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(54) **Single-stage liquid ring vacuum pump with suction and discharge manifold integrated in the central body.**

(57) A single-stage liquid-ring vacuum pump having a double axial inlet with flat-distribution plates comprises a central body (2), an impeller (5) eccentrically housed in a chamber (4) delimited by the central body (2), a flanged suction manifold (15) in fluid communication with two suction openings (8) located at opposite ends of the central body (2), a flanged exhaust manifold (17) in fluid communication with two exhaust openings (9) located at opposite ends of the central body (2). The flanged suction manifold (15), flanged exhaust manifold (17) and feed manifold are integrated into the central body (2), so as to reduce weights and bulkiness as compared with the pumps of the known art, the pump performance being the same.

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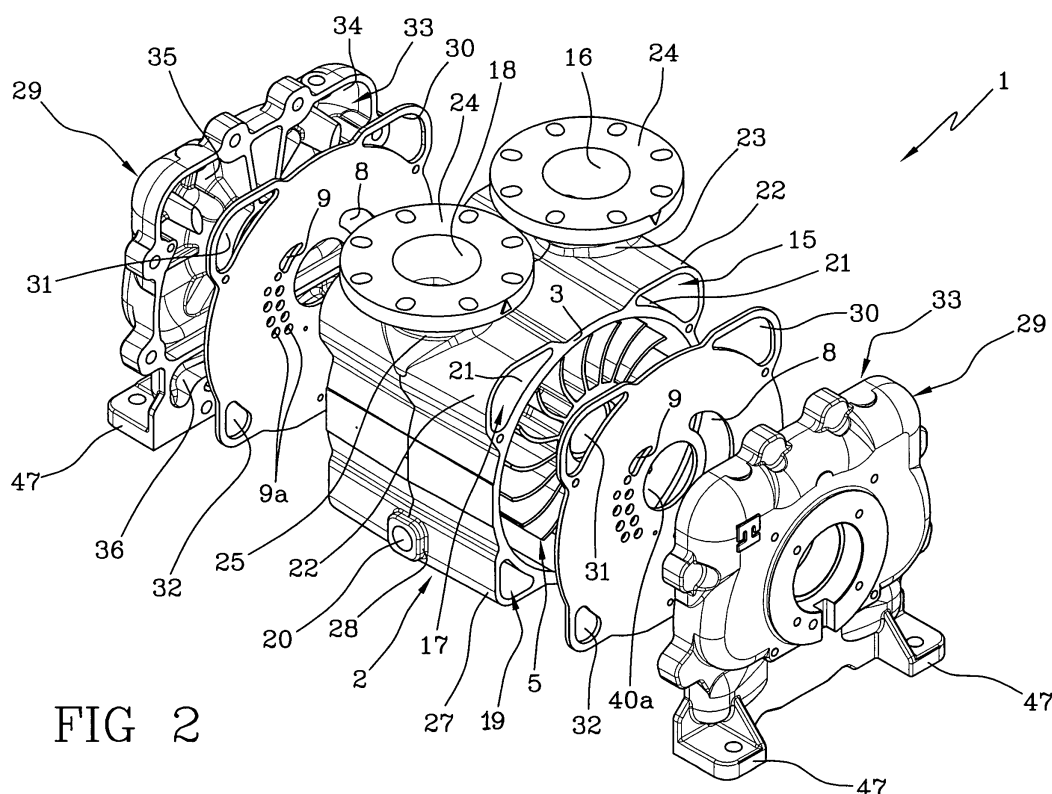


FIG 2

Description

[0001] The present invention relates to a single-stage liquid-ring vacuum pump having a double axial inlet with flat-distribution plates.

[0002] The present invention is particularly adapted for use in suction of aeriform substances also containing small solid particles or wet aeriform substances that, by effect of the compression following suction, cause water condensation, which is noxious to other types of pumps.

[0003] Pumps of this type are used in processes involving deaeration, impregnation, boiling, vacuum condensation, distillation, drying, sterilisation, filtration and solvent recovery.

[0004] By way of example, these pumps are therefore used in the sector concerning processing of plastic materials for example, where removal of the humidity that otherwise would be dangerous is required, or in all sectors in which it is necessary to create the vacuum, such as the pharmaceutical, chemical, petrochemical sectors, chemical or food distilleries, refineries, oil mills, dairies, etc.

[0005] Single-stage liquid-ring vacuum pumps having a double axial inlet generally comprise a central body defined in the specific technical field as spacer. The spacer internally confines a cylindrical chamber having a regular or irregular circular section with a longitudinal extension axis that, when the pump is installed, is oriented in a horizontal direction. Housed in the chamber is an impeller fitted on a shaft extending parallel to the longitudinal extension axis of the chamber and spaced apart therefrom. The impeller is therefore mounted eccentrically in the chamber. Installed on each of the opposite axial ends of the spacer is a cover closing the chamber and having passages for admission and exhaust of the fluid to be pumped and of a working liquid. In particular, each of the two covers internally has a first compartment open towards a first region of the chamber through a suction opening formed in a head wall delimiting the chamber. The first compartment also communicates with a suction manifold through a flanged body mounted on the cover itself. A second compartment opens on a second region of the chamber through an exhaust or pressurized opening formed in a head wall delimiting the chamber, which exhaust opening preferably has smaller sizes than the feeding opening. The second compartment further communicates with an exhaust manifold through a flanged exhaust or pressurized body, mounted on the cover too. The flanged suction bodies of the two covers are mutually connected by said suction manifold which is defined by a pipe disposed above the spacer and preferably running parallel to the longitudinal axis of the chamber. At an intermediate portion of the suction manifold there is a suction inlet designed to be connected to the environment from which the fluid is to be sucked.

