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ROTATING ELECTRIC MACHINE SYSTEM

Abstract

A rotor of a rotating electric machine system includes a sleeve and a collar. An internal space is formed between a rotating shaft and the collar. In the sleeve, in an inserted portion that is inserted into the internal space, a communication flow path is formed that serves to place the rotor internal flow path and the internal space in communication. An outer circumferential surface of the inserted portion includes an abutment surface against which an inner circumferential surface of the collar abuts. The sleeve includes an inlet port from the internal flow path to the communication flow path, and an outlet port from the communication flow path to the internal space.

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is based upon and claims the benefit of priority from Japanese Patent Application No. 2024-024670 filed on Feb. 21, 2024, the contents of which are incorporated herein by reference.

BACKGROUND OF THE INVENTION

Field of the Invention

[0002] The present invention relates to a rotating electric machine system equipped with a rotating electric machine having a rotor and a stator, and a housing in which the stator is accommodated.

Description of the Related Art

[0003] The rotating electric machine includes a rotor having a rotating shaft, and a stator positioned on the outer circumference of the rotor. The rotor includes permanent magnets that are retained on the rotating shaft. When the rotating shaft rotates, an induced electric current is generated in an electromagnetic coil that makes up the stator. In this case, the rotating electric machine functions as a generator.

[0004] When the induced electric current occurs continuously in the electromagnetic coil, the electromagnetic coil becomes high in temperature. Accordingly, the permanent magnets take on radiant heat. Further, when the rotating shaft is caused to rotate at a high speed, the rotor is subjected to a large amount of air resistance. As can be appreciated from the reasons mentioned above, the temperature of the permanent magnets becomes high. As the temperature of the permanent magnets approaches the Curie temperature, the magnetic force of the permanent magnets decreases.

[0005] In JP 2011-097784 A, there is proposed a configuration in which a coolant supply passage is formed in a hollow interior of a rotating shaft, and further, a coolant flow through space is formed between the rotating shaft and a rotor core. The rotor core is positioned and fixed to the rotating shaft via two individual retainers. Moreover, in the rotating shaft, a communication passage is formed in a diametrical direction thereof. Further, in each of the two individual retainers, there is provided a coolant discharge outlet port.

[0006] A cooling liquid is supplied to the coolant supply passage. The cooling liquid, next, travels via the communication passage to the outer circumferential surface of the rotating shaft, and thereafter, flows through the coolant flow through space. The cooling liquid is discharged via the coolant discharge outlet port to the exterior of the rotor (into a hollow interior of the housing). The cooling liquid flows towards the stator. Moreover, In JP 2011-097784 A, cooling oil is cited as an example of the cooling liquid.

SUMMARY OF THE INVENTION

[0007] It is undesirable for the cooling liquid to leak out to any location other than the normal discharge outlet port.

[0008] The present invention has the object of solving the aforementioned problem.

[0009] An aspect of the invention is characterized by a rotating electric machine system including a rotating electric machine including a rotor and a stator, and a housing in which the stator is accommodated.

[0010] The rotor includes a rotating shaft, a sleeve configured to cover the rotating shaft from an outer circumferential side, permanent magnets configured to be retained in the sleeve, a collar configured to be disposed on the outer circumferential side relative to the sleeve and the rotating shaft, a rotor internal flow path configured to include an annular shaped space formed between an outer circumferential surface of the rotating shaft and an inner circumferential surface of the sleeve, and configured to extend in an axial direction of the rotating shaft, and an internal space formed between the outer circumferential surface of the rotating shaft and an inner circumferential surface of the collar. The rotating electric machine system includes a liquid coolant supplying device configured to supply a liquid coolant to the rotor internal flow path. The sleeve includes an inserted portion that is an axial end portion of the sleeve and is inserted into the internal space to separate the internal space from the rotor internal flow path, and a communication flow path that is formed in the inserted portion and is configured to place the internal space and the rotor internal flow path in communication. The outer circumferential surface of the inserted portion includes an abutment surface against which the inner circumferential surface of the collar abuts.

[0011] In the above-described configuration, an inlet port through which the liquid coolant flows in from the rotor internal flow path into the communication flow path, and an outlet port through which the liquid coolant flows out from the communication flow path into the internal space are located more inwardly in a diametrical direction of the rotating shaft than the abutment surface.

[0012] According to the present invention, it is possible to prevent the liquid coolant from leaking out from between the abutment surface, which is one portion of the outer circumferential surface of the sleeve, and the inner circumferential surface in the collar that is placed in abutment against the abutment surface.

[0013] The above and other objects, features, and advantages of the present invention will become more apparent from the following description when taken in conjunction with the accompanying drawings, in which a preferred embodiment of the present invention is shown by way of illustrative example.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] FIG. **1** is a schematic overall perspective view of a combined power system including a rotating electric machine system according to an embodiment of the present invention;

[0015] FIG. **2** is a schematic cross-sectional side view of the rotating electric machine system as viewed from a direction perpendicular to an axial direction;

[0016] FIG. **3** is a schematic cross-sectional side view of the rotating electric machine system as viewed from a direction perpendicular to the axial direction, at an angle of rotation that is different from that shown in FIG. **2**;

[0017] FIG. **4** is an enlarged cross-sectional view of main parts in the vicinity of a first bearing;

[0018] FIG. **5** is an enlarged cross-sectional view of main parts in the vicinity of a second bearing;

[0019] FIG. **6** is a schematic perspective view of one end part (a second end) in the axial direction of a sleeve; and

[0020] FIG. **7** is a schematic flow diagram showing flow through passages of a gaseous coolant and a liquid coolant.

DETAILED DESCRIPTION OF THE INVENTION

[0021] In the following description, compressed air AR (refer to FIG. **2** and FIG. **7**) is illustrated as an example of a gaseous coolant, and a cooling oil CO**1** and a cooling oil CO**2** (refer to FIG. **2**, FIG. **3**, and FIG. **7**) are illustrated as examples of a liquid coolant. In the present embodiment, the cooling oil CO**1** and the cooling oil CO**2** are supplied from a same oil supplying device **904** (refer to FIG. **7**) as a lubricating oil LO that is supplied to a first bearing **400** and a second bearing **500**. However, these are merely exemplary illustrations. The gaseous coolant may be compressed nitrogen or the like. The liquid coolant may be an oil supplied from an oil supplying device that is separate from the oil supplying device **904**. The liquid coolant may be an organic solvent with a high boiling point and a low volatility.

[0022] FIG. **1** is a schematic overall perspective view of a combined power system **10** according to the present embodiment. The combined power system **10** is equipped with a rotating electric machine system **20** according to the present embodiment, and a gas turbine engine **950**. An axial line of the rotating electric machine system **20** and an axial line of the gas turbine engine **950** coincide with each other. Stated otherwise, the rotating electric machine system **20** and the gas turbine engine **950** are arranged in series on the same axial line.

[0023] The combined power system **10** is used, for example, as a motive power source for providing propulsion in a flying object, a ship, an automobile, or the like. Suitable specific examples of the flying object include drones and multi-copters. The combined power system **10**, when mounted on a flying object, is used as a power drive source for rotationally driving, for example, a prop, a ducted fan, or the like. The combined power system **10**, when mounted on a ship, is used as a screw rotational force generating device. The combined power system **10**, when mounted on an automobile, is used as a power drive source for rotating a motor.

[0024] The combined power system **10** can also be used as an auxiliary electrical power source in an aircraft, a ship, a building, or the like. Apart therefrom, it is also possible to utilize the combined power system **10** as gas turbine power generation equipment.

[0025] The gas turbine engine **950** is an internal combustion engine. Further, the gas turbine engine **950** serves as a gaseous coolant supplying device that supplies compressed air AR. As will be discussed later, the compressed air AR circulates as a gaseous coolant inside a rotating electric machine housing **22**.

[0026] In the following description, the respective terms “left”, “right”, “lower”, and “upper” refer specifically to the left, right, lower, and upper directions shown in FIG. **2** and FIG. **3**. However, these directions are provided for the sake of convenience in order to simplify the description and facilitate understanding. In particular, the directions described in the specification are not limited to the directions when the combined power system **10** is actually used.

[0027] Further, in the following description, the left end in the axial direction of each of the rotating electric machine system **20** and the gas turbine engine **950** may be referred to as a first end. Similarly, the right end in the axial direction of each of the rotating electric machine system **20** and the gas turbine engine **950** may be referred to as a second end. Further, in each of the members, a surface facing toward the first end may be referred to as a “first end surface”, and a surface facing toward the second end may be referred to as a “second end surface”.

[0028] A description will be given concerning the rotating electric machine system **20**. FIG. **2** and FIG. **3** are schematic cross-sectional side views of the rotating electric machine system **20** as viewed from a direction perpendicular to the axial direction. Moreover, in FIG. **2** and FIG. **3**, the angles of rotation of the rotating electric machine system **20** are mutually different from each other. The rotating electric machine system **20** is equipped with a rotating electric machine **60**, and the rotating electric machine housing **22** (a housing) in which the rotating electric machine **60** is accommodated. In the present embodiment, the rotating electric machine **60** is a generator.

[0029] The rotating electric machine housing **22** includes a main housing **24**, a first sub-housing **26**, and a second sub-housing **28**. A first end and a second end of the main housing **24** are open ends, and the main housing **24** exhibits a substantially cylindrical shape. The first sub-housing **26** is connected to the first end (the left open end) of the main housing **24**. The second sub-housing **28** is connected to the second end (the right open end) of the main housing **24**. In the manner described above, the first end and the second end of the main housing **24** are closed.

[0030] As shown in FIG. **1**, a first casing **40** and a second casing **42** are provided on the outer circumferential surface of the main housing **24**. A description will be given later concerning the first casing **40** and the second casing **42**.

[0031] A cooling jacket **38** is formed in the interior of a side circumferential part of the main housing **24**. A cooling medium such as cooling water or the like flows through the cooling jacket **38**.

[0032] As shown in FIG. **2** and FIG. **3**, the main housing **24** includes a hollow interior portion **30**. The hollow interior portion **30** is divided by a partition wall member **32** into a rotor chamber **34** and a stator chamber **36**. The rotor chamber **34** is a chamber that is formed on an inner side (an inner circumferential side) in a diametrical direction of the partition wall member **32**. The stator chamber **36** is a chamber that is formed on an outer side (an outer circumferential side) in the diametrical direction of the partition wall member **32**.

[0033] The rotating electric machine **60** is equipped with a rotor **62**, and a stator **64** that surrounds an outer circumference of the rotor **62**. The partition wall member **32** is interposed between the rotor **62** and the stator **64** in a diametrical direction of a rotating shaft **66**. Accordingly, the rotor **62** is positioned on the inner circumferential side of the partition wall member **32**. Stated otherwise, the rotor **62** is accommodated in the rotor chamber **34**. The stator **64** is positioned on the outer circumferential side of the partition wall member **32**. Stated otherwise, the stator **64** is accommodated in the stator chamber **36**.

