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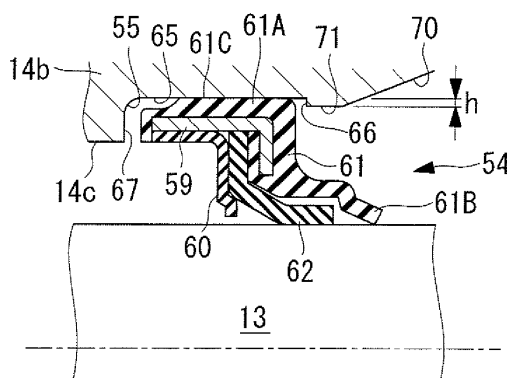
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(54) **COMPRESSOR**

(57) Disclosed is a compressor wherein one end of a revolving shaft (13) penetrates and protrudes to the outside of a housing and the penetrated part (14b) of the housing is shaft-sealed by a lip seal device (54). A lip seal device housing (55) comprising: a level surface (65) in contact with the entirety of a level outer surface (61 C) of a ring section (61A) of a main lip seal material (61) which extends in the axial direction of the revolving shaft (13); a first vertical locking surface (66) positioned nearer

to the inside of the housing than the level surface (65) and which extends radially inwardly in a direction at right angles to the direction of rotation of the revolving shaft (13); and a second vertical locking surface (67) positioned nearer to the outside of the housing than the level surface (65) and which extends radially inwardly in a direction at right angles to the direction of rotation of the revolving shaft (13); both forms the lip seal device (54) and is provided to the penetrated part (14b).

FIG. 2



Description

{Summary of Invention}

{Technical Field}

{Technical Problem}

[0001] The present invention relates to compressors including a shaft-sealed portion equipped with a lip seal device.

{Background Art}

[0002] For an open-type compressor, which is a compressor having a compression mechanism disposed in a housing including a through-portion through which an end of a rotating shaft coupled to the compression mechanism protrudes outside, the through-portion for the rotating shaft is sealed so that no gas flowing through the housing leaks out from the through-portion for the rotating shaft. A lip seal device has been used for the shaft-sealed portion in the related art.

[0003] A lip seal device includes an annular shape-retaining member formed of a metal and having high stiffness and an annular main lip seal and sub-lip seal formed of, for example, an elastically deformable rubber on the outer and inner circumferences, respectively, of the annular shape-retaining member, and is attached by press-fitting an outer circumferential portion of the main lip seal corresponding to the annular shape-retaining member into a lip-seal accommodating portion of the housing and bringing lip portions of the main lip seal and the sub-lip seal into pressure contact with the circumference of the rotating shaft, thereby sealing the through-portion for the rotating shaft.

[0004] To prevent the lip seal device from being detached from the accommodating portion of the housing while ensuring ease of attachment to the accommodating portion, PTL 1 proposes a seal structure including an annular groove provided on the inner circumferential surface of the accommodating portion of the housing, a flange formed on the outside of the annular groove so as to protrude inward, a plurality of elastically deformable seal ribs provided on the outer circumference of the main lip seal of the lip seal device so as to come into pressure contact with the inner circumferential surface of the accommodating portion, and an elastically deformable engaging rib located in front of or behind the seal ribs so as to engage with the annular groove.

{Citation List}

{Patent Literature}

{PTL 1}

[0005] Japanese Unexamined Patent Application, Publication No. HEI-11-248005 (see Figs. 3 and 5)

[0006] The structure proposed in PTL 1, which is intended to prevent the lip seal device from being detached by press-fitting the lip seal device from inside the housing toward the flange until the engaging rib provided on the outer circumference of the main lip seal engages with the annular groove, allows attachment of the lip seal device without using, for example, a snap ring, thus ensuring ease of attachment.

