(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 1 936 187 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
25.06.2008 Bulletin 2008/26

(21) Application number: **06425858.5**

(22) Date of filing: **22.12.2006**

(51) Int Cl.:
F04B 11/00 *(2006.01)* ***F04B 17/06*** *(2006.01)*
F04B 23/06 *(2006.01)* ***F04B 43/00*** *(2006.01)*

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IS IT LI LT LU LV MC NL PL PT RO SE SI SK TR
Designated Extension States:
AL BA HR MK RS

(71) Applicant: **F.LLI Tabanelli S.N.C. Di Tabanelli Paolo & C.**
48027 Faenza (Ravenna) (IT)

(72) Inventors:
- **Tabanelli, Paolo**
  48018 Faenza (Ravenna) (IT)
- **Tabanelli, Andrea**
  48013 Brisighella (Ravenna) (IT)
- **Tabanelli, Oliviero**
  48027 Solarolo (Ravenna) (IT)

(74) Representative: **Alagem Modiano, Lara S. et al**
Modiano & Associati
Via Meravigli, 16
20123 Milano (IT)

(54) Multiple membrane pump for food liquids and the like

(57) A multiple membrane pump for food liquids and the like, comprising at least one duct (6) for the compensated intake of the liquid, which is closed on itself in a loop and is provided with at least one intake port (7), at least one duct (8) for the compensated delivery of the liquid, which is closed on itself in a loop and is provided with at least one delivery port (9), at least four branches (10, 11, 12, 13), which provide a unidirectional connection between the intake duct (6) and the delivery duct (8) and are associated respectively with four liquid pumping membranes (14, 15, 16, 17), a gearmotor assembly (18), which is associated with a crank system (19) for actuating the membranes (14, 15, 16, 17) and is adapted to convert the rotary motion of an output shaft (20) of the gearmotor assembly (18) into a reciprocating motion, adjusted with an appropriate timing between two mutually opposite intake and delivery stroke limit positions, of each of the actuation axes (21, 22, 23, 24) of the membranes (14, 15, 16, 17).

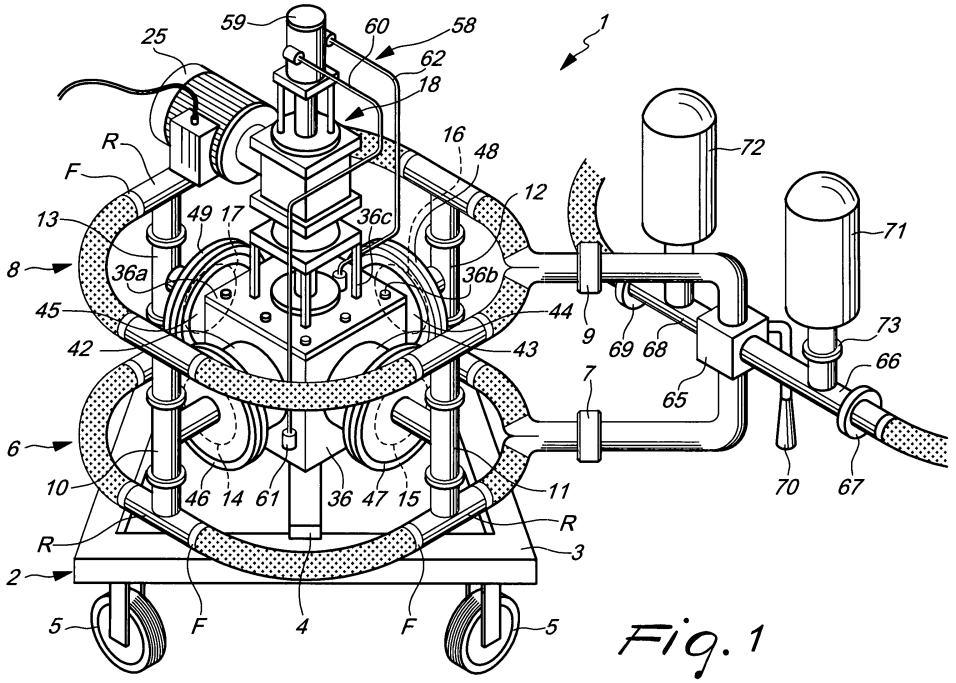

Fig. 1

EP 1 936 187 A1

Description

[0001] The present invention relates to a multiple membrane pump for food liquids and the like.

[0002] The food industry (particularly but not exclusively with reference to the production of wines and the like) traditionally uses, for the transfer of liquids, piston pumps, helical screw pumps, centrifugal pumps, peristaltic pumps or, as an alternative, membrane pumps which are actuated pneumatically or electromechanically.

[0003] Membrane pumps are often preferred to piston, helical screw, centrifugal and peristaltic pumps due to their smaller bulk and lower noise, to their gentle pumping, to the absence of mechanical seals, to the possibility to operate when empty or with delicate, viscous, abrasive fluids, even containing suspended solids; such membrane pumps currently comprise, in the most advanced version, two mutually opposite pumping elements, each provided with a respective membrane, both connected to an intake duct and a delivery duct; such pumping elements are usually actuated in phase opposition with respect to each other, i.e., when one is at the end of the intake step the other one is at the end of the delivery step, and vice versa

[0004] Membrane pumps of the type described here are not free from drawbacks. First of all, they generate a rather uneven stream of liquid, i.e., with a very conspicuous pulsed flow-rate: this fact, for particularly delicate food processes, such as wine packaging and the like, is certainly highly disadvantageous, since it subjects the liquid to mechanical stresses which might alter and compromise its organoleptic properties and therefore its quality. Secondly, they can deliver a flow-rate which in many applications is not sufficient even when using large-diameter membranes.

[0005] Thirdly, they do not provide flow reversal systems, which allow to selectively connect the ports for coupling to external sources or tanks to the delivery duct or to the intake duct.

[0006] Fourthly, pumps generally currently used in the food industry are expensive, demanding in terms of maintenance, noisy, scarcely efficient in terms of energy due to the high internal friction and to the scarcely effective types of lubrication, despite the use of large amounts of lubricating oils and greases.

[0007] The aim of the present invention is to obviate the above-mentioned drawbacks, by providing a multiple membrane pump for food liquids and the like which allows to deliver a flow-rate of liquid which is as uniform as possible, i.e., substantially without conspicuous pulsing phenomena which might alter the quality of said liquid.

[0008] Within this aim, an object of the present invention is to provide a multiple membrane pump for food liquids and the like which is capable of delivering significantly higher flow-rates than provided by currently commercially available membrane pumps.

[0009] Another object of the present invention is to provide a multiple membrane pump for food liquids and the like which has a flow reversal system which allows to reverse the direction of transfer of the liquid between the external tanks or sources.

