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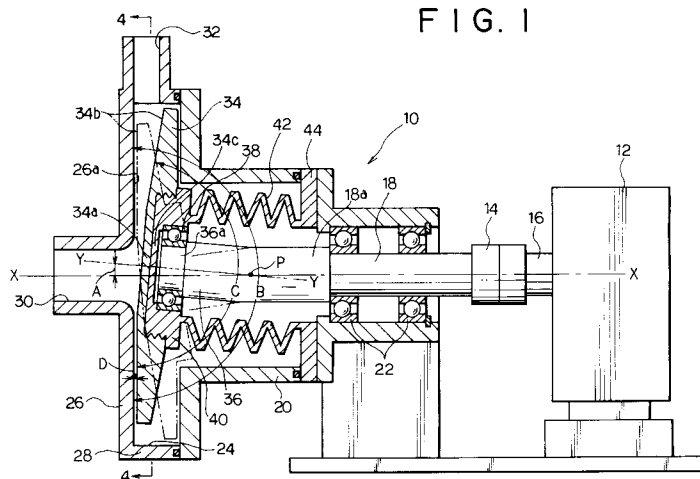
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Chiyoda-ku(54) **Pump with rocking disk.**

(57) A pump with rocking disk is disclosed, which has a commonly termed friction-free structure without any frictional part in the pump chamber(24). It is small in size and nevertheless has a function of pumping out process fluid continuously and at a high rate. It is thus suited for applications for feeding process liquid for semiconductor manufacture and also for feeding blood or the like in medical fields. In the pump chamber, a rocking disk(34) is coupled to a drive shaft(18) via an inclined shaft portion(36) or the like as operative coupling means such that it is

at an angle to the axis(X - X) of the drive shaft(18). A bellows(42) is stretched light-tight as a partitioning member between the rear side of the disk and a pump casing(20). The partitioning member prevents rotation of the disk in unison with the drive shaft but permits rocking motion of the disk. With this rocking motion, fluid in the pump chamber is fed from a suction port(30) formed in the central part of a front wall (26) through the pump chamber to a discharge port(32) formed on the outer periphery of a barrel-(28) of the pump casing.

FIG. 1**EP 0 595 279 A1**

BACKGROUND OF THE INVENTION

This invention relates to a pump, which is free from any mechanical frictional part in a fluid feeding zone in it and suitably applicable for feeding of chemical solution used in a process of semiconductor manufacture or for feeding blood for artificial lugs or artificial heart.

Among such friction-free pumps there is one, in which a rotor with an impeller is disposed in a pump chamber carrying fluid fed therethrough is supported contactlessly by a magnetic bearing and is driven for rotation from the outside of the pump chamber for pumping operation.

In another friction-free pump which does not use any rotor, the pump chamber is partitioned fluid-tight by a diaphragm, which is deformed reciprocally for pumping operation.

The above pump structure using the magnetic bearing is a centrifugal pump with an impeller, and thus can feed process fluid continuously and at a high rate. However, a special electronic circuit for controlling the magnetic bearing is indispensable, thus posing inevitable problems of complication of the structure and cost increase. As the prior art centrifugal pump without any magnetic bearing, there is one, in which a conventional mechanical bearing section is provided in the pump chamber. In this case, frictional rotation in the bearing section causes generation of frictional dust which is introduced into the process fluid in the pump. Therefore, this type of pump can not be applied to cases where intrusion of impurities into process liquid is extremely detested as in the case of semiconductor manufacture. Further, in a blood feed pump for medical purposes, it is necessary to prevent rupture of blood cells during the feed thereof as much as possible. However, the frictional part of the pump is liable to cause rupture of blood cells. Therefore, it is difficult to apply this type of pump to this end.

Further, in the reciprocal pump using the diaphragm as noted above, the deformation of the diaphragm is limited. Therefore, this pump is not suited for feeding process fluid continuously and at a high rate with a small size pump.

SUMMARY OF THE INVENTION

An object of the invention, accordingly, is to provide a pump with rocking disk, which can attain a friction-free structure with simple structure and nevertheless has a function of feeding process fluid continuously and at a high rate with a small structure, so that it is suited for feeding process fluid for semiconductor manufacture or feeding blood or the like in medical fields.