[0007] In this structure, however, the engaging rib that engages with the annular groove is provided in front of or behind the plurality of seal ribs provided on the outer circumference of the main lip seal in the axial direction thereof. Accordingly, the pitch of the plurality of seal ribs, which function to hold and secure the lip seal device to the inner circumferential surface of the accommodating portion of the housing, becomes smaller, thus causing a problem in that there is a higher risk of gas leakage because the lip seal device is more easily tilted when, for example, a negative pressure in the housing applies inward force to the lip seal device to elastically deform or displace the main lip seal.

It is also possible to increase the stiffness of the annular shape-retaining member so that the lip seal device is not easily tilted, although this has a problem in that it increases cost.

A further problem is that the plurality of seal ribs have to be provided on the outer circumference of the main lip seal, which further increases cost.

[0008] An object of the present invention, which has been made to solve the above problems, is to provide a compressor capable of holding a lip seal device so as not to be easily tilted, while maintaining ease of attachment, thus reducing the risk of gas leakage in a simple manner.

{Solution to Problem}

[0009] To achieve the above object, the present invention provides the following solutions.

A compressor according to the present invention includes a housing having an inner space, a compression mechanism that is disposed in the housing and that compresses a fluid taken into the space, and a rotating shaft that drives the compression mechanism, the housing includes a through-portion through which an end of the rotating shaft protrudes outside, the through-portion is sealed by a lip seal device, and the through-portion includes a lip-seal-device accommodating portion formed by a flat surface that contacts an entire flat outer circumferential surface of a ring portion of a main lip seal constituting the lip seal device and extending in the axial direction of the rotating shaft, a first detachment-preventing vertical surface located on the inside of the flat surface in the housing and extending radially inward in a direction

perpendicular to the axial direction of the rotating shaft, and a second detachment-preventing vertical surface located on the outside of the flat surface in the housing and extending radially inward in a direction perpendicular to the axial direction of the rotating shaft.

[0010] In the compressor according to the present invention, the lip seal device is attached to the through-portion of the housing without using, for example, a snap ring, thus maintaining ease of attachment.

In addition, the lip seal device is not easily tilted because the entire flat outer circumferential surface of the ring portion contacts the flat surface of the lip-seal-device accommodating portion, thus reducing the risk of gas leakage in a simple manner.

In addition, a cost increase can be avoided because there is no need to increase the stiffness of an annular shape-retaining member or provide a plurality of seal ribs on the outer circumference of the main lip seal.

[0011] In the above compressor, the depth of the first detachment-preventing vertical surface is preferably set to a depth equivalent to 8% to 40% of the thickness of the ring portion.

[0012] In such a compressor, no permanent strain remains after elastic deformation or no compression crack occurs in a main lip seal formed of rubber when the lip seal device is press-fitted (inserted) into the lip-seal-device accommodating portion from the inside to the outside of the housing past the first vertical surface, thus reducing the risk of gas leakage.

{Advantageous Effects of Invention}

[0013] The compressor according to the present invention provides the advantage of holding a lip seal device so as not to be easily tilted, while maintaining ease of attachment, thus reducing the risk of gas leakage in a simple manner.

{Brief Description of Drawings}

[0014]

{Fig. 1}

Fig. 1 is a longitudinal sectional view of a compressor according to an embodiment of the present invention.

{Fig. 2}

Fig. 2 is a partial enlarged view showing a relevant part of Fig. 1 in an enlarged view.

{Description of Embodiments}

[0015] An embodiment of a compressor (hereinafter referred to as "scroll compressor") according to the present invention will be described below with reference to Figs. 1 and 2. This, however, should not be construed as limiting the present invention.

Fig. 1 is a longitudinal sectional view of the scroll com-

pressor according to this embodiment, and Fig. 2 is a partial enlarged view showing a relevant part of Fig. 1 in an enlarged view.

