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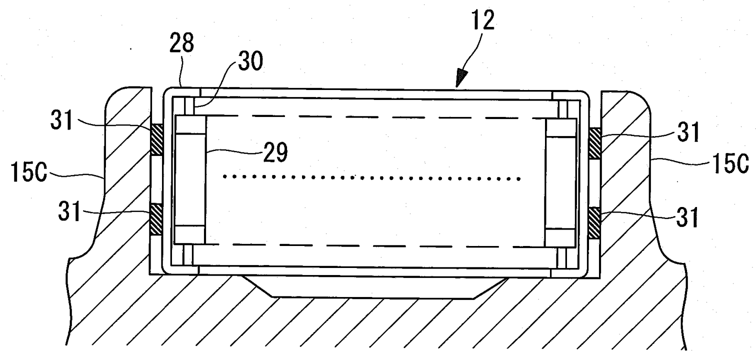
(54) **SCROLL-TYPE FLUID MACHINE**

(57) Provided is a scroll-type fluid machine in which deformation of a rotary scroll can be reduced when a bearing is fixed to the inside of a boss part. In a scroll compressor, a fluid-tight chamber is formed by engaging a fixed scroll and a rotary scroll each having a spiral wall on a side of an end plate. The scroll compressor comprises: a metallic boss part (15C) protruding from the other side of the end plate of the rotary scroll; a metallic rotary bearing (12) inserted in the boss part (15C); a crankshaft configured to be rotated about an axis line and including a bush part, the bush part being inserted in the rotary bearing (12) and rotatably supported by the rotary bearing (12); and an insert member (31) disposed between the boss part (15C) and the rotary bearing (12), the insert member (31) having a thermal expansion coefficient greater than those of the boss part (15C) and the rotary bearing (12).

FIG. 2




EP 2 708 749 A1

## Description

{Technical Field}

**[0001]** The present invention relates to a scroll-type fluid machine in which a sealed chamber confining a fluid is formed by a pair of fixed scroll and rotary scroll meshed together.

{Background Art}

**[0002]** A scroll compressor, in which a compression chamber is formed by a pair of fixed scroll and rotary scroll meshed together, includes a wall erected on one side face of an end plate of the rotary scroll and a boss part protruding from the other side face.

**[0003]** A bush part of a crankshaft is inserted in a rotary bearing inserted in the boss part, and the bush part is rotatably supported by the rotary bearing. The rotary scroll is caused to revolve, via the rotary bearing and the boss part, by rotation of the crankshaft around an axis. Since an axis of the bush part is eccentric to the axis of the crankshaft, the rotary scroll makes orbital motion.

**[0004]** On the other hand, a technique is disclosed in Patent Literature 1 in which use of the rotary bearing is avoided by adopting a drive bush made of polyimide resin and directly fitting the drive bush into the boss.

{Citation List}

{Patent Literature}

**[0005]**

{PTL 1} Japanese Unexamined Patent Application, Publication No. Hei 11-132170

{Summary of Invention}

{Technical Problem}

**[0006]** In the scroll compressor, different metallic materials are usually used for the boss part and the rotary bearing. Accordingly, there is a risk that, when inserting the rotary bearing into the boss part, a gap is generated between the boss part and the rotary bearing at high temperatures due to a difference in thermal expansion coefficients.

**[0007]** For this reason, when inserting and fixing the rotary bearing into the boss part at low temperatures, the rotary bearing has been conventionally inserted (press-fitted) into the boss part while applying pressure thereto so as not to generate a gap at the time of temperature rise. However, this creates a problem that, during press-fitting, an open side of the boss part is deformed to open outward and the end plate of the rotary scroll is deformed accordingly. As a result, contact portions of the wall bodies of the fixed scroll and the rotary scroll are brought into point contact, instead of line contact, causing a refrigerant to leak into an adjacent compression chamber during revolution. In some cases, a tip of the boss part is swaged in addition to press-fitting of the rotary bearing to prevent the rotary bearing from coming off.

**[0008]** In other cases, the rotary bearing is prevented from coming off by inserting a snap ring in a groove provided on the inner face of the boss part. In this case, deformation of the rotary scroll caused by press-fitting and swaging can be prevented, but a gap is generated between the boss part and the rotary bearing during a temperature rise due to the difference in thermal expansion coefficients. This leads to a problem that the boss part and the rotary bearing partially come into contact with each other and develop surface damage (fretting) by being subjected to vibration, repeated stress, and the like.

**[0009]** The present invention has been made in view of these circumstances, and an object thereof is to provide a scroll-type fluid machine which can reduce deformation of the rotary scroll caused when fixing the bearing into the boss part.

{Solution to Problem}

**[0010]** To solve the above problems, the scroll-type fluid machine of the present invention adopts the following solutions.