To attain the above object of the invention, there is provided a pump with rocking disk, which comprises a pump casing having a front wall with a central portion thereof formed with a suction port, and a substantially cylindrical barrel with the outer periphery thereof formed with a discharge port, the pump casing defining an inner pump chamber communicating with the suction and discharge ports, a rocking disk disposed in the pump chamber and having a front central portion facing the suction port, a peripheral edge portion facing the discharge port and a rear central portion opposite the front central portion, a drive shaft rotatable about an axis extending through the pump casing in the longitudinal direction thereof and having a free end portion, operative coupling means for coupling the rear central portion of the rocking disk to the free end portion of the drive shaft for relative rotation in a state with the axis of the rocking disk at an angle to the axis of the drive shaft, and a partitioning member stretched between the rocking disk and the pump casing such as to partition the pump chamber fluid-tight, thus permitting rocking motion of the rocking disk while preventing rotation thereof about the axis thereof by following the rotation of the drive shaft.

In the above structure according to the invention, the operative coupling means includes a shaft which is integral with the free end portion of the drive shaft and has an inclined axis at an angle to the axis of the drive shaft, and also a bearing is provided between the rear central portion of the rocking disk and the shaft portion.

Further, in the above structure according to the invention the partitioning member is a bellows surrounding the free end portion of the drive shaft, the bellows having the ends thereof coupled fluid-tight to the rocking disk and the pump casing, respectively.

In the pump according to the invention, the rocking disk in the pump chamber is operatively coupled by the coupling means to the drive shaft with its axis at an angle to the axis of the drive shaft, and while the drive shaft is rotated, the disk is held prevented from rotation in unison with the drive shaft. When the drive shaft is rotated, the rocking disk, without being rotated, undergoes a rocking motion in the pump chamber such that its peripheral edge portion is repeatedly brought toward and away from the front wall of the pump chamber. As a result, process fluid in a zone defined between the disk and the front wall of the pump chamber is fed out to the discharge port. Thus, the disk, although not rotated, effects a pumping operation similar to the centrifugal pumping operation brought about by a vane wheel. The flexible partitioning member stretched between the disk and the pump casing partitions the pump

chamber fluid-tight and eliminates any frictional part in the pump chamber. The partitioning member further has a function of preventing the rotation of the disk in unison with the drive shaft, although it permits a rocking motion of the disk.

According to the invention, since the rocking disk which is disposed in the pump chamber with its axis at an angle to the drive shaft is rocked in the pump chamber without being rotated about its axis, like the impeller of a centrifugal pump it is possible to pump out fluid continuously and at a high rate. Besides, owing to the friction-free structure that no rotationally frictional part is present in the pump chamber at all, the pump is particularly suitably applicable for feeding process liquid in a semiconductor manufacture process, in which intrusion of impurities into the process fluid in the pump is detested, or for feeding feeding blood in artificial lungs or artificial heart. Besides, the pump can have a simple mechanical structure without use of any complicated electronic circuit for control. Further, for most part of the whole pump structure, use may be made of components in prior art centrifugal pumps or the like. Thus, the pump can be manufactured easily and at low cost, as well as readily permitting the size reduction design.

In the pump according to the invention, in which the operative coupling means is a shaft having an inclined axis, the shaft may be formed by integrally bending a slight extension of the free end portion of the drive shaft. Thus, any separate member or a coupling mechanism therefor is needed.

Further, in the pump according to the invention, in which the partitioning member is a bellows, low resistance is offered to the rocking motion of the rocking disk, while sufficiently preventing the rotation of the disk in unison with the drive shaft. The pump thus has satisfactory seal property and high durability.

BRIEF DESCRIPTION OF THE DRAWINGS

The above and other objects, features and advantages of the present invention will become more apparent from the following detailed description of the preferred embodiments of the invention, when the same is considered in connection with the accompanying drawings, in which:

Fig. 1 is a front view, partly broken away, showing a first embodiment of the pump according to the invention;

Fig. 2 is a front view, partly broken away, showing a second embodiment of the pump according to the invention;

Fig. 3 is a front view, partly broken away, showing a third embodiment of the pump according to the invention; and

Figs. 4(a) to 4(c) are sectional views, to a contracted scale, showing various shapes of a pump casing taken along line 4-4 in Fig. 1.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

An embodiment of the invention will now be described with reference to the drawings. Fig. 1 shows a first embodiment of the pump with rocking disk.

Referring to the Figure, designated at 10 is a pump, and at 12 a drive motor. The drive motor 12 has a shaft 16 coupled via a coupling 14 to a drive shaft 18 of the motor 12 for torque transmission. The drive shaft 18 is supported in a bearing 22 for rotation around an axis X-X which extends in the longitudinal direction of a pump casing 20 of the pump 10. The drive shaft 18 has one end coupled via the coupling 14 to the motor shaft 16, and its other end extends as a free end 18a into a pump chamber 24 defined in the pump casing 20.