[0016] As shown in Fig. 1, a scroll compressor 10 according to this embodiment is mainly composed of a housing 11 having an inner hermetically sealed space m, a scroll compression mechanism 12 that is disposed in the housing 11 and that compresses a refrigerant gas (fluid) taken into the hermetically sealed space m, a rotating shaft 13 that drives the scroll compression mechanism 12, and a drive unit that causes the scroll compression mechanism 12 to orbit.

[0017] The housing 11 includes a front housing 14 and a rear housing 15 that are fitted and joined together with a plurality of bolts (not shown) to form the inner hermetically sealed space m. Reference sign 16 denotes an O-ring that seals the joint between the front housing 14 and the rear housing 15 to maintain the hermeticity of the hermetically sealed space m. In addition, a thrust plate 14a that matches an end surface of the front housing 14 is disposed on the end surface of the front housing 14 and has a hole (cutout, not shown) corresponding to a receiving portion 38, described later.

[0018] An intake port (not shown) for taking in the refrigerant gas is formed in the front of the side of the rear housing 15 so as to communicate with the hermetically sealed space m, and a discharge port 15a for discharging a compressed refrigerant gas that has been compressed by the scroll compression mechanism 12 and from which lubricating oil has been separated by an oil-separating chamber (not shown) is formed in the rear of the top of the rear housing 15. In addition, an oil-collecting chamber 18 (oil reservoir) for collecting the lubricating oil separated by the oil-separating chamber is formed on the discharge side (high-pressure side) of the rear housing 15. The oil-separating chamber may be any chamber that has the function of separating oil, for example, by centrifugation, and that guides the separated oil to the oil-collecting chamber 18.

[0019] The scroll compression mechanism 12 includes a fixed scroll 21 and an orbiting scroll 22. The fixed scroll 21 includes a fixed end plate 21a, a spiral wall 21b disposed upright on the inner surface thereof, and a discharge port 21c formed in the center of the fixed end plate 21a. The discharge port 21c is opened and closed by a discharge valve (not shown) attached to the rear surface (back surface) of the fixed end plate 21a with bolts (not shown).

A communicating channel (lubricating oil channel) 23 through which the bottom of the oil-collecting chamber 18 communicates with the bottom of the hermetically sealed space m on the intake side is formed at the lower end of the fixed scroll 21, and in order from the upstream side, a filter 24 and a spiral pin 25 for flow rate control are disposed at the upstream end of the communicating channel 23.

[0020] The communicating channel 23 through which the oil-collecting chamber 18, provided on the high-pres-

sure side in the scroll compressor 10, communicates with the low-pressure side includes a large-diameter portion 23a having an inner diameter substantially equal to the outer diameter of the spiral pin 25 and a small-diameter portion (narrowed portion) 23b having a smaller inner diameter than the large-diameter portion 23a, the large-diameter portion 23a and the small-diameter portion (reduced-diameter portion having a reduced diameter as compared with the upstream side) 23b being formed in order of the large-diameter portion 23a and the small-diameter portion 23b from the upstream side (the oil-collecting chamber 18 side).

The spiral pin 25 is a generally cylindrical member having tapered portions 25a at either end thereof and a main body 25b, excluding the tapered portions 25a, that has a groove of spiral shape (hereinafter referred to as "spiral groove") 25c cut in the side surface thereof. The spiral pin 25 is disposed on the upstream side (the oil-collecting chamber 18 side) in the large-diameter portion 23a. The lubricating oil passing through the filter 24 flows through the spiral groove 25c into the large-diameter portion 23a, located downstream of the spiral pin 25, and then flows (is ejected) through the small-diameter portion 23b into the bottom of the hermetically sealed space m on the intake side.

[0021] The narrowed portion 23b, which has an end opening 23c on the side of the communicating channel 23 facing the orbiting scroll 22, forms an independent narrowed structure separated from the narrowed portion formed by the spiral pin 25 by the space formed by the large-diameter portion 23a so that a different flow resistance can be set.

