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(71) Applicants:
• **Heishin Sobi Kabushiki Kaisha**
Hyogo-ku, Kobe-shi, Hyogo 652-0852 (JP)
• **Yamashita**
Mikio
Kobe-shi, Hyogo 652-0852 (JP)
• **Akamatsu, Yoshitada**
Kobe-shi, Hyogo 652-0852 (JP)

(72) Inventors:
• **YAMASHITA, Mikio**
Kobe-shi
Hyogo 652-0852 (JP)
• **AKAMATSU, Yoshitada**
Kobe-shi
Hyogo 652-0852 (JP)

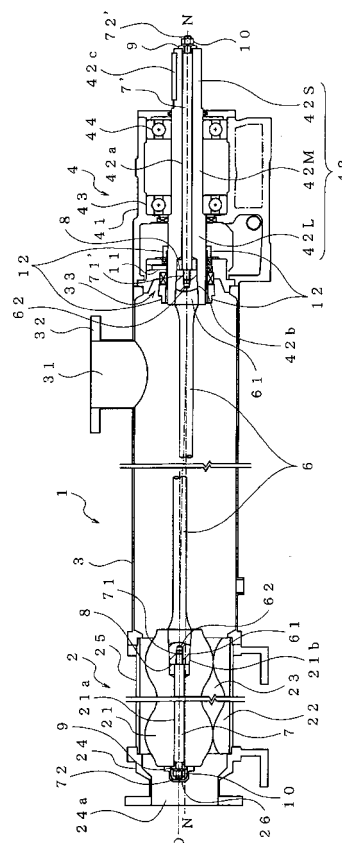
(74) Representative: **Knoblauch, Andreas et al**
Schlosserstrasse 23
60322 Frankfurt (DE)

(54) **UNIAXIAL ECCENTRIC SCREW PUMP**

(57) A double/triple-thread single-shaft eccentric screw pump is provided. The rotor of the pump overhangs little in comparison with the flange type connecting structure. The whole length of the pump is short, and the pump casing of the pump is short and small in diameter, so that the pump is small in size and light in weight.

One end 61 of a flexible rod 6 is tapered and has a tapped hole 62 formed at its axis. One end of the rotor 21 has a tapered bore 21b formed at its axis, into which the tapered end 61 of the flexible rod 6 is fitted. The rotor 6 has a through bore 21a formed at its axis, through which a tension bolt 7 extends from the other end of the rotor 21. The tension bolt 7 has a front threaded end 71, which is screwed into and fastened to the tapped hole 62 of the flexible rod 6.

Fig. 1



Description

FIELD OF THE INVENTION

[0001] The present invention relates to the structure for connecting the flexible rod, which is mainly metallic, to the drive shaft of the drive unit or the rotor in a single-shaft eccentric screw pump. Specifically, the invention relates to a single-shaft eccentric screw pump having a pump body and a flexible rod. The pump body includes an externally double-threaded rotor elliptic in section and a stator having an internally triple-threaded hole in the shape of a substantially equilateral triangle in aperture section. The pump rotor engages with the triple-threaded hole. The flexible rod couples the pump rotor and the drive shaft of a drive unit together.

BACKGROUND OF THE INVENTION

[0002] In general, a single-shaft eccentric screw pump has a pump body including an internally double-threaded stator and an externally single-threaded rotor. The pump stator has a longitudinally tapped hole elliptic in section. The pump rotor is circular in section, and its thread pitch is 1/2 of the thread pitch of the tapped hole. The pump rotor is in slidably rotatable engagement with the tapped hole and creates a pumping action by revolving eccentrically around the axis of revolution in the pump stator, rotating on its own axis while revolving in the opposite direction around the axis of revolution. The pump rotor and the drive shaft of a drive unit are coupled by a coupling rod. In general, a means is adopted for allowing the pump rotor to revolve eccentrically with a universal joint interposed between the rotor and the coupling rod, or with a flexible and relatively long coupling rod used between the rotor and the drive shaft.

[0003] If the coupling rod is a metallic flexible rod, it is proposed or adopted that the rod be or is connected to the pump rotor or the drive shaft by means of flanges (refer to the connection between the flexible rod 6 and drive shaft 42 in FIG. 4). One end of the flexible rod is tapered and has a hole tapped in it. A connecting casing has an outward flange formed around it and a tapered bore formed in it, into which the tapered end of the flexible rod is fitted. A bolt extends through the end of the connecting casing, is screwed into the tapped hole of the flexible rod, and is tightened to fix the rod and the casing together. A joint case has an inward flange formed at its front end and a tightening ring formed at its rear end. The inward flange engages with the outward flange of the connecting casing. The pump rotor or the drive shaft has a step formed at one of its ends. The tightening ring engages with the end step, supports it, and is tightened to fix the connecting casing and the pump rotor or the drive shaft together.

[0004] A single-shaft eccentric screw pump disclosed as a prior art has a rotor and a drive shaft, which are coupled together by a flexible rod made of engineering plastic. One end of the flexible rod may be tapered. One end of the drive shaft may have a tapered bore. The tapered end may be fitted into the tapered bore and bonded to it with an adhesive. Otherwise, one end of the flexible rod and one end of the drive shaft may have a key and a key groove, which connect the ends together. For this art, reference may be made to JP H9-264264 A (paragraphs 0013, 0016, and 0018, and figures 8 and 9).

DISCLOSURE OF THE INVENTION

PROBLEMS TO BE SOLVED BY THE INVENTION

[0005] The conventional single-shaft eccentric screw pump in which the rotor or the drive shaft is connected to the flexible rod by means of flanges has the following problems:

[0006]

1. Because the pump is fitted with a flanged connecting casing and a flanged joint case, the number of parts of the pump is large, and the pump is complicated in structure.

[0007]

2. In order to inspect and replace the mechanical seal etc. of the pump, it is necessary to remove the bearing in the bearing casing of the pump. This results in complicated disassembly and assembly.

[0008]

3. The formation of the flanges lengthens the pump.

[0009]

4. The rotor might have a tapered bore formed at one of its ends. The other end of the flexible rod might be tapered and fitted into the tapered bore of the rotor. A tension bolt might extend through the rotor from the other end of the rotor. The tension bolt has a front threaded end, which might be screwed into the tapered end of the flexible rod so as to connect the rod and the rotor. In this case, if the pump is a general single/double-thread single-shaft eccentric screw pump as described above, the rotor would be long, and its eccentricity would be great. The rotor of this pump could have a through bore for the tension bolt. The diameter of the through bore would be limited to a small value. This would make it impossible to secure sufficient thread strength for connection with the flexible rod.