**[0011]** That is, the scroll-type fluid machine according to the present invention is a scroll-type fluid machine in which a sealed chamber confining a fluid is formed by a fixed scroll and a rotary scroll meshed together, each of the scrolls having a spiral wall erected on one side face of an end plate. The scroll-type fluid machine includes: a metallic boss part protruding from the other side face of the end plate of the rotary scroll; a metallic bearing inserted into the boss part; a crankshaft rotating around an axis and including a bush part inserted in the bearing and rotatably supported by the bearing; and an insert member disposed between the boss part and the bearing and having a thermal expansion coefficient greater than those of the boss part and the bearing.

**[0012]** According to the present invention, the rotary scroll is provided with the wall erected on the one side face of the end plate, and the boss part protruding from the other side face, and the bush part is inserted in the bearing, which is inserted in the boss part, so that the bush part is rotatably supported by the bearing. By rotation of the crankshaft having the bush part around the axis, the rotary scroll is caused to revolve via the bearing and the boss part. When the axis of the bush part is eccentric to the axis of the crankshaft, the rotary scroll makes orbital motion.

**[0013]** In the present invention, the insert member is disposed between the boss part and the bearing. Since the insert member has the thermal expansion coefficient greater than those of the metallic boss part and bearing, the boss part and the bearing are securely fixed by the insert member at high temperatures. It is therefore not necessary to press-fit the bearing into the boss part at low temperatures in expectation of the difference in expansion occurring at high temperatures, and deformation of the rotary scroll caused when press-fitting the bearing into the boss part can be reduced or prevented.

**[0014]** As the insert member is made of, for example, synthetic resin or synthetic rubber, it is also possible to reduce noise and vibration during revolution of the rotary scroll.

**[0015]** In the present invention, the insert member may have a ring shape and be disposed along the inner face of the boss part.

**[0016]** According to the present invention, since the ring-shaped insert member is disposed along the inner face of the boss part, the metallic boss part and bearing do not come into contact with each other. Thus, it is possible to reduce or prevent surface damage (fretting) caused, when the insert member is not provided, by the boss part and the bearing partially coming into contact and being subjected to vibration, repeated stress, and the like.

{Advantageous Effects of Invention}

**[0017]** According to the present invention, deformation of the rotary scroll caused when fixing the bearing into the boss part can be reduced.

{Brief Description of Drawings}

**[0018]**

{Fig. 1}
Fig. 1 is a longitudinal cross-sectional view of a scroll compressor according to an embodiment of the present invention.

{Fig. 2}
Fig. 2 is a longitudinal cross-sectional view illustrating a boss part, a rotary bearing, and an insert member according to the embodiment.

{Fig. 3}
Fig. 3 is a perspective view illustrating the insert member according to the embodiment.

{Fig. 4}
Fig. 4 is a partially enlarged longitudinal cross-sectional view illustrating the boss part, the rotary bearing, and the insert member according to the embodiment.

{Fig. 5}
Fig. 5 is a longitudinal cross-sectional view illustrating a modification of the boss part, the rotary bearing, and the insert member according to the embodiment.

{Fig. 6}
Fig. 6 is a perspective view illustrating a modification of the insert member according to the embodiment.

{Description of Embodiments}

**[0019]** Hereinafter, an embodiment according to the present invention will be described with reference to the drawings.

**[0020]** Fig. 1 is a longitudinal cross-sectional view illustrating a scroll compressor 1 according to the embodiment of the present invention. The scroll compressor 1 includes a housing 2 constituting an outer shell. The housing 2 is constituted by integrally fastening and fixing a front housing 3 and a rear housing 4 by a bolt 5. The front housing 3 and the rear housing 4 have fastening flanges 3A and 4A integrally formed at regular intervals at multiple places, for example, at four places on a circumference. By fastening these flanges 3A and 4A to each other by the bolt 5, the front housing 3 and the rear housing 4 are integrally coupled.

**[0021]** A crankshaft 6 is supported freely rotatably around its axis L via a main bearing 7 and a sub-bearing 8 inside the front housing 3. One end side of the crankshaft 6 (the left side in Fig. 1) forms a small-diameter shaft part 6A, and the small-diameter shaft part 6A passes through the front housing 3 to protrude toward the left side in Fig. 1. A protruding portion of the small-diameter shaft part 6A is provided, as well known, with an electromagnetic clutch, a pulley, or the like (not shown) for receiving power, and the power is transmitted from a drive source such as an engine via a V-belt, etc. A mechanical seal (lip seal) 9 is disposed between the main bearing 7 and the sub-bearing 8 to air-tightly seal between the inside of the housing 2 and the atmosphere.