More specifically, the spiral groove described above forms a high-pressure-side narrowed portion, serving as a pressure/flow rate control portion, primarily for returning the oil from the high-pressure side to the low-pressure side, whereas the small-diameter portion 23b described above forms a low-pressure-side narrowed portion, serving as a pressure/flow rate control portion, for ejecting the oil from the communicating channel 23. Accordingly, the high-pressure-side narrowed portion has a higher flow resistance than the low-pressure-side narrowed portion, thus reliably supplying the oil under appropriate pressure from the high-pressure side to the low-pressure side.

[0022] In addition, the (lubricating-oil) receiving portion 38 is disposed opposite the opening 23c provided at the downstream end of the small-diameter portion 23b. The receiving portion 38 is a cutaway portion (recess) formed in the inner wall surface of the front housing 14 in the bottom of the hermetically sealed space m on the intake side. The bottom surface of the receiving portion 38 is a sloped surface of substantially constant width formed so as to gradually approach the opening 23c of the small-diameter portion 23b as it extends from the inside in the radial direction to the outside in the radial direction, with the lower end thereof located below the lower end of the opening 23c of the small-diameter portion 23b.

[0023] The orbiting scroll 22 includes an orbiting end plate 22a and a spiral wall 22b disposed upright on the inner surface thereof. An eccentric bush 31 is fitted in a boss 22c disposed upright on the outer surface of the orbiting end plate 22a so as to be rotatable with a needle bearing 32 therebetween, and an eccentric pin 13a protruding from an end of the rotating shaft 13 is fitted in a hole formed in the eccentric bush 31. The fixed scroll 21 and the orbiting scroll 22 mesh with each other such that the axes thereof are offset from each other by a predetermined distance and the angles thereof are shifted from each other by 180°, thus forming a plurality of compression chambers C.

In addition, an Oldham ring (rotation-preventing mechanism) 33 is disposed between the orbiting scroll 22 and the front housing 14 so that the orbiting scroll 22 does not rotate about the eccentric bush 31 as the rotating shaft 13 is rotated. Thus, the orbiting scroll 22 only orbits, without rotating, as the rotating shaft 13 is rotated. In addition, the eccentric bush 31 has a balance weight 34 that cancels out centrifugal force resulting from orbiting of the orbiting scroll 22.

[0024] The rotating shaft 13 is a rotor shaft that is rotated about the axis thereof by a drive mechanism (not shown) such as an engine or electric motor, and the eccentric pin 13a described above, whose axis is offset, is formed so as to protrude from the extremity of an end of the rotating shaft 13. The rotating shaft 13 is supported by a first bearing (main bearing) 35 and a second bearing (sub-bearing) 36 disposed on the front housing 14 so as to be rotatable about the axis thereof.

Reference sign 37 denotes an O-ring that seals the joint between the fixed scroll 21 and the rear housing 15 to maintain the hermeticity of the hermetically sealed space m.

[0025] Meanwhile, an electromagnetic clutch 40 is actuated to transmit, or not to transmit, driving force from, for example, an engine or electric motor to the rotating shaft 13.

The electromagnetic clutch 40 is mainly composed of a clutch bearing 41, a drive rotor 42, coils 43, covers 44, a hub 45, leaf springs 46, pins 47 and 48, and an armature plate 49.

The clutch bearing 41 is press-fitted to the outer circumferential surface of a nose portion 14b of the front housing 14 (such as by pressing using a press) such that the inner circumferential surface of the inner ring thereof makes intimate contact with the outer circumferential surface of the nose portion 14b.

[0026] The drive rotor 42 is attached to the outer circumferential surface of the outer ring of the clutch bearing 41 such that the inner circumferential surfaces thereof make intimate contact with the outer circumferential surface of the outer ring of the clutch bearing 41. In addition, the coils 43 are built into the drive rotor 42, and the armature plate 49 is disposed opposite the coils 43. The coils 43 are supplied with current based on a signal output from a controller (not shown).