[0010] The connecting structure disclosed in the foregoing Japanese publication is not sufficient in connecting strength if a metallic flexible rod is connected to the drive shaft by means of bonding or keying.

[0011] In view of the foregoing points, the object of the present invention is to provide a double/triple-thread single-shaft eccentric screw pump in place of a general single-shaft eccentric screw pump as described above. The double/triple-thread single-shaft eccentric screw pump has an internally triple-threaded stator and an externally double-threaded rotor. Because this pump is high in pressure resistance, the rotor can be short. Because the eccentricity of the rotor is small, the through bore which can be formed through it for a tension bolt can be large in diameter so that the bolt can fasten the rotor with sufficient thread strength. In comparison with the flange type connecting structure, the rotor little overhangs. The whole length of this pump is short. The pump casing of this pump is short and small in diameter. The mechanical seal of this pump is simple to disassemble and assemble. It is easy to make this pump small in size and light in weight. At least one end of the flexible rod of this pump has a taper-stop tension bolt type connecting structure, which is mechanically stronger than a bonding or keying type connecting structure.

MEANS FOR SOLVING THE PROBLEMS

[0012] In order to achieve the foregoing object, a single-shaft eccentric screw pump according to the present invention comprises a pump body, a pump casing, and a flexible rod, the pump body including an externally double-threaded rotor elliptic in section and a stator having an internally triple-threaded bore in the shape of a substantially equilateral triangle in aperture section, the rotor being in engagement with the stator bore, the flexible rod coupling the rotor and a drive shaft together, the drive shaft being connected to a drive unit, the single-shaft eccentric screw pump being characterized by:

the flexible rod being tapered at at least one of its ends, the tapered end having a tapped hole formed at its axis;
the rotor or the drive shaft having a tapered bore formed at its axis, the tapered end being fitted into the tapered bore;
the rotor or the drive shaft further having a through bore formed at its axis;
a tension bolt extending through the through bore from the other end of the rotor; and
the tension bolt having a front threaded end, the threaded end being screwed into and fastened to the tapped hole in the tapered end of the flexible rod so as to connect the rod and the rotor or the drive shaft together.

[0013] As described above, the pump body includes an externally double-threaded rotor and an internally triple-threaded stator. This enables the pump to be shorter than a conventional single-shaft eccentric screw pump having an externally single-threaded rotor and the same discharge rate. This also enables the through bore of the rotor to be large in diameter, so that the engaging parts of the rotor and tension bolt can have sufficient thread strength. Accordingly, not only the drive shaft but also the rotor can be connected by a taper-stop tension bolt. In comparison with the conventional flange type, the rotor or the drive shaft does not need to have a protrusion formed at an end of it, to which a flange would be fixed. Accordingly, the rotor or the drive shaft little overhangs, so that it is possible to minimize the bending moment exerted from the flexible rod particularly on the rotor. This improves the discharging performance of the pump. Because the rotor or the drive shaft has no flange and needs to have no protrusion or the like for engaging with a flange, the pump is simple in structure. This makes it easy to disassemble and inspect the mechanical seal in the pump. This also makes it easy for the pump to be small in size and light in weight.

[0014] As described in claim 2, the flexible rod may be tapered at both its ends. Each of the tapered ends has a tapped hole formed at its axis. Each of the rotor and the drive shaft may have a tapered bore formed at its axis. One of the tapered ends of the flexible rod is fitted into the tapered bore. Each of the rotor or the drive shaft may further have a through bore formed at its axis. A first tension bolt may extend through the through bore of the rotor from the other end of the rotor. A second tension bolt may extend through the through bore of the drive shaft from the other end of the rotor. Each of the tension bolts has a front threaded end, which is screwed into and fastened to the tapped hole in one of the tapered ends of the flexible rod so as to connect the rod to the rotor and the drive shaft.

[0015] In the single-shaft eccentric screw pump described in claim 2, both ends of the flexible rod are connected to the drive shaft and the rotor by taper-stop tension bolts. Accordingly, the drive shaft and the rotor need to have no flange. This makes the pump simple in structure and enables the pump casing to be smaller in diameter, making it easy for the

pump to be small in size and light in weight.

[0016] As described in claim 3, the first tension bolt may further have a rear threaded end, which engages with a nut. It is preferable that a cover for covering the nut be fitted to the end of the rotor which is away from the flexible rod.

[0017] In the single-shaft eccentric screw pump described in claim 3, the cover covers the nut and the rear threaded end of the first tension bolt. The cover keeps the nut and this bolt end out of contact with the liquid being transferred. This prevents the nut and the parts adjoining it from corroding. Accordingly, the pump can be used stably for a long period of time.

[0018] As described in claim 4, one end of the flexible rod may be connected to a central portion of the rotor or a central portion of the drive shaft at any point between both ends of the rotor or any point between both ends of the drive shaft.

[0019] In the single-shaft eccentric screw pump described in claim 4, the flexible rod may be connected to middle portions of the rotor and drive shaft. In this case, the load acting from the flexible rod through the rotor on the stator is exerted on a middle portion of the stator. This uniformizes the load on the stator, thereby lengthening the life of the stator 22. The bending moment acting from the flexible rod on the adjacent end of the drive shaft is supported near the bearing, so that the load on the drive shaft is reduced. The pump casing is shortened, so that the overall length of the pump is shortened. This saves space. Alternatively, the flexible rod may be connected to the ends of the rotor and drive shaft which are away from the pump casing. This further shortens the overall length of the pump. Depending on the properties of the liquid which the pump pumps, it is determined what portion of the rotor or the drive shaft between both its ends should most advantageously be connected to the flexible rod.

ADVANTAGES OF THE INVENTION

[0020] As described above, the pump body of the single-shaft eccentric screw pump according to the present invention includes an externally double-threaded rotor and an internally triple-threaded stator. This enables the pump to be shorter than a conventional single/double-thread single-shaft eccentric screw pump having an externally single-threaded rotor and the same discharge rate. This also enables the through bore of the rotor to be large in diameter, so that, if the rotor and the flexible rod are connected by a taper-stop tension bolt, the engaging parts of the rotor and tension bolt can have sufficient thread strength. Accordingly, not only the drive shaft but also the rotor can be connected by a taper-stop tension bolt. In comparison with the flange type, the rotor or the drive shaft does not need to have an outward flange formed at an end of it, to which another flange would be fixed. Accordingly, the mechanical seal is easy to disassemble and assemble. In addition, the rotor or the drive shaft little overhangs, so that the bending moment exerted from the flexible rod on the rotor or the shaft is minimized. This improves the discharging performance of the pump.