**[0022]** The other end side of the crankshaft 6 (the right side in Fig. 1) is provided with a large-diameter shaft part 6B, and the large-diameter shaft part 6B has a crank pin 6C integrally formed in a state of being eccentric to the axis L of the crankshaft 6 by a predetermined dimension. The crankshaft 6 is freely rotatably supported by the large-diameter shaft part 6B and the small-diameter shaft part 6A being supported by the front housing 3 via the main bearing 7 and the sub-bearing 8. A rotary scroll 15 to be described later is coupled to the crank pin 6C via a drive bush 10, a cylinder ring (floating bush) 11, and a rotary bearing 12, and the rotary scroll 15 is configured to be driven to revolve by the rotation of the crankshaft 6.

**[0023]** The drive bush 10 includes a balance weight 10A integrally formed for removing an unbalanced load generated when the rotary scroll 15 is driven to revolve, and is configured to revolve together with the rotary scroll 15 being driven to revolve. Further, the drive bush 10 is provided with a crank pin hole 10B for fitting the crank pin 6C at a position eccentric to the center thereof. Thus, the drive bush 10 fitted with the crank pin 6C and the rotary scroll 15 are caused to revolve around the crank pin 6C upon receiving gas compression reaction force, constituting a known driven crank mechanism with a variable revolution radius of the rotary scroll 15.

**[0024]** Further, the housing 2 has incorporated therein a scroll compression mechanism 13 constituted of a pair of fixed scroll 14 and rotary scroll 15. The fixed scroll 14 is constituted of a fixed end plate 14A and a fixed spiral lap 14B (wall) erected on the fixed end plate 14A, and the rotary scroll 15 is constituted of a revolving end plate 15A and a revolving spiral lap 15B (wall) erected on the revolving end plate 15A.

**[0025]** These fixed scroll 14 and rotary scroll 15 have their centers separated from each other by the revolution radius, are engaged with phases of the respective spiral laps 14B and 15B shifted by 180 degrees, and are installed so as to have a slight clearance (several tens to several hundreds of micrometers) at room temperature in a lap height direction between a tooth tip face and a tooth bottom face of the spiral laps 14B and 15B. Thus, as shown in Fig. 1, the both scrolls 14 and 15 are configured so that a plurality of pairs of compression chambers 16 formed therebetween by being partitioned by each end plate 14A and 15A and each spiral lap 14B and 15B are point-symmetric with respect to a scroll center, and the rotary scroll 15 can smoothly revolve around the fixed scroll 14.

**[0026]** The compression chambers 16 have a height in a rotation axis direction which is larger on an outer circumferential side than on an inner circumferential side of each spiral lap 14B and 15B, thereby constituting the scroll compression mechanism 13 capable of compressing gas three-dimensionally in both a circumferential direction and a height direction of each spiral lap 14B and 15B. The spiral laps 14B and 15B of the fixed scroll 14 and rotary scroll 15 may have incorporated therein tip seals 17 and 18, respectively, which seal a tip clearance formed between the tooth tip face and the tooth bottom face of the mating scroll, fitted to a seal groove provided on each tooth tip face.

**[0027]** The fixed scroll 14 is fixedly installed on the inner face of the rear housing 4 via a bolt 27. As described above, the rotary scroll 15 has the boss part 15C, which is provided on a back face of the revolving end plate 15A, coupled to the crank pin 6C, which is provided on one end side of the crankshaft 6, via the drive bush 10, the cylinder ring (floating bush) 11, and the rotary bearing 12, and is configured to be driven to revolve.

**[0028]** Further, the rotary scroll 15 has the back face of the revolving end plate 15A supported by a thrust receiving surface 3B of the front housing 3, and is configured to be driven to revolve around the fixed scroll 14 while being prevented from rotating on its own axis through a rotation preventing mechanism 19 provided between the thrust receiving surface 3B and the back face of the revolving end plate 15A. The rotation preventing mechanism 19 of the present embodiment is the pin-ring type rotation preventing mechanism 19, in which a rotation preventing pin 19B which is incorporated in a pin hole provided in the front housing 3 is freely slidably fitted to an inner circumferential face of the rotation preventing ring 19A which is incorporated in a ring hole provided in the revolving end plate 15A of the rotary scroll 15.

**[0029]** The fixed scroll 14 has a discharge port 14C for discharging compressed refrigerant gas opened at a central portion of the fixed end plate 14A, and the discharge port 14C has installed therein a discharge reed valve 21 mounted to the fixed end plate 14A via a retainer 20. Further, a seal material 22 such as an O-ring is inserted on the back face side of the fixed end plate 14A so as to be in close contact with the inner face of the rear housing 4, thereby forming a discharge chamber 23 divided from the inner space of the housing 2 between the back face of the fixed end plate and the inner face of the rear housing 4. Thus, the inner space of the housing 2 except for the discharge chamber 23 is configured to function as a suction chamber 24.