[0010] Another object of the present invention is to provide a multiple membrane pump for food liquids and the like which is easy to maintain, quiet, has high energy efficiency and a low use of lubricating oil due to low internal friction.

[0011] Another object of the present invention is to provide a multiple membrane pump for food liquids and the like which has a simple structure, is relatively easy to provide in practice, safe in use, effective in operation, and has a relatively low cost.

[0012] This aim and these and other objects, which will become better apparent hereinafter, are achieved by the present multiple membrane pump for food liquids and the like, characterized in that it comprises at least one duct for the compensated intake of the liquid, which is closed on itself in a loop and is provided with at least one intake port, at least one duct for the compensated delivery of the liquid, which is closed on itself in a loop and is provided with at least one delivery port, at least four branches, which provide a unidirectional connection between said intake duct and said delivery duct and are associated respectively with at least four liquid pumping membranes, at least one gearmotor assembly, which is associated with at least one crank system for actuating said membranes which is adapted to convert the rotary motion of an output shaft of said gearmotor assembly into a reciprocating motion, adjusted with an appropriate timing between two mutually opposite intake and delivery stroke limit positions of each of the actuation axes of said membranes.

[0013] Further characteristics and advantages of the invention will become better apparent from the following detailed description of a preferred but not exclusive embodiment of a multiple membrane pump for food liquids and the like according to the invention, illustrated by way of non-limiting example in the accompanying drawings, wherein:

Figure 1 is a perspective view of the pump according to the invention;
Figure 2 is a perspective detail view of the footing of the pump;
Figure 3 is a partially sectional exploded perspective view of one of the branches for connecting the intake duct to the delivery duct;
Figure 4 is a detail plan view of the intake valve and of the delivery valve;
Figure 5 is a transverse sectional view, taken along the line V-V of Figure 4;
Figure 6 is a detail side elevation view of the crank system for actuating the pump according to the invention;
Figure 7 is a detail plan view of said crank system.

[0014] In the exemplary embodiment that follows, in-

dividual characteristics, given in relation to this specific example, may actually be interchanged with other different characteristics that exist in other exemplary embodiments.

[0015] Moreover, it is noted that anything found to be already known during the patenting process is understood not to be claimed and to be the subject of a disclaimer.

[0016] With particular reference to Figure 1, the reference numeral 1 generally designates a multiple membrane pump for food liquids and the like according to the invention, particularly but not exclusively for liquids such as wine.

[0017] The pump comprises a supporting footing, generally designated by the reference numeral 2, which is constituted by a substantially square frame 3 provided with cross-members 4 which intersect at the center; optionally, the square frame 3 can be provided with substantially traditional wheels 5 which are adapted to facilitate the movement of the pump. Four vibration-damping elements 5a of a substantially traditional type are interposed between the cross-members 4 and the square frame 3 and dampen and limit the transmission of vibrations to the ground (Figure 2).

[0018] The footing 2 advantageously supports, according to the invention, a duct for compensated intake of the liquid, generally designated by the reference numeral 6, which is closed on itself in a loop and is provided with at least one intake port 7, a duct for compensated delivery of the liquid, generally designated by the reference numeral 8, which is closed on itself in a loop and is provided with at least one delivery port 9; there are also four branches 10, 11, 12, 13, which provide a unidirectional connection between the intake duct 6 and the delivery duct 8 and are associated respectively with four membranes 14, 15, 16, 17 for pumping the liquid.

[0019] The pump also conveniently comprises a gearmotor assembly, generally designated by the reference numeral 18, which is associated with a crank system, generally designated by the reference numeral 19 (Figures 5, 6) for the actuation of the four membranes 14, 15, 16, 17, which is adapted to convert the rotary motion of an output shaft 20 of the gearmotor assembly 18 into a reciprocating motion, which is adjusted with an appropriate timing between two mutually opposite intake and delivery stroke limit positions, as will become better apparent hereinafter, of each of actuation axes 21, 22, 23, 24 of the membranes 14, 15, 16, 17. The actuation axes 21, 22, 23, 24 of the membranes 14, 15, 16, 17, connected respectively to said membranes by means of screws V, are preferably arranged at right angles to each other, but in any case can be arranged, as an alternative, at different angles in relation to different requirements.

[0020] Each of the membranes 14, 15, 16, 17, as can be seen in Figure 3, is clamped between pairs of plates P1, P2, which facilitate their rolling during the movement of the actuation axes 21, 22, 23, 24.

[0021] The use of four membranes 14, 15, 16, 17 actuated in a continuous cycle and in succession with respect to each other allows to achieve the delivery of a highly regular flow-rate which is free from conspicuous pulses, even at a low rotation rate of the gearmotor assembly 18; this considerable advantage is achieved also by way of the closed-loop configuration of the intake duct 6 and of the delivery duct 8, which dampens and cushions any oscillating phenomena within the liquid.

[0022] In greater detail, the delivery duct 8 is arranged concentrically above the intake duct 6 and is supported by the four branches 10, 11, 12, 13, which accordingly are also mutually angularly equidistant at right angles to each other.

[0023] The gearmotor assembly 18 is preferably mounted so that the output shaft 20 is vertical, along a direction which is substantially concentric with respect to the intake duct 6 and the delivery duct 8. The gearmotor assembly 18 is of the type actuated with an electric motor 25, which is controlled with an electronic frequency inverter. As an alternative, a hydraulic, pneumatic, internal-combustion engine or a power takeoff or cardan shaft or also a motor of any other kind might also be used.

[0024] Each of the branches 10, 11, 12, 13 (Figure 3) is shaped substantially like a letter T tilted sideways and forms a first end 26 for connection to the intake duct 6, a second end 27 for connection to the delivery duct 8, and a third end 28 for connection to the respective membrane 14, 15, 16, 17; each of the branches 10, 11, 12, 13 comprises an intake valve 29 and a delivery valve 30, which are arranged respectively at the first end 26 and at the second end 27.

[0025] The intake valves 29 and the delivery valves 30 are conveniently of the type with a ball-shaped flow control element 31 (also known as ball check valves), but as an alternative it is possible to use also flap check valves or duck bill check valves or cone check valves. More precisely, in the embodiment with a ball-shaped flow control element, each intake valve 29 and delivery valve 30 comprises a tubular segment 32, which is affected by a fluid passage channel 33 which is arranged hermetically above an interchangeable and reversible seat 34 against which the ball-shaped flow control element 31 abuts by gravity. The seat 34 in turn rests on a sort of cup T, which is adapted to provide a connection to the ducts.