The pump chamber 24 is defined in a front part (i.e., left part in Fig. 1) of the pump casing 20 by a substantially circular flat front wall 26 and a substantially cylindrical barrel 28. The front wall 26 has a suction port 30 formed in its central portion, and the barrel 28 has a discharge port 32 formed in an edge portion of the periphery.

Designated at 34 is a rocking disk, which is disposed in the pump chamber 24 and has a front central portion 34a facing the suction port 30, a wing-like peripheral edge portion 34b facing the discharge port 32 and a rear central portion 34c opposite said the front central portion 34a. The rocking disk 34, as will be described later in detail, is caused to rock from its state shown by solid line in Fig. 1 to a state shown by a phantom line with the rotation of the drive shaft 18, but its rotation about the axis X-X is prevented. Thus, the shape of the space, which is defined between the inner surface 26a of the front wall 26 and the front edge surface portion 34b of the disk 34, is changed progressively with the rocking of the disk 34. In other words, although the disk 34 itself is not rotated, its front edge portion 34b is repeatedly brought toward and away from the inner wall surface 26a of the front wall 26 in a circumferentially excursive motion. With this motion, the process fluid such as a chemical solution entering the pump through the suction port 30 is progressively fed out to the discharge port 32. Pumping operation is performed in this way. For efficient pumping operation, the distance D between the front edge portion 34b of the disk 34 and the inner surface 26a of the front wall 26 is small when the former is closest to the latter, that is, when the space between the two is closed. This is so because fluid leaks through

the space at a low rate.

The rocking disk 34 is supported for rotation via a bearing 38 at the rear central portion 34c in an inclined shaft portion 36 which is integral with the free end 18a of the drive shaft 18. The inclined shaft portion 36 has an inclined axis Y-Y, which intersects with the axis X-X at point P and has an inclination angle A with respect to the axis X-X. The inclined shaft portion 36, the bearing 38 and a mounting member 40, on which the rocking shaft 38 is mounted, form an operative coupling means coupling the disk 34 in an inclined state with respect to the axis X-X. The bearing 38 has its inner race secured to a stepped end portion 36a of the inclined shaft portion 36 and its outer race secured to the mounting member 40. The axis of the disk 34 coincides with the inclined axis Y-Y.

Designated at 42 is a bellows serving as a flexible partitioning member. The member 42 surrounds the free end portion 18a of the drive shaft 18. Its one end is made integral with the mounting member 40 on the rear side of the disk 34 at the rear central portion 34c, while the other end is made integral with a flange 44 of the pump casing 20. In this embodiment, the partitioning member 42 is molded as a one-piece molding together with the mounting member 40 and flange 44 from a synthetic resin material. Where a chemical solution is handled as the process fluid in the pump, a highly corrosion-resistant Plastic material, e.g., "Teflon" (a trade name) is used as the molding material. Where the parts noted above are fabricated separately, they are coupled together fluid-tight by means of welding. The partitioning member 42 is just like stretched in a pump casing portion on the rear side of the disk 34. By the partitioning member 42 the pump chamber 24 is partitioned fluid-tight.

The partitioning member 42 is capable of elongation and contraction in the X-X axis direction to permit the rocking motion of the rocking disk 34. However, since the partitioning member 42 is substantially secured in position although it may undergo slight elastic deformation about the X-X axis, the rotation of the rocking disk 34 about its axis Y-Y, i.e., its rotation following the rotation of the drive shaft 18, is prevented by the partitioning member 42.

Thus, when the drive shaft 18 is rotated by a drive torque transmitted via the coupling 14 with energizing of the motor 12, the inclined shaft 36 is rotated about the axis Y-Y in unison with the drive shaft 18, while it undergoes a rocking motion with an inclination angle A. This motion of the inclined shaft 36 is transmitted via the bearing 38 to the rocking disk 34. At this time, the rotation of the inclined shaft 36 to follow the rotation of the drive shaft 18 is prevented by the partitioning member

42 as noted above, and the sole inclined shaft 36 is rotated relative to the disk 34 at the bearing 38. The disk 34 is thus caused to undergo rocking as noted above, thus attaining the pumping action.

As shown in Fig. 1, denoting the inclination angle of the inclined axis Y-Y with respect to the axis X-X by A, the angle B of the apex of the inner wall surface 26a of the front wall 26 on the axis X-X by B and the angle of the apex of the conical inclined surface of the front edge portion 34b of the disk 34 by C, the inclination of the front edge portion 34b of the disk 34 is set such as to meet a relation $C = B - 2A$. Thus, the peripheral edge portion 34b is parallel to the inner wall surface 26a of the front wall 26 when it is closest to the front wall 26. It is thus possible to set the distance D to a small value, and the disk 34 and front wall 26 may be brought so close as they are almost in contact with each other.

