US 20240133423A1

(19) **United States**

(12) **Patent Application Publication**

(10) **Pub. No.: US 2024/0133423 A1**

(43) **Pub. Date: Apr. 25, 2024**

FUTAE et al.

(54) **GAS BEARING DEVICE AND TURBOCHARGER**

(71) Applicant: **MITSUBISHI HEAVY INDUSTRIES ENGINE & TURBOCHARGER, LTD.**, Sagamihara-shi, Kanagawa (JP)

(72) Inventors: **Takaya FUTAE**, Tokyo (JP); **Shuichi ISAYAMA**, Tokyo (JP); **Toru SUZUKI**, Tokyo (JP); **Naomichi SHIBATA**, Sagamihara-shi (JP)

(73) Assignee: **MITSUBISHI HEAVY INDUSTRIES ENGINE & TURBOCHARGER, LTD.**, Sagamihara-shi, Kanagawa (JP)

(21) Appl. No.: **18/277,159**

(22) PCT Filed: **Feb. 21, 2022**

(86) PCT No.: **PCT/JP2022/006814**

§ 371 (c)(1),
(2) Date: **Aug. 13, 2023**

(30) **Foreign Application Priority Data**

Feb. 26, 2021 (JP) 2021-030469

Publication Classification

(51) **Int. Cl.**

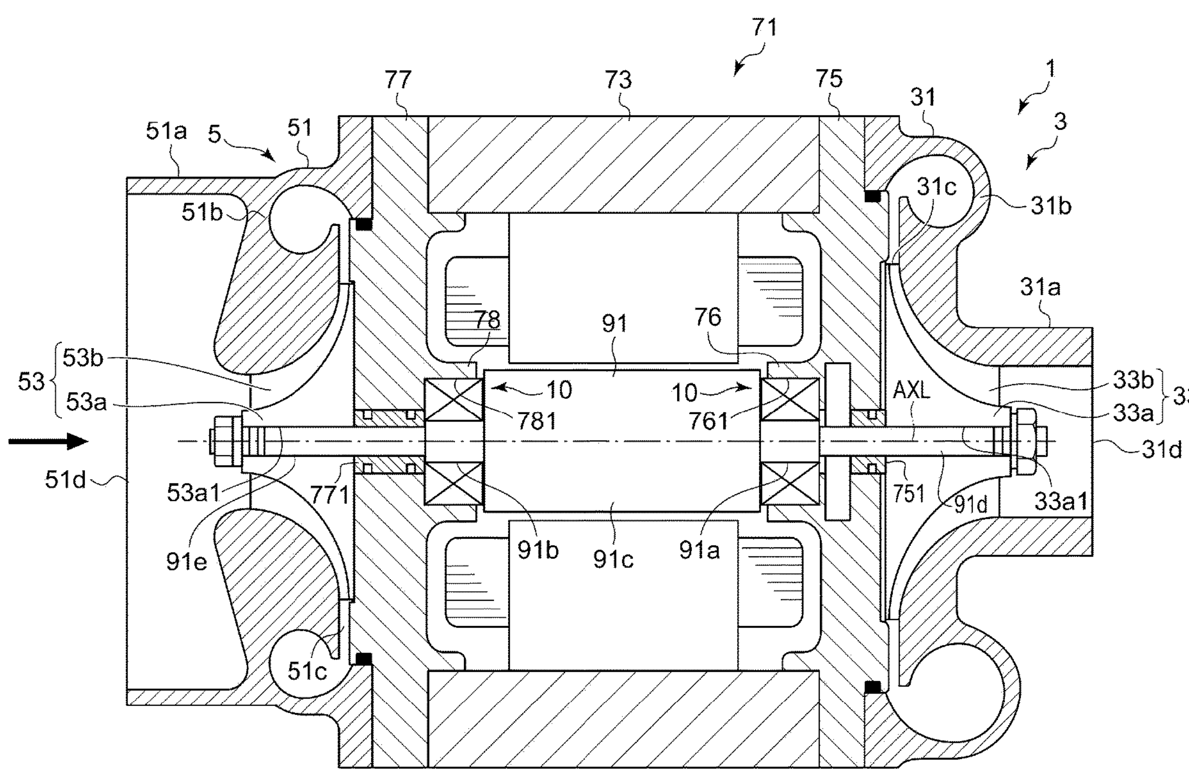
F16C 17/02	(2006.01)
F04D 17/10	(2006.01)
F04D 29/056	(2006.01)
F04D 29/66	(2006.01)

(52) **U.S. Cl.**

CPC ***F16C 17/024*** (2013.01); ***F04D 17/10*** (2013.01); ***F04D 29/056*** (2013.01); ***F04D 29/668*** (2013.01); *F16C 2360/24* (2013.01)

(57) **ABSTRACT**

A gas bearing device is a gas bearing device for rotatably supporting a rotational shaft by using a gas as a working fluid, including: a housing where the rotational shaft penetrates; an annular top foil disposed inside the housing and surrounding an outer periphery of the rotational shaft; a back spring disposed between the top foil and the housing, and having a plurality of crests contacting the top foil and a plurality of valleys contacting the housing; and a pair of snap rings fitted in shaft holes where the rotational shaft of the housing penetrates, and configured to restrict movement of the back spring in an axial direction of the rotational shaft. An inner peripheral surface of each of the pair of snap rings has self-lubricating properties.