[0006] The flanged exhaust bodies of the two covers are mutually connected by said exhaust manifold which is defined by a pipe disposed above the spacer and pref-

erably running parallel to the longitudinal axis of the chamber. At an intermediate portion of the exhaust manifold there is an exhaust or pressurized outlet designed to be connected to the environment into which the sucked fluid is to be introduced.

[0007] Each of the two covers is further provided with a third compartment that is open towards the chamber and communicates with a filling inlet for the working liquid which is formed in a head wall delimiting the chamber. The feeding inlet is defined by an attachment element mounted on the cover itself and designed to be coupled, through suitable pipes, with a feeding source for supply of said working liquid.

[0008] In particular the working-liquid feeding system contemplates use of pipe fittings and connecting pipes between each of the individual feed inlets present on the covers and the main element for attachment to the plant with, as a result, further complexity for installation of the pump before use.

[0009] The impeller while being only one, is divided into two axial portions working in parallel.

[0010] The fluid sucked by the suction inlet is shared between the two flanged suction bodies and enters the cylindrical chamber through each of the suction openings present on the covers. At each of the two axial portions of the impeller, the fluid is enclosed between two successive vanes and a ring defined by the working liquid that, by effect of the centrifugal force, lies close to the cylindrical side wall of said chamber. The progressive volume variation created between the two vanes and the liquid ring, by virtue of the eccentric rotation of the impeller relative to the spacer and the liquid ring, first creates a fluid expansion and, subsequently, a fluid compression until said fluid is ejected through the exhaust openings. The ejected fluid is then conveyed through the manifold into the single exhaust outlet.

[0011] However, the single-stage liquid-ring pumps having a double axial inlet with flat-distribution plates of known type which have been briefly described above have many limits and drawbacks.

[0012] In particular, the Applicant has perceived that the bulkiness and weight of the pumps of known type should be reduced. In fact, the vertical bulkiness of known pumps is greatly affected by the presence of the suction and exhaust manifolds that must be mounted on the pump itself.

[0013] Furthermore, also the presence of four flanges that are required for connection of the two manifolds to the pump adversely affects the bulkiness and weight of the covers, and therefore the bulkiness and overall weight of the pump itself because the flanged feeding inlets and exhaust outlets are positioned on the covers, and the flange size is fixed and strictly linked to the flow rate of the fluid to be treated. Under this situation, the technical task underlying the present invention consists in conceiving a single-stage liquid-ring vacuum pump having a double axial inlet with flat-distribution plates that is capable of substantially obviating the mentioned draw-

backs.

[0014] In particular, it is an aim of the present invention to propose a single-stage liquid-ring vacuum pump having a double axial inlet with flat-distribution plates that is able to reduce the overall bulkiness and the pump weight and to optimise the suction and exhaust fluid mechanics, the supplied performance being the same.

[0015] Within the scope of this technical task, it is an important aim of the invention to conceive a single-stage liquid-ring vacuum pump having a double axial inlet with flat-distribution plates that can be more easily transported and installed.

[0016] The technical task mentioned and the aims specified are substantially achieved by a single-stage liquid-ring vacuum pump having a double axial inlet with flat-distribution plates that is characterised in that it comprises one or more of the technical solutions claimed in the appended claims.

[0017] The description of a preferred but not exclusive embodiment of a single-stage liquid-ring vacuum pump having a double axial inlet with flat-distribution plates in accordance with the invention is now given by way of non-limiting example and illustrated in the accompanying drawings, in which:

- Fig. 1 is an overall perspective view of a single-stage liquid-ring vacuum pump having a double axial inlet with flat-distribution plates in accordance with the invention;
- Fig. 2 shows an exploded view of the pump seen in Fig. 1;
- Fig. 3 is a front view of the pump in Fig. 1;
- Fig. 4 is a section view taken along line IV-IV in Fig. 3;
- Fig. 5 is a section view taken along line V-V in Fig. 4;
- Fig. 6 is a perspective view of a first element of the pump shown in Fig. 1;
- Fig. 7 is a perspective view of a second element of the pump seen in Fig. 1; and
- Fig. 8 is a front view of a third element of the pump seen in Fig. 1.

[0018] With reference to the drawings, a single-stage liquid-ring vacuum pump having a double axial inlet with flat-distribution plates has been generally identified with reference numeral 1.

[0019] The pump comprises a central body 2 or spacer, better shown in Figs. 2 and 6. The central body 2 has a cylindrical side wall 3 of circular or substantially circular section, internally delimiting a cylindrical or substantially cylindrical chamber 4 having a longitudinal extension axis "X".

[0020] Housed in chamber 4 is an impeller 5 fitted on a shaft 6, said shaft extending parallel to the longitudinal extension axis "X" of the chamber. The longitudinal axis "Y" of the shaft 6 is spaced from the longitudinal extension axis "X" of the chamber (Fig. 4). In known manner, the impeller 5 is therefore eccentrically mounted in chamber 6, as better shown in Fig. 5. One end 6a of the shaft 6

emerges from the pump to enable connection to a motor, not shown.

[0021] Formed at each of the two opposite axial ends 7 of the central body 2, i.e. on opposite faces of the cylinder defined by the body 2 itself, is a suction opening 8 and an exhaust opening 9 (Fig. 2).