[0034] The partition wall member **32**, for example, is a cylindrically shaped body made up from an insulating and a non-magnetic ceramic. It is preferable that a separation distance between the outer circumferential surface of permanent magnets **270** constituting the rotor **62**, and the inner circumferential surface of the partition wall member **32** be greater than a separation distance between the outer circumferential surface of the partition wall member **32** and a plurality of individual electromagnetic coils **310** constituting the stator **64**. The value of the former is preferably set to be approximately 2.5 times to approximately 4 times the value of the latter. To cite one example of a combination of the former and the latter, the value of the former lies within a range of from 1.1 mm to 2.1 mm, and the value of the latter lies within a range of from 0.3 mm to 0.5 mm.

[0035] A first end of the partition wall member **32** is inserted into the interior of a tubular shaped portion **620** that projects out in the axial direction from a first wall surface **612** of a partition member **610**. The inner surface of the stator chamber **36** includes the first wall surface **612** of the partition member **610**, the outer circumferential surface of the partition wall member **32**, and the inner circumferential surface of the main housing **24**. More specifically, the first wall surface **612** of the partition member **610** forms one portion of the inner surface of the stator chamber **36**. By the partition wall member **32**, the partition member **610**, and the inner circumferential surface of the main housing **24**, the rotor chamber **34** and the stator chamber **36** are separated in a liquid-tight and airtight manner. More specifically, the rotor chamber **34** and the stator chamber **36** are spaces that are independent from each other.

[0036] The rotor **62** is constituted by including the rotating shaft **66**, a sleeve **220**, and the permanent magnets **270**. An inner hole **222**, which extends in the axial direction of the sleeve **220**, is formed in the sleeve **220**. The rotating shaft **66** passes through the inner hole **222**. Accordingly, in the diametrical direction of the rotating shaft **66**, the sleeve **220** is interposed between the rotating shaft **66** and the permanent magnets **270**. A major portion of a later-described rotor internal flow path **210** is formed by the inner hole **222** and the rotating shaft **66**.

[0037] The rotating shaft **66** includes an inner shaft **68**, and a hollow tubular shaped outer shaft **70**. Both ends of the outer shaft **70** are open ends. More specifically, as shown in FIG. **2**, the outer shaft **70** has a first hollow end part **72** and a second hollow end part **74**.

[0038] The inner shaft **68** is removably inserted into the interior of the outer shaft **70**. The inner shaft **68** is longer in length than the outer shaft **70**. As shown in FIG. **2**, the inner shaft **68** includes a left end part **80** (an end part on a first end side) which is one end part in the axial direction, and a right end part **82** (an end part on a second end side) which is another end part in the axial direction.

[0039] One portion of the left end part **80** is exposed from the first hollow end part **72** of the outer shaft **70**. Hereinafter, in the left end part **80**, one portion thereof that is exposed from the first hollow end part **72** will be referred to as an extending portion **90**. The extending portion **90** is connected to the first hollow end part **72** of the outer shaft **70** by a positioning fixture **100** that includes a nut member **102** or the like.

[0040] A resolver rotor **52** and a lock nut **104** are provided on an extending distal end of the extending portion **90**. By the lock nut **104**, the resolver rotor **52** is prevented from coming off from the extending portion **90**.

[0041] A first end of an output shaft **964** that constitutes the gas turbine engine **950** is connected to the right end part **82** of the inner shaft **68**. A description will be given later concerning this feature.

[0042] The outer shaft **70** includes a first shaft portion **70***a* to a fifth shaft portion **70***e* in a direction from the first end to the second end. The outer diameter becomes larger in a stepwise manner from the first shaft portion **70***a* until the fourth shaft portion **70***d*. The outer diameter of the fifth shaft portion **70***e* is smaller than the outer diameter of the fourth shaft portion **70***d*, and further, is substantially the same as the outer diameter of the third shaft portion **70***c*.

[0043] As shown in FIG. **4**, the first shaft portion **70***a* has a first external thread **76** thereon. As shown in FIG. **3** and FIG. **4**, a second shaft portion **70***b* has a plurality of individual groove shaped flow paths **212** formed on an outer circumferential surface thereof in the circumferential direction of the second shaft portion **70***b*. In FIG. **4**, an individual one from among the plurality of individual groove shaped flow paths **212** is shown. Each of the plurality of individual groove shaped flow paths **212** is recessed inwardly in a diametrical direction of the rotating shaft **66** from the outer circumferential surface of the second shaft portion **70***b*, and extends in the axial direction of the rotating shaft **66**.

[0044] The third shaft portion **70***c* has a cylindrical shape in which an inner diameter and an outer diameter thereof are substantially constant. A plurality of individual guide flow paths **214** are formed on the outer circumferential surface of the third shaft portion **70***c* in the circumferential direction of the third shaft portion **70***c*. In FIG. **4**, an individual one from among the plurality of individual guide flow paths **214** is shown. Each of the plurality of guide flow paths **214** is formed at a first end of the third shaft portion **70***c* facing toward the second shaft portion **70***b*. First ends of the guide flow paths **214** are connected to second ends of the groove shaped flow paths **212**. The guide flow paths **214** constitute one portion (to be discussed later) of the rotor internal flow path **210**. The guide flow paths **214**, as they separate away from the second shaft portion **70***b*, are inclined in a manner so as to be inclined from the inner side toward the outer side (the outer circumferential surface of the third shaft portion **70***c*) in the diametrical direction of the rotating shaft **66**.

[0045] As shown in FIG. **2** and FIG. **5**, the fourth shaft portion **70***d* includes on the outer circumferential surface thereof a flange member **77** and a second external thread **78**. As shown in FIG. **2**, FIG. **3**, and FIG. **5**, the fifth shaft portion **70***e* is of a cylindrical shape in which the inner diameter and the outer diameter thereof are substantially constant.

[0046] As shown in FIG. **2**, FIG. **3**, and FIG. **4**, a screw cap **200** is screwed onto the first external thread **76** of the first shaft portion **70***a*. A second end surface of the screw cap **200** abuts against a first end surface of a first inner ring **402** (refer to FIG. **4**) of the first bearing **400**.

[0047] As shown in FIG. **2** and FIG. **3**, most of the third shaft portion **70***c* is covered with the sleeve **220**. Stated otherwise, the sleeve **220** covers from an outer circumferential side the third shaft portion **70***c* that constitutes the rotating shaft **66**.

[0048] The permanent magnets **270** are retained in the sleeve **220**. In the present aspect, the rotor **62** is a so-called SPM (surface permanent magnet motor) type in which the permanent magnets **270** are disposed on the outer circumferential surface of the sleeve **220**. Alternatively, the rotor **62** may be of a so-called IPM (interior permanent magnet motor) type in which the permanent magnets **270** are embedded in the sleeve **220**.

[0049] The sleeve **220** and the permanent magnets **270** are sandwiched between a magnet stopper **272** and a collar **240** in the axial direction of the rotating shaft **66**. In accordance therewith, the sleeve **220** is positioned and fixed on an outer circumferential surface of the outer shaft **70**. More specifically, a positional deviation of the sleeve **220** and the permanent magnets **270** with respect to the outer shaft **70** is prevented. In this manner, by fixing and positioning the sleeve **220**, the magnet stopper **272** and the collar **240** serve to position and fix the permanent magnets **270**.

[0050] As shown in FIG. **4**, one portion of the magnet stopper **272** is interposed between an inner circumferential surface of a guide member **560** and an outer circumferential surface of an inner ring stopper **460**. A first ring body **274** is sandwiched between the magnet stopper **272** and the permanent magnets **270** in the axial direction of the rotating shaft **66**. A second ring body **276** is sandwiched between the permanent magnets **270** and the collar **240** in the axial direction of the rotating shaft **66**.

[0051] The collar **240** is disposed on an outer circumferential side of the sleeve **220** and the fourth shaft portion **70***d*. An internal space **242** is formed between the outer circumferential surface of the fourth shaft portion **70***d* and an inner circumferential surface **256** of the collar **240**. More specifically, the rotor **62** includes the internal space **242**. As shown in FIG. **5**, an inserted portion **224** of the sleeve **220** is inserted into the internal space **242**. The inserted portion **224** is an end portion at a second end of the sleeve **220**.

[0052] In an exemplary illustration, the inserted portion **224** includes a first annular shaped convex portion **226**, and a second annular shaped convex portion **228**. In the sleeve **220**, the first annular shaped convex portion **226** is a portion that is projected out in an annular shape in the axial direction from the second end of a main body portion **225**, the inner diameter and the outer diameter of which are constant. The first annular shaped convex portion **226** is smaller in diameter than the main body portion **225**. The second annular shaped convex portion **228** is a portion that is projected out in an annular shape in the axial direction of the sleeve **220** from the second end of the first annular shaped convex portion **226**. The second annular shaped convex portion **228** is smaller in diameter than the first annular shaped convex portion **226**.

[0053] The inserted portion **224** may be at the second end of the main body portion **225**. More specifically, it is not essential that the inserted portion **224** includes the first annular shaped convex portion **226** and the second annular shaped convex portion **228**.

[0054] The outer circumferential surface of the first annular shaped convex portion **226** abuts against an inner circumferential surface **256***a* of a first inner chamber **242***a*. The inner circumferential surface **256***a* of the first inner chamber **242***a* is one portion of the inner circumferential surface **256** of the collar **240**. Hereinafter, in the outer circumferential surface of the first annular shaped convex portion **226**, a portion thereof that abuts against the inner circumferential surface **256***a* of the collar **240** will be referred to as an abutment surface **230**. In the illustrated example, the entirety of the outer circumferential surface of the first annular shaped convex portion **226** is the abutment surface **230**. However, the abutment surface **230** may be one portion of the outer circumferential surface of the first annular shaped convex portion **226**.

[0055] The second annular shaped convex portion **228** constituting the inserted portion **224** separates the rotor internal flow path **210**, and the internal space **242**. As shown in FIG. **5** and FIG. **6**, a communication flow path **232** is provided, which extends from the inner circumferential surface of the main body portion **225** to the first end of the second annular shaped convex portion **228**. The communication flow path **232** may be one individual flow path, or may be a plurality of individual flow paths.

[0056] The rotor internal flow path **210** and the internal space **242** communicate with each other via the communication flow path **232**. An inlet port **234** for the cooling oil CO**2** to the communication flow path **232** is formed on the inner circumferential surface of the main body portion **225** in facing relation to the rotor internal flow path **210**. An outlet port **236** for the cooling oil CO**2** from the communication flow path **232** is formed at a first end of the second annular shaped convex portion **228** in facing relation to the internal space **242**. The inlet port **234** is positioned more inwardly in the diametrical direction of the rotating shaft **66** than the outlet port **236**. The outlet port **236** is positioned more inwardly in the diametrical direction of the rotating shaft **66** than the abutment surface **230**. Therefore, the outlet port **236** is not formed in the abutment surface **230**. Accordingly, the entirety of the abutment surface **230** abuts against the inner circumferential surface **256***a* of the first inner chamber **242***a*.