[0026] The channel 33 is provided with linear guides provided with a stop element 34a and with simple linear guides 34b, which are arranged alternately at right angles to each other and allow to guide in a straight manner the flow control element 31 from its inactive position on the seat 34 to the fully raised position, set by a stop tooth 34c of each of the guides 34a: this allows to achieve quicker closure by gravity of the ball-shaped flow control element 31 on the seat 34, so as to utilize effectively the delivery valve 30 and the intake valve 29 even at high pumping rates. The channel 33 has a transverse cross-section which accordingly forms four peripheral sectors 35, which are angularly equidistant and are adapted to give the valves 29, 30 minimal resistance to the passage

of the liquid and through which any suspended solids, even of substantial dimensions, conveyed by said fluid, can flow freely without being crushed by the ball-shaped flow control element 31 against the internal wall of the channel 33; said fluid can thus provide a self-cleaning effect on said channel (for example, it is possible to pump fruit salad or the like without breaking the pieces of fruit, which must remain intact).

[0027] The first ends 26 and the second ends 27 of each of the branches 10, 11, 12, 13 are connected to substantially T-shaped couplings R, are provided with respective rings G (or for example clamps of the tri-clamp type or the like) for fixing to the branches 10, 11, 12, 13, and are connected respectively to the intake duct 6 and to the delivery duct 8 (each constituted by five pieces of rubber, plastics or metal pipe), by means of hermetic clamps F, or also by means of flanges.

[0028] The crank system 19 for actuating the membranes 14, 15, 16, 17 (see Figures 6, 7) comprises a box 36, which has a lid 36a which is fixed hermetically by means of screws 36b and on which a frame 36c for supporting the gearmotor assembly 18 is mounted. The box 36 accommodates internally a first rectangular body 37 and a second rectangular body 38, which are arranged so as to cross each other at right angles and one above the other, both being arranged above the level of the oil that is present on the bottom of the box 36 and being affected centrally respectively by a first rectangular opening 37a and a second rectangular opening 38a. Each of said bodies is rigidly coupled, at the respective short sides, to two of the actuation axes of two of the mutually opposite membranes 14, 15, 16, 17: more precisely, the short sides of the first rectangular body 37 are respectively rigidly coupled to the axes 21, 23, while the short sides of the second rectangular body 38 are rigidly coupled to the axes 22, 24.

[0029] The actuation crank system 19 further comprises an eccentric pivot 39, which is rigidly coupled to the output shaft 20 of the gearmotor assembly 18, which is arranged so that its axis of symmetry lies within the first opening 37a of the first rectangular body 37 and of the second opening 38a of the second rectangular body 38: advantageously, the rotation of the eccentric pivot 39 about the axis of the output shaft 20 of the gearmotor assembly 18 allows to provide the alternating translational motion of the axes 21, 22, 23, 24 of the membranes 14, 15, 16, 17 one after the other sequentially and in a continuous cycle.

[0030] The eccentric pivot 39 is provided, at its free end, with two rolling bearings 40, 41, which are adapted to engage, with an appropriate tolerance and without play, respectively within the first opening 37a of the first rectangular body 37 and within the second opening 38a of the second rectangular body 38.

[0031] The box 36 is associated with four pumping chambers 42, 43, 44, 45, which are angularly equidistant at right angles to each other and inside which the four membranes 14, 15, 16, 17 are fitted which are closed by four respective heads 46, 47, 48, 49, which are connected to the four branches 10, 11, 12, 13. The four actuation axes 21, 22, 23, 24 of the membranes 14, 15, 16, 17 protrude partially from the box 36 through four respective through holes 50, 51, 52, 53, at which four respective sliding bushes 54, 55, 56, 57 are fitted; advantageously, there are no mechanical seals, since the level of the oil contained in the bottom of the box 36 is lower than the level of the pair of lowest sliding bushes 55, 57.

[0032] The pump 1 comprises a forced lubrication system, generally designated by the reference numeral 58, for the actuation crank system 19. The lubrication system 58 comprises a gear or vane pump 59, which is connected to the output shaft 20 of the gearmotor assembly 18 at the top thereof, i.e., at the opposite end with respect to the eccentric pivot 39. The gear pump or vane pump 59 is associated with an intake tube 60, which is connected to a first coupling 61, which is arranged substantially at the base of the box 36, and to a delivery tube 62, which is connected to a second coupling 63, which is connected to the eccentric pivot 39 by way of an appropriately provided channel 64. The lubrication system 58 is conveniently suitable to convey a preset flow-rate of oil along the channel 64, said oil being drawn from the bottom of the box 36, onto the eccentric pivot 39 and accordingly, substantially by dripping, onto the first rectangular body 37 and the second rectangular body 38, so as to keep them constantly lubricated and cooled.

[0033] The pump comprises advantageously a flow reversal element 65, which is associated with a first tubular portion 66 which forms a first port 67 for connection to external tanks or sources, and with a second tubular portion 68, which forms a second port 69, also for connection to external tanks or sources, and is provided with a manual selection lever 70; the first port 67 and the second port 69 are mutually opposite. The flow reversal element 65 allows to selectively connect the intake duct 6 and the delivery duct 8 to the first port 67 or to the second port 69.

[0034] Advantageously, there are two expansion vessels 71 and 72, which are adapted to compensate and dampen any oscillations within the liquid in the tubes for connection between the external tanks or sources and the pump, which are connected respectively to the first tubular portion 66 and to the second tubular portion 68 by means of couplings 73 for example of the ring, tri-clamp, clamp type or the like.

[0035] The operation of the pump according to the invention is as follows. The source of liquid to be drawn is connected to the first port 67 or to the second port 69, depending on the position of the reversal element 65; an external duct is connected to the other port and conveys the fluid toward the destination tank, whichever it may be.

[0036] By starting the gearmotor assembly 18, at the rotation rate set according to the chosen flow-rate, the output shaft 20 drives the eccentric pivot 39, which in turn imparts an alternating translational motion to the first rectangular body 37 and to the second rectangular body 38 and consequently to the pairs of actuation axes 21,

22 and 23, 24. Said axes actuate in succession, one after the other, the membranes 14, 15, 16, 17, which in a continuous cycle aspirate the liquid that flows along the intake duct 6 and along the branches 10, 11, 12, 13 through the intake valve 29 and the delivery valve 30. The liquid aspirated by the membranes 14, 15, 16, 17 gathers in the delivery duct 8 and from there is conveyed to the destination tank. Any oscillations within the liquid in the tubes for connection between the external tanks or sources and the pump are dampened and cushioned in the expansion vessels 71 and 72. In greater detail, the timing of the rectangular bodies 37, 38 is adjusted so that when one membrane is at the end of the intake step, the diametrically opposite membrane is at the end of the delivery step, while the remaining two are respectively halfway through the intake step and halfway through the delivery step.

[0037] It has thus been shown that the invention achieves the intended aim and objects.

[0038] The invention thus conceived is susceptible of numerous modifications and variations, all of which are within the scope of the appended claims.

