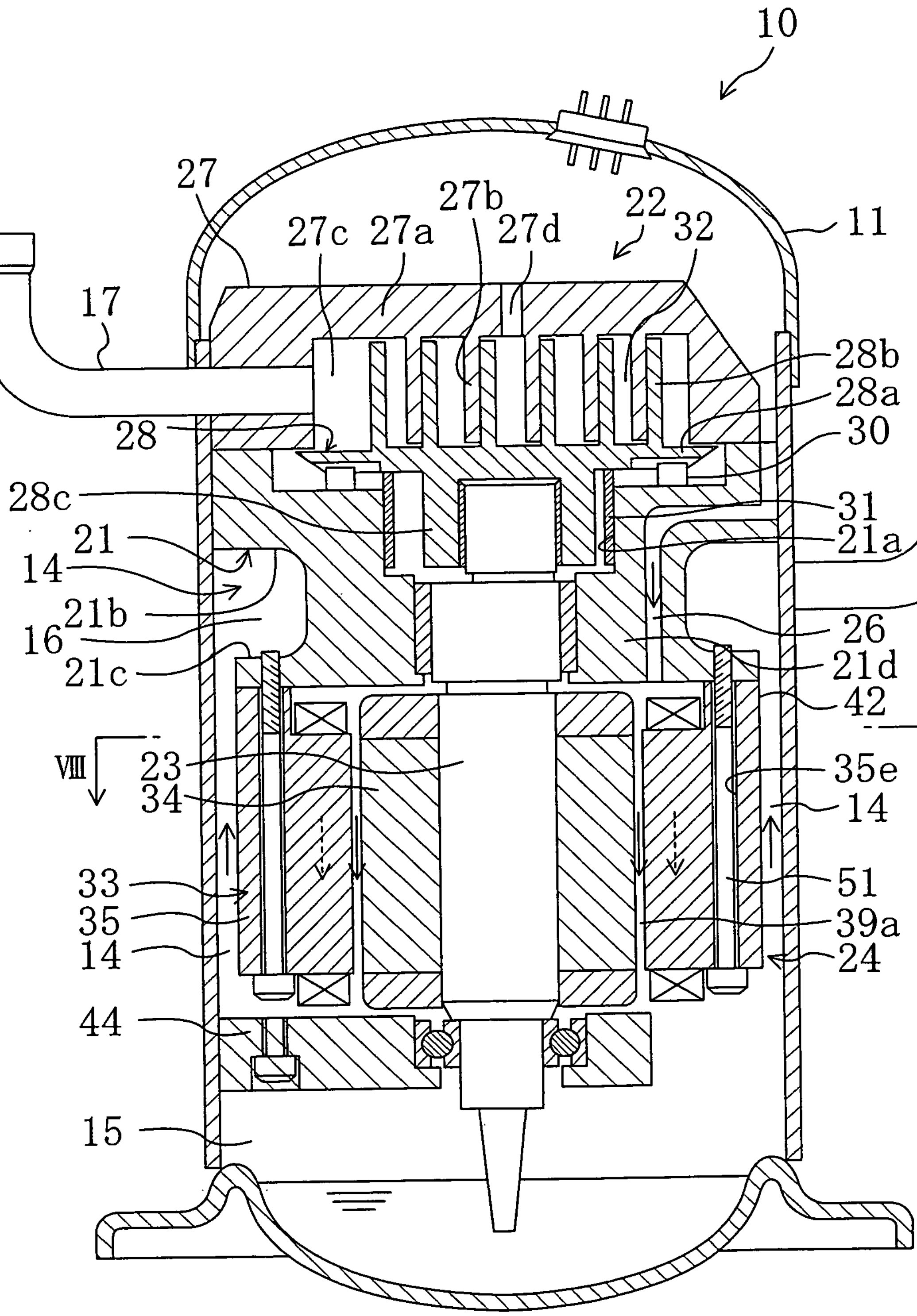
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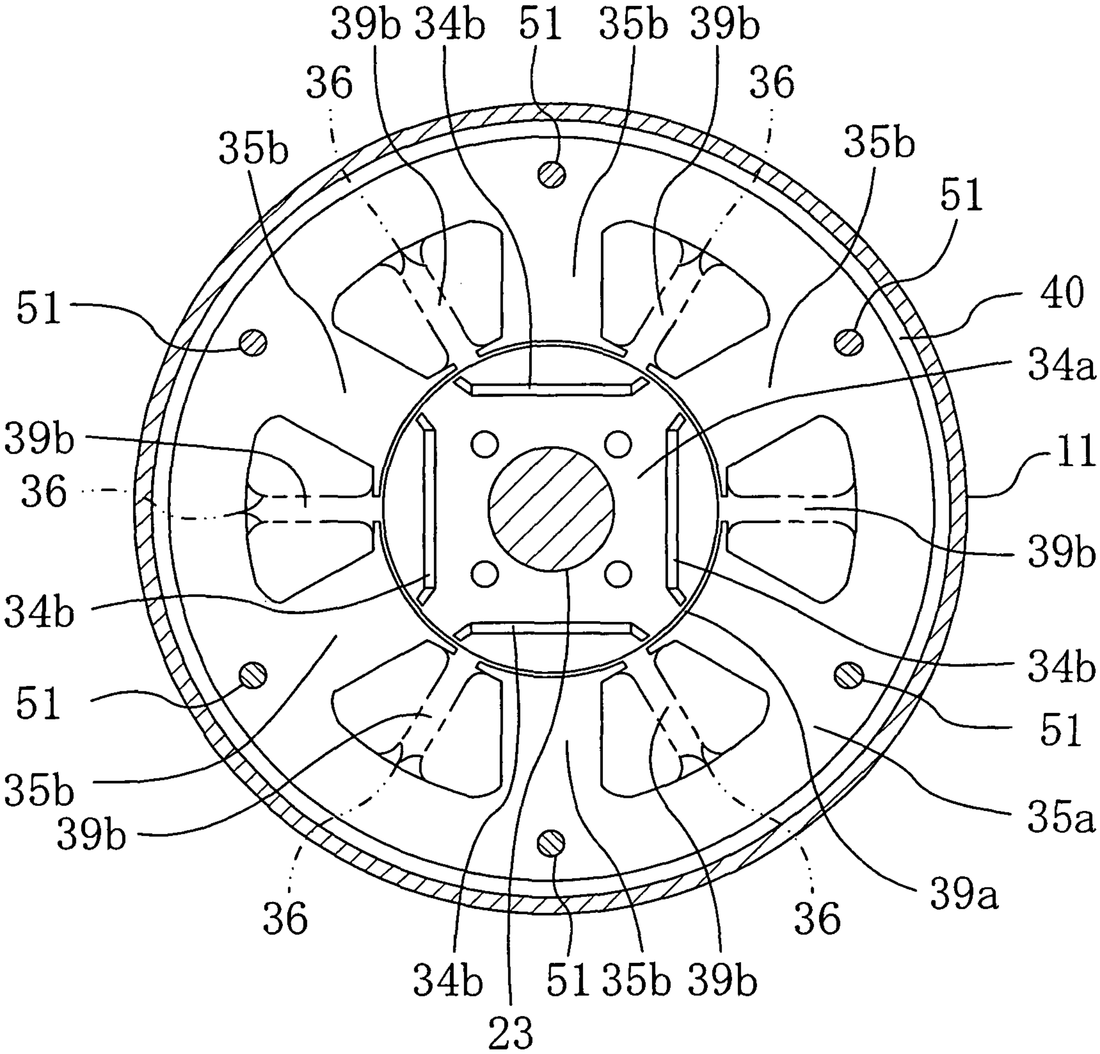
FIG. 7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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2004/008418