[0057] The communication flow path **232**, as it approaches in close proximity to the internal space **242** from the rotor internal flow path **210**, or stated otherwise, as it approaches from the inlet port toward the outlet port, is inclined in a manner so as to face from an inner side to an outer side in the diametrical direction of the rotating shaft **66**. However, this feature is just one aspect. The communication flow path **232** may be an L-shaped member having a portion that extends in the axial direction.

[0058] The collar **240** includes a tubular shaped portion **244** and a partition wall **246**. The partition wall **246** is formed in a disk-like shape in the interior of the tubular shaped portion **244**. An insertion hole **248** through which the rotating shaft **66** is inserted is formed at the center in the diametrical direction of the partition wall **246**. An internal thread **250** is formed on the inner circumferential surface of the insertion hole **248**. Further, a receiving hole **252** is connected to a first end side of the insertion hole **248**. The inner diameter of the receiving hole **252** is larger than the inner diameter of the insertion hole **248**. The flange member **77**, which is provided on the fourth shaft portion **70***d* in the outer shaft **70**, engages with the receiving hole **252**. The internal thread **250** is screw-engaged with the second external thread **78** that is provided on the fourth shaft portion **70***d*. In the manner described above, the collar **240** is retained on the outer shaft **70**.

[0059] The partition wall **246** divides the internal space **242** into the first inner chamber **242***a* and a second inner chamber **242***b*. In the diametrical direction of the partition wall **246**, a discharge flow path **254** is formed more on the outer circumference than the insertion hole **248**. The discharge flow path **254** may be one individual flow path, or may be a plurality of individual flow paths. The first inner chamber **242***a* and the second inner chamber **242***b* are placed in communication by the discharge flow path **254**. The inner circumferential surface **256***a* of the first inner chamber **242***a* abuts against the abutment surface **230** of the sleeve **220**.

[0060] Next, a description will be given concerning the configuration around the circumference of the first end of the rotor **62**.

[0061] As shown in FIG. **2**, FIG. **3**, and FIG. **4**, the second shaft portion **70***b* of the outer shaft **70** is retained via the first bearing **400** to be capable of rotating in the first sub-housing **26**. Specifically, a first bearing chamber **410** is formed in the first sub-housing **26**. A hollow tubular shaped first bearing holder **420**, and a hollow tubular shaped holder spacer **450** are inserted into the first end side of the first bearing chamber **410**. The first bearing **400** is interposed between the second shaft portion **70***b* and the first bearing holder **420**. The first end of the rotating shaft **66** is passed through the first inner ring **402** of the first bearing **400**.

[0062] An insulating material **430** is interposed between the outer surface of a first outer ring **406** of the first bearing **400**, and the inner surface of the first bearing holder **420**. Due to the insulating material **430**, the first bearing **400** and the first bearing holder **420** are electrically insulated.

[0063] As shown in FIG. **4**, an annular shaped groove **422** is formed in the first bearing holder **420**. Within the annular shaped groove **422**, a plurality of first oil supply holes **424** are radially formed. Further, in the holder spacer **450**, a plurality of individual communication holes **452** are formed in a radial shape. An inner circumferential opening of each of the plurality of individual communication holes **452** overlaps with the outer circumferential opening of each of the plurality of individual first oil supply holes **424**. The plurality of individual communication holes **452** and the plurality of individual first oil supply holes **424** are holes for the purpose of supplying the lubricating oil LO from the oil supplying device **904** to the first bearing **400**.

[0064] The first bearing holder **420** includes a plurality of individual flow through holes **426** therein. The plurality of individual flow through holes **426** are holes for the purpose of discharging the lubricating oil LO that was supplied to the first bearing **400** to the exterior of the first bearing holder **420**.

[0065] A spacer ring **440** is positioned and fixed inside an interior of the first bearing holder **420**. A pressure applying member **442** made up from a disk spring applies a load (an applied pressure), via the spacer ring **440**, to the second end surface of the first outer ring **406**. The direction of the load is in the axial direction of the rotating shaft **66**. Moreover, an insulating material **444** is interposed between the second end surface of the first bearing **400**, and the first end surface of the spacer ring **440**.

[0066] The spacer ring **440** includes a plurality of individual relay holes **446**. Each of the individual relay holes **446** communicates, via each of the individual flow through holes **426**, with each of the individual first oil supply holes **424**.
[0067] The inner ring stopper **460** is inserted into the interior of the first bearing holder **420**. The first inner ring **402** of the first bearing **400** is sandwiched between the screw cap **200** and the inner ring stopper **460** in the axial direction of the outer shaft **70**. Consequently, the first bearing **400** is positioned and fixed at a predetermined location on the outer circumferential surface of the outer shaft **70**.
[0068] The left end of the first bearing chamber **410** is separated farther away from the output shaft **964** than the right end of the first bearing chamber **410** is. Hereinafter, in the first bearing chamber **410**, the left end, which is separated farther away from the output shaft **964** than the right end is, may be referred to as a "first distal end **412**". Further, the right end, which is in closer proximity to the output shaft **964** than the first distal end **412** is, may be referred to as a "first proximal end **414**".
[0069] As shown in FIG. **2**, a shaft hole **470** is formed at a diametrical center of a resolver holder **56**. An extending distal end of the extending portion **90** is passed through the shaft hole **470**. At a first end of the resolver holder **56**, the shaft hole **470** is closed by a cap cover **472**.
[0070] A resolver stator **54** is retained on an inner circumferential surface of the shaft hole **470**. The resolver rotor **52** is positioned on an inner circumferential side of the resolver stator **54**. A resolver **50** is constituted by the resolver stator **54** and the resolver rotor **52**.
[0071] An engagement hole **474** is formed in the resolver holder **56**. A transmission connector **58** is engaged with the engagement hole **474**. The resolver stator **54** and the transmission connector **58** are electrically connected via a signal line **59**. The transmission connector **58** is a connector for the purpose of transmitting a signal in relation to a rotation parameter to a non-illustrated receiver.
[0072] Next, a description will be given concerning the configuration around the circumference of the second end of the rotor **62**. As shown in FIG. **2**, FIG. **3**, and FIG. **5**, the second end of the rotating shaft **66** is retained to be capable of rotating in the main housing **24** via the second bearing **500**.
[0073] A retaining concave portion **508**, which is recessed toward the first end and communicates with the rotor chamber **34**, is formed at the second end of the main housing **24**. A second bearing chamber **520** is formed by the retaining concave portion **508** of the main housing **24**, and a hollow concave portion **512** of the second sub-housing **28** which is a hollow body. The second bearing **500** is accommodated in the second bearing chamber **520**.
[0074] The left end of the second bearing chamber **520** is separated farther away from the output shaft **964** than the right end of the second bearing chamber **520** is. Hereinafter, in the second bearing chamber **520**, the left end, which is separated farther away from the output shaft **964** than the right end is, may be referred to as a "second distal end **522**". Further, the right end, which is in closer to the output shaft **964** than the second distal end **522** is, may be referred to as a "second proximal end **524**".
[0075] The second bearing **500** is sandwiched between the outer circumferential surface of the second end of the outer shaft **70**, and the inner circumferential surface of a second bearing holder **530**. The second bearing holder **530** is connected via bolts or the like to the second end of the main housing **24**. Consequently, the second bearing holder **530** is positioned and fixed to the rotating electric machine housing **22**.
[0076] The second bearing holder **530** is positioned diametrically outward of a second outer ring **506**, and covers the second bearing **500** from the outer circumferential surface side of the second outer ring **506**. A non-illustrated insulating material is interposed between the outer circumferential surface of the second outer ring **506**, and the inner circumferential surface of the second bearing holder **530**.
[0077] An inner side inner ring stopper **540** and an outer side inner ring stopper **542** are inserted

into the interior of the second bearing holder **530**. The inner side inner ring stopper **540** is positioned at the second distal end **522**, and the outer side inner ring stopper **542** is positioned at the second proximal end **524**. A second inner ring **502** of the second bearing **500** is sandwiched between the inner side inner ring stopper **540** and the outer side inner ring stopper **542**. Consequently, the second bearing **500** is positioned and fixed at a predetermined location on the outer circumferential surface of the outer shaft **70**.

[0078] A flow rectifying member **550** is accommodated in the hollow concave portion **512** of the second sub-housing **28**. The flow rectifying member **550** is of a substantially truncated conical shape, and decreases in diameter in a tapered shape from a first end toward a second end thereof. The second end of the flow rectifying member **550** is positioned and fixed to the second end of the main housing **24**.

[0079] A ventilation hole **554** is formed at a center in the diametrical direction of the flow rectifying member **550**. The outer circumferential surface of the outer side inner ring stopper **542** faces in the diametrical direction with respect to the inner circumferential surface of the ventilation hole **554**.

[0080] As shown in FIG. **2**, FIG. **3**, FIG. **4**, and FIG. **5**, annular shaped flow through spaces **216** are formed respectively on the screw cap **200**, between the groove shaped flow paths **212** of the second shaft portion **70***b* and the first inner ring **402** of the first bearing **400**, between the third shaft portion **70***c* and the inner ring stopper **460**, and between the third shaft portion **70***c* and the sleeve **220**. The rotor internal flow path **210** is formed by these flow through spaces **216**.

[0081] The rotor internal flow path **210** is a flow path that extends in the axial direction of the rotating shaft **66**, and for example, may be an annular shaped space that extends partially in the axial direction. The rotor internal flow path **210** extends from the first end to the second end of each of the permanent magnets **270** in the axial direction of the rotating shaft **66**. The rotor internal flow path **210** may be a groove or the like.

[0082] The rotor **62** is constituted in the manner described above. Next, with reference to FIG. **2** and FIG. **3**, a description will be given concerning the stator **64**. The stator **64** constitutes the rotating electric machine **60** together with the aforementioned rotor **62**. The stator **64** includes a stator core **300**, and the plurality of individual electromagnetic coils **310**.

[0083] The stator core **300** is a cylindrically shaped member. The stator core **300** is constituted, for example, by laminating a plurality of ring-shaped electromagnetic steel plates in the axial direction. A plurality of individual slots are formed in the stator core **300**. Teeth portions are positioned between adjacent ones of the slots.

[0084] The plurality of individual electromagnetic coils **310** are a U-phase coil, a V-phase coil, and a W-phase coil. As can be understood from this feature, in the case that the rotating electric machine **60** is a generator, the rotating electric machine **60** is a so-called three-phase electrical power source. Each of the plurality of individual electromagnetic coils **310** is constituted by winding a conductive wire around the teeth portions of the stator core **300**.

[0085] Among the plurality of individual electromagnetic coils **310**, portions thereof that project out in the axial direction from the stator core **300** become end portions of the electromagnetic coils **310**. The end portions of the plurality of individual electromagnetic coils **310** constitute a coil end portion **314** shown in FIG. **2**.

[0086] Concerning each of the plurality of individual electromagnetic coils **310**, the other end (a terminal end **316**) of the conductive wire that makes up each of the electromagnetic coils **310** is pulled out from the coil end portion **314**. The terminal ends **316**, by being bundled together and connected, thereby constitute a neutral point **318**. The neutral point **318**, by being inserted into the interior of a neutral point terminal **320**, is fixed to the coil end portion **314**.