As shown above, with the pump with rocking disk according to the invention, the rocking disk 34 is not rotated but is only rocked, and there is no rotationally frictional part in the pump chamber 24. Thus, it is possible to eliminate the problem of introduction of friction dust that is generated from the rotationally frictional part in the prior art pump into the process fluid. The pump according to the invention is suitably applicable for feeding a process solution or the like in semiconductor manufacture which detects intrusion of impurities. Also, it is suitably applicable to feeding blood or the like in medical fields without problem of rupture of blood cells in a frictional part.

Fig. 2 shows a second embodiment. In this embodiment, parts like those in the first embodiment are designated by like reference numerals while omitting their description, and the description concerns only a different part from the first embodiment. In this second embodiment, free end portion 18a of drive shaft 18 is further extended, and integral inclined shaft 36 is formed such that it is slightly off-set with respect to the axis X-X so that the point P of intersection between the inclined axis Y-Y and axis X-X coincides with the apex of front central portion 34a of the rocking disk 34 having a conical shape. With the structure of the first embodiment, while the disk 34 rocks, the axis Y-Y thereof is revolved, and thus the disk concurrently undergoes an excentric motion. With the structure of the second embodiment, the axis Y-Y intersects with the axis X-X at the apex of the front central portion 34a of the disk 34. Thus, the front side of the disk 34 does not undergo any excentric motion, but undergoes a sole rocking motion as shown.

That is, while the disk 34 rocks, the peripheral edge portion thereof is moved only back and forth in the barrel 28. This means that it is possible to

increase the wing length R of the peripheral edge portion. In other words, it is possible to increase the diameter of the disk 34, i.e., increase the discharge pressure, with the same diameter of the barrel 28, that is, it is possible to reduce the size of the pump casing with the same discharge pressure.

Fig. 3 shows a third embodiment. Similar to the preceding case, in this embodiment parts like those in the first embodiment are designated by like reference numerals while omitting their description, and only a part different from the first embodiment will be described. Like the preceding second embodiment, free end portion 18a of drive shaft 18 is further extended, and integral inclined shaft 36 is provided in an off-set state. The point P of intersection between the inclined axis Y-Y and axis X-X is set at the center of rocking disk 34. With this arrangement, the peripheral edge portion 34d of the disk 34 is caused to rock by drawing a spherical surface with the intersection point P as the center and a radius of R1. The inner peripheral surface 28a of barrel 28 of pump casing 20, on the other hand, is a spherical surface with the intersection point P as the center and a radius of R2, R2 being made closer to R1. With this arrangement, the play between the peripheral edge portion 34d of the disk 34 and the inner peripheral surface 24a, thus reducing the leakage of fluid from the space defined by the disk 34 and front wall 26 to the back side of the disk 34 and increasing the discharge pressure.

In the above structure, discharge port 32 is provided at an off-set position from the barrel 28 facing the edge 34d of the disk 34. This is done so because a sufficient fluid path area can not be secured in the barrel 28. Specifically, a portion of the pump casing 20, in which the front wall 26 and barrel 28 are united to each other, is shifted forward to form a ring-like communication path 46 between the discharge port 32 and pump chamber 24, thus securing the fluid path.

While the first to third embodiments of the invention have been described, the shape of the pump casing 20, particularly the sectional profile of the barrel 28, may be as shown in Figs. 4(a) to 4(c) in these embodiments. In these Figures, the rocking disk 34 is shown by a phantom line. In the case of Fig. 4(a), the radius of the barrel 28 is increased gradually in the direction of flow of fluid toward the discharge port 32. This structure is the same as that of the pump casing of the usual centrifugal pump. In the case of Fig. 4(b), the barrel 28 is concentric with the disk 34, and the discharge port 32 extends in the radial direction. In the case of Fig. 4(c), the discharge port 32 extends not radially but tangentially. Either of the above structures is applicable to the above embodiments of the inven-

tion. The ring-like communication path 46 in the third embodiment is, for instance, formed over the entire circumference as shown in Fig. 4(b).

In the pump construction in each of the above embodiments, where a chemical solution is handled as process fluid in the pump, the portions defining the pump chamber 24 and in contact with the process liquid may be made of high corrosion-resistant synthetic resins or like material. At any rate, since the fluid is partitioned fluid-tight by the partitioning member 42 from the space accommodating the drive shaft, bearing 38, etc., portions other than those forming the pump chamber 24 may be made of any desired material. As the partitioning member 42, a bellows is most suitable for permitting the rocking motion of the disk 34 while preventing the rotation thereof. However, it is also possible to construct it with a cylindrical elastic film member or other flexible members. The process fluid that is handled in the pump is not limited to liquid, but the invention is applicable as well to feeding gas such as in an air pump. Further, the above embodiments of the invention may be modified variously.