BEST MODE OF CARRYING OUT THE INVENTION

[0021] Embodiments of a single-shaft eccentric screw pump according to the present invention will be described below with reference to the drawings.

[0022] FIG. 1 is a sectional view of an embodiment of a single-shaft eccentric screw pump. FIG. 2 is an enlarged sectional view of an end portion of the rotor shown in FIG. 1. FIG. 3 is a view in the direction A in FIG. 2.

[0023] As shown in FIG. 1, the single-shaft eccentric screw pump 1 of this embodiment includes a pump body 2, a pump casing 3, a bearing unit 4, a drive motor (not shown), and a drive shaft 42. The pump body 2 is fitted at one end (on the left side in FIG. 1) of the pump 1. The pump casing 3, bearing unit 4, and drive motor are arranged in order. The drive shaft 42 protrudes from the other end of the pump 1. The drive motor is coupled to the drive shaft 42 and drives the pump 1.

[0024] The pump body 2 consists principally of an externally double-threaded rotor 21 elliptic in section and a stator 22 having an internally triple-threaded hole 23 in the shape of a substantially equilateral triangle in aperture section. The rotor 21 rotates in one direction (clockwise in FIG. 5) on its axis O in the triple-threaded hole 23, with the axis O revolving eccentrically (FIG. 5) in the opposite direction (counterclockwise in FIG. 5) around the axis N of the stator 22. This pumps a material in one direction through the spaces X (FIG. 5) between the rotor 21 and the sides of the triple-threaded hole 23. The eccentricity e of the rotor axis O from the stator axis N is as small as 2/3 of that of a conventional single/double-thread single-shaft eccentric screw pump. The discharge rate of the single-shaft eccentric screw pump 1 is about 1.5 times as high as that of a single/double-thread single-shaft eccentric screw pump of the same outer diameter (and length).

[0025] The front end of the stator 22 is fitted with an end stud 24 as a discharge port 24a (in this embodiment) or a suction port. The stator 22 is surrounded by a cylindrical stator casing 25, which is held by the end stud 24 and pump casing 3.

[0026] The pump casing 3 includes a bearing casing 41 formed as an extension at its other end. The pump casing 3 has a suction port 31 formed at its top near the bearing casing 41. The suction port 31 opens upward, rightward, or leftward and is surrounded integrally by an outward flange 32. The drive shaft 42 is supported rotatably by a left bearing

43 and a right bearing 44 in the bearing casing 41 and protrudes from this casing. The outer diameter of the drive shaft 42 increases by three steps leftward in FIG. 1. The drive shaft 42 includes a large diameter part 42L, a medium diameter part 42M, and a small diameter part 42S in rightward order in FIG. 1. One end (adjacent to the bearing casing 41) of the pump casing 3 is open. An annular support housing 11 is fitted to the inside of the open end 33 of the pump casing 3 and surrounds the large diameter part 42L of the drive shaft 42. The large diameter part 42L is surrounded by mechanical seals 12, between which the support housing 11 is positioned. The mechanical seals 12 prevent the liquid being transferred from leaking out of the pump casing 3 into the bearing casing 41.

[0027] The rotor 21 and drive shaft 42 are coupled by a metallic flexible rod 6, which is made of titanium alloy or stainless steel in this embodiment. As shown in FIG. 1, the ends 61 of the flexible rod 6 are slightly thick and tapered. Each tapered end 61 has a threaded hole 62 formed in its center for engagement with the front threaded end 71 of a tension bolt 7, which will be described later on.

[0028] In this embodiment, the flexible rod 6 is connected to each of the rotor 21 and drive shaft 42 by a taper-stop tension bolt. Specifically, the rotor 21 has a through bore 21a formed through it along its axis for the tension bolt 7. Likewise, the drive shaft 42 has a through bore 42a formed through it along its axis for a tension bolt 7'. The tension bolts 7 and 7' have front threaded ends 71 and 71' respectively and rear threaded ends 72 and 72' respectively, all of which are smaller in outer diameter than the main bodies of the tension bolts 7 and 7'. The rear threaded ends 72 and 72' are slightly larger in outer diameter than the front threaded ends 71 and 71' respectively.

[0029] The rotor 21 has a tapered bore 21b formed in its end adjacent to the pump casing 3. One tapered end 61 of the flexible rod 6 is fitted into the tapered bore 21b. The tension bolt 7 is inserted from the other end of the rotor 21. The front threaded end 71 of the tension bolt 7 is screwed into the threaded hole 62 of the flexible rod 6, with a washer 8 interposed. The tension bolt 7 is then tightened to be fixed to the flexible rod 6.

[0030] As shown in FIG. 2, the rear threaded end 72 of the tension bolt 7 engages with a nut 10, with a washer 9 interposed, which consists of a small diameter part 9a and an outward flange 9b formed integrally around this part. The small diameter part 9a can be inserted into the through bore 21a of the rotor 21. The nut 10 is tightened to fix the rotor 21 and flexible rod 6 together. A cover 26 in the form of a hat is fixed to the end of the rotor 21 by set screws 27 and covers the nut 10 and washer 9. The rotor 21 has a pair of steps 21c formed at its end opposite each other. The steps 21c are spaced from the end of the rotor 21. As shown in FIG. 3, each step 21c has an engaging hole 21d for engagement with a part of a tool (not shown) for keeping the rotor 21 from rotating.

[0031] Likewise, the drive shaft 42 has a tapered bore 42b formed in its end adjacent to the pump casing 3. The other tapered end 61 of the flexible rod 6 is fitted into the tapered bore 42b. The tension bolt 7' is inserted from the other end of the rotor 42. The front threaded end 71' of the tension bolt 7' is screwed into the threaded hole 62 of the flexible rod 6, with a washer 8 interposed. The tension bolt 7' is then tightened to be fixed to the flexible rod 6. The rear threaded end 72' of the tension bolt 7' engages with a nut 10, with a washer 9 interposed, which consists of a small diameter part 9a and an outward flange 9b formed integrally around this part. The small diameter part 9a can be inserted into the through bore 42a of the drive shaft 42. The nut 10 is tightened to fix the drive shaft 42 and flexible rod 6 together. The nut 10 and washer 9 on the tension bolt 7' are not covered because this nut 10 and other parts adjacent to the drive shaft 42 are exposed to the atmosphere and kept out of contact with the liquid being transferred. The protruding end part of the drive shaft 42 is fitted with a connecting key 42c for connection with the drive motor (not shown).

[0032] A description will be provided below of how the single-shaft eccentric screw pump 1 of Embodiment 1 operates.