The hub 45 is attached to the extremity of the other end of the rotating shaft 13 with a bolt 50 and a stopper 51.

[0027] The covers 44 and the leaf springs 46 each have an end thereof attached to a flange of the hub 45 with the pins 48, and the leaf springs 46 have the armature plate 49 attached to the other ends thereof with the pins 47.

In addition, a lip seal device (shaft-sealing device) 54 for sealing the inside of the housing 11 from the outside (atmosphere side) is disposed in the nose portion (through-portion) 14b of the front housing 14 between the first bearing 35 and the second bearing 36. The lip seal device 54 is press-fitted into a lip-seal-device accommodating portion (hereinafter referred to as "accommodating portion") 55 provided on the inner circumferential surface (through-hole) 14c of the nose portion 14b from the inside to the outside (atmosphere side) of the front housing 14.

[0028] As shown in Fig. 2, the lip seal device 54 is composed of an annular shape-retaining member 59 formed of a metal and having high stiffness, a backup ring 60 formed of a metal and disposed on the inner circumference of the annular shape-retaining member 59, an annular main lip seal 61 formed of an elastically deformable rubber and disposed on the outer circumference of the annular shape-retaining member 59, and an annular sub-lip seal 62 formed of a plastic and disposed on the inner circumferential side of the annular shape-retaining member 59 and the main lip seal 61.

The main lip seal 61 includes a ring portion 61A fixed to the outer circumferential surface of the annular shape-retaining member 59 and a lip portion 61B extending diagonally sideward and inward from the ring portion 61A, and the lip portion 61B and the sub-lip seal 62 are brought into pressure contact with the circumferential surface of the rotating shaft 13.

[0029] The accommodating portion 55 is an annular groove provided circumferentially and is formed by a (first) flat surface 65 that contacts the entire outer circumferential surface 61C of the ring portion 61A extending in the axial direction of the rotating shaft 13, a (first detachment-preventing) vertical surface 66 located on the inside of the flat surface 65 and extending radially inward in a direction perpendicular to the axial direction of the rotating shaft 13, and a (second detachment-preventing) vertical surface 67 located on the outside (atmosphere side) of the flat surface 65 and extending radially inward in a direction perpendicular to the axial direction of the rotating shaft 13. In addition, the depth (height: the dimension in the radial direction) h of the vertical surface 66 is set to a depth equivalent to 8% to 40% (in this embodiment, 40%) of the thickness of the main lip seal 61 (more specifically, the ring portion 61A), that is, such that the thickness of the main lip seal 61 is 92% to 60% (in this embodiment, 60%) at the position of the vertical surface 66 when the lip seal device 54 is press-fitted (inserted) into the accommodating portion 55 from the inside to the outside of the front housing 14.

[0030] Meanwhile, the depth (height: the dimension in

the radial direction) of the vertical surface 67 is set to more than the depth of the vertical surface 66 (in this embodiment, more than the sum of the thicknesses of the ring portion 61A, the annular shape-retaining member 59, and the backup ring 60). The flat surface 65 is formed such that the thickness of the main lip seal 61 (more specifically, the ring portion 61A) is 90% to 80% (in this embodiment, 80%) of the original thickness (the thickness before press-fitting into the accommodating portion 55) after the lip seal device 54 is press-fitted into the accommodating portion 55.

In addition, a tapered surface 70 whose diameter decreases gradually from the inside to the outside of the front housing 14 is formed on the inside of the vertical surface 66, and the vertical surface 66 and the tapered surface 70 are joined together by a (second) flat surface 71 extending in the axial direction of the rotating shaft 13.