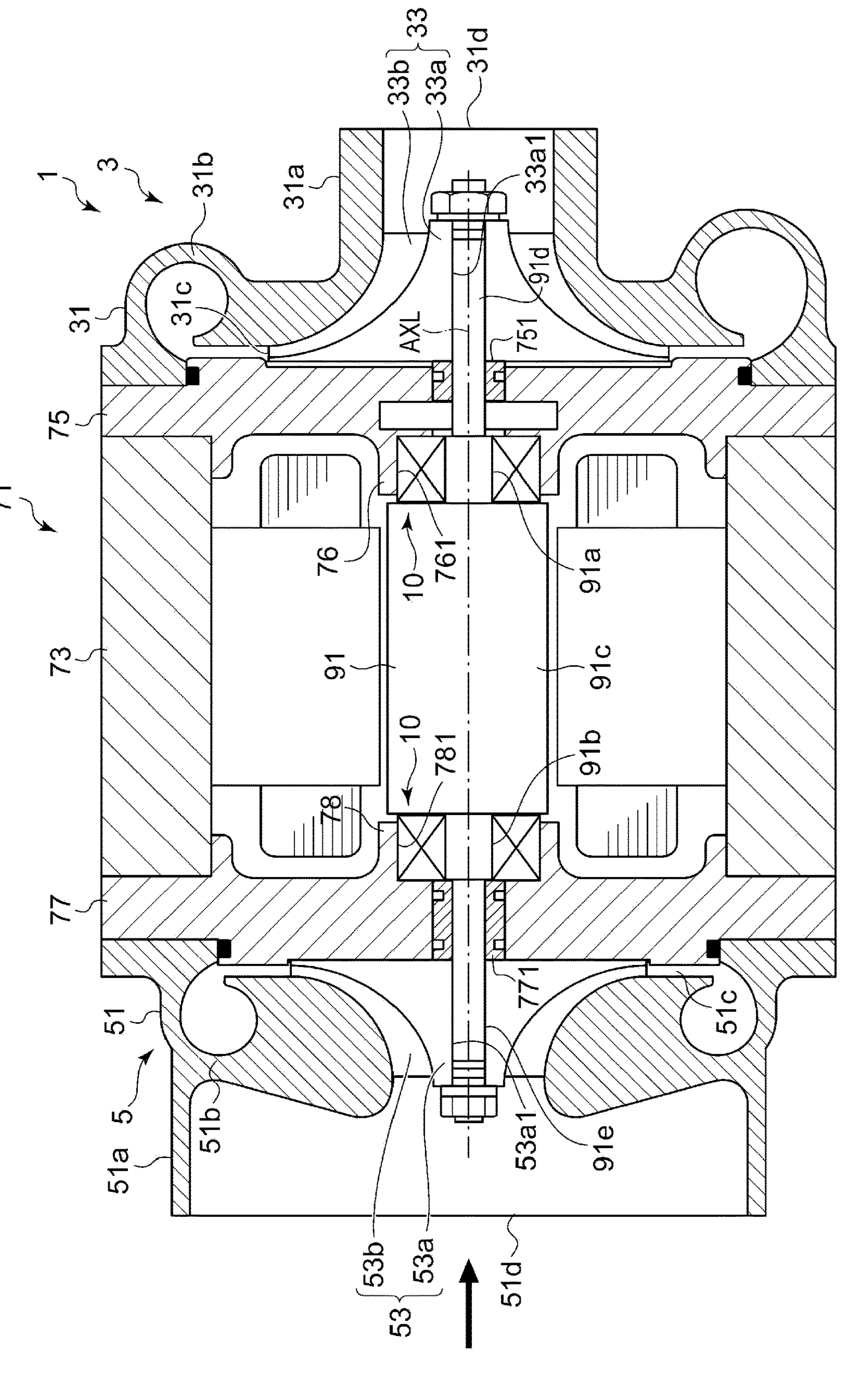

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FIG. 1

FIG. 2

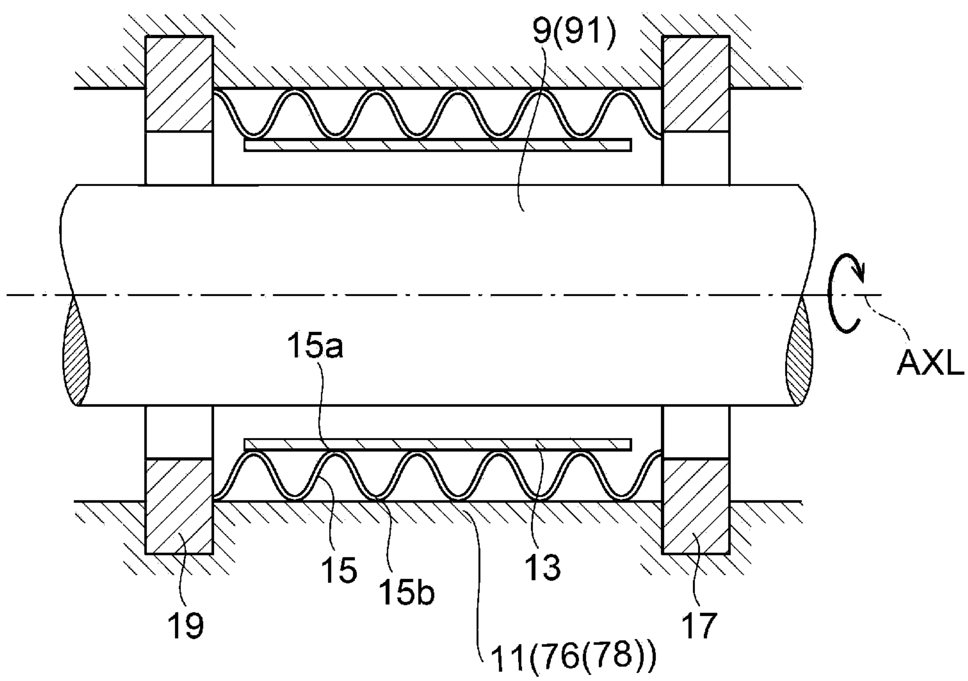


FIG. 3

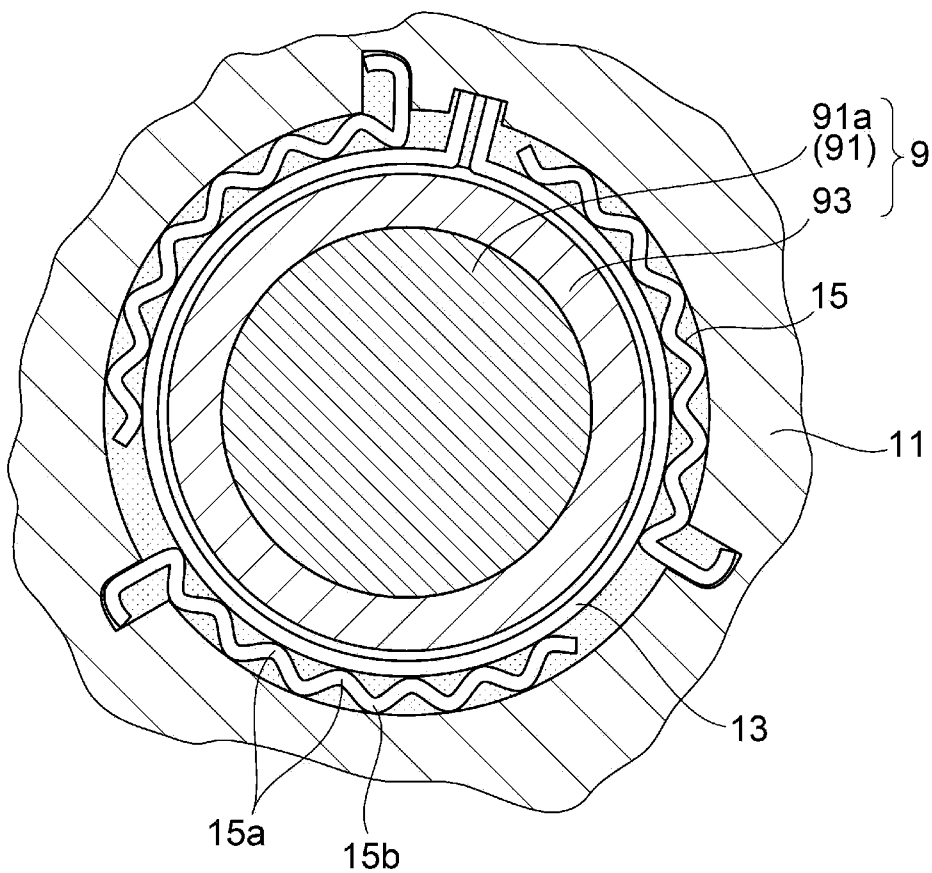


FIG. 4-1

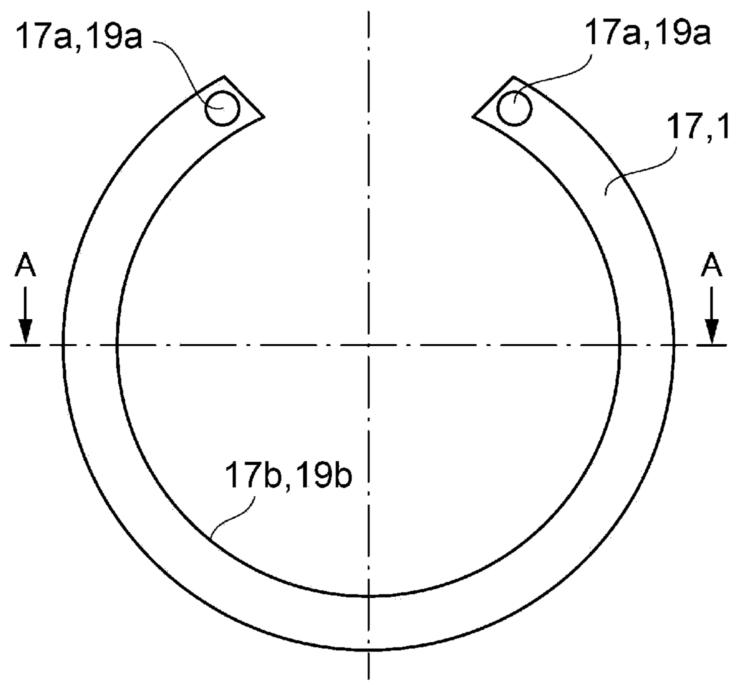


FIG. 4-2

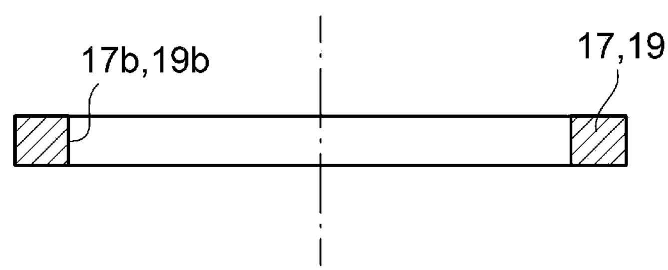


FIG. 5-1

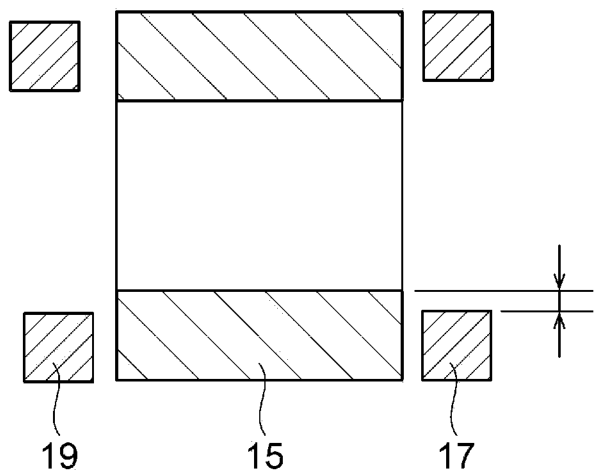


FIG. 5-2

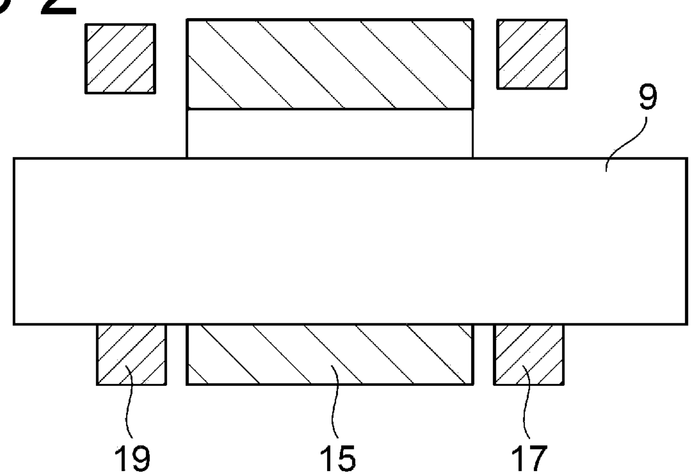


FIG. 5-3

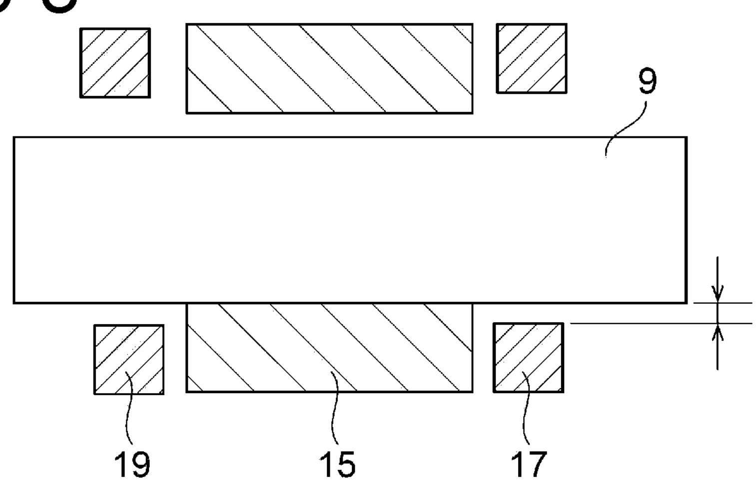


FIG. 6

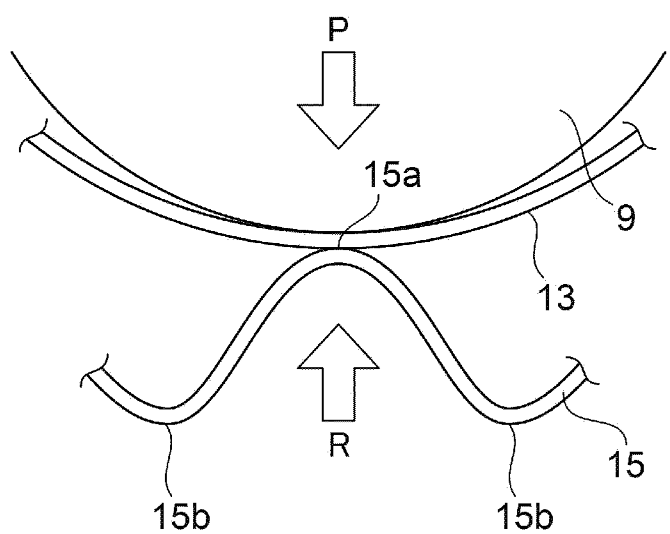


FIG. 7-1

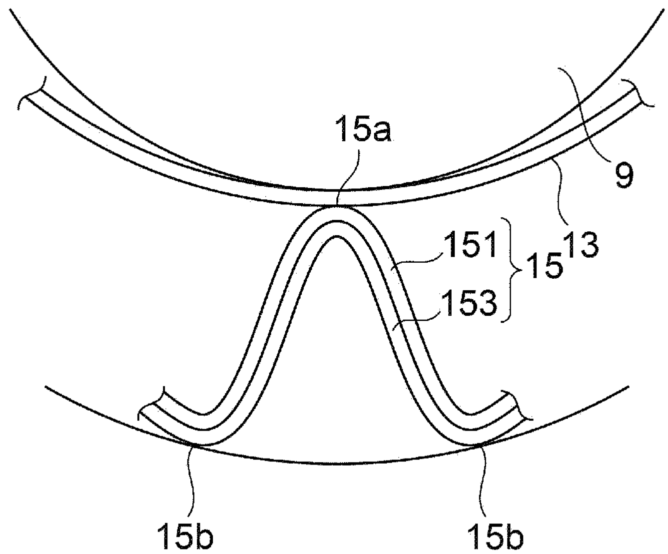
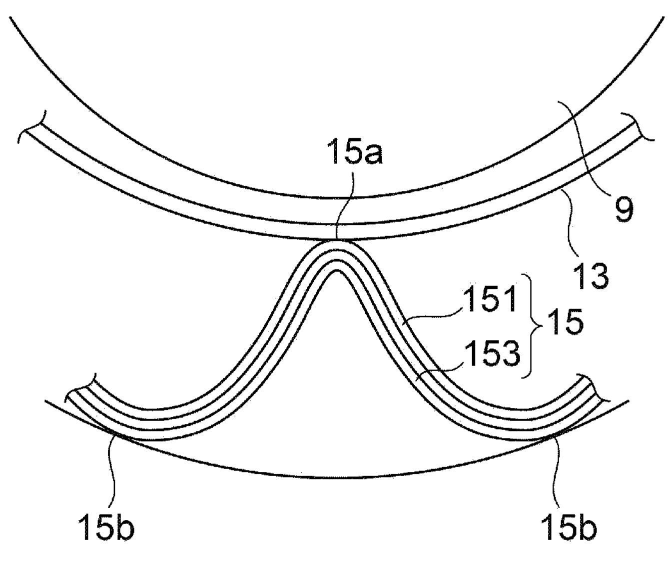


FIG. 7-2



GAS BEARING DEVICE AND TURBOCHARGER

TECHNICAL FIELD

[0001] The present disclosure relates to a gas bearing device and a turbocharger.

[0002] This application claims the priority of Japanese Patent Application No. 2020-030469 filed on Feb. 26, 2021, the content of which is incorporated herein by reference.

BACKGROUND