[0087] A brief description will now be given concerning the external configuration of the rotating electric machine housing **22**. As shown in FIG. **1**, the first casing **40** and the second casing **42** are integrally provided on an outer circumferential surface in the vicinity of a left end of the main housing **24**. More specifically, the first casing **40** and the second casing **42** serve as one portion of the main housing **24**.

[0088] As shown in FIG. **2**, a lower contact chamber **44** and an upper terminal chamber **46** are formed in the interior of the first casing **40**. The contact chamber **44** and the terminal chamber **46** become spaces that are independent from each other. The contact chamber **44** communicates with the stator chamber **36**. In the contact chamber **44**, an insertion port **48** is formed that opens at a first end surface of the first casing **40**. The insertion port **48** is closed by a lid member **45**.

[0089] A U-phase terminal **110***a*, a V-phase terminal **110***b*, and a W-phase terminal **110***c* are accommodated in the terminal chamber **46**. The U-phase terminal **110***a*, the V-phase terminal **110***b*, and the W-phase terminal **110***c* are electrically connected to the U-phase coil, the V-phase coil, and the W-phase coil of the electromagnetic coils **310**, respectively, in the contact chamber **44**. In FIG. **2**, a state is illustrated in which a terminal portion **112** of the V-phase terminal **110***b*, and a terminal wire **322** of the V-phase coil are connected via a screw **280**.

[0090] As shown in FIG. **1**, the second casing **42** is adjacent to the first casing **40**. A thermistor **120**, which serves as a temperature measurement device, is accommodated in the second casing **42**. A harness **122** that is connected to the thermistor **120** is drawn out from the second casing **42**.

[0091] In the rotating electric machine system **20** which is configured in the manner described above, there are provided an air coolant flow path **730** (refer to FIG. **2**) that includes a gaseous coolant flow path **700**, a first oil coolant flow path **800** (refer to FIG. **2**), a lubricating oil flow path **840** (refer to FIG. **3**), and a second oil coolant flow path **870** (refer to FIG. **3**). Initially, a description will be given concerning the air coolant flow path **730**.

[0092] As shown in FIG. **2**, the air coolant flow path **730** includes an air supply passage **732**, the gaseous coolant flow path **700**, a first branching passage **734**, a first drain passage **736**, a second branching passage **738**, and a second drain passage **740**. An air supply port serving as an inlet to the air supply passage **732** is provided on a side circumferential surface of the first sub-housing **26**. The first branching passage **734** and the second branching passage **738** are one portion of the rotor chamber **34**. The second drain passage **740** serves in a dual manner as an oil discharge passage and a gaseous coolant discharge passage.

[0093] As shown in FIG. **2**, the air supply passage **732** is formed in the interior of the first sub-housing **26**. The air supply passage **732** extends from the side circumferential surface of the first sub-housing **26** toward the interior of the first sub-housing **26**. Moreover, although in FIG. **2**, a configuration is illustrated in which one air supply passage **732** is formed, a plurality of individual air supply passages **732** may be formed therein.

[0094] As noted previously, the gaseous coolant flow path **700** is a space formed between the second end surface of the first sub-housing **26** and a second wall surface **614** of the partition member **610**. The gaseous coolant flow path **700**, as it approaches toward the interior of the first sub-housing **26**, is inclined in a manner so as to face from the first end toward the second end.

[0095] An opening of a first end in the partition wall member **32** is an inlet port for the compressed air AR that has flowed out from the gaseous coolant flow path **700** into the rotor chamber **34**. Moreover, an opening of a second end of the partition wall member **32** is an outlet port for the compressed air AR from the rotor chamber **34**.

[0096] The first branching passage **734** and the second branching passage **738**, in the interior of the rotor chamber **34**, branch off mutually from each other at a border of the magnet stopper **272**. The first branching passage **734** is a flow path that faces from the magnet stopper **272** toward the first bearing **400**. The second branching passage **738** is a flow path that passes through a clearance that extends in the axial direction between the magnet stopper **272** and the partition wall member **32**, and faces toward the second bearing **500**. Hereinafter, in the compressed air AR, one portion thereof that flows through the first branching passage **734** will be referred to as a “first branched air flow AR**1**”, and a remaining portion thereof that flows through the second branching passage **738** will be referred to as a “second branched air flow AR**2**”.

[0097] As shown in FIG. **2** and FIG. **4**, the first branching passage **734** includes a space formed between a first end surface of the magnet stopper **272** and a second end surface of the guide member **560**, and a clearance formed between the inner ring stopper **460** and the guide member **560**. As can be understood from this feature, the first proximal end **414** of the first bearing chamber **410** is contained within the first branching passage **734**.
[0098] The first drain passage **736** includes a first guidance passage **742**, a hollow portion **464**, a second guidance passage **744**, and a merging flow path **746**. An inlet port into the first guidance passage **742** is formed in the first sub-housing **26** at a location facing toward the flow through holes **426** of the first bearing holder **420**. It should be noted that the number of the first drain passage **736** is not particularly limited, but is typically from one to three. An outlet port of the first guidance passage **742** communicates with the hollow portion **464**.
[0099] The hollow portion **464** is a space surrounded by an annular wall portion **462** of the first sub-housing **26**, and further, which is closed by the resolver holder **56**. The second guidance passage **744** is formed at the lower part of the first sub-housing **26**, and extends downward in a straight line shape. An inlet port of the second guidance passage **744** opens toward the hollow portion **464**.
[0100] The merging flow path **746** is perpendicular with respect to the second guidance passage **744**, and extends in the axial direction. An inlet of the merging flow path **746** opens toward the second guidance passage **744**.
[0101] The second branching passage **738** is primarily formed between the outer circumferential surfaces of the permanent magnets **270** and the inner circumferential surface of the partition wall member **32**. The opening at the second end of the partition wall member **32** is an outlet port by which the compressed air AR flows out from the rotor chamber **34**.
[0102] The main housing **24** includes in an interior thereof an air distribution passage **702** as shown in FIG. **2**. An inlet port into the air distribution passage **702** faces toward an opening of the second end of the partition wall member **32**. Therefore, one portion of the second branched air flow AR**2** flows into the air distribution passage **702**. Hereinafter, the compressed air AR that flows into the air distribution passage **702** will be referred to as a “branched air flow Sb”. The air distribution passage **702** communicates with an internal passage between an inner surface that forms the hollow concave portion **512** of the second sub-housing **28**, and an outer surface of the flow rectifying member **550**. The outlet port of the internal passage communicates with the second proximal end **524** of the second bearing chamber **520**. The outlet port of the internal passage also communicates with the ventilation hole **554**. The ventilation hole **554** is an annular shaped space that is formed between the second sub-housing **28** and the outer shaft **70**.
[0103] The second branching passage **738** further includes the clearance between the outer circumferential surface of the collar **240** and the inner circumferential surface of the partition wall member **32**, and the second distal end **522** of the second bearing chamber **520**. In the second branched air flow AR**2**, a remaining portion thereof that did not flow into the air distribution passage **702** flows in between the second bearing holder **530** and the inner side inner ring stopper **540**, at the second distal end **522** of the second bearing chamber **520**. Moreover, in order to simplify the description, hereinafter, the remaining portion of the second branched air flow AR**2** that flows through the second branching passage **738** will be referred to as a “main air flow Ms”.
[0104] The second drain passage **740** extends downwardly in the interior of the main housing **24**. The merging flow path **746** communicates perpendicularly with the second drain passage **740**. Stated otherwise, the merging flow path **746** merges into the second drain passage **740**. The second drain passage **740** extends to the outer surface of the rotating electric machine housing **22**.
[0105] As shown in FIG. **7**, the compressed air AR that is discharged from the second drain passage **740** is recovered in a gas-liquid separation device **900**. As will be discussed later, the compressed air AR is separated from the cooling oil CO**2** and the lubricating oil LO in the gas-liquid separation device **900**. The compressed air AR from which the oil has been separated is discharged from the

gas-liquid separation device **900** into the atmosphere. The gas-liquid separation device **900** serves as an oil recovery device **901**, and further, together with a later-described circulation pump **902**, constitutes the oil supplying device **904**. In this manner, the gas-liquid separation device **900** serves in a dual manner as both the oil recovery device **901**, and one portion of the oil supplying device **904**.

[0106] A description will be given concerning the first oil coolant flow path **800**. The first oil coolant flow path **800** is a flow path in order to circulate and supply the cooling oil Col into the stator chamber **36**. The first oil coolant flow path **800** includes a first oil supply passage **802** that is connected to a tank **906**, the stator chamber **36**, and a stator chamber side drain passage **804** that is connected to the tank **906**. The first oil supply passage **802** is disposed in close proximity to the second end of the main housing **24**. The stator chamber side drain passage **804** is disposed on a side part of the first casing **40**. The first oil supply passage **802** communicates with the stator chamber **36**, and the stator chamber **36** communicates with the contact chamber **44** of the first casing **40** (refer to FIG. **2**). The contact chamber **44** communicates with the stator chamber side drain passage **804**.

[0107] A first return pipe **910** in order to resupply the cooling oil CO**1** to the first oil supply passage **802** is connected to the tank **906**. As shown in FIG. **7**, the cooling oil Col that flows through the stator chamber side drain passage **804** may be delivered to the gas-liquid separation device **900**, and thereafter, may be delivered from the gas-liquid separation device **900** to the tank **906**.

[0108] Next, a description will be given concerning the lubricating oil flow path **840**. The lubricating oil flow path **840** is a flow path in order to circulate and supply the lubricating oil LO to the first bearing **400** and the second bearing **500**. The lubricating oil flow path **840** includes a second oil supply passage **842**, a first oil distribution passage **846**, a second oil distribution passage **848**, the first drain passage **736**, a third oil supply passage **843**, a third oil distribution passage **852**, and the second drain passage **740**.

[0109] The second oil supply passage **842** is disposed on an upper part of the first sub-housing **26**. The second oil supply passage **842**, in the interior of the first sub-housing **26**, branches into the first oil distribution passage **846** and the second oil distribution passage **848**. The first oil distribution passage **846** extends from the diametrical outward direction toward the diametrical inward direction of the first sub-housing **26**. The communication holes **452** of the holder spacer **450** are positioned downstream of the first oil distribution passage **846**. The first oil supply holes **424** of the first bearing holder **420** are positioned downstream of the communication holes **452**.

[0110] The second oil distribution passage **848** branches off from the first oil distribution passage **846**. The second oil distribution passage **848** is formed in the interior of a first nozzle member **844** (refer to FIG. **3**). A discharge portion **850** of the first nozzle member **844** faces toward the first distal end **412** of the first bearing chamber **410**.

[0111] The first drain passage **736** including the hollow portion **464** is formed at a lower portion of the first sub-housing **26**. The lubricating oil LO supplied to the first bearing **400**, after having passed through the first drain passage **736**, flows out via the second drain passage **740** to the exterior of the rotating electric machine housing **22**. The lubricating oil LO discharged from the second drain passage **740** is recovered by the gas-liquid separation device **900**.