Claims

1. A pump with rocking disk characterized by comprising:

a pump casing(20) having a front wall(26) with a central portion thereof formed with a suction port(30), and a substantially cylindrical barrel(28) with the outer periphery thereof formed with a discharge port(32), said pump casing defining an inner pump chamber(24) communicating with said suction and discharge ports;

a rocking disk(34) disposed in said pump chamber and having a front central portion-(34a) facing said suction port, a peripheral edge portion(34b) facing said discharge port, and a rear central portion(34c) opposite said front central portion;

a drive shaft(18) rotatable about an axis(X - X) extending through said pump casing in the longitudinal direction thereof and having a free end portion(18a);

operative coupling means(36,38,40) for coupling said rear central portion of said rocking disk to said free end portion of said drive shaft for relative rotation in a state with the axis(Y - Y) of said rocking disk at an angle to the axis(X - X) of said drive shaft; and

a partitioning member(42) stretched between said rocking disk and said pump casing such as to partition said pump chamber fluid-tight, thus permitting rocking motion of said rocking disk while preventing rotation thereof

about the axis thereof by following the rotation of said drive shaft.

2. The pump with rocking disk according to claim 1, characterized in that said operative coupling means includes an inclined shaft portion(36) which is integral with said free end portion(18a) of said drive shaft(18) and has an inclined axis (Y - Y) at an angle to the axis(X - X) of said drive shaft.
3. The pump with rocking disk according to claim 1 or 2, characterized in that said partitioning member(42) is a bellows surrounding said free end portion(18a) of said drive shaft(18), said bellows having the ends thereof coupled fluid-tight to said rocking disk(34) and said pump casing(20), respectively.
4. The pump with rocking disk according to claim 2, characterized by further comprising a bearing(38) disposed between said rear central portion(34c) of said rocking disk(34) and said inclined shaft portion(36).

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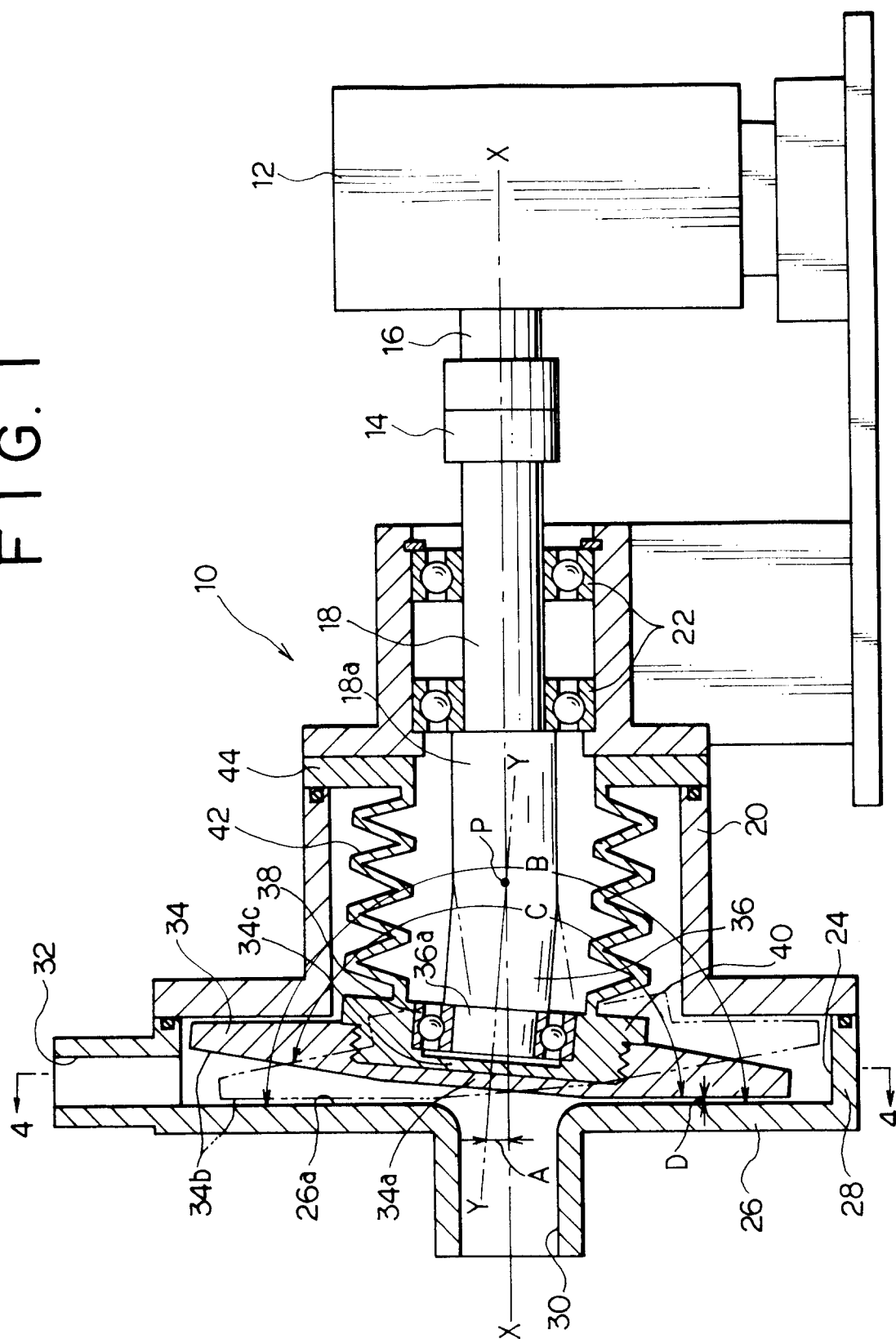