[0003] Patent Document 1 discloses a gas bearing device that includes a ring-shaped top foil into which a rotatable cylindrical rotational shaft is inserted and an inner peripheral surface of which is spaced from an outer peripheral surface of the rotational shaft, a damping member which is disposed on an outer periphery of the top foil and is configured to damp vibration in a direction intersecting an axis of the rotating rotational shaft, and a ring-shaped housing disposed on an outer periphery of the damping member.

CITATION LIST

Patent Literature

[0004] Patent Document 1: JP2020-122555A

SUMMARY

Technical Problem

[0005] However, in the gas bearing device disclosed in Patent Document 1, if stiffness of the damping member (back spring) is high, a gas film is not formed between the rotational shaft and the top foil during high-speed rotation of the rotational shaft, which may increase a mechanical loss. On the other hand, if the stiffness of the damping member (back spring) is low, the rotational shaft cannot rotatably be supported during low-speed rotation of the rotational shaft.

[0006] The present disclosure has been made in view of the above-described problems, and the object of the present disclosure is to provide a turbocharger and a gas bearing device capable of reliably forming the gas film between the rotational shaft and the top foil during high-speed rotation of the rotational shaft, and reliably rotatably supporting the rotational shaft during low-speed rotation of the rotational shaft.

Solution to Problem

[0007] In order to achieve the above object, a gas bearing device according to the present disclosure is a gas bearing device for rotatably supporting a rotational shaft by using a gas as a working fluid, including: a housing where the rotational shaft penetrates; an annular top foil disposed inside the housing and surrounding an outer periphery of the rotational shaft; a back spring disposed between the top foil and the housing, and having a plurality of crests contacting the top foil and a plurality of valleys contacting the housing; and a pair of snap rings fitted in shaft holes where the rotational shaft of the housing penetrates, and configured to restrict movement of the back spring in an axial direction of the rotational shaft. An inner peripheral surface of each of the pair of snap rings has self-lubricating properties.