[0031] In the thus-configured electromagnetic clutch 40, the drive rotor 42 is coupled to a driving source such as an engine or electric motor with, for example, a V-belt (not shown) so that the drive rotor 42 is rotated at all times during the rotation of the engine or electric motor. When a current is supplied to the coils 43 based on a signal output from the controller (not shown), the armature plate 49 comes into intimate contact with the drive rotor 42 against the elastic force of the leaf springs 46, and the rotation of the drive rotor 42 is transmitted through the armature plate 49, the pins 47, the leaf springs 46, the pins 48, and the hub 45, in this order, to the rotating shaft 13, thus rotating the rotating shaft 13. In addition, when the supply of current to the coils 43 is stopped, the armature plate 49 is separated from the drive rotor 42 by the restoring force of the leaf springs 46, thus interrupting the transmission of power to the rotating shaft 13.

[0032] In the scroll compressor 10, on the other hand, the electromagnetic clutch 40 is actuated to transmit the driving force from the engine or electric motor to the rotating shaft 13, thus rotating the rotating shaft 13, and the rotation is transmitted through the eccentric pin 13a, the eccentric bush 31, and the boss 22c to the orbiting scroll 22 of the scroll compression mechanism 12. The orbiting scroll 22 orbits on a circular orbit whose radius is the orbit radius, while being prevented from rotating by the Oldham ring 33.

[0033] The refrigerant gas then enters the hermetically sealed space m in the housing 11 through the intake port and is taken into the compression chambers C of the scroll compression mechanism 12 through a path (not shown). The refrigerant gas reaches the center while being compressed as the volume of the compression chambers C is decreased by the orbiting of the orbiting scroll 22, and the refrigerant containing lubricating oil is guided through the discharge port 21c into the oil-separating chamber and is swirled along the inner wall surface of the oil-separating chamber. As a result, the lubricating oil contained in the refrigerant falls downward while being swirled along the inner wall surface of the oil-separating chamber under the action of centrifugation, thus collect-

ing in the oil-collecting chamber 18, whereas the refrigerant having the lubricating oil separated therefrom is discharged outside through the interior of the inner cylinder and the discharge port 15a of the rear housing 15. In view of the refrigerant pressure, the side where the discharge port 21c, the oil-collecting chamber 18, etc. are provided in the scroll compressor 10 is the high-pressure side, and the side where the intake port, the first bearing 35, etc. are provided is the low-pressure side.

[0034] In the scroll compressor 10 according to this embodiment, the lip seal device 54 is attached to the through-portion 14b of the front housing 14 without using, for example, a snap ring, thus maintaining ease of attachment.

In addition, the lip seal device 54 is not easily tilted because the entire flat outer circumferential surface 61C of the ring portion 61A contacts the flat surface 65 of the accommodating portion 55, thus reducing the risk of gas leakage in a simple manner.

In addition, a cost increase can be avoided because there is no need to increase the stiffness of the annular shape-retaining member 59 or to provide a plurality of seal ribs on the outer circumference of the main lip seal 61.

[0035] In addition, because the depth of the vertical surface 66 is set to a depth equivalent to 8% to 40% of the thickness of the ring portion 61A, no permanent strain remains after elastic deformation or no compression crack occurs in the main lip seal 61, which is formed of rubber, when the lip seal device 54 is press-fitted (inserted) into the accommodating portion 55 from the inside to the outside of the front housing 14 past the vertical surface 66, thus reducing the risk of gas leakage.

[0036] The present invention is not limited to the above embodiment; it can be practiced with modifications or changes as needed.

{Reference Signs List}

[0037]

10	scroll compressor	40
11	housing	
12	compression mechanism	
13	rotating shaft	
14	front housing	45
14b	through-portion	
54	lip seal device	
55	(lip-seal-device) accommodating portion	
61	main lip seal	
61A	ring portion	50
61C	outer circumferential surface	
65	(first) flat surface	
66	(first) detachment-preventing vertical surface	
67	(second) detachment-preventing vertical surface	
m	hermetically sealed space	55