FIG. 2

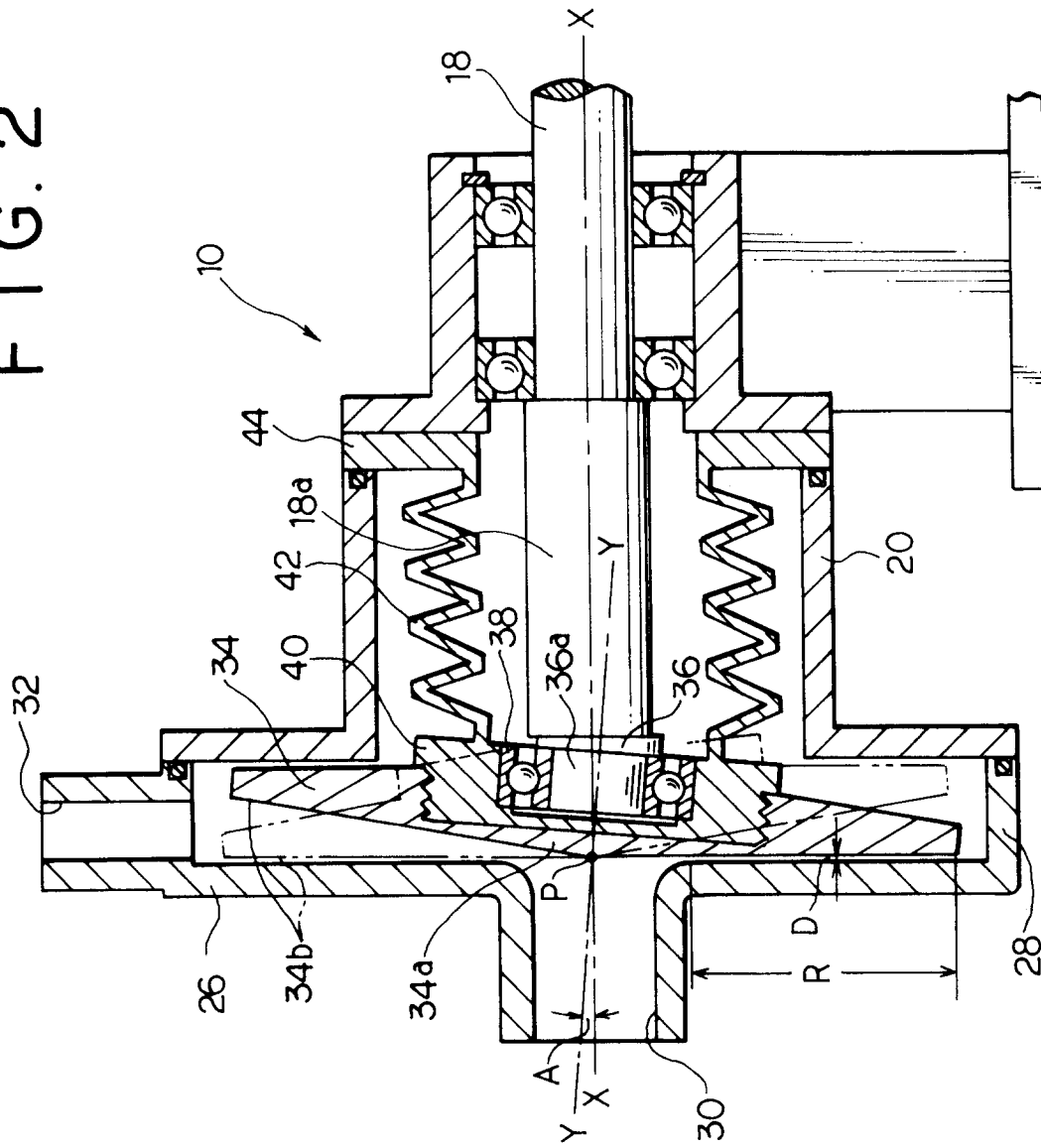


FIG. 3