Advantageous Effects

[0008] With the gas bearing device of the present disclosure, since the inner peripheral surface of each of the pair of snap rings has self-lubricating properties, the load of the rotational shaft need not be supported only by the back spring during low-speed rotation of the rotational shaft and the support stiffness of the back spring can be reduced. Whereby, the gas film can reliably be formed between the rotational shaft and the top foil during high-speed rotation of the rotational shaft. Further, by reducing the support stiffness of the back spring, the pair of snap rings support the rotational shaft during low-speed rotation of the rotational shaft, and since the inner peripheral surface of each of the pair of snap rings has self-lubricating properties, the pair of snap rings can reliably rotatably support the rotational shaft.

BRIEF DESCRIPTION OF DRAWINGS

[0009] FIG. **1** is a longitudinal cross-sectional view schematically showing the configuration of a turbocharger in which a gas bearing device is built according to an embodiment.

[0010] FIG. **2** is a longitudinal cross-sectional view schematically showing the configuration of the gas bearing device shown in FIG. **1**.

[0011] FIG. **3** is a transverse cross-sectional view schematically showing the configuration of the gas bearing device shown in FIG. **2**.

[0012] FIG. **4-1** is a front view of a snap ring shown in FIG. **2**.

[0013] FIG. **4-2** is a transverse cross-sectional view (cross-sectional view taken along line A-A) of the snap ring shown in FIG. **4-1**.

[0014] FIG. **5-1** is a view (cross-sectional view) conceptually showing a relationship between the snap rings and a back spring, the view showing a state before a rotational shaft is installed.

[0015] FIG. **5-2** is a view (cross-sectional view) conceptually showing the relationship between the snap rings and the back spring, the view showing a state during low-speed rotation of the rotational shaft.

[0016] FIG. **5-3** is a view (cross-sectional view) conceptually showing the relationship between the snap rings and the back spring, the view showing a state during medium-speed rotation of the rotational shaft.

[0017] FIG. **6** is a view for describing support stiffness of the back spring.

[0018] FIG. **7-1** is a view conceptually showing an example in which the back spring disposed between a top foil and a housing is composed of a bimetal, the view showing a state at low temperature.

[0019] FIG. **7-2** is a view conceptually showing an example in which the back spring disposed between the top foil and the housing is composed of the bimetal, the view showing a state at high temperature.

DETAILED DESCRIPTION

[0020] A gas bearing device and a turbocharger according to embodiments will be described below with reference to the accompanying drawings. It is intended, however, that unless particularly specified, dimensions, materials, shapes, relative positions and the like of components described in the embodiment or shown in the drawings shall be interpreted as illustrative only and not intended to limit the scope of the present invention.

[0021] FIG. **1** is a longitudinal cross-sectional view schematically showing the configuration of a turbocharger **1** in which a gas bearing device **10** is built according to an embodiment.

[0022] The turbocharger **1** with the built-in gas bearing device **10** according to the embodiment is mounted on, for example, an automobile engine. The turbocharger **1** includes a turbine **3** which rotates with a flow of an exhaust gas, and a compressor **5** which takes in and compresses air with the rotation of the turbine **3**. The turbine **3** includes a turbine housing **31** and a turbine rotor blade **33** (turbine impeller) accommodated rotatably in the turbine housing **31**, and the compressor **5** includes a compressor housing **51** and an impeller **53** (compressor impeller) accommodated rotatably in the compressor housing **51**.

[0023] Each of the turbine housing **31** and the compressor housing **51** is fixed by a fastening member (such as a bolt) to a bearing housing **71** in which the gas bearing device **10** is built, and the turbine rotor blade **33** and the impeller **53** are coupled to each other by a rotational shaft **91** penetrating the inside of the bearing housing **71** (gas bearing device **10**). Thus, the turbine rotor blade **33**, the impeller **53**, and the rotational shaft **91** are disposed on the same axis AXL. The turbine rotor blade **33** is rotated by an exhaust gas discharged from the automobile engine, for example, whereby the impeller **53** of is rotated via the rotational shaft **91** and supply air to be supplied to the automobile engine is compressed.

[0024] For example, the turbine housing **31** includes a cylindrical section **31***a* (shroud section) for accommodating the turbine rotor blade **33**, and a scroll section **31***b* for surrounding a part of the cylindrical section **31***a* on a side of the bearing housing **71**. The scroll section **31***b* has a non-depicted inlet of the exhaust gas, and is in communication with the cylindrical section **31***a* via a throat section **31***c*. An opening of the cylindrical section **31***a* on an opposite side from the bearing housing **71** forms an outlet **31***d* of the exhaust gas.

[0025] To an opening of the turbine housing **31** on the side of the bearing housing **71**, an end wall **75** (turbine-side end wall) of the bearing housing **71** is fitted. The end wall **75** of the bearing housing **71** is fastened by a fastening member (for example, a bolt) to one end portion of a peripheral wall **73** (bearing housing body) formed into a cylindrical shape, and forms a part (end wall **75**) of the bearing housing **71**. The end wall **75** is provided with a seal section **751**, the seal section **751** is formed with a seal hole penetrating the center of the end wall **75**, and the rotational shaft **91** is disposed in the seal section **751**.

[0026] For example, the compressor housing **51** includes a cylindrical section **51***a* (shroud section) for accommodating the impeller **53**, and a scroll section **51***b* for surrounding a part of the cylindrical section **51***a* on the side of the bearing housing **71**. The scroll section **51***b* has a non-depicted outlet of supply air, and is in communication with the cylindrical section **51***a* via a diffuser section **51***c*. An opening of the cylindrical section **51***a* on an opposite side from the bearing housing **71** forms an inlet **51***d* of the supply air.

[0027] To an opening of the compressor housing **51** on the side of the bearing housing **71**, an end wall **77** (compressor-side end wall) of the bearing housing **71** is fitted. The end wall **77** of the bearing housing **71** is fastened by a fastening member (for example, a bolt) to another end portion of the peripheral wall **73** (bearing housing body), and forms a part (end wall **77**) of the bearing housing **71**. An annular seal section **771** is fitted in the end wall **77**. The seal section **771** is formed with a seal hole penetrating the center, and the rotational shaft **91** is disposed in the seal section **771**.