[0033] With reference to FIG. 1, the drive motor rotates the drive shaft 42 in a specified direction. The torque of the drive shaft 42 is transmitted through the flexible rod 6 to the rotor 21, rotating the rotor 21 on the axis O while revolving it eccentrically in the triple-threaded hole 23 of the stator 22. The eccentricity of the rotor 21 from the stator 22 is absorbed by the deformation of the flexible rod 6. This creates a pumping action in the pump body 2, sucking liquid through the suction port 31 into the pump casing 3, forcing it through the body 2, and discharging it through the discharge port 24a at the end stud 24. If the drive motor (not shown) were rotated in the opposite direction, liquid would be sucked through the discharge port 24a at the end stud 24 and the pump body 2 into the pump casing 3 and discharged through the suction port 31.

[0034] One embodiment of the single-shaft eccentric screw pump of the present invention has been described above and may be modified as follows.

[0035] In the single-shaft eccentric screw pump 1 of the foregoing embodiment, only the flexible rod 6 and drive shaft 42 could be coupled together by means of flanges. FIG. 4 shows the single-shaft eccentric screw pump 1' of another embodiment of the present invention. The pump 1' includes a substantially cylindrical connector 15 and a tightening ring 16. The connector 15 has a tapered bore 42b for one tapered end 61 of a flexible rod 6. The connector 15 further has an outward flange 15a formed around a middle portion of it. The tightening ring 16 has an inward flange 16a formed at its front end. The tapered end 61 is fitted into the tapered bore 15b of the substantially cylindrical connector 16. A short headed tension bolt 17 is inserted through the rear opening 15c of the connector 15. The front threaded part 17a of the tension bolt 17 is screwed into the threaded hole 62 of the flexible rod 6 and tightened to fix the rod 6 and connector 15 together. With the inward flange 16a engaging with the outward flange 15a of the connector 15, the tightening ring 16

may tighten it around the step 42d formed at an end of the drive shaft 42, so that the flexible rod 6 can be connected to the drive shaft 42 rotatably with it. Otherwise, this embodiment is similar in structure to the foregoing embodiment. Therefore, the parts of this embodiment which are common to that embodiment are shown with the same reference numerals, and the descriptions of these parts are omitted. In this case, the formation of the flanges results in the pump 1' being longer, and they protrude radially, but the pumping operation of this embodiment is common to that embodiment.

[0036] FIG. 6 is a sectional view of a third embodiment of the single-shaft eccentric screw pump according to the present invention. The single-shaft eccentric screw pump 1-3 of this embodiment differs from the screw pump 1 of the first embodiment in that the tapered ends 61 of the flexible rod 6 of the pump 1-3 are connected to substantially middle portions of the rotor 21 and drive shaft 42.

[0037] As shown in FIG. 6, the rotor 21 has a circular long bore 27 formed between a central portion of its end face adjacent to the pump casing 3 and a substantially middle point of the rotor 21. The rotor 21 further has a tapered bore 27b formed at the bottom of the long bore 27. One tapered end 61 of the flexible rod 6 is fitted into the tapered bore 27b. A tension bolt 7 is inserted from a central portion of the other end face of the rotor 21. The front threaded end 71 of the tension bolt 7 is screwed into the threaded hole 62 of the flexible rod 6, with a washer 8 interposed, and is tightened to fix the rod 6 and the rotor 21 together.

[0038] Likewise, the drive shaft 42 has a circular long bore 45 formed between a central portion of its end face adjacent to the pump casing 3 and a substantially middle point of the shaft 42. The drive shaft 42 further has a tapered bore 45b formed at the bottom of the long bore 45. The other tapered end 61 of the flexible rod 6 is fitted into the tapered bore 45b. In this embodiment, the bearing unit 43 is positioned at the tapered end 61 (where the drive shaft 42 and flexible rod 6 are connected). A tension bolt 7' is inserted from a central portion of the other end face of the rotor 42. The front threaded end 71' of the tension bolt 7' is screwed into the threaded hole 62 of the flexible rod 6, with a washer 8 interposed, and is tightened to fix the rod 6 and the drive shaft 42 together. Otherwise, this embodiment is similar in structure to the foregoing embodiments. Therefore, the parts of this embodiment which are common to those embodiments are shown with the same reference numerals, and the descriptions of these parts are omitted.

[0039] In the single-shaft eccentric screw pump 1-3 of this embodiment, the load acting on the stator 22 from the flexible rod 6 is exerted on a middle portion of the stator 22. This uniformizes the load on the stator 22, thereby lengthening the life of the stator 22. In this pump 1-3, the bearing unit 43 directly supports the bending moment acting on the end of the drive shaft 42 from the flexible rod 6. This reduces the load on the drive shaft 42. The foregoing structure shortens the pump casing 3, thereby shortening the whole length of the pump 1-3, so that space is saved.

[0040] FIG. 7 is a sectional view of a fourth embodiment of the single-shaft eccentric screw pump according to the present invention. The single-shaft eccentric screw pump 1-4 of this embodiment differs from the screw pump 1-3 of the third embodiment in that the ends 61 of the flexible rod 6 of the pump 1-4 are connected to the ends of the rotor 21 and drive shaft 42 which are away from the pump casing 3, and that one end 61 of the rod is shrink-fitted or screwed to the rotor 21.

[0041] As shown in FIG. 7, the rotor 21 has a circular long bore 25 formed between a central portion of its end face adjacent to the pump casing 3 and its other end. A plug 28 in the form of a hat is fitted into an end portion 25a of the long bore 25 and has threaded holes 29a. Bolts 29 extend through an end of the rotor 21, are screwed into the threaded holes 29a, and are tightened to screw the plug 28 to the rotor 21. Alternatively, the end portion 25a of the long hole 25 might be internally threaded, and the peripheral surface of the plug 28 might be externally threaded so that the plug 28 could engage with the hole portion 25a and be tightened to be connected to the rotor 21. The plug 28 has a straight bore 28b formed at its axis. The flexible rod 6 has a cylindrical end 63, which is shrink-fitted into the straight bore 28b so as to fix the rod 6 to the plug 28.

[0042] Likewise, the drive shaft 42 has a circular long bore 45 formed between a central portion of its end face adjacent to the pump casing 3 and its other end. The drive shaft 42 further has a tapered bore 45b formed at the bottom of the long bore 45. The tapered end 61 of the flexible rod 6 is fitted into the tapered bore 45b. A tension bolt 7" is inserted from a central portion of the other end face of the drive shaft 42. The front threaded end 71" of the tension bolt 7" is screwed into the threaded hole 62 of the flexible rod 6, with a washer 8 interposed, and is tightened to fix the rod 6 and the drive shaft 42 together. Otherwise, this embodiment is similar in structure to the foregoing embodiments. Therefore, the parts of this embodiment which are common to those embodiments are shown with the same reference numerals, and the descriptions of these parts are omitted.