[0022] The central body 2 further has an opening 10 (only visible in Fig. 7) at each of said two axial ends 7, said opening being designed to feed a working liquid 11 that will define the liquid ring.

[0023] In the preferred embodiment herein shown, these openings 8, 9, 10 are formed in a plate 12. As shown in Figs. 2 and 4, each of the two plates 12 closes a respective end 7 of the central body 2 and confines chamber 4. In addition, each plate 12 lies close to an edge of the impeller vanes 13 and to an end surface of the impeller hub 5a, so that a work volume for a fluid 14 to be treated is defined between two consecutive vanes 13 and together with the liquid ring.

[0024] Further auxiliary exhaust openings 9a known by themselves and therefore not further described can be present next to the exhaust opening 9, said exhaust opening 9 having smaller sizes than the suction opening 8, as visible in Figs. 2 and 4. The auxiliary exhaust openings 9a are preferably closed by flexible blades or similar elements not shown that under the action exerted by the fluid, open when the pressure overcomes a predetermined threshold.

[0025] Both suction openings 8 are in fluid communication with a suction manifold 15 having a suction inlet 16 adapted to be connected to the environment from which the fluid 14 is to be sucked.

[0026] Both exhaust openings 9 are in fluid communication with an exhaust manifold 17 having an exhaust outlet 18 adapted to be connected to the environment into which the previously sucked fluid 14 is to be introduced.

[0027] The opening 10 designed to feed the working liquid 11 is in fluid communication with a feed manifold 19 having a feeding inlet 20 adapted to be connected to a feeding source not shown, for supply of said liquid 11.

[0028] Advantageously the suction manifold 15 and exhaust manifold 17 are integrated into the central body 2.

[0029] Preferably, the feed manifold 19 too is integrated into the central body 2.

[0030] In more detail, as better shown in Figs. 2, 5 and 6, the suction manifold 15 and exhaust manifold 17 are formed close to the cylindrical side wall 3 of the central body 2 and are preferably located close to an upper portion of the pump 1, considering the installed pump 1 resting on the ground with its longitudinal axis "X" disposed horizontally.

[0031] The two manifolds 15, 17 preferably extend parallel to the longitudinal axis "X" and preferably are symmetric relative to a vertical plane passing through said longitudinal axis "X".

[0032] In the preferred embodiment herein illustrated,

the suction manifold 15 and exhaust manifold 17 are formed of one piece construction, by melting for example, with the central body 2. The manifolds are formed in the thickness of the central body 2 wall.

[0033] The geometric configuration thus taken enables the suction and exhaust fluid mechanics to be optimised because generation of imbalances or disequilibrium between the incoming and outgoing fluids is avoided. Therefore the construction symmetry outlined above gives further advantageous aspects to the pump being the object of the invention.

[0034] Each of the two manifolds 15, 17 is confined by a convex portion 21 of the outer surface of the cylindrical wall 3 and by an arched portion 22 having opposite edges oriented as generatrices of the cylindrical wall 3 and joined to the cylindrical wall 3 itself (Fig. 6). The manifold shape seen in cross section is not however given in a limiting sense. In fact the wall 22 can have different shapes and the outer surface of the cylindrical wall 3 can be such shaped as to give the manifold the most appropriate section.

[0035] At an axially intermediate portion of the suction manifold 15, a suction duct 23 of circular section is present and it preferably extends vertically from said manifold 15 and terminates with the suction inlet 16.

[0036] A flange 24 surrounds the suction inlet 16, is also preferably formed of one piece construction with the suction duct 23 and the suction manifold 15, and is used to connect the pump 1 to the environment from which the fluid 14 is to be drawn.

[0037] Likewise, at an axially intermediate portion of the exhaust manifold 17, an exhaust duct of circular section 25 is present which extends vertically from said manifold 17 and terminates with the exhaust outlet 18.

[0038] The flange 24 too surrounding the exhaust outlet 18 is preferably of one piece construction with the exhaust duct 25 and the exhaust manifold 17 and is used to connect the pump 1 to the environment into which the sucked fluid 14 is to be introduced.

[0039] As shown in Figs. 2 and 6, also the feed manifold 19 for the working liquid 11 is preferably integrated into the central body 2, in the same manner as the manifolds 15, 17.

[0040] This feed manifold 19 is formed at the cylindrical side wall 3 of the central body 2 and is preferably located close to a lower side portion of pump 1.

[0041] In the preferred embodiment herein illustrated, the feed manifold 19 extends parallel to the longitudinal axis "X" of the central body 2 and is of one piece construction, by melting for example, with the central body 2.

[0042] This feed manifold 19 is confined by a convex portion 26 of the outer surface of the cylindrical wall 3 and by an arched wall 27 having opposite edges oriented as generatrices of the cylindrical wall 3 and joined to the cylindrical wall 3 itself (Fig. 6).

[0043] An attachment element 28 is present at an axially intermediate portion of the feed manifold 19 and it extends from said manifold 15 and terminates with the

feeding inlet 20 for supply of the working liquid 11.

[0044] Said attachment element 28 too is preferably formed unitary, by melting for example, with the central body 2.

5 **[0045]** The wall 27 can have different shapes and the outer surface of the cylindrical wall 3 can be such shaped as to give the manifold the most appropriate section.