Claims

1. A compressor comprising:

a housing having an inner space;
 a compression mechanism that is disposed in the housing and that compresses a fluid taken into the space; and
 a rotating shaft that drives the compression mechanism,
 the housing including a through-portion through which an end of the rotating shaft protrudes outside, the through-portion being sealed by a lip seal device,
 the through-portion including a lip-seal-device accommodating portion formed by
 a flat surface that contacts an entire flat outer circumferential surface of a ring portion of a main lip seal constituting the lip seal device and extending in the axial direction of the rotating shaft;
 a first detachment-preventing vertical surface located on the inside of the flat surface in the housing and extending radially inward in a direction perpendicular to the axial direction of the rotating shaft; and
 a second detachment-preventing vertical surface located on the outside of the flat surface in the housing and extending radially inward in a direction perpendicular to the axial direction of the rotating shaft.

2. The compressor according to Claim 1, wherein the first detachment-preventing vertical surface has a depth equivalent to 8% to 40% of the thickness of the ring portion.

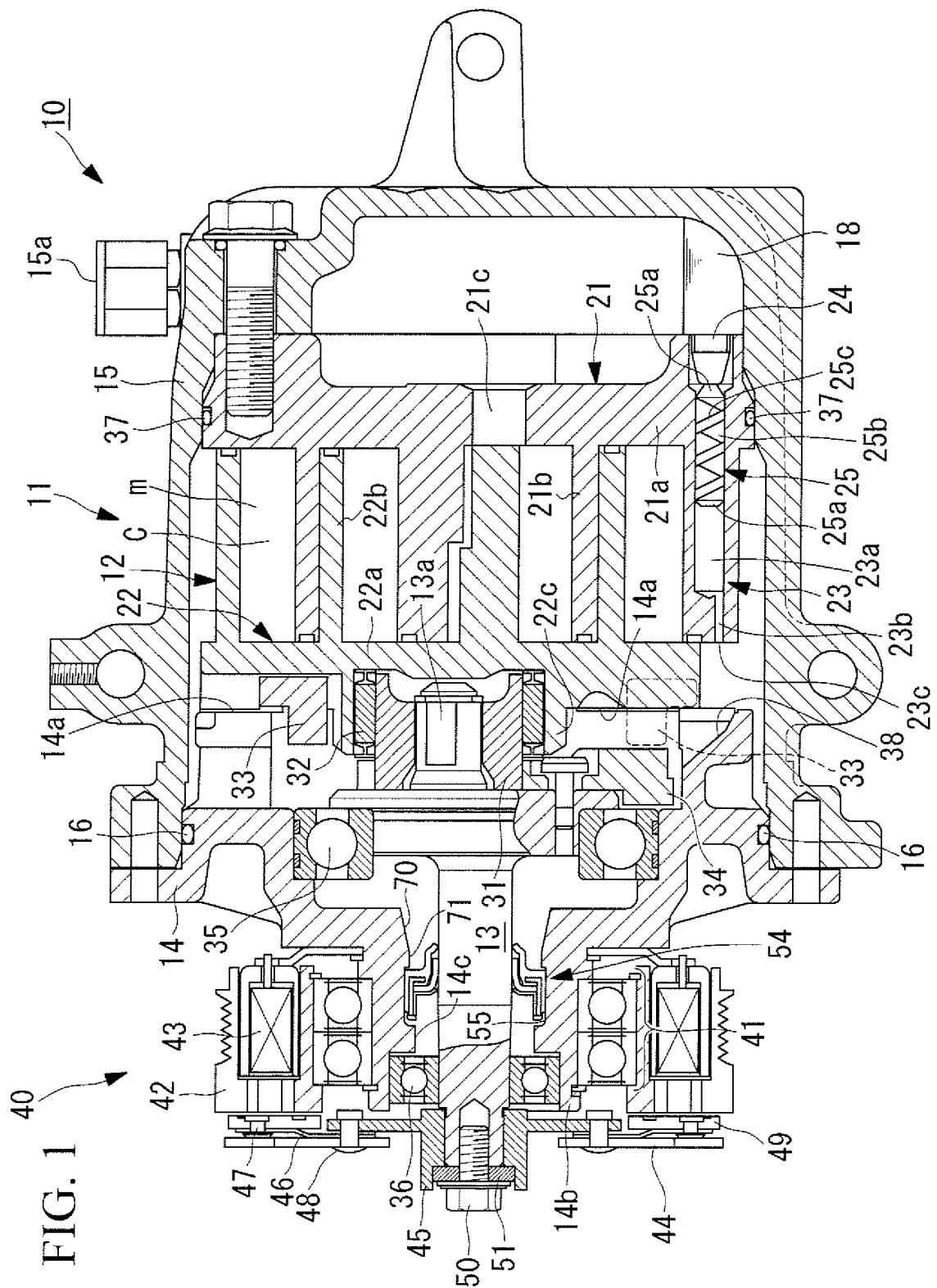
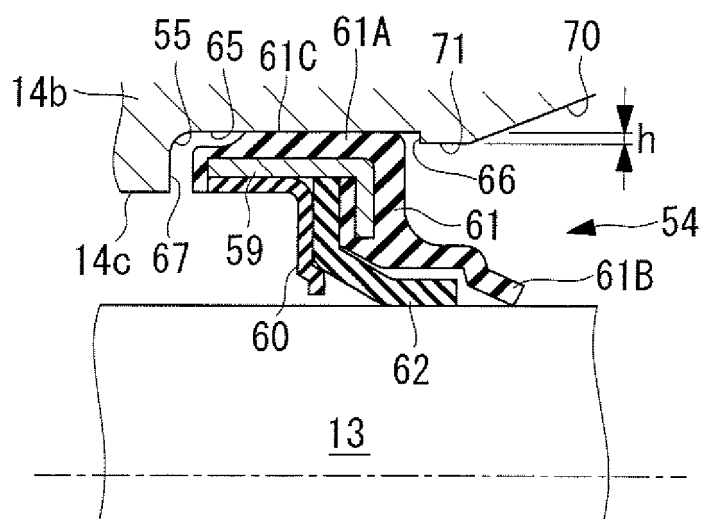