[0039] The pump according to the invention can also have more than four membranes; for example, there can be six membranes associated with three rectangular bodies whose respective actuation axes are mutually angularly equidistant at 60° to each other, or eight membranes, associated with four rectangular bodies, with the respective actuation axes arranged so as to be angularly equidistant at 45° to each other; in these two cases, the box of the actuation crank has a hexagonal and octagonal plan shape, respectively. At the cost of greater constructive complexity, which can also include the need to provide a support with a bearing for the crank system 19 on the bottom of the box 36, even more evident advantages are achieved in terms of pumping uniformity.

[0040] The pump according to the invention can be used usefully also for other fields of use, such as for example depuration (sludges), the supply of filter presses, the pumping of powders which can be fluidized, and other applications in chemical, ceramics, and paper industries.

[0041] All the details may be replaced with other technically equivalent ones.

[0042] In practice, the materials used, as well as the shapes and dimensions, may be any according to requirements without thereby abandoning the scope of the protection of the appended claims.

[0043] Where technical features mentioned in any claim are followed by reference signs, those reference signs have been included for the sole purpose of increasing the intelligibility of the claims and accordingly such reference signs do not have any limiting effect on the interpretation of each element identified by way of example by such reference signs.

Claims

1. A multiple membrane pump for food liquids and the like, **characterized in that** it comprises at least one duct (6) for the compensated intake of the liquid, which is closed on itself in a loop and is provided with at least one intake port (7), at least one duct (8) for the compensated delivery of the liquid, which is closed on itself in a loop and is provided with at least one delivery port (9), at least four branches (10, 11, 12, 13), which provide a unidirectional connection between said intake duct (6) and said delivery duct (8) and are associated respectively with four liquid pumping membranes (14, 15, 16, 17), a gearmotor assembly (18), which is associated with a crank system (19) for actuating said membranes (14, 15, 16, 17) which is adapted to convert the rotary motion of an output shaft (20) of said gearmotor assembly (18) into a reciprocating motion, adjusted with an appropriate timing between two mutually opposite intake and delivery stroke limit positions of each of the actuation axes (21, 22, 23, 24) of said membranes (14, 15, 16, 17).

2. The pump according to claim 1, **characterized in that** said actuation axes (21, 22, 23, 24) of said membranes (14, 15, 16, 17) are arranged at right angles to each other.

3. The pump according to one or more of the preceding claims, **characterized in that** said delivery duct (8) is arranged concentrically above said intake duct (6) and is supported by said four branches (10, 11, 12, 13).

4. The pump according to one or more of the preceding claims, **characterized in that** said gearmotor assembly (18) is mounted so that said output shaft (20) is vertical, along a direction which is substantially concentric with respect to said intake duct (6) and said delivery duct (8).

5. The pump according to one or more of the preceding claims, **characterized in that** said gearmotor assembly (18) is of the type actuated by means of an electric motor (25) which is controlled by an electronic frequency inverter.

6. The pump according to one or more of claims 1 to 4, **characterized in that** said gearmotor assembly (18) is of the type actuated by means of a hydraulic motor.

7. The pump according to one or more of claims 1 to 4, **characterized in that** said gearmotor assembly (18) is of the type actuated by means of a pneumatic motor.

8. The pump according to one or more of claims 1 to 4, **characterized in that** said gearmotor assembly (18) is of the type actuated by means of an internal-combustion engine.

9. The pump according to one or more of claims 1 to 4, **characterized in that** said gearmotor assembly (18) is of the type actuated by means of a power take-off or cardan shaft.

10. The pump according to one or more of the preceding claims, **characterized in that** each of said branches (10, 11, 12, 13) is substantially shaped like a letter T tilted on its side and forms at least one first end (26) for connection to said intake duct (6), at least one second end (27) for connection to said delivery duct (8), and at least one third end (28) for connection to the membrane (14, 15, 16, 17).

11. The pump according to one or more of the preceding claims, **characterized in that** each of said branches (10, 11, 12, 13) comprises at least one intake valve (29) and at least one delivery valve (30), which are arranged respectively at said first end (26) and at said second end (27).

12. The pump according to one or more of the preceding claims, **characterized in that** said intake valve (29) and said delivery valve (30) are of the type with a ball-shaped flow control element (31), also known as ball check valve.

13. The pump according to one or more of the preceding claims, **characterized in that** each of said intake and delivery valves (29, 30) comprises a tubular segment (32), which is affected by a channel (33) for the passage of the fluid which is arranged hermetically above an interchangeable and reversible seat (34) against which said ball-shaped flow control element (31) abuts by gravity, said channel (33) forming linear guides provided with a stop element (34a) and simple linear guides (34b), which are arranged alternately at right angles to each other so as to force said ball-shaped flow control element (31) to perform a rectilinear movement from an inactive position on said seat (34) to a fully raised position, set by the stop tooth (34c) of each of said guides (34a), so as to achieve rapid closure by gravity of said ball-shaped flow control element (31) on said seat (34) and so as to use said intake and delivery valves (29, 30) also at high pumping rates.

14. The pump according to one or more of the preceding claims, **characterized in that** said channel (33) has a transverse cross-section which forms four peripheral sectors (35), which are adapted to give said intake and delivery valves (29, 30) minimal resistance to the flow of liquid and the free flow of any solid bodies suspended in the pumped liquid without said bodies being crushed by said ball-shaped flow control element (31) against the internal wall of said channel (33), with a self-cleaning effect of said channel.

15. The pump according to one or more of claims 1 to 11, **characterized in that** said intake and delivery valves (29, 30) are of the flap check type.

16. The pump according to one or more of claims 1 to 11, **characterized in that** said intake and delivery valves (29, 30) are of the duck bill check type.

17. The pump according to one or more of claims 1 to 11, **characterized in that** said intake and delivery valves (29, 30) are of the cone check type.

18. The pump according to one or more of the preceding claims, **characterized in that** said crank system (19) for the actuation of said membranes (14, 15, 16, 17) comprises at least one box (36) within which a first rectangular body (37) and a second rectangular body (38) are accommodated, said first rectangular body (37) being affected by a first rectangular opening (37a), said second rectangular body (38) being affected by a second rectangular opening (38a), said bodies crossing each other at right angles to each other, one above the other, each being rigidly coupled, in pairs, at the respective short sides, to said actuation axes (21, 22, 23, 24) of said mutually opposite membranes (14, 15, 16, 17), said actuation crank system (19) further comprising at least one eccentric pivot (39), which is rigidly coupled to said output shaft (20) of said gearmotor assembly (18), inserted within said first opening (37a) and said second opening (38a), the rotation of said eccentric pivot (39) about the axis of said output shaft (20) being adapted to produce the alternating translational motion of said actuation axes (21, 22, 23, 24) of said membranes (14, 15, 16, 17) one after the other in succession and in a continuous cycle.