[0043] The pump casing 3 of the single-shaft eccentric screw pump 1-4 of this embodiment is further shortened as compared with the single-shaft eccentric screw pump 1-3 of the third embodiment, so that the whole length of the pump 1-4 is minimized. Because the rotor 21 and flexible rod 6 are connected by means of shrink fitting, the pump 1-4 is simple in structure. However, the flexible rod 6 and drive shaft 42 are connected by the tension bolt 7', which is tightened to securely couple the rotor 21, the rod 6, and the shaft 42 together.

[0044] The positions where the ends of the flexible rod 6 are connected to the central portions of the rotor 21 and drive shaft 42 might not be limited to those in the single-shaft eccentric screw pumps 1-3 and 1-4 of the third and fourth embodiments. Depending on the properties (kind, viscosity, etc.) of the liquid which the pump 1-3 or 1-4 pumps, the

ends of the flexible rod 6 could be connected to any (advantageous) portion of the rotor 21 between the ends of the rotor, and to any (advantageous) portion of the drive shaft 42 between the ends of the shaft. One end of the flexible rod 6 could be connected to the rotor 21 by means of not only shrink fitting but also screws. The connection by means of shrink fitting or screws might not be limited to the flexible rod 6 and rotor 21, but could be applied to the rod 6 and drive shaft 42 as well. In this case, the flexible rod 6 would need to be connected to the rotor 21 by a tension bolt.

BRIEF DESCRIPTION OF THE DRAWINGS

[0045]

FIG. 1 is a sectional view showing an embodiment of a single-shaft eccentric screw pump according to the present invention.

FIG. 2 is an enlarged sectional view showing an end portion of the rotor shown in FIG. 1.

FIG. 3 is a view in the direction A in FIG. 2.

FIG. 4 is a sectional view showing a second embodiment of the single-shaft eccentric screw pump according to the present invention.

FIGS. 5(a) - 5(f) are enlarged sectional views showing in order the rotation and revolution of the rotor at a position in the stator of a double/triple-thread single-shaft eccentric screw pump.

FIG. 6 is a sectional view showing a third embodiment of the single-shaft eccentric screw pump according to the present invention.

FIG. 7 is a sectional view showing a fourth embodiment of the single-shaft eccentric screw pump according to the present invention.

WHAT IS REPRESENTED BY REFERENCE NUMERALS

[0046]

1, 1', 1-3, 1-4:	single-shaft eccentric screw pump
2:	pump body
3:	pump casing
4:	bearing unit
6:	flexible rod
7, 7', 7" :	tension bolt
8, 9:	washer
10:	nut
11:	support housing
12:	mechanical seal
15:	substantially cylindrical connector
16:	tightening ring
16a:	flange
17:	headed tension bolt
22:	stator
23:	threaded hole
24:	end stud
24a:	discharge port
25:	stator casing
26:	cover in the form of a hat
27, 45:	long bore
28:	plug in the form of a hat
31:	suction port
41:	bearing casing
42:	drive shaft
61:	tapered end
62:	tapered bore
71, 71', 72, 72':	threaded end

Claims

1. A single-shaft eccentric screw pump comprising a pump body, a pump casing, and a flexible rod, the pump body including an externally double-threaded rotor elliptic in section and a stator having an internally triple-threaded bore in the shape of a substantially equilateral triangle in aperture section, the rotor being in engagement with the stator bore, the flexible rod coupling the rotor and a drive shaft together, the drive shaft being connected to a drive unit, the single-shaft eccentric screw pump being

characterized by:

the flexible rod being tapered at at least one end thereof, the tapered end having a tapped hole formed at the axis thereof;
the rotor or the drive shaft having a tapered bore formed at the axis thereof, the tapered end being fitted into the tapered bore;
the rotor or the drive shaft further having a through bore formed at the axis thereof;
a tension bolt extending through the through bore from the other end of the rotor; and
the tension bolt having a front threaded end, the threaded end being screwed into and fastened to the tapped hole in the tapered end of the flexible rod so as to connect the rod and the rotor or the drive shaft together.

2. A single-shaft eccentric screw pump as claimed in claim 1, further

characterized by:

the flexible rod being tapered at both ends thereof, each of the tapered ends having a tapped hole formed at the axis thereof;
each of the rotor and the drive shaft having a tapered bore formed at the axis thereof, one of the tapered ends being fitted into the tapered bore;
each of the rotor or the drive shaft further having a through bore formed at the axis thereof;
a first tension bolt extending through the through bore of the rotor from the other end of the rotor;
a second tension bolt extending through the through bore of the drive shaft from the other end of the rotor; and
each of the tension bolts having a front threaded end, the threaded end being screwed into and fastened to the tapped hole in one of the tapered ends of the flexible rod so as to connect the rod to the rotor and the drive shaft.

3. A single-shaft eccentric screw pump as claimed in claim 1 or 2, further

characterized by:

the first tension bolt further having a rear threaded end;
a nut engaging with the rear threaded end;
a cover fitted to the end of the rotor which is away from the flexible rod; and
the cover covering the nut.

4. A single-shaft eccentric screw pump as claimed in claim 1 or 2, further **characterized in that** one end of the flexible rod is connected to a central portion of the rotor or a central portion of the drive shaft at any point between both ends of the rotor or any point between both ends of the drive shaft.