[0046] To enable passage of fluid 14 from the suction manifold 15 to the suction opening 8 and from the exhaust opening 9 to the exhaust manifold 17, pump 1 comprises a pair of covers 29 each abutting against one of the ends 7 of the central body 2 (Figs. 1 and 2).

10 **[0047]** Each cover 29 is mounted on one of the plates 12, said one plate therefore being interposed between the central body 2 and cover 29 (Fig. 4); in this way the assembly tightness to the fluids is simplified because only a hermetic tightness between the cover 29 and plate 12 and between the plate 12 and central body 2 is required to be ensured. In particular the necessity of seals simultaneously operating on the three parts is avoided, which would make the assembling process more complicated and would impair the overall pump reliability.

20 **[0048]** The two covers 29, two plates 12 and central body 2 are pack-wise closed by means of tie-rods 29a passing through slots formed in the covers 29 themselves (Fig. 1).

25 **[0049]** In addition, as better shown in Figs. 2 and 7, each of the two plates 12 has a first aperture 30 in register with the suction manifold 15 and shaped like the cross section of this manifold 15, a second aperture 31 in register with the exhaust manifold 17 and shaped like the cross section of this manifold 17 and a third aperture 32 in register with the feed manifold 19 and shaped like the cross section of this manifold 19. The first, second and third apertures 30, 31, 32 are formed close to a peripheral edge of plate 12 (Fig. 7).

30 **[0050]** Cover 29 on a concave face 33 thereof facing the respective plate 12 delimits a first compartment 34 (Figs. 2 and 8) that, when pump 1 is assembled, is in fluid communication with the respective suction opening 8 of plate 12 and with the suction manifold 15, a second compartment 35 in fluid communication with the respective exhaust opening 9 of plate 12 and with the exhaust manifold 17 and a third compartment 36 in fluid communication with the feed manifold 19 for the working liquid 11 and with the respective opening 10 in plate 12 to supply said working liquid 11.

35 **[0051]** Said compartments 34, 35, 36 are separated from each other by baffles 37 and delimited by a peripheral edge 38 of cover 29 and an inner edge 39, said inner edge 39 surrounding a central hole 40 designed to receive the shaft 6 (Figs. 8 and 4). Said shaft 6 further passes through a central hole 40a formed in each plate 12.

40 **[0052]** Each plate 12 has opposite flat surfaces, is coupled with one of the ends 7 of the central body 2 on a single plane and is further coupled with the respective cover 29 on a single plane. This flat coupling without cou-

pling locators enables the working operations to be simplified, the production times and costs to be improved and the sealing capacity of the pump to be greatly increased.

[0053] In fact, the peripheral edge 38, inner edge 39 and baffles 37 of cover 29 abut against plate 12 and are coplanar.

[0054] In addition, as shown in Figs. 4 and 6, an end edge 41 of the cylindrical wall 3 and end edges 41 of the arched walls 22, 27 lie in the same plane and abut against plate 12.

[0055] Each plate 12 has the respective suction opening 8 facing chamber 4 and the first compartment 34, the respective exhaust opening 9 facing chamber 4 and the second compartment 35 and the respective opening 10 for supply of the working liquid 11 facing chamber 4 and the third compartment 36.

The first aperture 30 of plate 12 further faces the first compartment 34 and the suction manifold 15, the second aperture 31 faces the second compartment 35 and the exhaust manifold 17 and the third aperture 32 faces the third compartment 36 and the feed manifold 19.

[0056] Referring in particular to Fig. 4, a flange or box 42 carrying a bearing 43 which supports shaft 6 is housed in each of the holes 40 of covers 29.

[0057] Installed between each flange 42 and the shaft 6 is a rotating sealing element 44 known by itself, which lies between the impeller 5 and the respective bearing 43. Possible liquid leakages are collected by means of a pipe fitting 45 positioned in flange 42, said pipe fitting opening into said flange 42 close to the shaft 6 between the sealing element 44 and the respective bearing 43. Interposed between the bearing 43 and pipe fitting 45 is an annular gasket 46.

[0058] The collected liquid 11 can be recycled by connecting said pipe fittings 45 to a circuit for re-introduction of the leaked liquid 11 into the feed manifold 19.

[0059] Each of the two covers 29 has a pair of support feet 47 provided with holes for anchoring the pump 1 to a base.

[0060] Finally, as shown in the preferred embodiment in Fig. 4, the pump 1 comprises an auxiliary flange, or bearing support, 48 located at the end 42a opposite to the end 6a of the shaft 6 to be connected to the motor and housed in the main flange 42 in coaxial relationship.

[0061] The auxiliary flange 48 carries the bearing 43 supporting the shaft 6 and is axially adjustable relative to the main flange 42, so as to easily adjust the axial position of the shaft 6 and impeller 5 in chamber 4.

[0062] In particular, adjusting screws 49, not shown in detail, are used to move the auxiliary flange 48 within the main flange 42 along an axial direction, while locking screws 50 lock the two flanges 48, 42 to the desired position, once adjustment has been carried out.

[0063] The pump in accordance with the invention achieves the intended purposes and offers many advantages.

[0064] In fact, the supplied performance being the

same, the pump of the invention is much more compact and lighter in weight than the pumps of the known art. The weight reduction as compared with pumps of same performance is about 30% and the reduction in volume is about 40%.

[0065] This result has been achieved because said suction and exhaust manifolds with flanged inlets and outlets are integrated into the central body and a single-attachment feed is provided; in addition, due to the presence of said single-attachment feed, the flanges for coupling to the manifolds and the feeding inlet present in covers of known pumps have been eliminated. Consequently, the two covers have been greatly reduced in size and bulkiness which has brought about an important reduction in weights and materials.