[0028] Inside the bearing housing **71**, bearing sections **76**, **78** are respectively disposed in the turbine-side end wall **75** and the compressor-side end wall **77**, and the bearing sections **76**, **78** are respectively formed with bearing holes **761**, **781**. The gas bearing devices **10** according to the present embodiment are respectively disposed as radial bearings in the bearing holes **761**, **781**, and the rotational shaft **91** is disposed in the bearing holes **761**,**781** of the bearing sections **76**, **78** while penetrating the gas bearing devices **10**, respectively.

[0029] The rotational shaft **91** includes a pair of shaft sections **91***a*, **91***b*, an middle section **91***c*, a turbine rotor blade attachment section **91***d*, and a compressor impeller attachment section **91***e*. The pair of shaft sections **91***a*, **91***b* are sections disposed in shaft holes of the bearing sections **76**, **78** while penetrating the gas bearing devices **10** respectively, and extend into the seal sections **751**, **771** respectively. The middle section **91***c* is a section disposed between the pair of shaft sections **91***a*, **91***b*, has a larger diameter than the pair of shaft sections **91***a*, **91***b*, and is provided with a step at a boundary between the pair of shaft sections **91***a*, **91***b*. The turbine rotor blade attachment section **91***d* is a section disposed in an end portion on a side of the turbine **3**, has a smaller diameter than the shaft section **91***a*, and is provided with a step between itself and the shaft section **91***a*. The compressor impeller attachment section **91***e* is a section disposed in an end portion on a side of the compressor **5**, and as with the turbine rotor blade attachment section **91***d*, has a smaller diameter than the shaft section **91***b* and is provided with a step between itself and the shaft section **91***b*.

[0030] The turbine rotor blade **33** includes a hub **33***a* and a plurality of blades **33***b*. The hub **33***a* has a shape which is rotationally symmetric with respect to the axis AXL. One end side of the hub **33***a* is located on an outlet side of the exhaust gas, and another end side of the hub **33***a* is located on the side of the bearing housing **71**, in a direction along the axis AXL. An outer peripheral surface of the hub **33***a* has a trumpet shape that widens from the one end side toward the another end side, and the hub **33***a* has on the another end side a back surface that faces the bearing housing **71**.

[0031] The hub **33***a* has an attachment hole **33***a***1** penetrating the hub **33***a* along the axis AXL, and the attachment hole **33***a***1** has openings at the both ends of the hub **33***a*. The plurality of blades **33***b* are integrally attached to the outer peripheral surface of the hub **33***a*, and is arranged at a predetermined interval in the circumferential direction of the hub **33***a*.

[0032] The impeller **53** includes a hub **53***a* and a plurality of blades **53***b*. The hub **53***a* has a shape which is rotationally symmetric with respect to the axis AXL. One end side of the hub **53***a* is located on a side of the inlet **51***d* of the supply air, and another end side of the hub **53***a* is located on the side of the bearing housing **71**, in the direction along the axis AXL. An outer peripheral surface of the hub **53***a* has a trumpet shape that widens from the one end side toward the another end side, and the hub **53***a* has on the another end side a back surface that faces the bearing housing **71** (end wall **75**).

[0033] The hub **53***a* has an attachment hole **53***a***1** penetrating the hub **53***a* along the axis AXL, and the attachment hole **53***a***1** has openings at the both ends of the hub **53***a*. The plurality of blades **53***b* are integrally attached to the outer peripheral surface of the hub **53***a*, and is arranged at a predetermined interval in the circumferential direction of the hub **53***a*.

[0034] FIG. **2** is a longitudinal cross-sectional view schematically showing the configuration of the gas bearing device **10** shown in FIG. **1**, and FIG. **3** is a transverse cross-sectional view schematically showing the configuration of the gas bearing device **10** shown in FIG. **2**. FIG. **4-1** is a front view of a snap ring **17**, **19** shown in FIG. **2**, and FIG. **4-2** is a transverse cross-sectional view (cross-sectional view taken along line A-A) of the snap ring **17**, **19** shown in FIG. **4-1**.

[0035] As shown in FIGS. **2** and **3**, the gas bearing device **10** is a bearing device for rotatably supporting a rotational shaft **9** by using a gas as a working fluid, and includes a housing **11**, a top foil **13**, a back spring **15**, and a pair of snap rings **17**, **19**.

[0036] The rotational shaft **9** penetrates the housing **11**. For example, the housing **11** is formed by the above-described bearing section **76** (**78**), and the rotational shaft **9** is formed by the above-described rotational shaft **91**.

[0037] The top foil **13** is disposed inside the housing **11** and has an annular shape surrounding an outer periphery of the rotational shaft **9**.

[0038] The back spring **15** is disposed between the top foil **13** and the housing **11** (shaft hole), and has a plurality of crests **15***a* contacting the top foil **13** and a plurality of valleys **15***b* contacting the housing **11**.

[0039] The pair of snap rings **17**, **19** are fitted in shaft holes where the rotational shaft **9** of the housing **11** penetrates, and is configured to restrict movement of the back spring **15** in the axial direction of the rotational shaft **9**. The pair of snap rings **17**, **19** is a snap ring for hole, is fitted in a ring groove (circumferential groove) disposed in the shaft hole where the rotational shaft **9** of the housing **11** penetrates, and is fixed by an elastic restoring force of the snap ring **17**, **19**. As shown in FIG. **4**, the pair of snap rings **17**, **19** has a partially notched annular shape, is formed such that an outer circumference and an inner circumference are concentrically disposed, and has holes **17***a*, **19***a* for tool in both end portions of the notch. An inner peripheral surface **17***b*, **19***b* of each of the pair of snap rings **17**, **19** has self-lubricating properties, and is constituted by, for example, a smooth surface.

[0040] FIG. **5** is a view (cross-sectional view) conceptually showing a relationship between the snap rings **17**, **19** and the back spring **15**, FIG. **5-1** is a view showing a state before the rotational shaft **9** is installed, FIG. **5-2** is a view showing a state during low-speed rotation of the rotational shaft **9**, FIG. **5-3** is a view showing a state during medium-speed rotation of the rotational shaft **9**. Further, FIG. **6** is a view for describing support stiffness of the back spring **15**. Although the top foil **13** is omitted in FIG. **5**, the top foil **13** is an essential component, and the omission does not mean that the top foil **13** is not the essential component.