**[0030]** The refrigerant gas returning from a refrigeration cycle through a suction port 25 provided in the front housing 3 is sucked into the suction chamber 24, and the refrigerant gas is sucked through this suction chamber 24 into the compression chamber 16. A seal material 26 such as an O-ring is interposed between joining faces of the front housing 3 and the rear housing 4 so as to airtightly seal the suction chamber 24 formed inside of the housing 2 against the atmosphere.

**[0031]** Note that the scroll compressor 1 uses lubricant oil for smoothly moving a sliding part inside thereof. The lubricant oil coexists with the refrigerant in a predetermined ratio, and is sucked into the fixed scroll 14 and the rotary scroll 15 together with the refrigerant. This lubricant oil is capable of sealing a minute clearance by adhering to inner wall faces of the fixed scroll 14 and the rotary scroll 15. In the case of application in air conditioning, an oil film thickness of the lubricant oil adhering to the inner wall faces is approximately 5 $\mu$m in a thin part, approximately 100 $\mu$m in a thick part, and approximately 40 $\mu$m on average.

**[0032]** The lubricant oil is discharged from the scroll compressor 1 to, for example, a refrigerant pipe constituting a refrigeration circuit, passes through each component of the refrigeration circuit, returns to the scroll compressor 1, and is sucked into the scroll compressor 1. Note that some refrigeration circuits are provided with an oil separator for separating the lubricant oil and the refrigerant installed on the discharge side of the scroll compressor 1, and the oil separator is capable of returning the separated lubricant oil into the scroll compressor 1.

**[0033]** Next, a description will be given of a joining portion between the boss part 15C and the rotary bearing 12 with reference to Figs. 2 to 4. In this embodiment, an insert member 31 is disposed in a gap formed between the boss part 15C and the rotary bearing 12.

**[0034]** The boss part 15C has a ring shape and is made of metal, for example, aluminum, and protrudes from the back face of the revolving end plate 15A. The insert member 31 and the rotary bearing 12 are inserted into the boss part 15C.

**[0035]** The rotary bearing 12 is a metallic, for example, steel needle bearing. An outer diameter of the rotary bearing 12 is smaller than an inner diameter of the boss part 15C. As shown in Fig. 2, the rotary bearing 12 is constituted of an outer ring 28, a plurality of needle rollers 29, and a holder 30. The outer ring 28 is of a substantially hollow cylindrical shape, and for example, has a collar part, which is bent at an approximately right angle toward the inside, formed on both ends in the axis L direction of the crankshaft 6. The holder 30 holds the plurality of needle rollers 29 at almost equal intervals in the circumferential direction, and is mounted to the inside of the outer ring 28.

**[0036]** As shown in Fig. 3, the insert member 31 has a ring shape. The insert member 31 has a thermal expansion coefficient greater than those of the metallic boss part 15C and rotary bearing 12, and is made of synthetic resin, for example, nylon 66, or synthetic rubber. In the example shown in Figs. 1 and 2, two insert members 31 are disposed between the boss part 15C and the rotary bearing 12.

**[0037]** The insert member 31 is first installed on the inner face of the boss part 15C at room temperature, and thereafter the rotary bearing 12 is inserted into the insert member 31. The boss part 15C may have a groove portion formed on the inner face to prevent displacement of the insert member 31. Further, one end side 31a of the insert member 31 may be round-chamfered or corner-chamfered as shown in Fig. 4. This shape allows the rotary bearing 12 to be smoothly inserted into the insert member 31. Note that the other end side 31b may be chamfered, or have a right-angled shape as it is as shown in Fig. 4.

**[0038]** It is preferable that the insert member 31 and the rotary bearing 12 are securely fixed to the boss part 15C, that is, to the rotary scroll 15 at room temperature. According to the present embodiment, since the insert member 31 has the thermal expansion coefficient greater than those of the metallic boss part 15C and rotary bearing 12, even if each member expands at high temperatures at which the scroll compressor 1 is operating, the rotary bearing 12 is securely fixed to the boss part 15C by the insert member 31.

**[0039]** Supposing, for example, that the rotary scroll 15 and the boss part 15C are made of aluminum and the rotary bearing 12 is made of steel, linear thermal expansion coefficients are $22.0\times10^{-6}$/°C and $12.5\times10^{-6}$/°C, respectively, and the outer diameter of the rotary bearing 12 is 36 mm, if the temperature rises by 80°C, a difference of 27 $\mu$m is produced, generating a gap between the boss part 15C and the rotary bearing 12. For this reason, the inner diameter of the boss part 15C has been set smaller at room temperature, and the rotary bearing 12 has been press-fitted into the boss part 15C in the conventional practice.