[0066] Furthermore, due to the reduced weight and bulkiness, the pump of the invention can be transported and installed in a simpler and quicker manner.

[0067] Installation is also simplified as a result of the fact that the integrated manifolds are already in place and must not be mounted in situ.

[0068] In addition, a feeding integrated with a single attachment element does not require pipe fittings and particular plant connections.

[0069] The compactness in an axial direction of the pump of the invention also enables the shaft length of the impeller to be reduced, as compared with known pumps of same performance. This reduction, in addition to involving a decrease in the shaft weight, also gives rise to a reduction in the shaft bending during rotation and, therefore, to an important vibration reduction.

[0070] The vibration reduction brings about, as a consequence, an increase in the fatigue life of the pump components and a decreased operational noise.

Claims

1. A single-stage liquid-ring vacuum pump having a double axial inlet comprising: a central body (2) being formed with a suction opening (8) and an exhaust opening (9) at each of its two axial ends (7); an impeller (5) eccentrically housed in a chamber (4) delimited by said central body (2); a suction manifold (15) in fluid communication with both the suction openings (8) and having a suction inlet (16) adapted to be connected to an environment from which the fluid (14) is to be sucked; an exhaust manifold (17) in fluid communication with both the exhaust openings (9) and having an exhaust outlet (18) adapted to be connected to an environment into which the sucked fluid (14) is to be discharged; the central body (2) being further provided, at each of said two axial ends (7), with an opening (10) designed to feed a working liquid (11) that will define the liquid ring; **characterised in that** the flanged suction manifold (15) and flanged exhaust manifold (17) are integrated into the central body (2).

2. A pump as claimed in claim 1, wherein the suction manifold (15) and exhaust manifold (17) are formed close to a side wall (3) of the central body (2).
3. A pump as claimed in claim 1, wherein the suction manifold (15) and exhaust manifold (17) are formed of one piece construction with the central body (2).
4. A pump as claimed in claim 1, further comprising a feed manifold (19) for supply of the working liquid, (11) which manifold is in fluid communication with said feed openings (10) and has a feeding inlet (20) adapted to be connected to a feeding source for said working liquid (11); said feed manifold (19) being integrated into the central body (2).
5. A pump as claimed in claim 4, wherein the feed manifold (19) is formed close to a side wall (3) of the central body (2).
6. A pump as claimed in claim 4, wherein the feed manifold (19) is formed of one piece construction with the central body (2).
7. A pump as claimed in claim 4, further comprising a pair of covers (29), each abutting against one end (7) of the central body (2) and defining a first compartment (34) in fluid communication with the respective suction opening (8) and the suction manifold (15), a second compartment (35) in fluid communication with the respective exhaust opening (9) and the exhaust manifold (17) and a third compartment (36) in fluid communication with the feed manifold (19) and a respective opening (10) for supply of said working liquid (11).
8. A pump as claimed in claim 7, further comprising a pair of plates (12), each abutting against one of the ends (7) of the central body (2), being interposed between said central body (2) and the respective cover (29) and confining the first, second and third compartments (34, 35, 36) together with the respective cover (29).
9. A pump as claimed in claim 8, wherein each plate (12) has the respective suction opening (8) facing the chamber (4) and the first compartment (34), the respective exhaust opening (9) facing the chamber (4) and the second compartment (35), and the respective opening (10) for supply of the working liquid (11), facing the chamber (4) and the third compartment (36).
10. A pump as claimed in claim 8, wherein each plate (12) further has a first aperture (30) in register with the first compartment (34) and the suction manifold (15), a second aperture (31) in register with the second compartment (35) and the exhaust manifold (17) and a third aperture (32) in register with the third compartment (36) and the feed manifold (19).
11. A pump as claimed in claim 8, wherein each plate (12) has opposite flat surfaces.
12. A pump as claimed in claim 8, wherein each plate (12) is coupled with one of the ends (7) of the central body (2) in a single plane.
13. A pump as claimed in claim 8, wherein each plate (12) is coupled with the respective cover (29) in a single plane.
14. A pump as claimed in claim 1, further comprising a suction duct (23) extending from the suction manifold (15) and terminating with the suction inlet (16); said suction duct (23) being formed of one piece construction with the central body (2).
15. A pump as claimed in claim 1, further comprising an exhaust duct (25) extending from the exhaust manifold (17) and terminating with the exhaust outlet (18); said exhaust duct (25) being formed of one piece construction with the central body (2).
16. A pump as claimed in claim 4, further comprising a feed attachment element (28) extending from the feed manifold (19) for supply of the working liquid (11) and terminating with the feeding inlet (20); said attachment element (28) being formed of one piece construction with the central body (2).