[0041] As described above, if the inner peripheral surface of each of the pair of snap rings **17**, **19** has self-lubricating properties, as shown in FIG. **5-2**, a load of the rotational shaft **9** need not be supported only by the back spring **15** and the support stiffness of the back spring **15** can be reduced. As shown in FIG. **6**, the support stiffness of the back spring **15** is resistance to deformation of the back spring **15** and is a reaction force (R) obtained from the back spring **15** by the rotational shaft **9**.

[0042] In the gas bearing device **10** where the support stiffness of the back spring **15** is reduced, as shown in FIG. **5-1**, in the state before the rotational shaft **9** is installed, the height of the crest **15***a* of the back spring **15** has an equilibrium length and the height of the crest **15***a* of the back spring **15** is located inward of inner peripheries of the snap rings **17**, **19**. As shown in FIG. **5-2**, in the state where the rotational shaft **9** is installed, the rotational shaft **9** is supported by the back spring **15** and the snap rings **17**, **19**, and the height of the crest **15***a* of the back spring **15** is located at the same height as the inner peripheries of the snap rings **17**, **19**. Even in the state during low-speed rotation of the rotational shaft **9**, the height of the crest **15***a* of the back spring **15** is located at the same height as the inner peripheries of the snap rings **17**, **19**, and the rotational shaft **9** is supported by the back spring **15** and the snap rings **17**, **19**. As shown in FIG. **5-3**, in the state during medium-speed rotation of the rotational shaft **9**, the rotational shaft **9** rises from the inner peripheries of the snap rings **17**, **19** and the rotational shaft **9** is supported by the back spring **15**. At this time, the height of the crest **15***a* of the back spring **15** is located inward of the inner peripheries of the snap rings **17**, **19**.

[0043] With such configuration, the gas film can reliably be formed between the rotational shaft **9** and the top foil **13** during high-speed rotation of the rotational shaft **9**. Further, by reducing the support stiffness of the back spring **15**, the pair of snap rings **17**, **19** support the rotational shaft **9** during low-speed rotation of the rotational shaft **9**, and since the inner peripheral surface of each of the pair of snap rings **17**, **19** has self-lubricating properties, the pair of snap rings **17**, **19** can reliably rotatably support the rotational shaft **9**.

[0044] For example, each of the pair of snap rings **17**, **19** is composed of a self-lubricating material.

[0045] With such configuration, since each of the pair of snap rings **17**, **19** is composed of the self-lubricating material, the inner peripheral surface of each of the pair of snap rings **17**, **19** has self-lubricating properties. Whereby, it is possible to reduce the support stiffness of the back spring **15**.

[0046] For example, each of the pair of snap rings **17**, **19** is composed of a synthetic resin. For example, the synthetic resin is a high functional resin called engineering plastic, and for example, MC nylon, polyacetal (POM), etc. can be adopted.

[0047] With such configuration, each of the pair of snap rings **17**, **19** is composed of the synthetic resin.

[0048] For example, the back spring **15** is composed of a spring whose support stiffness is lower at high temperature than at low temperature.

[0049] With such configuration, the support stiffness of the back spring **15** increases during low-speed rotation (during startup) of the rotational shaft **9** when the back spring **15** is at low temperature, and the support stiffness of the back spring **15** decreases at high temperature of the rotational shaft **9** when the back spring **15** is at high temperature. Thus, the rotational shaft **9** is supported by the back spring **15** during low-speed rotation (during startup) of the rotational shaft **9**, and the gas film is formed between the rotational shaft **9** and the top foil **13** during high-speed rotation of the rotational shaft **9**. Whereby, it is possible to reliably form the gas film during high-speed rotation of the rotational shaft **9**, and it is possible to reliably support the rotational shaft **9** during low-speed rotation during rotation.

[0050] FIG. **7** is a view conceptually showing an example in which the back spring **15** disposed between the top foil **13** and the housing **11** is composed of a bimetal, FIG. **7-1** is a view showing a state at low temperature, and FIG. **7-2** is a view showing a state at high temperature.

[0051] As shown in FIG. **7** the back spring **15** disposed between the top foil **13** and the housing **11** is composed of the bimetal formed by joining together two metal plates **151**, **153** having different coefficients of thermal expansion, for example. In the example shown in FIG. **7**, the metal plate **153** on a side of the housing **11** has the greater coefficient of thermal expansion than the metal plate **151** on a side of the top foil **13**, and the support stiffness of the back spring **15** is higher at high temperature than at low temperature.

[0052] With such configuration, the support stiffness of the back spring **15** can be lower at high temperature than at low temperature.

[0053] The present invention is not limited to the above-described embodiments, and also includes an embodiment obtained by modifying the above-described embodiments and an embodiment obtained by combining these embodiments as appropriate.

[0054] The contents described in the above embodiments would be understood as follows, for instance.

[0055] A gas bearing device (**10**) according to an aspect [1] is a gas bearing device (**10**) for rotatably supporting a rotational shaft (**9**) by using a gas as a working fluid, including: a housing (**11**) where the rotational shaft (**9**) penetrates; an annular top foil (**13**) disposed inside the housing (**11**) and surrounding an outer periphery of the rotational shaft (**9**); a back spring (**15**) disposed between the top foil (**13**) and the housing (**11**), and having a plurality of crests (**15***a*) contacting the top foil (**13**) and a plurality of valleys (**15***b*) contacting the housing (**11**); and a pair of snap rings (**17**, **19**) fitted in shaft holes where the rotational shaft (**9**) of the housing (**11**) penetrates, and configured to restrict movement of the back spring (**15**) in an axial direction of the rotational shaft (**9**). An inner peripheral surface of each of the pair of snap rings (**17**, **19**) has self-lubricating properties.

[0056] With such configuration, since the inner peripheral surface of each of the pair of snap rings (**17**, **19**) has self-lubricating properties, the load of the rotational shaft (**9**) need not be supported only by the back spring (**15**) during low-speed rotation of the rotational shaft (**9**) and the support stiffness of the back spring (**15**) can be reduced. Whereby, the gas film can reliably be formed between the rotational shaft (**9**) and the top foil (**13**) during high-speed rotation of the rotational shaft (**9**). Further, by reducing the support stiffness of the back spring (**15**), the pair of snap rings (**17**, **19**) support the rotational shaft (**9**) during low-speed rotation of the rotational shaft (**9**), and since the inner peripheral surface of each of the pair of snap rings (**17**, **19**) has self-lubricating properties, the pair of snap rings (**17**, **19**) can reliably rotatably support the rotational shaft (**9**).