[0112] At the second end of the main housing **24**, the third oil distribution passage **852** is bent in a manner so as to face in a diametrically inward direction. The third oil distribution passage **852** is connected to a second oil supply hole **536** that is formed in the second bearing holder **530**. The third oil supply passage **843** merges with the third oil distribution passage **852** at a location more upstream than the second oil supply hole **536**.

[0113] The second drain passage **740** that communicates with the second bearing chamber **520** is formed at a lower portion of the first sub-housing **26**. The lubricating oil LO supplied to the second bearing **500** flows out via the second drain passage **740** to the exterior of the rotating electric machine housing **22**. The lubricating oil LO discharged from the second drain passage **740** is recovered by the gas-liquid separation device **900**.

[0114] The second oil coolant flow path **870** is a flow path in order to circulate and supply the cooling oil CO**2** into the rotor internal flow path **210**. More specifically, the second oil coolant flow path **870** includes a fourth oil supply passage **872** that is connected via a third return pipe **914** to the gas-liquid separation device **900**, the rotor internal flow path **210**, and the second drain passage **740** that is connected to the tank **906**. The fourth oil supply passage **872** is disposed on a lower part of the first sub-housing **26**. An oil guidance passage **876** that is formed in a second nozzle member **874** is connected to the fourth oil supply passage **872**. A discharge portion **878**, which is an outlet port of the oil guidance passage **876**, faces toward the first shaft portion **70***a*.

[0115] The screw cap **200** includes the annular shaped flow through space **216** therein. The flow through space **216** communicates with the groove shaped flow paths **212** that are formed on the outer surface of the second shaft portion **70***b*, and further, are covered by the first inner ring **402** of the first bearing **400**. Furthermore, the groove shaped flow paths **212** communicate with the second distal end **522** of the second bearing chamber **520**, via the guide flow path **214**, the flow through space **216** between the outer shaft **70** and the inner ring stopper **460**, the flow through space **216** between the outer shaft **70** and the magnet stopper **272**, the flow through space **216** between the outer shaft **70** and the sleeve **220**, and the internal space **242** between the outer shaft **70** and the collar **240**.

[0116] The second bearing chamber **520** communicates with the second drain passage **740**. The cooling oil CO**2** that has flowed through the second drain passage **740** is discharged to the exterior of the rotating electric machine housing **22** in the same manner as the lubricating oil LO. The cooling oil CO**2** that is discharged from the second drain passage **740** is recovered by the gas-liquid separation device **900**. The cooling oil CO**2** that is discharged from the gas-liquid separation device **900** passes through the tank **906**, and then is returned via the third return pipe **914** to the fourth oil supply passage **872**.

[0117] An oil delivery passage **908** in which the tank **906** and the circulation pump **902** are provided is connected to the gas-liquid separation device **900** shown in FIG. **7**. The oil that is stored in the tank **906** is delivered by the circulation pump **902** to the first return pipe **910**, a second return pipe **912**, and the third return pipe **914** that are connected to the circulation pump **902**.

[0118] An unillustrated recovery passage is connected to the gas-liquid separation device **900**. The compressed air AR, the cooling oil CO**1**, and the cooling oil CO**2** and the lubricating oil LO that are discharged from the second drain passage **740** flow via the recovery passage into the gas-liquid separation device **900**. In the foregoing manner, the gas-liquid separation device **900** serves to separate the compressed air AR and the oil. The compressed air AR is discharged to the atmosphere via an exhaust line **920**. On the other hand, the oil is temporarily stored in the tank **906**. Thereafter, the lubricating oil LO is drawn in from the tank **906** by the circulation pump **902**, and is delivered to the first return pipe **910**, the second return pipe **912**, and the third return pipe **914**. By the foregoing process being repeated, the oil inside the tank **906** is circulated and supplied as the lubricating oil LO, the cooling oil CO**1**, or the cooling oil CO**2**.

[0119] Moreover, it should be noted that it is also possible to make use of both the lubricating oil LO, and the cooling oil CO**2** that flows through the rotor internal flow path **210**. In this case, for example, the lubricating oil LO which is supplied to the second oil supply passage **842** is distributed to the first nozzle member **844** and the second nozzle member **874**.

[0120] The rotating electric machine system **20** is basically configured as described above. Next, a description will be given concerning the gas turbine engine **950**. Moreover, it should be noted that the configuration of the gas turbine engine **950**, for example, is similar to the configuration shown in FIG. 8 of JP 2022-157789 A. Therefore, the description of the gas turbine engine **950** will be kept brief.

[0121] The gas turbine engine **950** is equipped with an engine housing **952**. The engine housing

952 includes an inner housing **954** and an outer housing **956**. The inner housing **954** is connected to the second sub-housing **28** of the rotating electric machine system **20**. The outer housing **956** is connected to the inner housing **954**.
[0122] The inner housing **954** has a plurality of individual leg members **958**. In the illustrated example, the number of the leg members **958** is six. However, the number of the leg members **958** is determined in accordance with the coupling strength required between the gas turbine engine **950** and the rotating electric machine system **20**. Stated otherwise, the number of the leg members **958** is not limited to being six as in the illustrated example. Air intake spaces **960** are formed between the leg members **958**.
[0123] The gas turbine engine **950** is equipped with the output shaft **964** that is coupled to the rotating shaft **66**. A non-illustrated compressor wheel and a non-illustrated turbine wheel are mounted in a diametrical outward direction of the output shaft **964**. The compressor wheel and the turbine wheel are capable of rotating integrally together with the rotating shaft **66** and the output shaft **964**.
[0124] Next, a description will be given concerning the operations of the combined power system **10**.
[0125] At first, an alternating current is supplied to the plurality of individual electromagnetic coils **310** (the U-phase coil, the V-phase coil, and the W-phase coil) via the U-phase terminal **110***a*, the V-phase terminal **110***b*, and the W-phase terminal **110***c*. By the alternating current flowing through the electromagnetic coils **310**, an alternating magnetic field is generated in the stator **64**. Therefore, an attractive force and a repulsive force act alternately between the electromagnetic coils **310**, and the permanent magnets **270** of the rotor **62**. As a result, the rotating shaft **66** begins to rotate. Alternatively, the rotating shaft **66** may be rotated by a well-known type of starter (not shown).
[0126] When the rotating shaft **66** begins to rotate, the output shaft **964** also starts rotating integrally together with the rotating shaft **66**. Along therewith, the compressor wheel and the turbine wheel, which are supported by the output shaft **964**, rotate integrally together with the output shaft **964**.
[0127] After the gas turbine engine **950** has been started in the manner described above, the output shaft **964** rotates accompanying the driving of the gas turbine engine **950**. Accordingly, even if the supply of the electric current to the electromagnetic coils **310** is stopped, the rotating shaft **66** rotates integrally together with the output shaft **964**.
[0128] Since the rotating shaft **66** retains the permanent magnets **270**, the alternating current is generated in the electromagnetic coils **310** that surround the permanent magnets **270**. Via the U-phase terminal **110***a*, the V-phase terminal **110***b*, and the W-phase terminal **110***c*, the alternating current is delivered to a non-illustrated current converter. By the current converter, the alternating current is converted into a direct current. When a non-illustrated control circuit has determined that the output of the external load electrically connected to the battery has decreased, the current converter supplies the direct current to the battery. Consequently, charging is carried out on the battery.
[0129] By the output shaft **964** undergoing rotation, atmospheric air is drawn into the engine housing **952** via the air intake spaces **960** provided between the leg members **958** of the inner housing **954**. In this instance, the second sub-housing **28** of the rotating electric machine system **20** exhibits a mountain shape (chevron shape) in a manner so as to decrease in diameter as it proceeds from the main housing **24** toward the engine housing **952**. Therefore, the drawn in atmospheric air is rectified by the second sub-housing **28**, and flows in a manner so as to be directed toward the engine housing **952**. Since the second end of the second sub-housing **28** is inserted into the opening at the first end of the engine housing **952**, the atmospheric air is efficiently guided into the engine housing **952**.
[0130] The atmospheric air that is drawn into the engine housing **952** is compressed by the compressor wheel. In accordance therewith, the compressed air AR is generated. One portion of

this compressed air AR is extracted, and is supplied to an air supply port provided on the outer circumferential surface of the first sub-housing **26**. Moreover, the compressed air AR, which is obtained by compressing the atmosphere by means of the compressor, may be supplied to the air supply port. Alternatively, a compressed gas may be supplied to the air supply port from an oxygen cylinder or a nitrogen cylinder.

[0131] The compressed air AR that has flowed via the air supply port into the air supply passage **732** flows into the gaseous coolant flow path **700** that is formed between the second end surface of the first sub-housing **26**, and the second wall surface **614** of the partition member **610**. The compressed air AR moves through the gaseous coolant flow path **700** toward the rotor chamber **34** in the interior of the rotating electric machine housing **22**.

[0132] The compressed air AR flows, via the opening at the first end of the partition wall member **32**, from the gaseous coolant flow path **700** into the rotor chamber **34**. In the rotor chamber **34**, the compressed air AR is divided into the first branched air flow AR**1** and the second branched air flow AR**2** with the magnet stopper **272** serving as a boundary therebetween. The first branched air flow AR**1** reaches the first proximal end **414** of the first bearing chamber **410** along the first branching passage **734**, and forms an air curtain at the first proximal end **414**. Due to the air curtain, the first bearing **400** is cooled.

[0133] As shown in FIG. **4**, an excess amount of the first branched air flow AR**1** passes through the relay holes **446** of the spacer ring **440**, and the flow through holes **426** of the first bearing holder **420**, and flows into the first drain passage **736**. As noted previously, the first drain passage **736** includes the first guidance passage **742**, the hollow portion **464**, the second guidance passage **744**, and the merging flow path **746**. The first branched air flow AR**1** that has passed through the flow through holes **426** initially flows into the first guidance passage **742** that is formed in the first sub-housing **26**. Since the first guidance passage **742** communicates with the second guidance passage **744** via the hollow portion **464**, and the second guidance passage **744** communicates with the merging flow path **746**, the first branched air flow AR**1** flows sequentially through the hollow portion **464**, the second guidance passage **744**, and the merging flow path **746**. Thereafter, the first branched air flow AR**1** flows from the merging flow path **746** into the second drain passage **740**.

[0134] As shown in FIG. **5**, the second branched air flow AR**2** flows inside the rotor chamber **34** which is one portion of the second branching passage **738**. Inside the rotor chamber **34**, the second branched air flow AR**2** primarily flows between the outer circumferential surface of the permanent magnets **270** and the inner circumferential surface of the partition wall member **32**. At this time, the second branched air flow AR**2** comes into contact with the permanent magnets **270**. Due to such contact, the rotor **62** is cooled. The second branched air flow AR**2** that has cooled the rotor **62**, at the opening of the second end of the partition wall member **32**, is separated into the main air flow Ms that flows through the second branching passage **738**, and the branched air flow Sb that flows through the air distribution passage **702**.