FIG 1

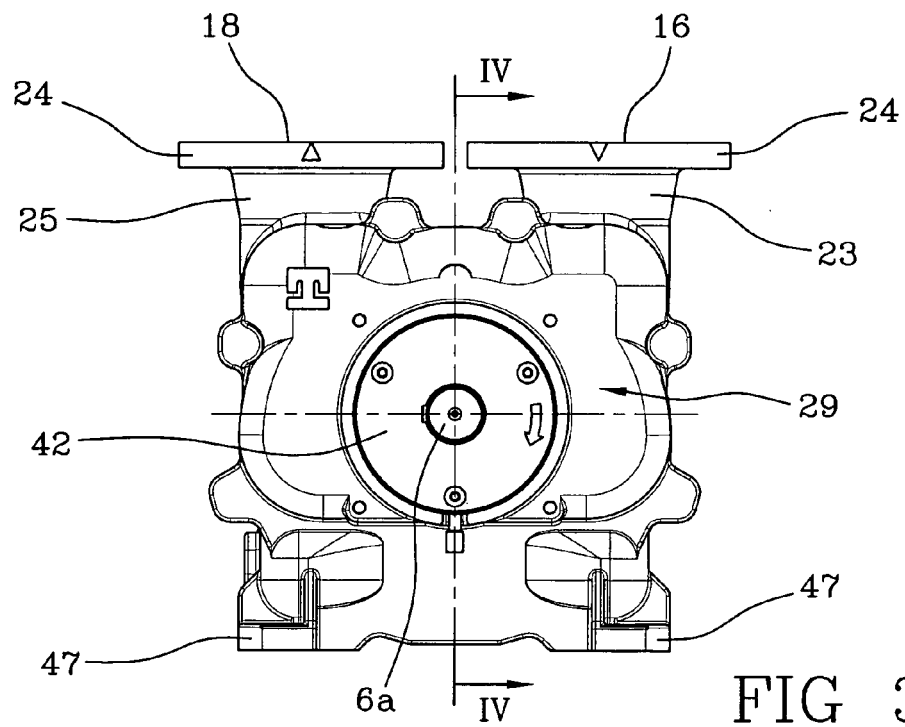
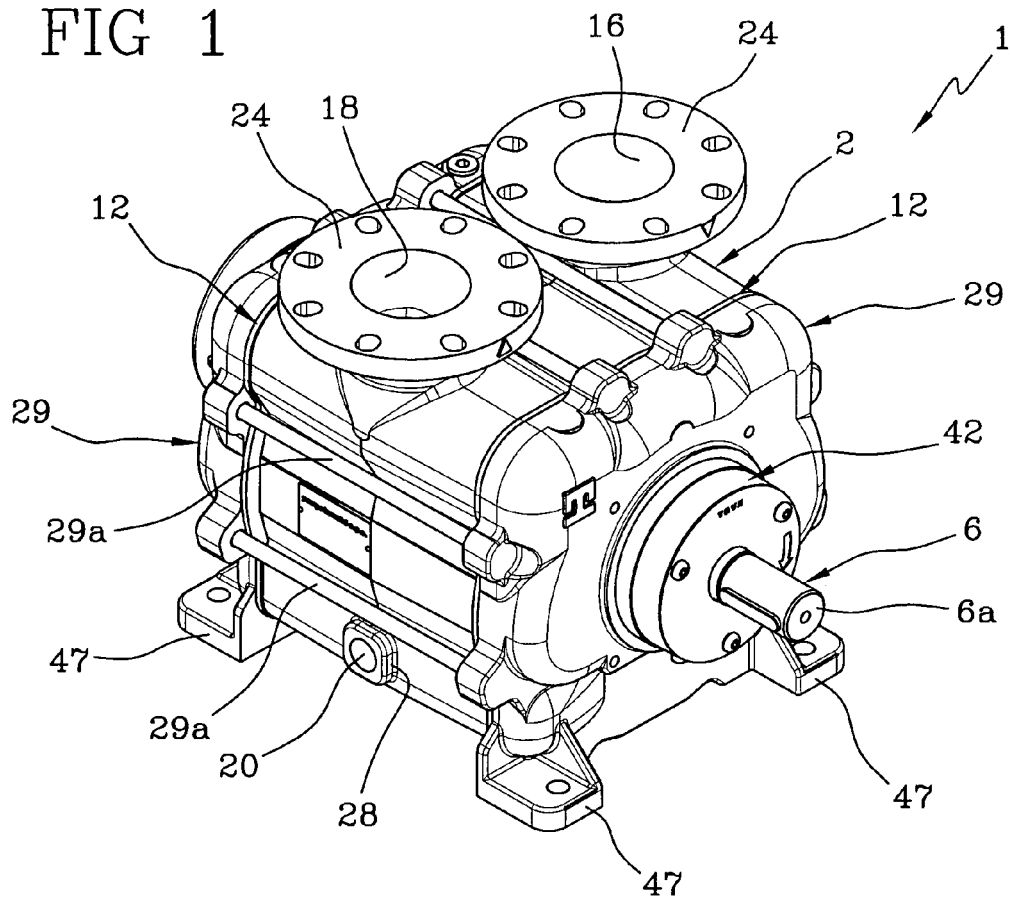