[0057] [2]A gas bearing device (**10**) according to another aspect is the gas bearing device (**10**) as defined in [1], wherein each of the pair of snap rings (**17**, **19**) is composed of a self-lubricating material.

[0058] With such configuration, since each of the pair of snap rings (**17**, **19**) is composed of the self-lubricating material, the inner peripheral surface of each of the pair of snap rings (**17**, **19**) has self-lubricating properties. Whereby, it is possible to reduce the support stiffness of the back spring (**15**).

[0059] [3] A gas bearing device (**10**) according to another aspect is the gas bearing device (**10**) as defined in [1] or [2], wherein the self-lubricating material is a synthetic resin.

[0060] With such configuration, each of the pair of snap rings (**17**, **19**) is composed of the synthetic resin.

[0061] [4] A gas bearing device (**10**) according to another aspect is the gas bearing device (**10**) as defined in any one of [1] to [3], wherein the back spring (**15**) is composed of a spring whose support stiffness is lower at high temperature than at low temperature.

[0062] With such configuration, the support stiffness of the back spring (**15**) increases during low-speed rotation (during startup) of the rotational shaft (**9**) when the back spring (**15**) is at low temperature, and the support stiffness of the back spring (**15**) decreases during high-speed rotation of the rotational shaft (**9**) when the back spring (**15**) is at high temperature. Thus, the rotational shaft (**9**) is supported by the back spring (**15**) during low-speed rotation of the rotational shaft (**9**), and the gas film is formed between the rotational shaft (**9**) and the top foil (**13**) during high-speed rotation of the rotational shaft (**9**). Whereby, it is possible to reliably form the gas film between the rotational shaft (**9**) and the top foil (**13**) during high-speed rotation of the rotational shaft (**9**), and it is possible to reliably support the rotational shaft (**9**) during low-speed rotation of the rotational shaft (**9**).

[0063] [5] A gas bearing device (**10**) according to another aspect is the gas bearing device (**10**) as defined in [4], wherein the back spring (**15**) is composed of a bimetal formed by joining together two metal plates (**151**, **153**) having different coefficients of thermal expansion.

[0064] With such configuration, the support stiffness of the back spring (**15**) can be lower at high temperature than at low temperature.

[0065] A turbocharger (**1**) according to an aspect [6], includes: the gas bearing device (**10**) as defined in any one of the above [1] to [5].

[0066] With such configuration, since the inner peripheral surface of each of the pair of snap rings (**17**, **19**) has self-lubricating properties, it is possible to reduce the support stiffness of the back spring (**15**). Whereby, the gas film can reliably be formed between the rotational shaft (**9**) and the top foil (**13**) during high-speed rotation of the rotational shaft (**9**). Further, by reducing the support stiffness of the back spring (**15**), the pair of snap rings (**17**, **19**) support the rotational shaft (**9**) during low-speed rotation of the rotational shaft (**9**), and since the inner peripheral surface of each of the pair of snap rings (**17**, **19**) has self-lubricating properties, the pair of snap rings (**17**, **19**) can reliably rotatably support the rotational shaft (**9**).

REFERENCE SIGNS LIST

[0067] **1** Turbocharger
[0068] **3** Turbine
[0069] **31** Turbine housing
[0070] **31***a* Cylindrical section (shroud section)
[0071] **31***b* Scroll section
[0072] **31***c* Throat section
[0073] **31***d* Outlet of exhaust gas
[0074] **33** Turbine rotor blade (turbine impeller)
[0075] **33***a* Hub

[0076] **33***a***1** Attachment hole
[0077] **33***b* Blade
[0078] **5** Compressor
[0079] **51** Compressor housing
[0080] **51***a* Cylindrical section (shroud section)
[0081] **51***b* Scroll section
[0082] **51***c* Diffuser section
[0083] **51***d* Inlet of supply air
[0084] **53** Impeller (compressor impeller)
[0085] **53***a* Hub
[0086] **53***a***1** Attachment hole
[0087] **53***b* Blade
[0088] **71** Bearing housing
[0089] **73** Peripheral wall (bearing housing body)
[0090] **75** End wall (turbine-side end wall)
[0091] **751** Seal section
[0092] **76** Bearing section
[0093] **761** Bearing hole
[0094] **77** End wall (compressor-side end wall)
[0095] **771** Seal section
[0096] **78** Bearing section
[0097] **781** Bearing hole
[0098] **9** Rotational shaft
[0099] **91** Rotational shaft
[0100] **91***a*, **91***b* Shaft section
[0101] **91***c* Middle section
[0102] **91***d* Turbine rotor blade attachment section
[0103] **91***e* Compressor impeller attachment section
[0104] Gas bearing device
[0105] **11** Housing
[0106] **13** Top foil
[0107] **15** Back spring
[0108] **15***a* Crest
[0109] **15***b* Valley
[0110] **151**,**153** Metal plate
[0111] **17**, **19** Snap ring
[0112] **17***a*, **19***a* Hole for tool
[0113] **17***b*, **19***b* Inner circumferential surface
[0114] AXL Axis

1. A gas bearing device for rotatably supporting a rotational shaft by using a gas as a working fluid, comprising:
a housing where the rotational shaft penetrates;
an annular top foil disposed inside the housing and surrounding an outer periphery of the rotational shaft;
a back spring disposed between the top foil and the housing, and having a plurality of crests contacting the top foil and a plurality of valleys contacting the housing; and
a pair of snap rings fitted in shaft holes where the rotational shaft of the housing penetrates, and configured to restrict movement of the back spring in an axial direction of the rotational shaft,
wherein an inner peripheral surface of each of the pair of snap rings has self-lubricating properties.

2. The gas bearing device according to claim **1**,
wherein each of the pair of snap rings is composed of a self-lubricating material.

3. The gas bearing device according to claim **2**,
wherein the self-lubricating material is a synthetic resin.

4. The gas bearing device according to claim **1**,
wherein the back spring is composed of a spring whose support stiffness is lower at high temperature than at low temperature.

5. The gas bearing device according to claim **4**,
wherein the back spring is composed of a bimetal formed by joining together two metal plates having different coefficients of thermal expansion.

6. A turbocharger comprising:
the gas bearing device according to claim **1**.

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