FIG. 2



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2011/053362

A. CLASSIFICATION OF SUBJECT MATTER F04B39/00 (2006.01) i, F04C2/02 (2006.01) i, F04C18/02 (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) F04B39/00, F04C2/02, F04C18/02		
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 1996-2011 Kokai Jitsuyo Shinan Koho 1971-2011 Toroku Jitsuyo Shinan Koho 1994-2011		
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.
Y	JP 11-125337 A (NOK Corp.), 11 May 1999 (11.05.1999), entire text; all drawings & US 6209879 B1 & EP 913605 A2	1-2
Y	JP 7-55015 A (Freudenberg-Nok General Partnership), 03 March 1995 (03.03.1995), fig. 11 to 13 & US 5329898 A	1-2
☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.		
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Date of the actual completion of the international search 09 May, 2011 (09.05.11)		Date of mailing of the international search report 17 May, 2011 (17.05.11)
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INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2011/053362

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 119871/1990 (Laid-open No. 77066/1992) (NOK Corp.), 06 July 1992 (06.07.1992), fig. 10 (Family: none)	1-2
A	JP 36-13017 Y1 (Toyota Motor Co., Ltd.), 23 May 1961 (23.05.1961), fig. 1 to 2 (Family: none)	1-2
A	JP 2002-71028 A (Koyo Seiko Co., Ltd.), 08 March 2002 (08.03.2002), fig. 2 to 4 (Family: none)	1-2
A	JP 11-248005 A (Toyoda Automatic Loom Works, Ltd.), 14 September 1999 (14.09.1999), entire text; all drawings & EP 940609 A2	1-2

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REFERENCES CITED IN THE DESCRIPTION

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