FIG 3

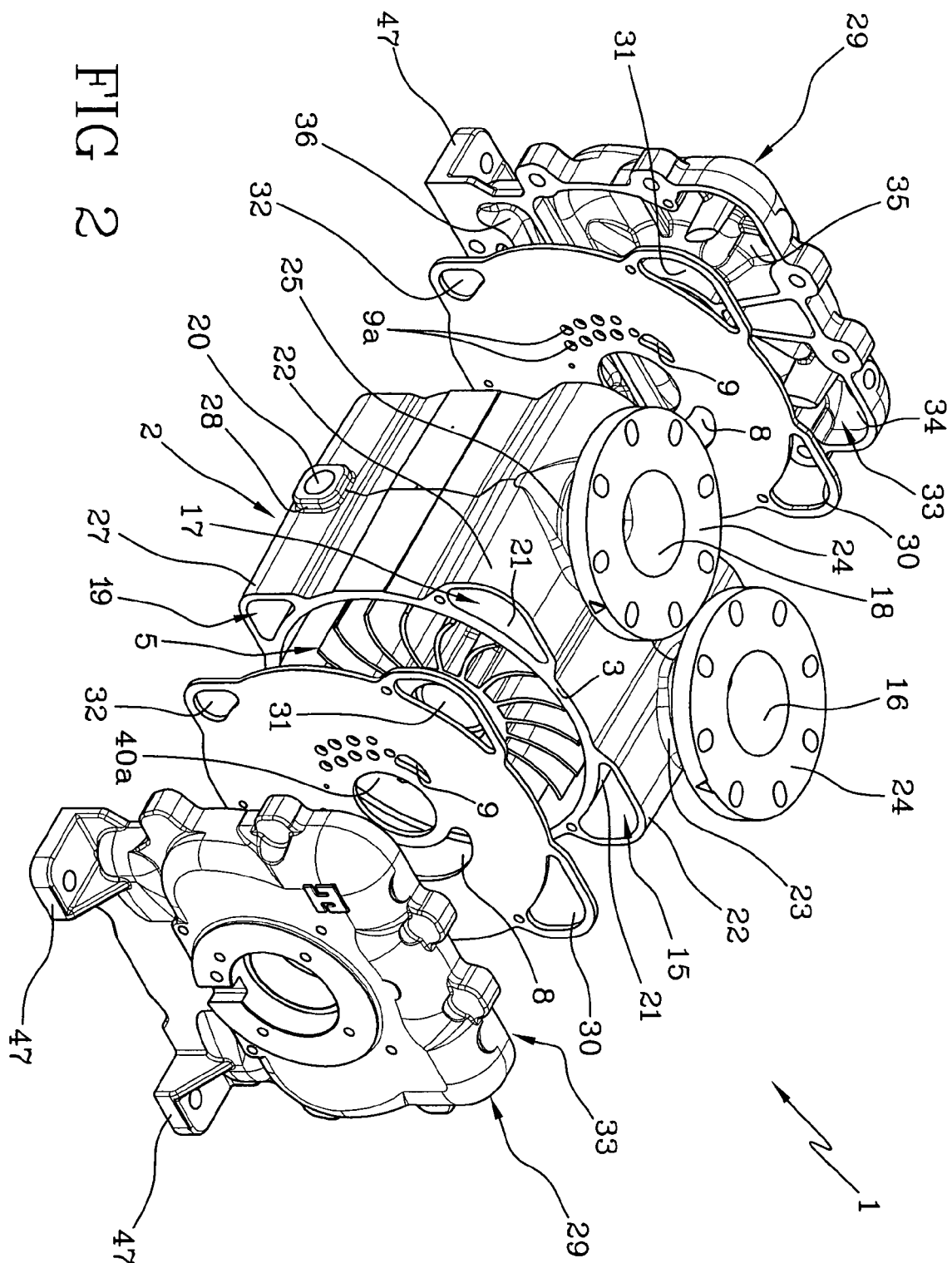


FIG 2

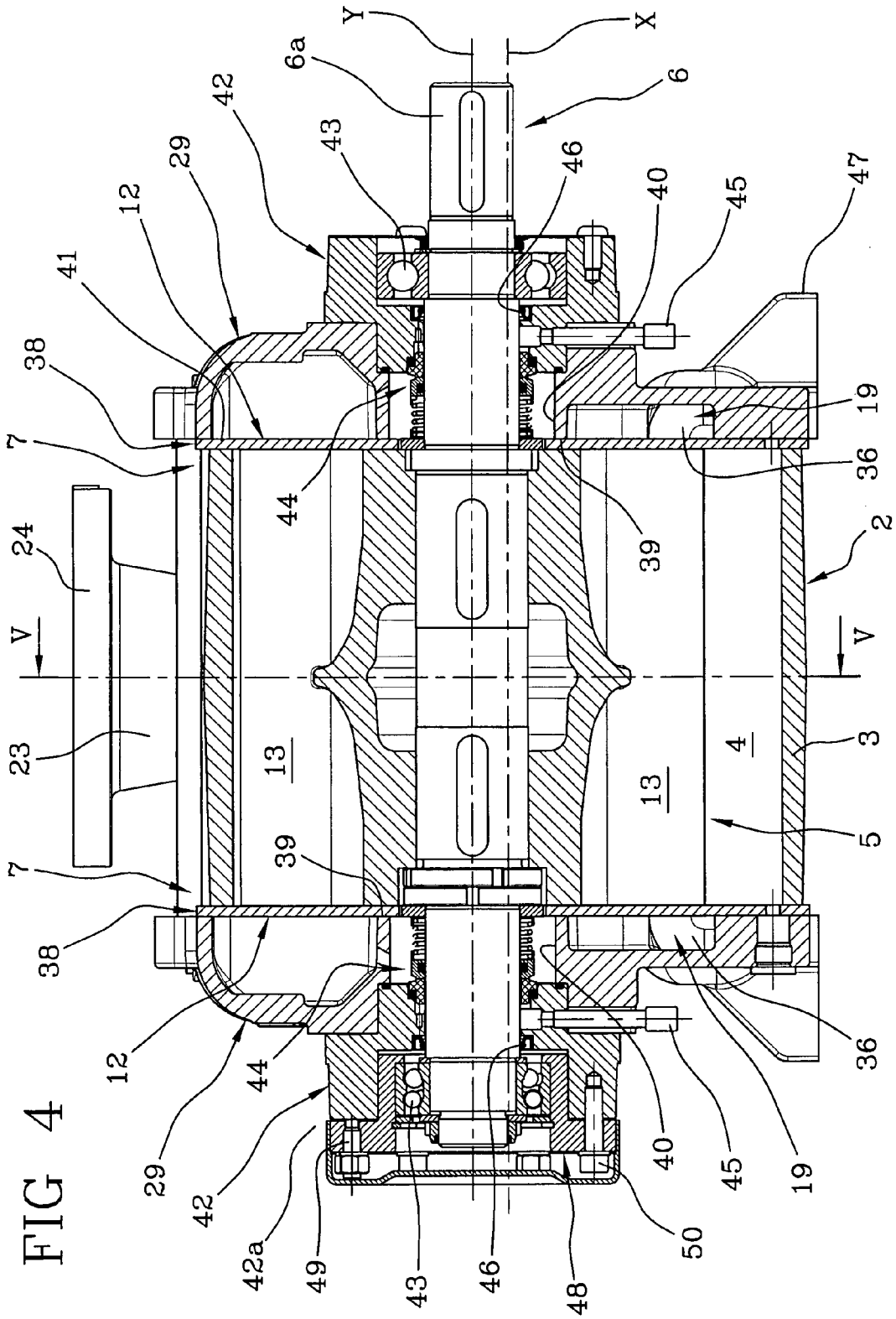