19. The pump according to one or more of the preceding claims, **characterized in that** said eccentric pivot (39) is provided, at its free end, with rolling bearings (40, 41), which are adapted to engage within said first opening (37a) and said second opening (38a).

20. The pump according to one or more of the preceding claims, **characterized in that** said box (36) is associated with four pumping chambers (42, 43, 44, 45), which are mutually angularly equidistant at right angles and within which said four membranes (14, 15, 16, 17) are accommodated, said membranes being closed by four respective heads (46, 47, 48, 49), which are connected to said four branches (10, 11, 12, 13).

21. The pump according to one or more of the preceding claims, **characterized in that** said four actuation axes (21, 22, 23, 24) of said membranes (14, 15, 16, 17), protrude from said box (36) through four respective through holes (50, 51, 52, 53) at which four respective sliding bushes (54, 55, 56, 57) are fitted which are arranged above the level of the oil contained on the bottom of said box (36).

22. The pump according to one or more of the preceding claims, **characterized in that** each of said membranes (14, 15, 16, 17) is clamped between pairs of plates (P1, P2), which facilitate their rolling during the movement of said actuation axes (21, 22, 23, 24).

23. The pump according to one or more of the preceding claims, **characterized in that** said membranes (14, 15, 16, 17) are six and are associated with three rectangular bodies (37, 38), their respective actuation axes being mutually angularly equidistant at 60° to each other.

24. The pump according to one or more of the preceding claims, **characterized in that** said membranes (14, 15, 16, 17) are eight and are associated with four rectangular bodies (37, 38), their respective actuation axes being mutually angularly equidistant at 45° to each other.

25. The pump according to one or more of the preceding claims, **characterized in that** it comprises at least one system (58) for the forced lubrication of said actuation crank system (19), said lubrication system (58) comprising at least one gear pump or vane pump (59), which is actuated by said output shaft (20) of said gearmotor assembly (18), which is associated with at least one intake tube (60) which is connected to said box (36) and to at least one delivery tube (62) which is connected to said eccentric pivot (39), said delivery tube (62) being adapted to convey a preset flow-rate of oil along said eccentric pivot (39) and, substantially by dripping, onto said first rectangular body (37) and onto said second rectangular body (38).

26. The pump according to one or more of the preceding claims, **characterized in that** it comprises at least one flow reversal element (65), which is connected to at least one first port (67) and at least one second port (69) for connection to external tanks or sources, said reversal system (65) being adapted to connect selectively said intake duct (6) and said delivery duct (8) to said first port (67) or to said second port (69).

27. The pump according to one or more of the preceding claims, **characterized in that** it comprises at least one pair of expansion vessels (71, 72), which are adapted to compensate and dampen any oscillations within the liquid in the tubes for connection between the external tanks or sources and the pump, which are connected respectively to a first tubular portion (66) which leads to said first port (67) and to a second tubular portion (68), which leads to said second port (69).

28. The pump according to one or more of the preceding claims, **characterized in that** it comprises a supporting footing (2), which is constituted by a substantially square frame (3) provided with cross-members (4) which cross at the center and to which the lower face of said box (36) is fixed, said frame (3) being provided with wheels (5) which allow the movement of the pump, four vibration-damping elements (5a) being interposed between said cross-members (4) and said square frame (3) and damping and limiting the transmission of vibrations to the ground.

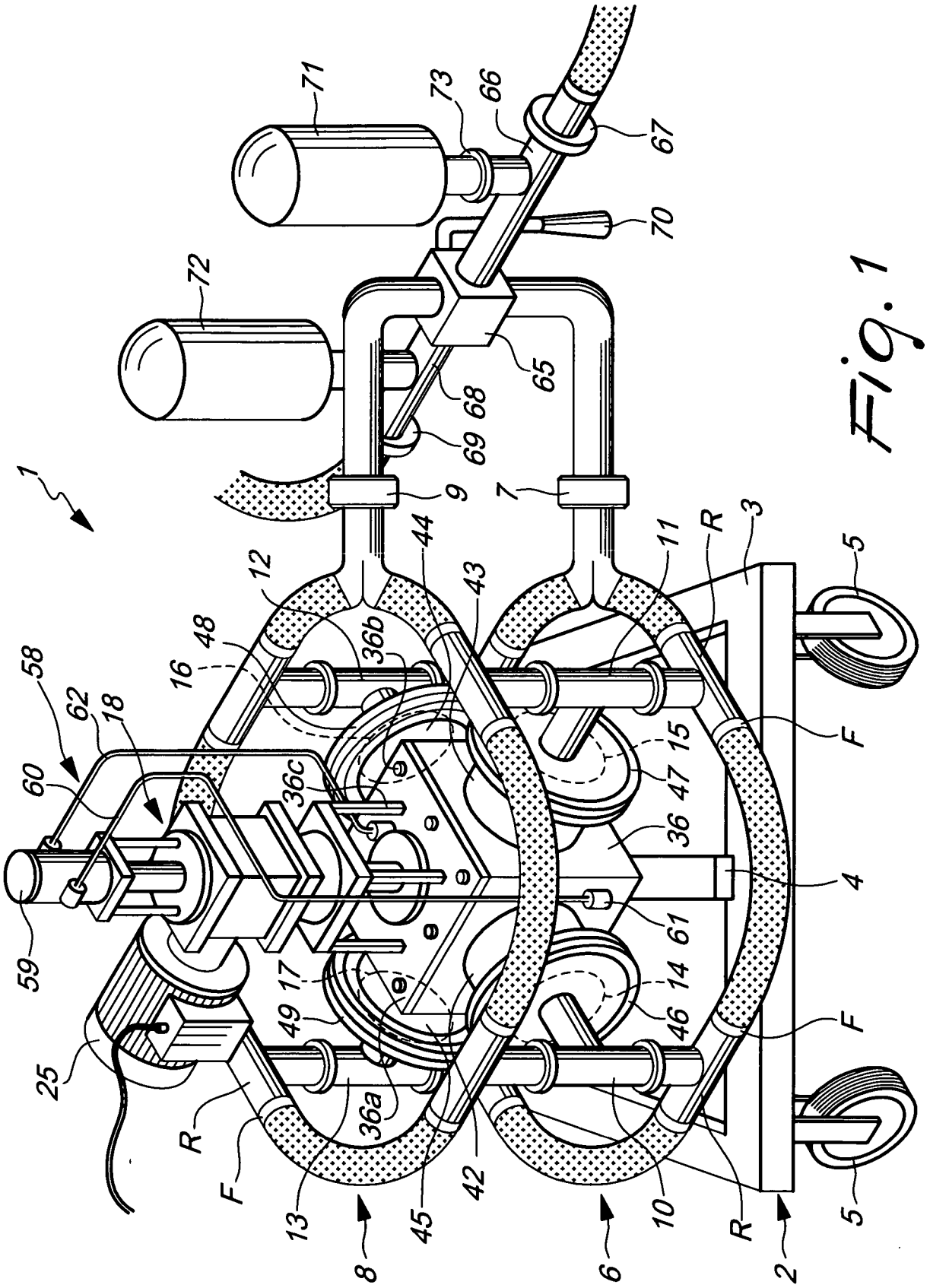
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
25
36
36a
36b
36c
42
43
44
45
46
47
48
49
58
59
60
61
62
65
66
67
68
69
70
71
72
73
F
R