[0135] The main air flow Ms reaches the second distal end **522** of the second bearing chamber **520**. On the other hand, the branched air flow Sb passes between the inner surface forming the hollow concave portion **512** of the second sub-housing **28**, and the outer surface of the flow rectifying member **550**, and reaches the second proximal end **524** of the second bearing chamber **520**. Moreover, the remainder of the branched air flow Sb is discharged externally of the rotating electric machine housing **22** via the ventilation hole **554** that is formed between the second sub-housing **28** and the outer shaft **70**. In this manner, by the excess amount of the compressed air AR being discharged externally of the rotating electric machine housing **22**, the pressure of the compressed air AR that flows through the interior of the rotating electric machine housing **22** is adjusted to be substantially constant.

[0136] As can be understood from the foregoing, an air curtain that surrounds the second bearing **500** is formed in the second bearing chamber **520**. Due to the air curtain, the second bearing **500** is cooled.

[0137] The second branched air flow AR**2** that is supplied to the second bearing chamber **520** is guided by an inner surface **551** of the flow rectifying member **550**, and flows toward the second drain passage **740**. In the second drain passage **740**, the first branched air flow AR**1** and the second branched air flow AR**2** merge together. In this instance, the lubricating oil LO is supplied respectively to the first bearing **400** and the second bearing **500**. Therefore, the first branched air flow AR**1** that has passed through the first bearing chamber **410** is a gas-liquid mixture. Similarly, the second branched air flow AR**2** that has passed through the second bearing chamber **520** is a gas-liquid mixture. The first branched air flow AR**1** and the second branched air flow AR**2** that have passed through the merging flow path **746** are led from the rotating electric machine housing **22** to the gas-liquid separation device **900**.
[0138] In the gas-liquid separation device **900**, the compressed air AR and the oil (for example, the lubricating oil LO) are separated from each other. The compressed air AR from which the oil has been separated is discharged from the gas-liquid separation device **900** into the atmosphere.
[0139] Simultaneously with the compressed air AR flowing through the rotating electric machine housing **22** in the manner described above, the cooling oil CO**1**, the cooling oil CO**2**, and the lubricating oil LO also flow inside the rotating electric machine housing **22**. A description will be given concerning the flow through passages of the cooling oil CO**1**, the cooling oil CO**2**, and the lubricating oil LO.
[0140] In the first oil coolant flow path **800**, the cooling oil Col is supplied from the tank **906** to the first oil supply passage **802**. Since the first oil supply passage **802** communicates with the stator chamber **36**, the cooling oil CO**1** moves toward the stator chamber side drain passage **804** while filling the stator chamber **36**. In this manner, the stator **64** inside the stator chamber **36** becomes placed in a state of being immersed in the cooling oil CO**1**. In accordance with this feature, the stator **64** is cooled.
[0141] In a process in which the cooling oil CO**1** inside the stator chamber **36** flows toward the stator chamber side drain passage **804**, the neutral point **318** and the neutral point terminal **320** are cooled by the cooling oil CO**1**. Further, the conduction of heat from the coil end portion **314** to the neutral point terminal **320** can be reduced.
[0142] The cooling oil CO**1** inside the stator chamber **36** flows toward the first casing **40** along the first wall surface **612** of the partition member **610**. As can be understood from this feature, the flow through direction of the cooling oil Col that flows along the first wall surface **612** of the partition member **610**, and the flow through direction of the compressed air AR that flows along the second wall surface **614** of the partition member **610** are mutually opposite directions.
[0143] The cooling oil Col that has flowed through the stator chamber **36** flows from the first end of the stator chamber **36** and into the contact chamber **44** of the first casing **40**. The cooling oil CO**1** inside the contact chamber **44** comes into contact with the terminal portions **112**, the terminal wires **322**, and the screws **280**. Consequently, the electrical contact between the U-phase terminal **110***a* and the U-phase coil is cooled. For the same reason, the electrical contact between the V-phase terminal **110***b* and the V-phase coil is also cooled. The electrical contact between the W-phase terminal **110***c* and the W-phase coil is also cooled.
[0144] The cooling oil CO**1** inside the contact chamber **44** passes through the stator chamber side drain passage **804**, and is recovered in the tank **906**. Thereafter, the cooling oil CO**1** is resupplied from the tank **906** to the first oil supply passage **802** via the first return pipe **910**. Moreover, the cooling oil Col that had flowed through the stator chamber side drain passage **804** may be delivered to the gas-liquid separation device **900**, and thereafter, delivered from the gas-liquid separation device **900** to the tank **906**.
[0145] In the lubricating oil flow path **840**, the lubricating oil LO is supplied from the tank **906** to the second oil supply passage **842**. One portion of the lubricating oil LO is supplied to the first outer ring **406** of the first bearing **400** via the first oil distribution passage **846**, the communication holes **452** of the holder spacer **450**, and the first oil supply holes **424** of the spacer ring **440**.

Another portion of the lubricating oil LO flows from the first oil distribution passage **846** into the second oil distribution passage **848** that is formed in the first nozzle member **844**, and furthermore, is discharged from the discharge portion **850** provided in the first nozzle member **844** into the first distal end **412** of the first bearing chamber **410**. Accordingly, the direction in which the lubricating oil LO is supplied to the first bearing chamber **410** is a first direction from the first bearing chamber **410** toward the permanent magnets **270**. In the foregoing manner, the lubricating oil LO that is supplied to the first bearing **400** cools and lubricates the first bearing **400**. Thereafter, the lubricating oil LO passes via the hollow portion **464** of the first sub-housing **26** and the first drain passage **736**, and is recovered in the gas-liquid separation device **900**.
[0146] Still another portion of the lubricating oil LO flows from the second oil supply passage **842** into the third oil distribution passage **852**, and is supplied, via the second oil supply hole **536** that is formed in the second bearing holder **530**, to the second outer ring **506** of the second bearing **500**. The lubricating oil LO is also supplied to the second bearing **500** from a discharge portion **556** provided in the main housing **24**. Such a lubricating oil LO cools and lubricates the second bearing **500**. Thereafter, via the second drain passage **740** that communicates with the second bearing chamber **520**, the lubricating oil LO is recovered in the gas-liquid separation device **900**.
[0147] As noted previously, the first branched air flow AR**1** supplied to the first proximal end **414** of the first bearing chamber **410** forms an air curtain. It is difficult for the lubricating oil LO that is supplied to the first bearing **400** to pass through the air curtain and infiltrate into the rotor chamber **34**. In the second bearing chamber **520**, the main air flow Ms that is supplied to the second distal end **522**, and the branched air flow Sb that is supplied to the second proximal end **524** form an air curtain. It is difficult for the lubricating oil LO that is supplied to the second bearing **500** to pass through the air curtain and infiltrate into the rotor chamber **34**. Therefore, the lubricating oil LO is prevented from infiltrating into the rotor chamber **34**. Consequently, it is possible to avoid a situation in which the permanent magnets **270** become contaminated by the lubricating oil LO.
[0148] Further, it is difficult for the lubricating oil LO to infiltrate from the second bearing chamber **520** into the hollow concave portion **512** of the second sub-housing **28**. Accordingly, it is also possible to avoid a situation in which the flow rectifying member **550** becomes contaminated by the lubricating oil LO.
[0149] The lubricating oil LO contains the compressed air AR that has formed the air curtain. The gas-liquid separation device **900** separates the compressed air AR from the lubricating oil LO. The lubricating oil LO from which the compressed air AR has been separated is temporarily stored in the tank **906**, and thereafter, is resupplied to the second oil supply passage **842** from the second return pipe **912**.
[0150] A description will now be given concerning the cooling oil CO**2** that flows through the rotor internal flow path **210**.
[0151] In the second oil coolant flow path **870**, the cooling oil CO**2** is supplied from the tank **906** to the fourth oil supply passage **872**, and flows through the oil guidance passage **876** that is formed in the second nozzle member **874**. The cooling oil CO**2** is discharged from the discharge portion **878** provided in the second nozzle member **874**, and toward the first shaft portion **70***a* of the outer shaft **70**. The cooling oil CO**2** flows, in the axial direction of the rotating shaft **66**, through the rotor internal flow path **210** from the first end toward the second end. Specifically, the cooling oil CO**2** passes through the flow through space **216** between the screw cap **200** and the first shaft portion **70***a*, the groove shaped flow path **212** that is covered by the first inner ring **402** of the first bearing **400**, the guide flow path **214**, the flow through space **216** between the outer shaft **70** and the inner ring stopper **460**, the flow through space **216** between the outer shaft **70** and the magnet stopper **272**, and the flow through space **216** between the outer shaft **70** and the sleeve **220**.
[0152] The cooling oil CO**2** that has reached the flow through space **216** between the outer shaft **70** and the sleeve **220** flows, at the second end of the sleeve **220**, into the communication flow path **232** via the inlet port **234**. The communication flow path **232** is inclined in a manner so that, as it

proceeds from the upstream side to the downstream side in the flow through direction of the cooling oil CO**2**, faces from the inner side toward the outer side in the diametrical direction of the rotating shaft **66**. A centrifugal force acts on the rotating shaft **66** that is undergoing rotation. Due to the centrifugal force, the cooling oil CO**2** easily moves along the communication flow path **232** toward the first inner chamber **242***a*.

[0153] The cooling oil CO**2** that has flowed through the communication flow path **232** flows into the first inner chamber **242***a* which is one portion of the internal space **242**. The inner circumferential surface **256***a* of the collar **240** that forms the first inner chamber **242***a* abuts against the abutment surface **230** of the first annular shaped convex portion **226**. The outlet port **236** for the cooling oil CO**2** to the communication flow path **232** is positioned more inwardly in the diametrical direction of the rotating shaft **66** than the abutment surface **230**. More specifically, the abutment surface **230** is not provided with the outlet port **236** (such as a notch or a hole or the like). Accordingly, the entirety of the abutment surface **230** abuts against the inner circumferential surface **256***a* of the first inner chamber **242***a*.

[0154] Since the rotor **62** is undergoing rotation, a centrifugal force acts on the sleeve **220** and the collar **240**. Due to the centrifugal force, the inserted portion **224** and the tubular shaped portion **244** are deformed in a manner so as to bulge slightly outward in the diametrical direction of the rotating shaft **66**. As noted previously, the abutment surface **230** does not include the outlet port **236**. Based on this feature, even in the case that the rotor **62** rotates at a high speed, the surface pressure of the abutment surface **230** with respect to the inner circumferential surface **256***a* of the first inner chamber **242***a* is maintained. Consequently, the sealing property between the abutment surface **230** and the inner circumferential surface **256***a* is maintained. Accordingly, the cooling oil CO**2** is prevented from leaking out from between the abutment surface **230** and the inner circumferential surface **256***a*.