A. CLASSIFICATION OF SUBJECT MATTER

Int.Cl[7] F04B39/06

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Int.Cl[7] F04B39/06, F04B39/04, F04C29/04, F04C29/02

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho	1922-1996	Toroku Jitsuyo Shinan Koho	1994-2004
Kokai Jitsuyo Shinan Koho	1971-2004	Jitsuyo Shinan Toroku Koho	1996-2004

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y A	JP 58-160587 A (Hitachi, Ltd.), 24 September, 1983 (24.09.83), Page 2, lower right column, line 11 to page 3, upper left column, line 5; Figs. 6 to 8 (Family: none)	1-3 4-5,7-8, 12-14 6
X Y A	JP 6-26481 A (Career Corp.), 01 February, 1994 (01.02.94), Par. No. [0017]; Figs. 1 to 2 & EP 0569119 B1 & US 5221191 A & CA 2090381 A1 & DE 69310996 D, D1 & DE 69310996 T, T2 & KR 9703257 B1	1-4 5,7-8,12-14 6

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

* Special categories of cited documents:

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- "E" earlier application or patent but published on or after the international filing date
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- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed
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- "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
- "&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
17 August, 2004 (17.08.04)	31 August, 2004 (31.08.04)

Name and mailing address of the ISA/	Authorized officer
Japanese Patent Office	
Facsimile No.	Telephone No.

Form PCT/ISA/210 (second sheet) (January 2004)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2004/008418

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y A	JP 60-190690 A (The Trane Co.), 28 September, 1985 (28.09.85), Page 6, lower right column, lines 12 to 20; Figs. 1 to 3 & CA 1222733 A1 & DE 3506375 C2 & FR 2559847 B1 & GB 2154664 B & US 4552518 A	1-3,8 4-5,7-8, 12-14 6
Y A	JP 2-86989 A (Mitsubishi Electric Corp.), 27 March, 1990 (27.03.90), Page 2, lower left column, line 8 to page 3, lower right column, line 10; Figs. 3 to 12 (Family: none)	4-5,7,12,14 6
X Y A	JP 7-189964 A (Matsushita Electric Industrial Co., Ltd.), 28 July, 1995 (28.07.95), Par. Nos. [0019] to [0031]; Figs. 1 to 4 (Family: none)	1,9-11 5,8,12,14 6
Y	JP 60-224991 A (Daikin Industries, Ltd.), 09 November, 1985 (09.11.85), Page 2, lower right column, line 3 to page 3, upper right column, line 17; Fig. 1 (Family: none)	12,14
E,X	JP 2003-193986 A (Hino Motors, Ltd.), 09 July, 2003 (09.07.03), Par. Nos. [0009] to [0038]; Figs. 1 to 7 (Family: none)	1-4,7-8,12

Form PCT/ISA/210 (continuation of second sheet) (January 2004)