**[0040]** On the other hand, in this embodiment, when supposing that the insert member 31 is, for example, made of nylon 66 and has a linear thermal expansion coefficient of $10\times10^{-5}$/°C, since the thermal expansion coefficient is greater compared with that of the boss part 15C and the rotary bearing 12, the rotary bearing 12 is securely fixed to the boss part 15C by the insert member 31. It is preferable that the thickness, material, and the like of the insert member 31 are set or selected such that a gap generated between the boss part 15C and the rotary bearing 12 at high temperatures, and an expansion difference of the insert member 31 when the temperature shifts from room temperature to a high temperature are equal.

{Industrial Applicability}

**[0041]** Thus, according to the present embodiment, it is not necessary, during manufacturing, etc. of the scroll compressor 1 at low temperatures, to press-fit the rotary bearing 12 into the boss part 15C in expectation of a difference in expansion occurring at high temperatures, and deformation of the rotary scroll 15 caused when press-fitting the rotary bearing 12 into the boss part 15C can be prevented. As a result, it is also possible to prevent performance degradation of the scroll compressor 1 due to deformation during press-fitting.

**[0042]** Further, since the insert member 31 has a ring shape and is evenly disposed between the boss part 15C and the rotary bearing 12, the metallic boss part 15C and rotary bearing 12 do not come into contact with each other. It is therefore possible to prevent surface damage (fretting) which has been conventionally caused, when the insert member 31 is not provided, on the contact portion between the boss part 15C and the rotary bearing 12 by being subjected to vibration, repeated stress, and the like. Note that the shape of the insert member 31 is not limited to the ring shape, and other shapes may be used as long as the boss part 15C and the rotary bearing 12 do not come into contact with each other.

**[0043]** Further, as the insert member 31 is made of, for example, synthetic resin or synthetic rubber, it is also possible to reduce noise and vibration during revolution of the rotary scroll 15.

**[0044]** Note that it is not necessary to form a groove for fixing the insert member 31 to the outer face of the outer ring 28, as long as the boss part 15C and the rotary bearing 12 can be securely fixed by the insert member 31. For example, the present embodiment can be applied even where the outer ring is thin like in the case of the needle bearing, that is, even where no groove can be formed on the outer face of the outer ring unlike the outer ring of a ball bearing, etc.

**[0045]** Further, the insert member of the present invention is not limited to the insert member 31 described above. For example, the insert member may be sheet-shaped, like the insert member 32 shown in Figs. 5 and 6, and a wider member than the example shown in Figs. 1 to 4, or may be an O-ring made of NBR. When the insert member 31 or the insert member 32 is made of nylon, a slit 33 may be provided as shown in Figs. 5 and 6. Although it is difficult to insert the insert members 31 and 32 made of nylon into the boss part 15C due to the relative hardness, providing the slit 33 allows the insert members

31 and 32 to be smoothly installed into the boss part 15C.

**[0046]** Note that in the above embodiment, it has been described that the insert members 31 and 32 are disposed between the boss part 15C and the rotary bearing 12, and that the boss part 15C and the rotary bearing 12 do not come into contact with each other. However, the present invention is not limited to this example. The rotary bearing 12 may be inserted into the boss part 15C while compressing the insert members 31 and 32 with a press-fitting allowance for the fitting between the boss part 15C and the rotary bearing 12 set to 0 or a value smaller than a conventional allowance. In this case, the boss part 15C and the rotary bearing 12 partially come into contact with each other at low temperatures, for example, at room temperature. Even by such an insertion method, it is possible to suppress deformation caused when press-fitting the rotary bearing 12 into the boss part 15C, and also to reduce noise and vibration during revolution of the rotary scroll.

**[0047]** Moreover, in the above embodiment, description has been given of the case where the cylinder ring (floating bush) 11 is provided to the crankshaft 6 on the outside of the drive bush 10. However, the present invention is not limited to this example. For example, the present invention can also be applied to a case where no cylinder ring 11 is provided and the drive bush 10 is directly inserted into the rotary bearing 12. Further, in the above embodiment, description has been given of the case where the present invention is applied to the scroll compressor, but it can be applied to a scroll expander as well.

{Reference Signs List}

**[0048]**

| | |
|---|---|
| 6 | crankshaft |
| 10 | drive bush |
| 11 | cylinder ring (floating bush) (bush part) |
| 12 | rotary bearing (bearing) |
| 14 | fixed scroll |
| 15 | rotary scroll |
| 15A | revolving end plate |
| 15B | spiral lap (wall) |
| 15C | boss part |
| 28 | outer ring |
| 29 | roller |
| 30 | holder |
| 31, 32 | insert member |
| 33 | slit |

**Claims**

**1.** A scroll-type fluid machine, in which a sealed chamber confining a fluid is formed by a fixed scroll and a rotary scroll meshed together, each of the scrolls having a spiral wall erected on one side face of an end plate, the scroll-type fluid machine comprising:

a metallic boss part protruding from the other side face of the end plate of the rotary scroll;
a metallic bearing inserted into the boss part;
a crankshaft rotating around an axis and including a bush part inserted in the bearing and rotatably supported by the bearing; and
an insert member disposed between the boss part and the bearing and having a thermal expansion coefficient greater than those of the boss part and the bearing.