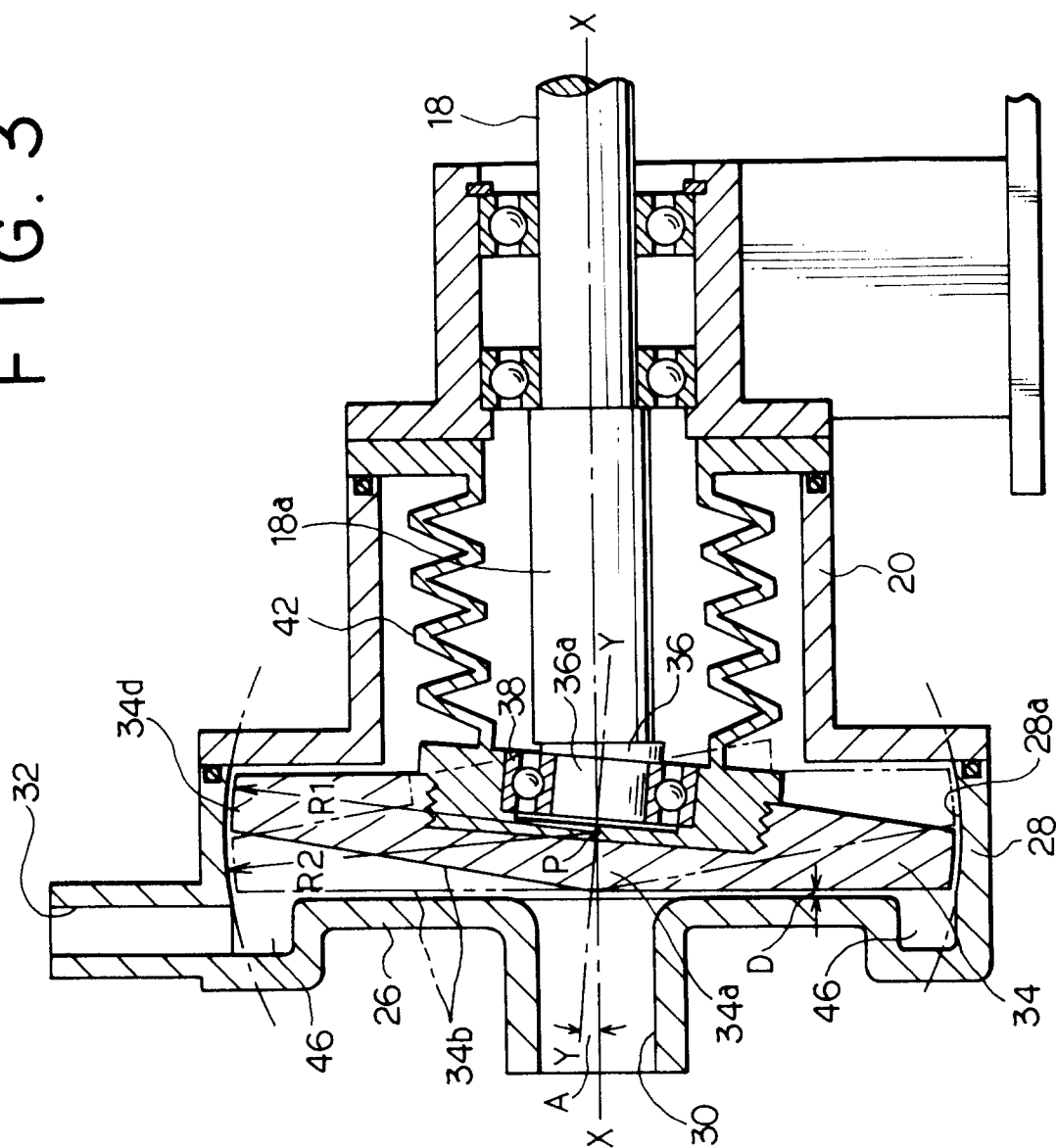


FIG. 4(a)