Fig. 1

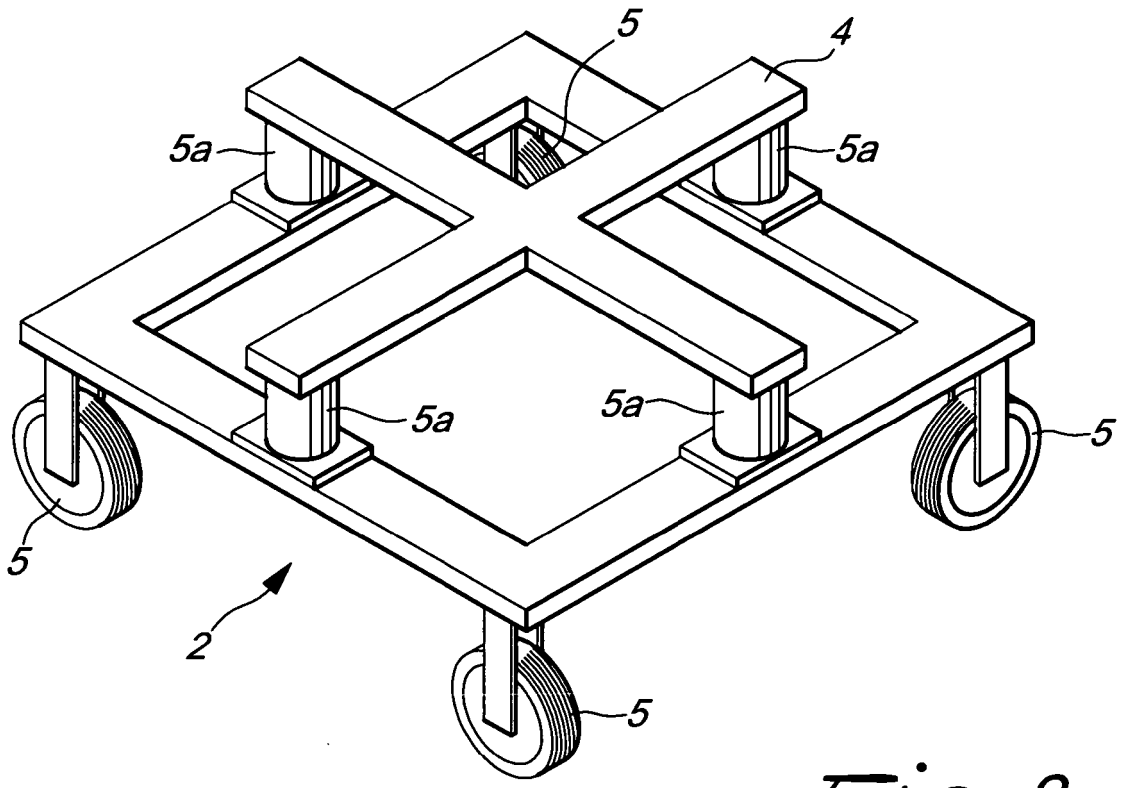

Fig. 2

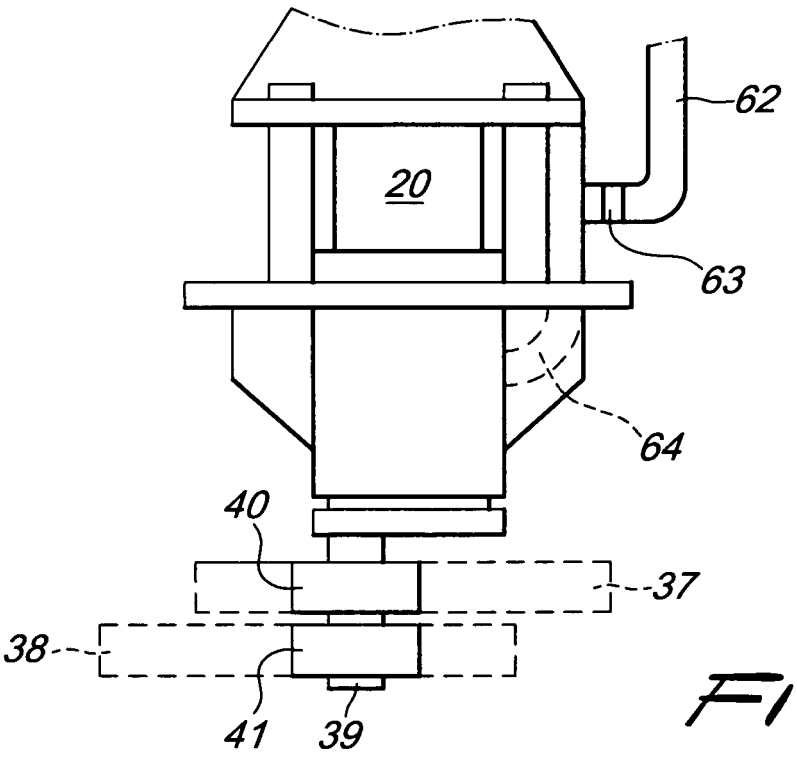

Fig. 6

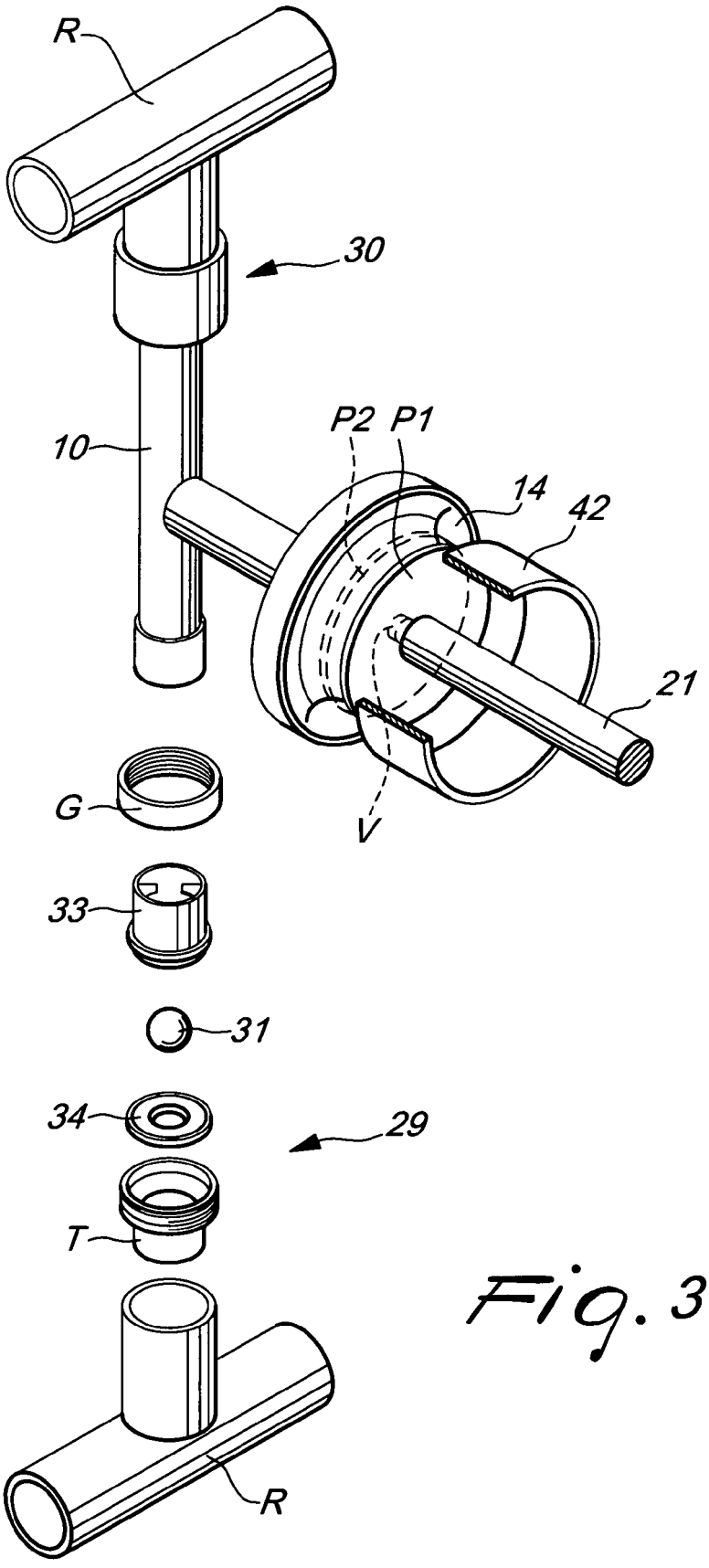

Fig. 3

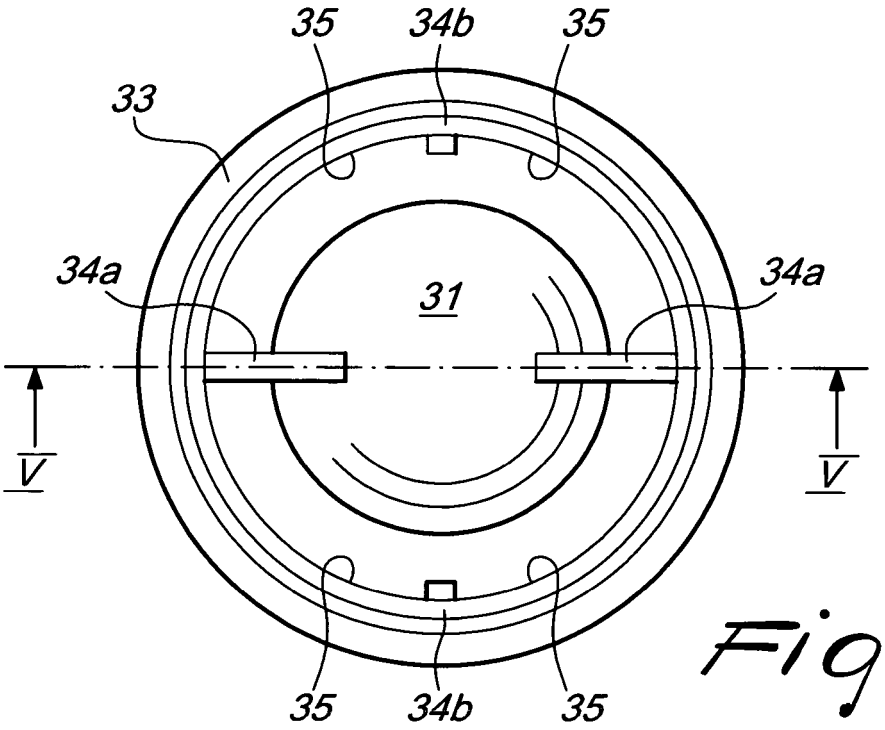
35
34b
35
33
34a
31
34a
V
V
35
34b
35

Fig. 4

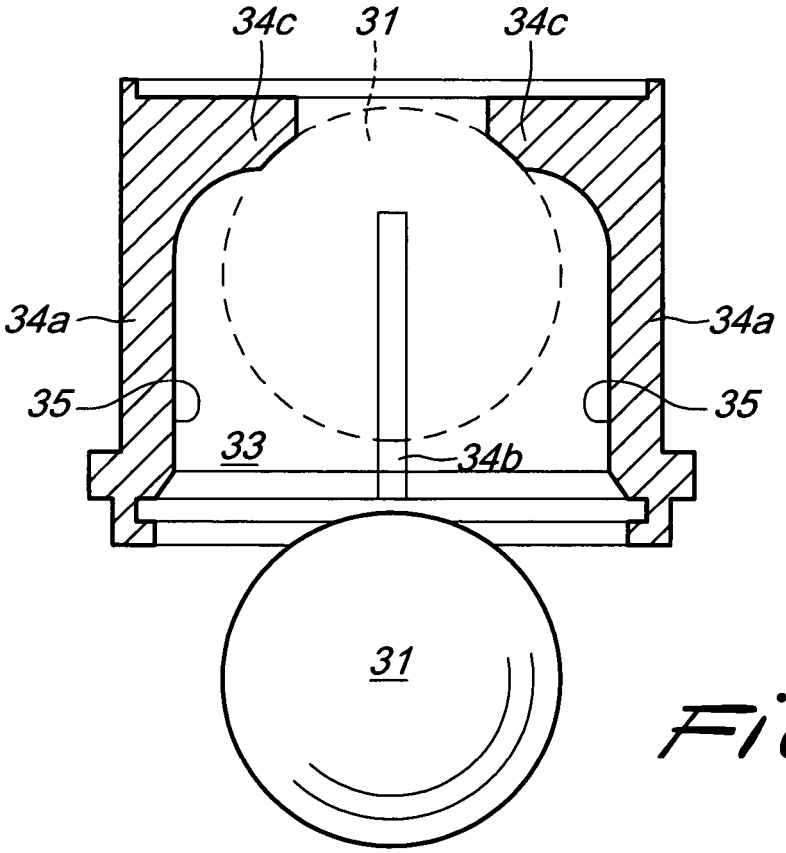
34c
31
34c
34a
34a
35
35
33
34b
31

Fig. 5

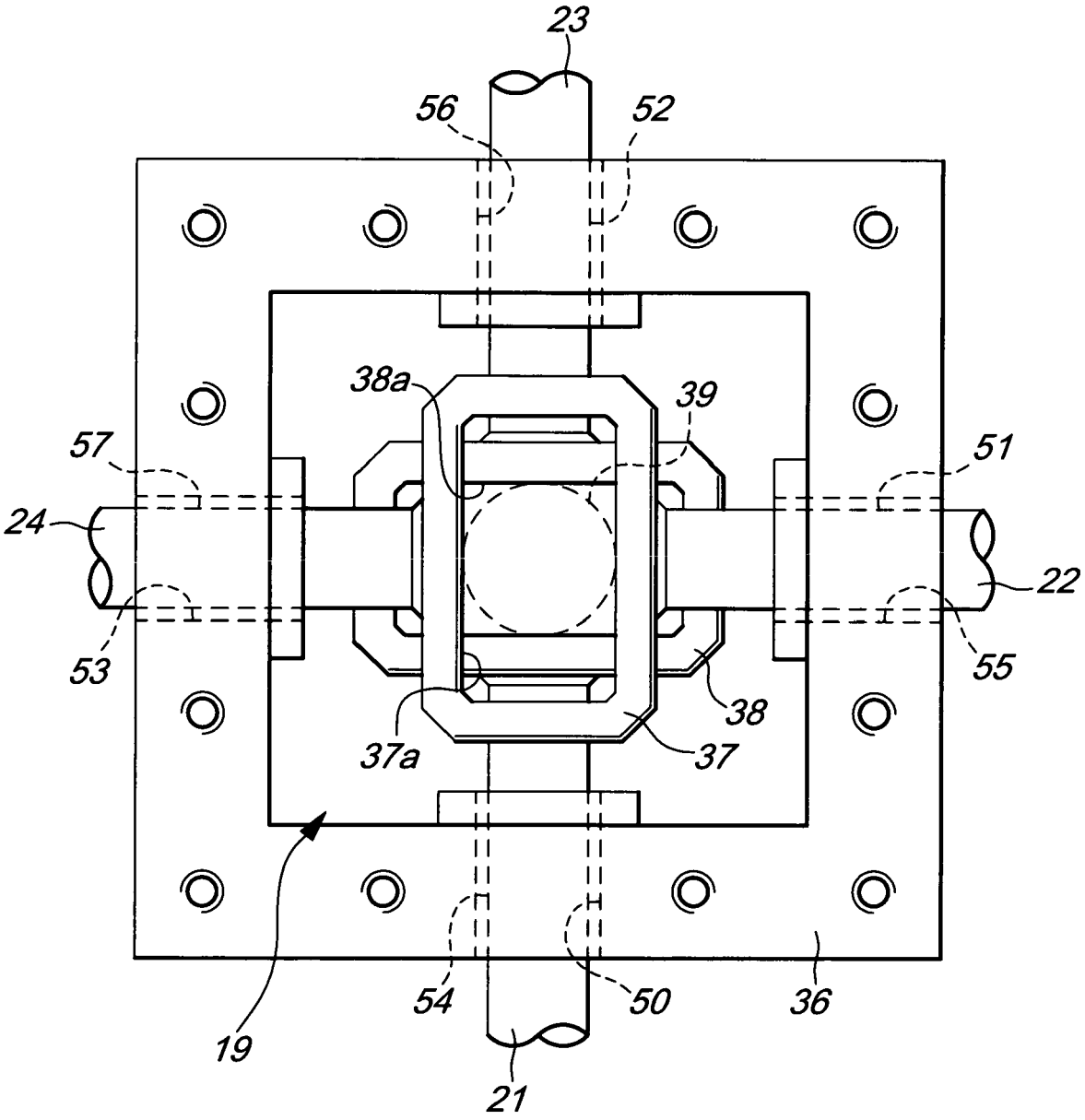

Fig. 7

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 06 42 5858

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	DE 20 59 903 A1 (MESSERSCHMITT BOELKOW BLOHM) 15 June 1972 (1972-06-15) * page 1, paragraph 1 - page 2, paragraph 2 * * page 2, line 33 - page 3, line 3 * * page 4, line 16 - line 19 * * page 4, line 34 - page 5, line 28 * * figures 1,3,4 *	1,5,11	INV. F04B11/00 F04B17/06 F04B23/06 F04B43/00