[0155] As can be appreciated from the reasons described above, it is easy to cause the cooling oil CO**2** to be moved from the first inner chamber **242***a* through the discharge flow path **254** and to the second inner chamber **242***b*. Stated otherwise, the cooling oil CO**2** is prevented from being discharged from any place other than the opening of the second end of the second inner chamber **242***b*. The direction from the first inner chamber **242***a* to the second inner chamber **242***b* is a direction to separate away from the sleeve **220** and the permanent magnets **270**. More specifically, according to the above-described configuration, it is easy to cause the cooling oil CO**2** to move in a direction away from the permanent magnets **270**. Accordingly, even if the rotor **62** is of an SPM type, the permanent magnets **270** are unlikely to become contaminated by the cooling oil CO**2**.

[0156] The cooling oil CO**2** is discharged from the opening at the second end of the collar **240** to the exterior of the second inner chamber **242***b*. The cooling oil CO**2**, which has flowed through the rotor internal flow path **210** and the internal space **242** in the manner described above, reaches the second distal end **522** of the second bearing chamber **520**.

[0157] At the second distal end **522**, the cooling oil CO**2** mixes together with the compressed air AR. The cooling oil CO**2** in which the compressed air AR is contained merges with the lubricating oil LO in the second drain passage **740**. Thereafter, in the same manner as the lubricating oil LO, the cooling oil CO**2** is recovered via the second drain passage **740** in the gas-liquid separation device **900**. The cooling oil CO**2**, from which the compressed air AR has been separated in the gas-liquid separation device **900**, is temporarily stored in the tank **906**, and thereafter, is returned via the third return pipe **914** to the fourth oil supply passage **872**.

[0158] In the foregoing manner, according to the present embodiment, the same oil is used in a dual manner as the lubricating oil LO (the lubricant), and the cooling oil CO**1** and the cooling oil CO**2** (both of which are a liquid coolant). Therefore, it is possible to combine a circulation and supply flow path for the lubricant, and a circulation and supply flow path for the liquid coolant. Accordingly, it is possible to simplify the configuration of the circulation and supply flow path for the lubricant, and the circulation and supply flow path for the liquid coolant. However, the

lubricant and the liquid coolant may be different liquids.
[0159] The advantageous effects of the present embodiment can be summarized in the following manner.
[0160] The sleeve **220** includes the inserted portion **224** at one end part (the second end) in the axial direction of the sleeve **220**. The inserted portion **224** is inserted into the internal space **242** of the collar **240**, and thereby separates the rotor internal flow path **210** from the internal space **242**. The sleeve **220** further includes the communication flow path **232** that is formed in the inserted portion **224**, and which places the rotor internal flow path **210** and the internal space **242** in communication. The entirety or a portion of the outer circumferential surface of the inserted portion **224** serves as the abutment surface **230** against which the inner circumferential surface **256***a* of the first inner chamber **242***a* of the collar **240** abuts.
[0161] The sleeve **220** further has the inlet port **234** in order for the cooling oil CO**2**, which is a liquid coolant, to flow from the rotor internal flow path **210** into the communication flow path **232**, and the outlet port **236** in order for the cooling oil CO**2** to flow out from the communication flow path **232** into the internal space **242** (the first inner chamber **242***a*). In the diametrical direction of the rotating shaft **66**, the outlet port **236** is positioned more inwardly than the abutment surface **230**.
[0162] In accordance with such a configuration, it is unnecessary to form the outlet port **236** in the abutment surface **230**. Accordingly, it is unnecessary to cut out and remove a portion of the abutment surface **230** in the axial direction in order to form the outlet port **236** in the abutment surface **230**. Accordingly, the entirety of the abutment surface **230** abuts against the inner circumferential surface **256***a* of the first inner chamber **242***a* of the collar **240**.
[0163] By the rotor **62** undergoing rotation, a centrifugal force acts on the sleeve **220** and the collar **240**. Due to the centrifugal force, the inserted portion **224** and the tubular shaped portion **244** are deformed in a manner so as to bulge slightly outward in the diametrical direction of the rotating shaft **66**. Since the outlet port **236** is not provided on the abutment surface **230**, at the time when the rotor **62** is rotated, the surface pressure of the abutment surface **230** with respect to the inner circumferential surface **256***a* of the first inner chamber **242***a* is maintained. Consequently, the sealing property between the abutment surface **230** and the inner circumferential surface **256***a* is maintained. Accordingly, the cooling oil CO**2** is prevented from leaking out from between the abutment surface **230** and the inner circumferential surface **256***a*. As a result, the cooling oil CO**2** is prevented from being discharged from any place other than the opening of the second end of the second inner chamber **242***b*.
[0164] The communication flow path **232**, as it approaches the internal space **242** from the rotor internal flow path **210**, is inclined in a manner so as to face from the inner side to the outer side in the diametrical direction of the rotating shaft **66**. The direction from the rotor internal flow path **210** toward the internal space **242** is a direction from upstream to downstream in the flow through direction of the cooling oil CO**2**.
[0165] At the time when the rotating shaft **66** rotates, a centrifugal force acts on the rotating shaft **66**. Due to the centrifugal force, the cooling oil CO**2** easily moves along the communication flow path **232** toward the internal space **242** (the first inner chamber **242***a*). More specifically, in accordance with such a configuration, the flowing of the cooling oil CO**2** within the communication flow path **232** is assisted.
[0166] The collar **240** includes the partition wall **246** that divides the internal space **242** into the first inner chamber **242***a* and the second inner chamber **242***b*. The insertion hole **248** and the discharge flow path **254** are formed in the partition wall **246**. The discharge flow path **254** places the first inner chamber **242***a* and the second inner chamber **242***b* in communication. The inserted portion **224** is inserted into the first inner chamber **242***a*, and the liquid coolant that is supplied to the rotor internal flow path **210** passes from the first inner chamber **242***a* through the discharge flow path **254**, and is discharged to the exterior of the collar **240** from the second inner chamber **242***b*.

[0167] By the rotating shaft **66** being inserted through the insertion hole **248**, the collar **240** can be easily retained on the rotating shaft **66**. Further, the liquid coolant CO**2** that has flowed through the rotor internal flow path **210** can be quickly discharged, via the communication flow path **232**, the internal space **242**, and the discharge flow path **254**, in a direction away from the abutment surface **230**.
[0168] The inserted portion **224** includes the first annular shaped convex portion **226** that is projected out in an annular shape in the axial direction from the second end of the main body portion **225** of the sleeve **220**, and the second annular shaped convex portion **228** that is projected out in an annular shape in an axial direction from the second end of the first annular shaped convex portion **226**. The outer diameter of the second annular shaped convex portion **228** is smaller than the outer diameter of the first annular shaped convex portion **226**. Stated otherwise, the second annular shaped convex portion **228** is smaller in diameter than the first annular shaped convex portion **226**. The outer circumferential surface of the first annular shaped convex portion **226** includes the abutment surface **230**, and the second annular shaped convex portion **228** includes the outlet port **236**.
[0169] In the inserted portion **224**, the distance (the outer diameter) from the center in the diametrical direction of the rotating shaft **66** to the abutment surface **230** can be made smaller in comparison with a case in which the first annular shaped convex portion **226** does not exist. Therefore, the inner diameter of the collar **240** is capable of being made smaller. Consequently, the collar **240** can be made thinner and lighter in weight.
[0170] The liquid coolant supplying device is the oil supplying device **904** that supplies the cooling oil CO**1** and the cooling oil CO**2** as liquid coolants. The rotating electric machine housing **22** includes the lubricating oil flow path **840** for the purpose of supplying the lubricating oil LO from the oil supplying device **904** to the first bearing **400** and the second bearing **500** that support the rotating shaft **66**.
[0171] One portion of the lubricating oil LO for the purpose of lubricating the first bearing **400** and the second bearing **500** can be supplied to the rotating electric machine housing **22** from the oil supplying device **904** via a system that is separate from the lubricating oil LO, and can be used as a liquid coolant (the cooling oil CO**1** and the cooling oil CO**2**). Accordingly, one individual oil supplying device **904** can be used as a device that serves both as a supplying device for supplying the lubricating oil LO, and as a supplying device for supplying the cooling oil CO**1** and the cooling oil CO**2**. Therefore, it is possible to reduce the cost of capital investment. In addition, the configuration of the rotating electric machine system **20** can be simplified.
[0172] The rotating electric machine housing **22** includes the oil discharge passage (the second drain passage **740**) that discharges to the oil supplying device **904** the cooling oil CO**2** that has passed through the rotor internal flow path **210**, and the lubricating oil LO that has flowed through the lubricating oil flow path **840**. The oil supplying device **904** resupplies the oil that has been discharged from the oil discharge passage to the rotor internal flow path **210** and the lubricating oil flow path **840**.
[0173] In accordance with such a configuration, the lubricating oil LO supplied to the first bearing **400** and the second bearing **500**, and the cooling oil CO**2** that has cooled the rotor **62** are discharged from the rotating electric machine housing **22**, while on the other hand, a new lubricating oil LO can be supplied to the first bearing **400** and the second bearing **500**, and further, a new cooling oil CO**2** can be supplied to the rotor **62**. Accordingly, it is possible to continuously lubricate the first bearing **400** and the second bearing **500**, and further, it is possible to continuously cool the rotor **62**. In addition, since the oil is circulated and supplied, the cost is lower than in a case in which the new oil is continuously supplied.
[0174] The rotating electric machine system **20** is equipped with the gaseous coolant supplying device that supplies the gaseous coolant to the first bearing **400** and the second bearing **500**. In one aspect, the gaseous coolant supplying device is the gas turbine engine **950** which, together with the