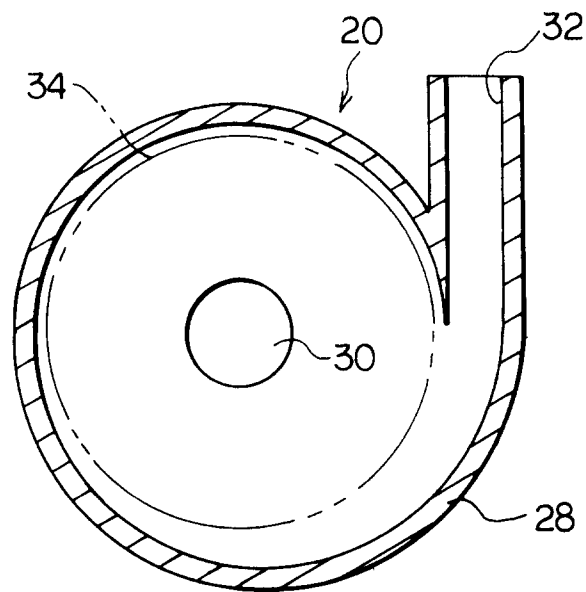


FIG. 4(b)

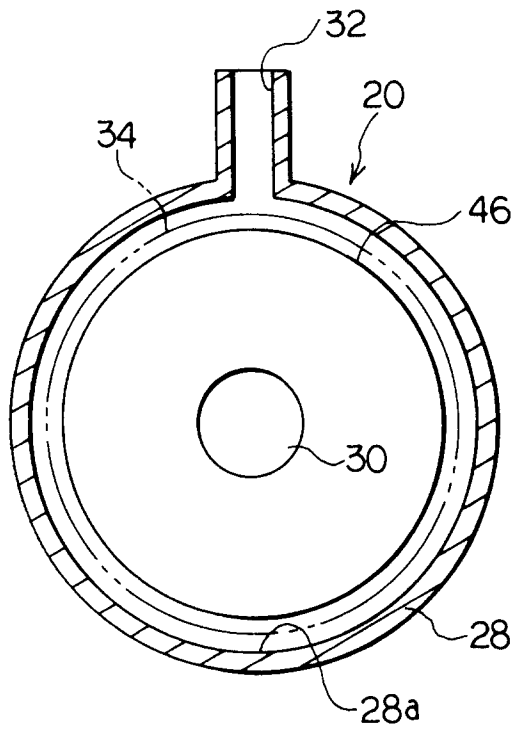
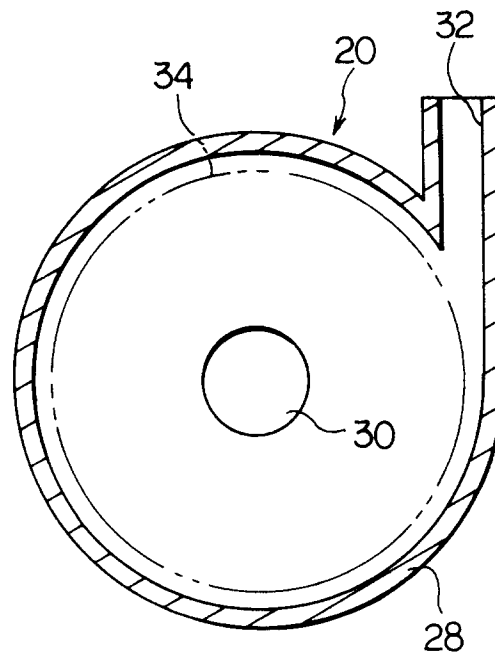


FIG. 4(c)





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EUROPEAN SEARCH REPORT

Application Number
EP 93 11 7372

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.5)
X	FR-A-1 361 933 (SOREXI)	1, 3	F04C9/00
Y	* the whole document * ---	2, 4	
Y	FR-E-84 244 (MOGNITORE) * the whole document * ---	2, 4	
A	FR-A-1 049 230 (SALGUES) * the whole document * ---	1-4	
A	GB-A-752 435 (CORNELIUS) * the whole document * ---	1	
A	GB-A-1 143 675 (FORD AND SKIPPER) * the whole document * -----	1	
The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (Int.Cl.5)
			F04C F01C
Place of search		Date of completion of the search	Examiner
THE HAGUE		13 January 1994	DIMITROULAS, P
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