**2.** The scroll-type fluid machine according to Claim 1, wherein
the insert member has a ring shape and is disposed along an inner face of the boss part.

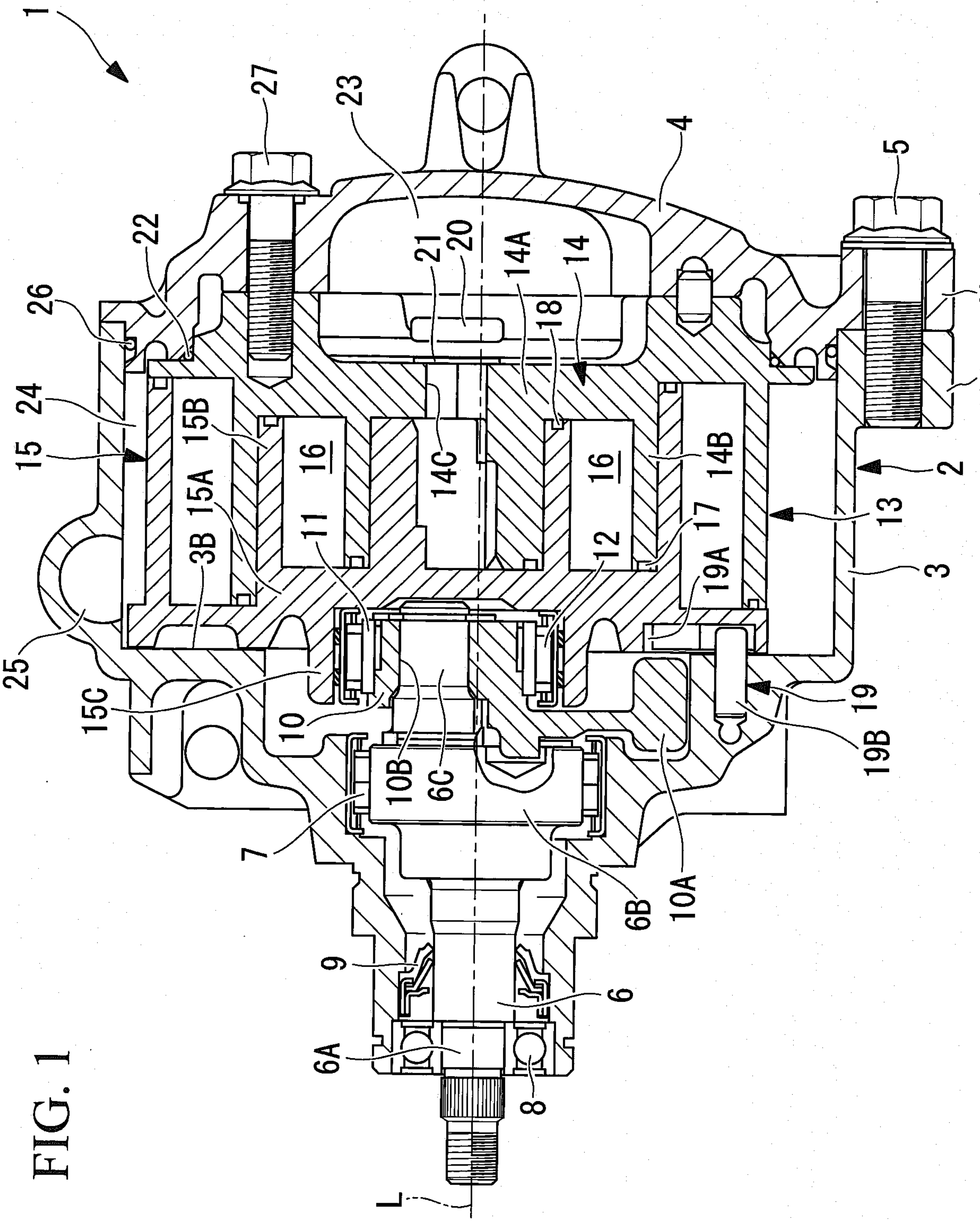

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FIG. 1

FIG. 2

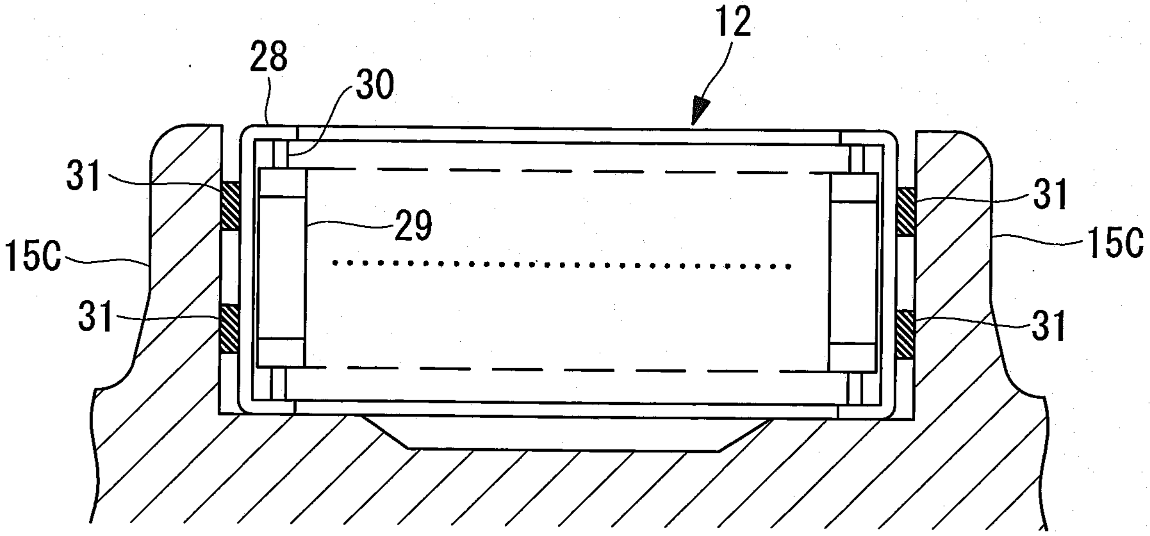



FIG. 3

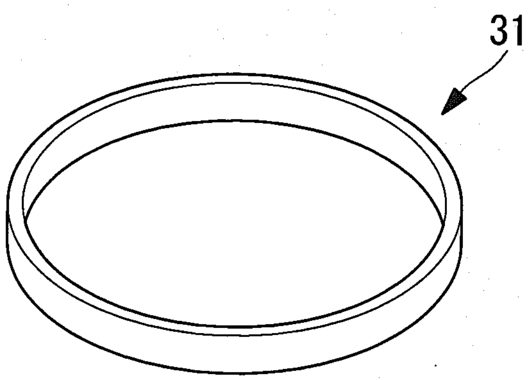


FIG. 4

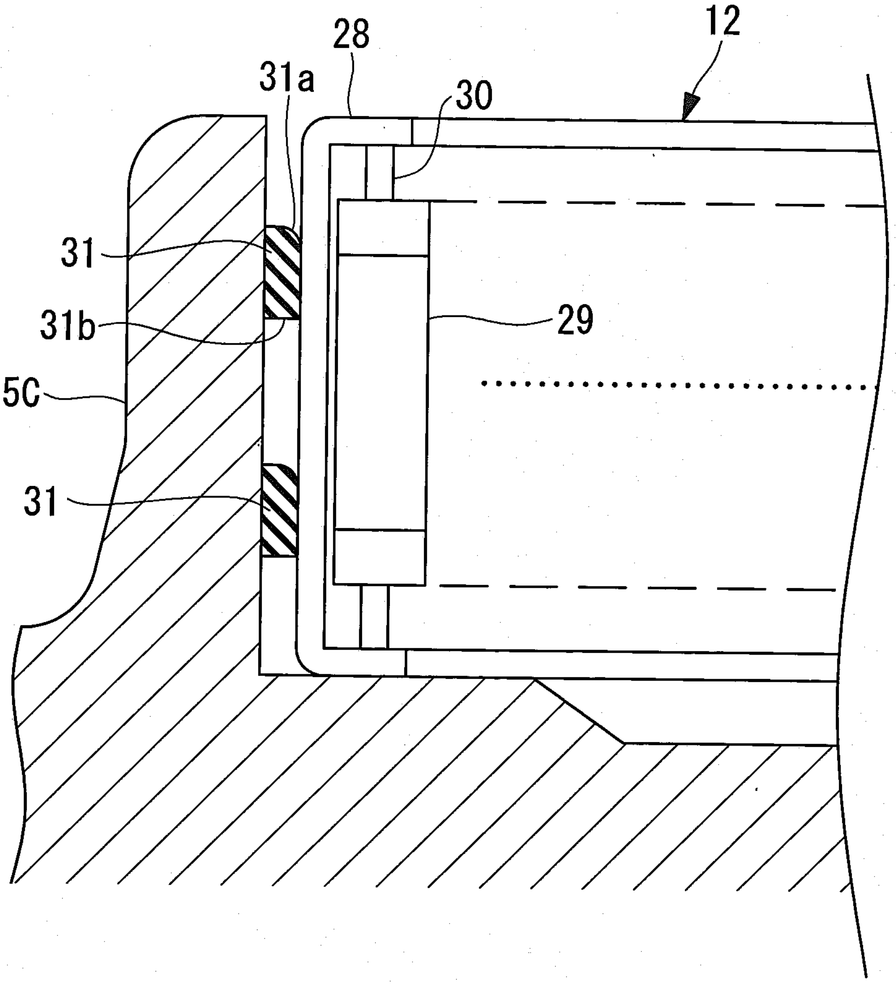



FIG. 5

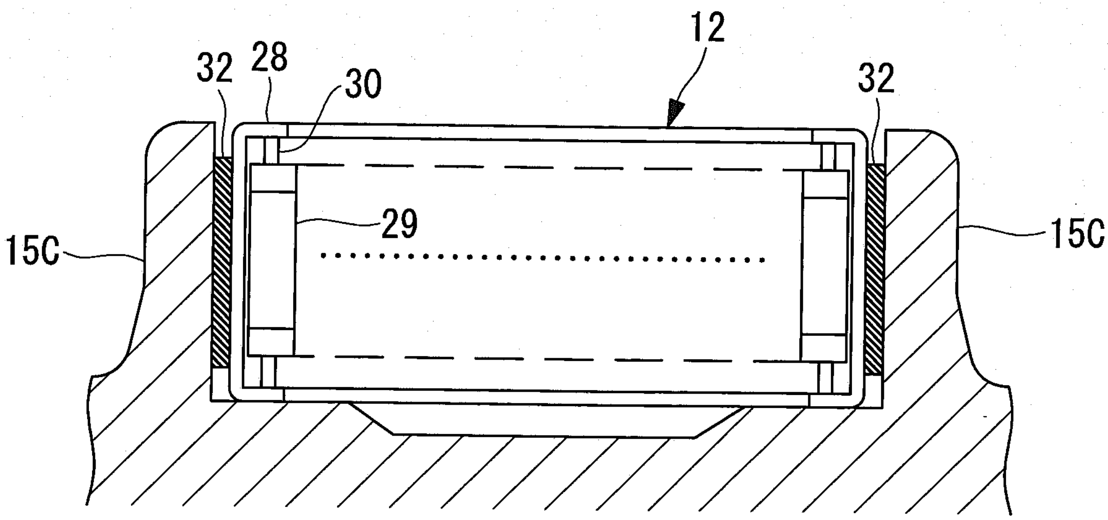
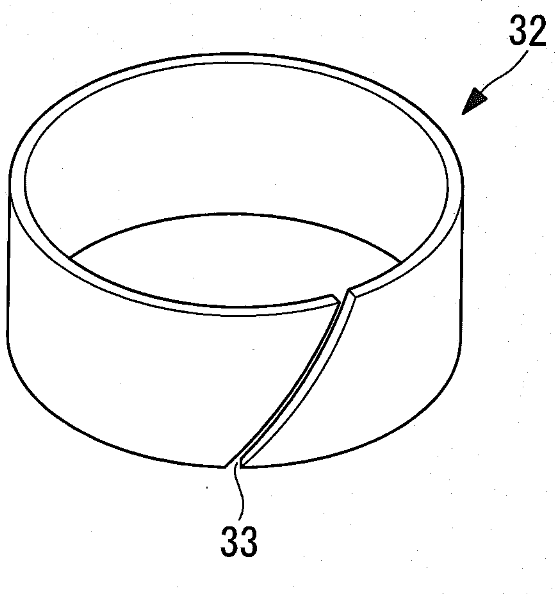


FIG. 6



**INTERNATIONAL SEARCH REPORT**

International application No.
PCT/JP2012/061181

A. CLASSIFICATION OF SUBJECT MATTER
*F04C18/02*(2006.01)i, *F04C29/00*(2006.01)i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F04C18/02, F04C29/00

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

| | | | |
|---|---|---|---|
| Jitsuyo Shinan Koho | 1922-1996 | Jitsuyo Shinan Toroku Koho | 1996-2012 |
| Kokai Jitsuyo Shinan Koho | 1971-2012 | Toroku Jitsuyo Shinan Koho | 1994-2012 |

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| X | JP 63-100293 A (Mitsui Seiki Kogyo Co., Ltd.), 02 May 1988 (02.05.1988), entire text; all drawings (Family: none) | 1,2 |
| A | JP 9-314695 A (Koyo Seiko Co., Ltd.), 09 December 1997 (09.12.1997), paragraphs [0002] to [0004] & US 5928779 A | 1,2 |
| A | JP 3-57893 A (Mitsubishi Electric Corp.), 13 March 1991 (13.03.1991), claims; fig. 1 to 5 (Family: none) | 1,2 |

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

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| 05 July, 2012 (05.07.12) | 17 July, 2012 (17.07.12) |

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