A	WO 2006/122268 A (PENDOTECH [US]; FUREY JAMES FRANCIS [US]) 16 November 2006 (2006-11-16) * paragraphs [0006], [0007] * * page 3, line 16 - line 17 * * paragraphs [0010], [0021], [0022], [0034], [0035] * * figures 1,2 *	1,5, 10-12, 15,16	
A	US 2 951 450 A (FISHER JOHN C) 6 September 1960 (1960-09-06) * column 1, line 37 - line 50 * * column 1, line 68 - column 2, line 25 * * column 2, line 68 - column 3, line 3 * * column 9, line 3 - line 36 * * column 9, line 45 - line 61 * * figure 4 *	1,5,10, 11,27	TECHNICAL FIELDS SEARCHED (IPC) F04B
A	DE 14 28 007 A1 (BECKER ERICH) 5 December 1968 (1968-12-05) * page 3, line 8 - line 20 * * page 5, line 27 - page 6, line 17 * * figures 4,5 *	1,2,4	
A	EP 0 976 925 A2 (MITSUBISHI ELECTRIC CORP [JP]) 2 February 2000 (2000-02-02) * column 1, line 31 - line 54 * * column 2, line 14 - line 32 * * column 3, line 21 - line 33 * * figure 1 *	1,11,27	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	30 May 2007	BERMEJO GUILLEN, I

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 06 42 5858

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

30-05-2007

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE 2059903 A1	15-06-1972	NONE	
WO 2006122268 A	16-11-2006	NONE	
US 2951450 A	06-09-1960	NONE	
DE 1428007 A1	05-12-1968	NONE	
EP 0976925 A2	02-02-2000	DE 69916720 D1	03-06-2004
		DE 69916720 T2	31-03-2005
		JP 2000045906 A	15-02-2000
		US 6095774 A	01-08-2000

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82