Fig. 1

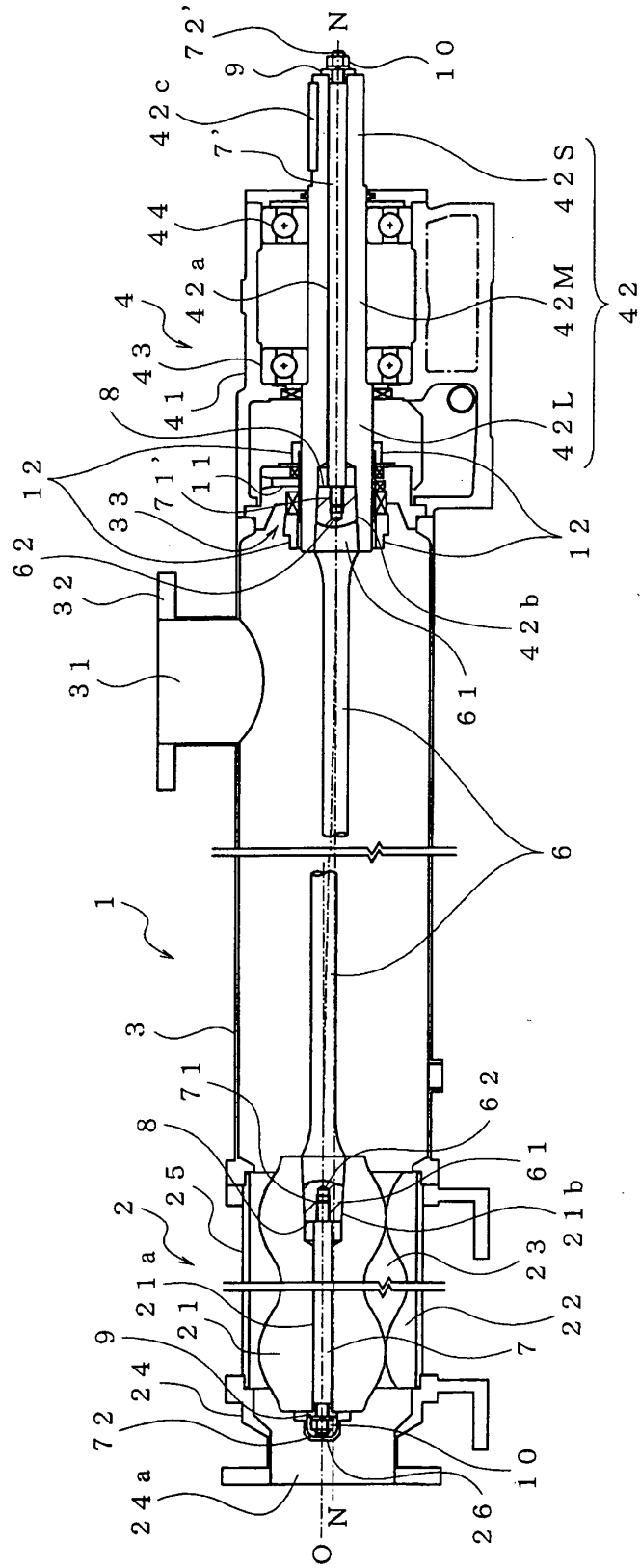


Fig. 2

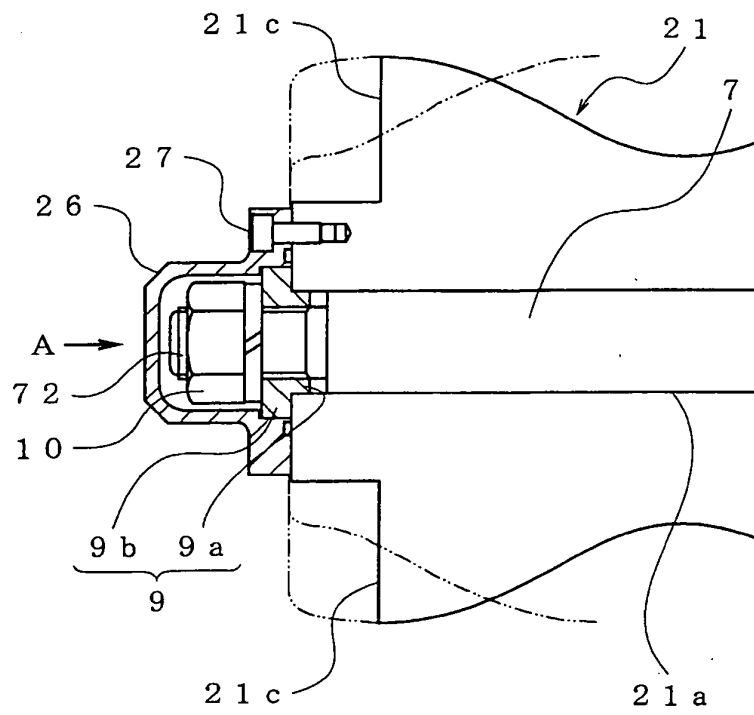


Fig. 3

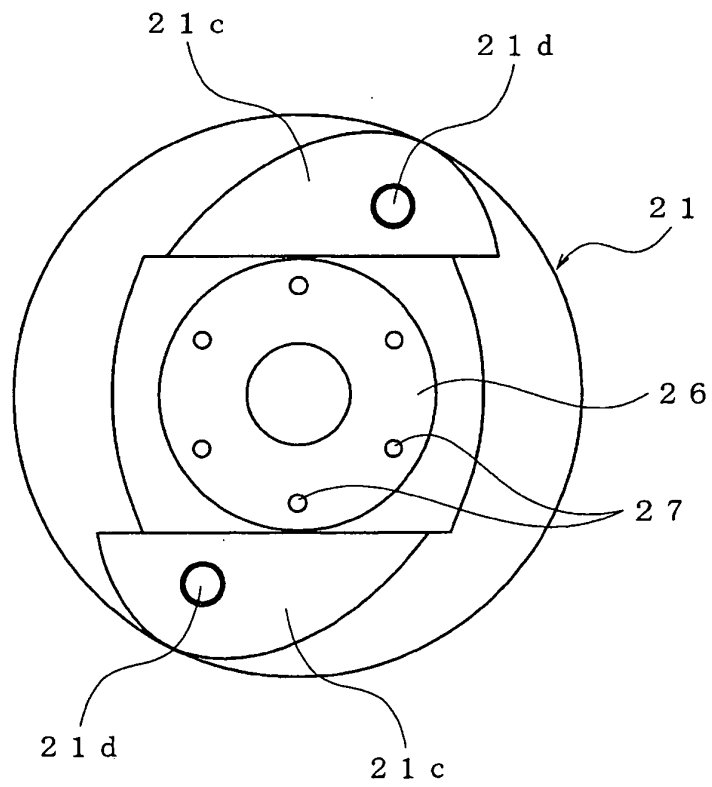


Fig. 4

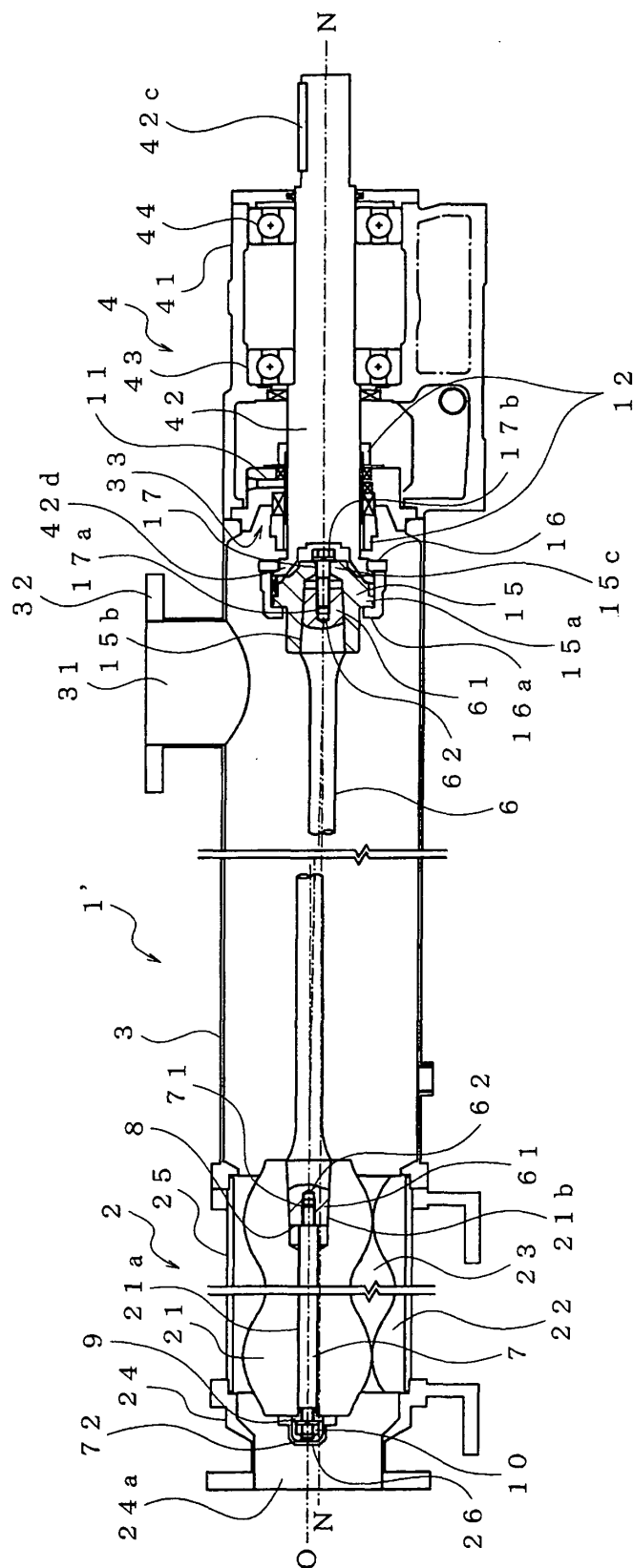


Fig. 5

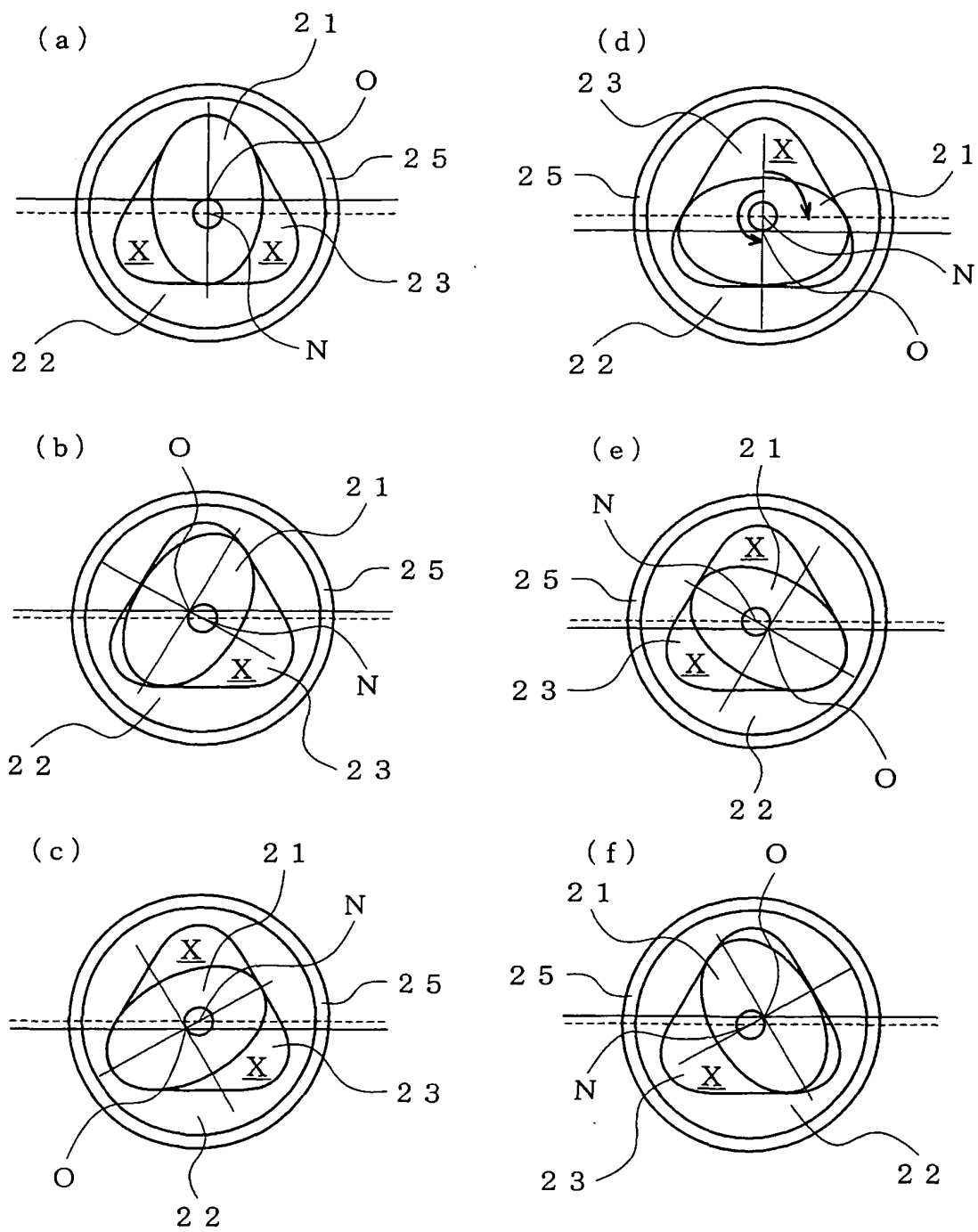


Fig. 6

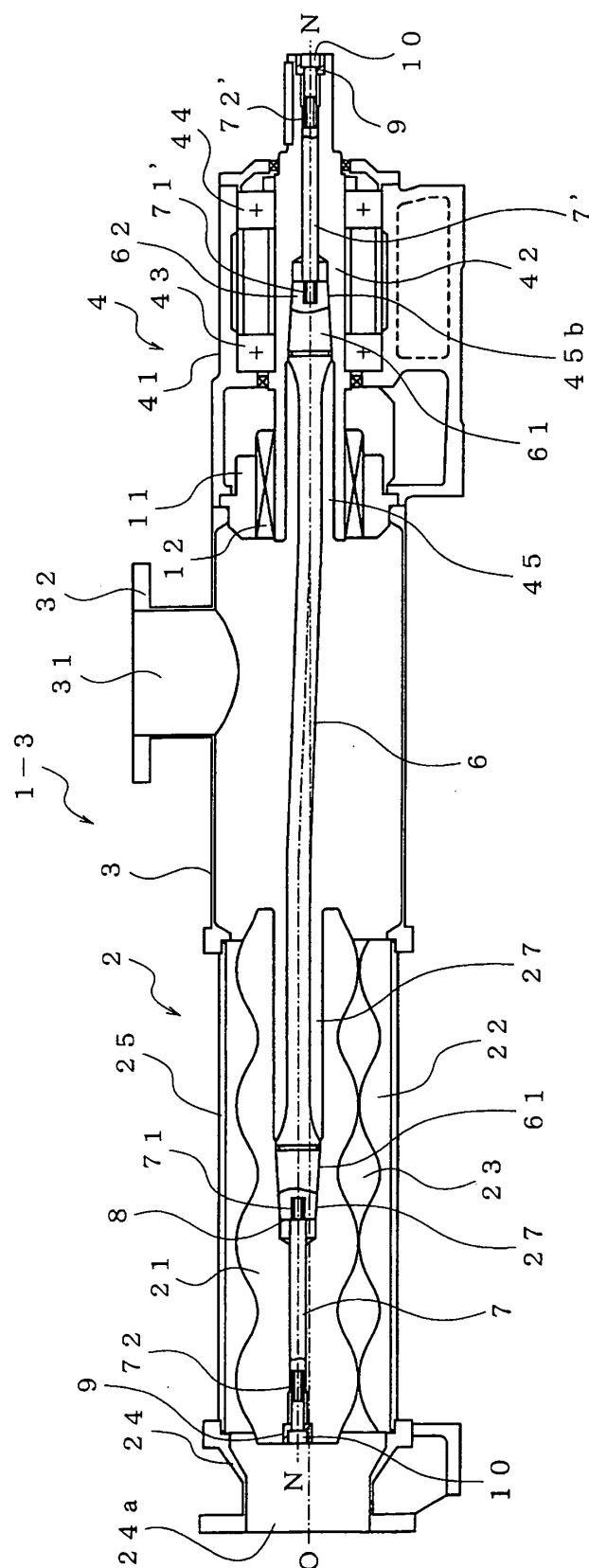
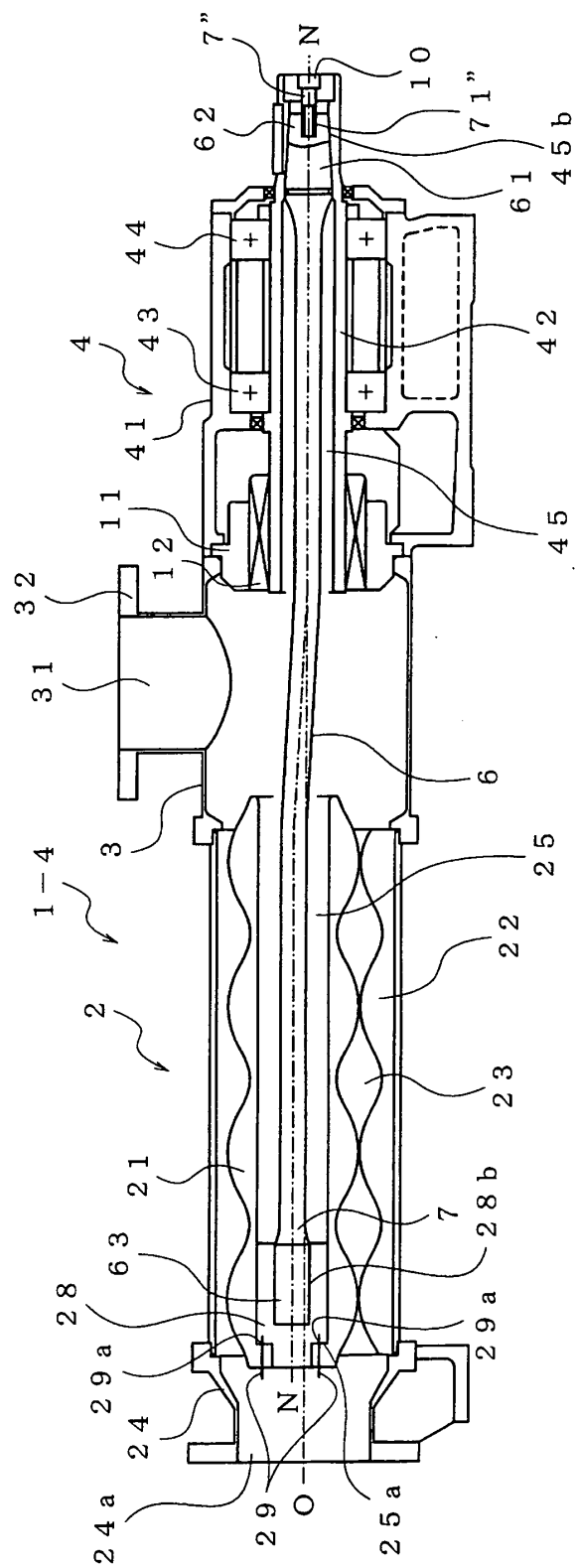


Fig. 7



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2006/302470

A. CLASSIFICATION OF SUBJECT MATTER

F04C2/107(2006.01), **F04C15/00**(2006.01)

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)

F04C2/107, **F04C15/00**

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 1996-2006

Kokai Jitsuyo Shinan Koho 1971-2006 Toroku Jitsuyo Shinan Koho 1994-2006

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.
A	JP 2000-345970 A (Heishin Ltd.), 12 December, 2000 (12.12.00), Full text; all drawings (Family: none)	1-4
A	JP 2001-271764 A (Shin Nippon Machinery Co., Ltd.), 05 October, 2001 (05.10.01), Full text; all drawings (Family: none)	1-4

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

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"&" document member of the same patent family

Date of the actual completion of the international search
13 April, 2006 (13.04.06)Date of mailing of the international search report
25 April, 2006 (25.04.06)Name and mailing address of the ISA/
Japanese Patent Office

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP H9264264 A [0004]