rotating electric machine system **20**, constitutes the combined power system **10**. In another aspect, the gaseous coolant supplying device is a compressor that compresses the atmospheric air. In these cases, the gaseous coolant is the compressed air AR. In still another aspect, the gaseous coolant supplying device includes a container in which a compressed gas is contained.
[0175] The rotating electric machine housing **22** includes the gaseous coolant flow path **700** through which the gaseous coolant flows, and the gaseous coolant discharge passage (the second drain passage **740**) for the purpose of discharging the gaseous coolant to the exterior of the rotating electric machine housing **22**. The oil supplying device **904** recovers the gaseous coolant that has flowed through the gaseous coolant discharge passage and the oil (the lubricating oil LO and the cooling oil CO**2**) that has flowed through the oil discharge passage (the second drain passage **740**), and further, resupplies the oil that has been recovered to the rotor internal flow path **210** and the lubricating oil flow path **840**.
[0176] Since the oil supplying device **904** recovers the gaseous coolant and the lubricating oil together, it is unnecessary for the gaseous coolant and the lubricating oil to be recovered separately. Accordingly, it is unnecessary to include in the rotating electric machine system **20** a gaseous coolant recovery device that is separate from the oil supplying device **904**. Therefore, a situation is avoided in which the configuration of the rotating electric machine system **20** becomes complex.
[0177] The oil supplying device **904** includes the gas-liquid separation device **900** that separates the gaseous coolant and the oil.
[0178] Since the gas-liquid separation device **900** separates the gaseous coolant and the oil, even though the gaseous coolant and the oil are recovered together, it is possible to resupply only the oil to the rotor internal flow path **210** and the lubricating oil flow path **840**. More specifically, according to the present configuration, it is easy to circulate and supply the lubricating oil LO to the first bearing **400** and the second bearing **500**.
[0179] In relation to the above-described embodiment, the following supplementary notes are further disclosed.
Supplementary Note 1
[0180] The rotating electric machine system (**20**) is characterized by a rotating electric machine system equipped with the rotating electric machine (**60**) including the rotor (**62**) and the stator (**64**), and the housing (**22**) in which the stator is accommodated.
[0181] The rotor includes the rotating shaft (**66**), the sleeve (**220**) configured to cover the rotating shaft from the outer circumferential side, the permanent magnets (**270**) configured to be retained in the sleeve, the collar (**240**) configured to be disposed on the outer circumferential side relative to the sleeve and the rotating shaft, the rotor internal flow path (**210**) configured to include the annular shaped space formed between the outer circumferential surface of the rotating shaft and the inner circumferential surface of the sleeve, and configured to extend in the axial direction of the rotating shaft, and the internal space (**242**) formed between the outer circumferential surface of the rotating shaft and the inner circumferential surface (**256**) of the collar.
[0182] The rotating electric machine system includes the liquid coolant supplying device (**904**) configured to supply the liquid coolant (CO**2**) to the rotor internal flow path. The sleeve includes the inserted portion (**224**) that is the axial end portion of the sleeve and is inserted into the internal space to separate the internal space from the rotor internal flow path, and the communication flow path (**232**) that is formed in the inserted portion and is configured to place the internal space and the rotor internal flow path in communication. The outer circumferential surface of the inserted portion includes the abutment surface (**230**) against which the inner circumferential surface of the collar abuts.
[0183] In the above-described configuration, the outlet port (**230**) through which the liquid coolant flows out from the communication flow path into the internal space is located more inwardly in the diametrical direction of the rotating shaft than the abutment surface.
[0184] In accordance with such a configuration, it is unnecessary to form an inlet port and an outlet

port by cutting out a portion of the abutment surface of the sleeve. Accordingly, the liquid coolant is prevented from leaking out from between the abutment surface of the sleeve and the inner circumferential surface of the collar.

Supplementary Note 2

[0185] In the rotating electric machine system according to Supplementary Note 1, the communication flow path may be inclined in a manner so as to face outwardly from inwardly in the diametrical direction approaching in close proximity to the internal space from the rotor internal flow path.

[0186] When the rotating shaft rotates, a centrifugal force acts on the liquid coolant. Therefore, in the case that the communication flow path is inclined in the manner described above, the liquid coolant can easily move through the communication flow path from the rotor internal flow path toward the internal space.

Supplementary Note 3

[0187] In the rotating electric machine system according to Supplementary Note 1 or 2, the collar may include the partition wall (**246**) configured to divide the internal space into the first inner chamber (**242***a*) and the second inner chamber (**242***b*), the insertion hole (**248**) formed in the partition wall and through which the rotating shaft is inserted, and the discharge flow path (**254**) formed in the partition wall and that places the first inner chamber and the second inner chamber in communication, and the inserted portion may be inserted into the first inner chamber, and the liquid coolant that is supplied to the rotor internal flow path may pass from the first inner chamber via the discharge flow path, and may be discharged to the exterior of the collar from the second inner chamber.

[0188] In accordance with such a configuration, the liquid coolant that is supplied to the rotor internal flow path can be quickly discharged, via the communication flow path, the internal space, and the discharge flow path, in a direction away from the abutment surface.

Supplementary Note 4

[0189] The rotating electric machine system according to any one of Supplementary Notes 1 to 3, wherein the inserted portion may include the first annular shaped convex portion (**226**) configured to project out in an annular shape in the axial direction of the sleeve, and the second annular shaped convex portion (**228**) configured to be connected to the first annular shaped convex portion, to project out in an annular shape in the axial direction of the sleeve, and further, to be smaller in diameter than the first annular shaped convex portion, and the outer circumferential surface of the first annular shaped convex portion may include the abutment surface, and the second annular shaped convex portion may include the outlet port.

[0190] In the inserted portion, the distance (the outer diameter) from the center of the rotating shaft to the abutment surface can be made smaller in comparison with a case in which the first annular shaped convex portion does not exist. In accordance with this feature, the inner diameter of the collar is capable of being made smaller. Therefore, the collar can be made thinner and lighter in weight.

Supplementary Note 5

[0191] The rotating electric machine system according to any one of Supplementary Notes 1 to 4, wherein the liquid coolant supplying device may be the oil supplying device (**904**) configured to supply the oil as the liquid coolant, and the housing may include the lubricating oil flow path (**840**) through which the oil as the lubricant (LO) is supplied to the bearing (**400** and **500**) that supports the rotating shaft.

[0192] In this case, one portion of the lubricating oil for the purpose of lubricating the bearings can be used as the liquid coolant. Accordingly, one individual device is capable of being used both as the oil supplying device and the liquid coolant supplying device. Therefore, it is possible to reduce the cost of capital investment. In addition, the configuration of the rotating electric machine system can be simplified.

Supplementary Note 6

[0193] In the rotating electric machine system according to Supplementary Note 5, the housing may include the oil discharge passage (**740**) through which the oil that has flowed through the rotor internal flow path and the lubricating oil flow path is discharged to the oil supplying device, and the oil supplying device may resupply the oil that has been discharged from the oil discharge passage to the rotor internal flow path and the lubricating oil flow path.

[0194] In accordance with such a configuration, the oil (the lubricating oil) that is supplied to the bearing, and the oil (the cooling oil) that has cooled the rotor can be discharged from the housing, while on the other hand, new oil can be supplied to the bearing and rotor. Accordingly, it is possible to continuously lubricate and cool the bearing, and it is also possible to continuously cool the rotor. In addition, since the oil is circulated and supplied, the cost is lower than in a case in which the new oil is continuously supplied.

Supplementary Note 7

[0195] In the rotating electric machine system according to Supplementary Note 6, there may further be provided the gaseous coolant supply device (**950**) configured to supply the gaseous coolant (AR) to the bearing, wherein the housing may include the gaseous coolant flow path (**700**) through which the gaseous coolant flows, and the gaseous coolant discharge passage (**740**) through which the gaseous coolant is discharged to the exterior of the housing, and the oil supplying device may recover the gaseous coolant that has flowed through the gaseous coolant discharge passage and the oil that has flowed through the oil discharge passage, and may resupply the oil to the lubricating oil flow path.

[0196] Since the oil supplying device recovers the gaseous coolant and the lubricating oil together, it is unnecessary for the gaseous coolant and the lubricating oil to be recovered separately. Accordingly, there is no particular need to provide a gaseous coolant recovery device in the rotating electric machine system. Therefore, a situation is avoided in which the configuration of the rotating electric machine system becomes complex.

Supplementary Note 8

[0197] In the rotating electric machine system according to Supplementary Note 7, the oil supplying device may include the gas-liquid separation device (**900**) configured to separate the gaseous coolant and the lubricating oil.

[0198] Since the gas-liquid separation device separates the gaseous coolant and the oil, even though the gaseous coolant and the oil are recovered together, only the oil is capable of being resupplied to the oil supply passage. More specifically, in accordance with such a configuration, it is easy to circulate and supply the lubricating oil to the bearings.

[0199] Moreover, it should be noted that the present invention is not limited to the disclosure described above, but various configurations may be adopted therein without departing from the essence and gist of the present invention.

Claims

1. A rotating electric machine system comprising a rotating electric machine including a rotor and a stator, and a housing in which the stator is accommodated, wherein: the rotor comprises a rotating shaft, a sleeve configured to cover the rotating shaft from an outer circumferential side, permanent magnets configured to be retained in the sleeve, a collar configured to be disposed on the outer circumferential side relative to the sleeve and the rotating shaft, a rotor internal flow path configured to include an annular shaped space formed between an outer circumferential surface of the rotating shaft and an inner circumferential surface of the sleeve, and configured to extend in an axial direction of the rotating shaft, and an internal space formed between the outer circumferential surface of the rotating shaft and an inner circumferential surface of the collar; the rotating electric machine system comprises a liquid coolant supplying device configured to supply a liquid coolant to the rotor internal flow path; the sleeve comprises an inserted portion that is an axial end portion of the sleeve and is inserted into the internal space to separate the internal space from the rotor internal flow path, and a communication flow path that is formed in the inserted portion and is configured to place the internal space and the rotor internal flow path in communication; an outer circumferential surface of the inserted portion comprises an abutment surface against which the inner circumferential surface of the collar abuts; and an outlet port through which the liquid coolant flows out from the communication flow path into the internal space is located more inwardly in a diametrical direction of the rotating shaft than the abutment surface.

2. The rotating electric machine system according to claim 1, wherein the communication flow path is inclined in a manner so as to face outwardly from inwardly in the diametrical direction approaching in close proximity to the internal space from the rotor internal flow path.

3. The rotating electric machine system according to claim 1, wherein: the collar comprises a partition wall configured to divide the internal space into a first inner chamber and a second inner chamber, an insertion hole formed in the partition wall and through which the rotating shaft is inserted, and a discharge flow path formed in the partition wall and that places the first inner chamber and the second inner chamber in communication; and the inserted portion is inserted into the first inner chamber, and the liquid coolant that is supplied to the rotor internal flow path passes from the first inner chamber via the discharge flow path, and is discharged to an exterior of the collar from the second inner chamber.

4. The rotating electric machine system according to claim 1, wherein: the inserted portion comprises a first annular shaped convex portion configured to project out in an annular shape in the axial direction of the sleeve, and a second annular shaped convex portion configured to be connected to the first annular shaped convex portion, to project out in an annular shape in the axial direction of the sleeve, and further, to be smaller in diameter than the first annular shaped convex portion; and an outer circumferential surface of the first annular shaped convex portion includes the abutment surface, and the second annular shaped convex portion includes the outlet port.

5. The rotating electric machine system according to claim 1, wherein: the liquid coolant supplying device is an oil supplying device configured to supply oil as the liquid coolant; and the housing comprises a lubricating oil flow path through which the oil as a lubricant is supplied to a bearing that supports the rotating shaft.

6. The rotating electric machine system according to claim 5, wherein the housing comprises an oil discharge passage through which the oil that has flowed through the rotor internal flow path and the lubricating oil flow path is discharged to the oil supplying device, and the oil supplying device resupplies the oil that has been discharged from the oil discharge passage to the rotor internal flow path and the lubricating oil flow path.

7. The rotating electric machine system according to claim 6, further comprising a gaseous coolant supply device configured to supply a gaseous coolant to the bearing, wherein the housing comprises a gaseous coolant flow path through which the gaseous coolant flows, and a gaseous coolant discharge passage through which the gaseous coolant is discharged to an exterior of the housing, and the oil supplying device recovers the gaseous coolant that has flowed through the gaseous coolant discharge passage and the oil that has flowed through the oil discharge passage, and resupplies the oil to the lubricating oil flow path.

8. The rotating electric machine system according to claim 7, wherein the oil supplying device includes a gas-liquid separation device configured to separate the gaseous coolant and the lubricating oil.