FIG 5

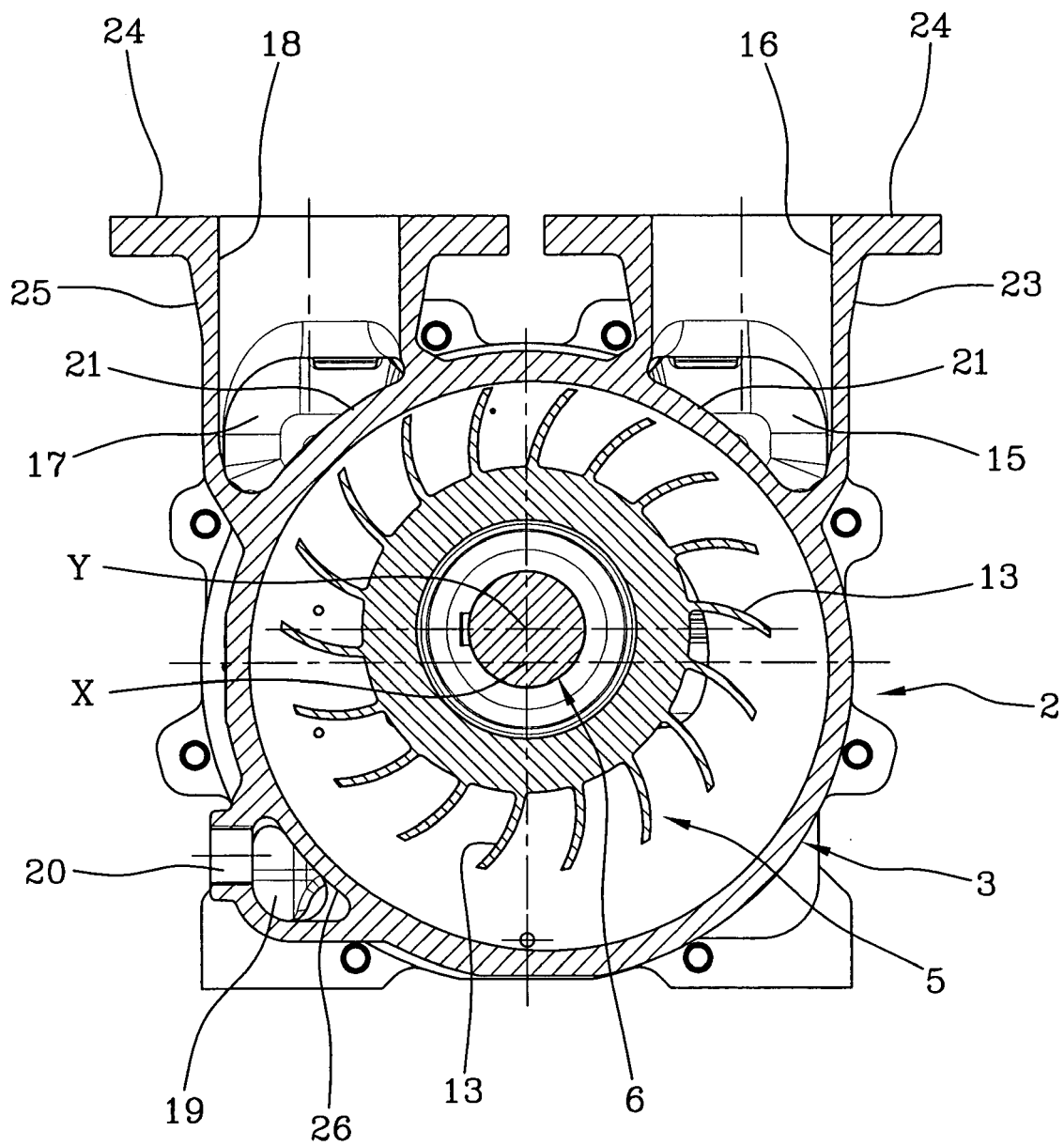


FIG 6

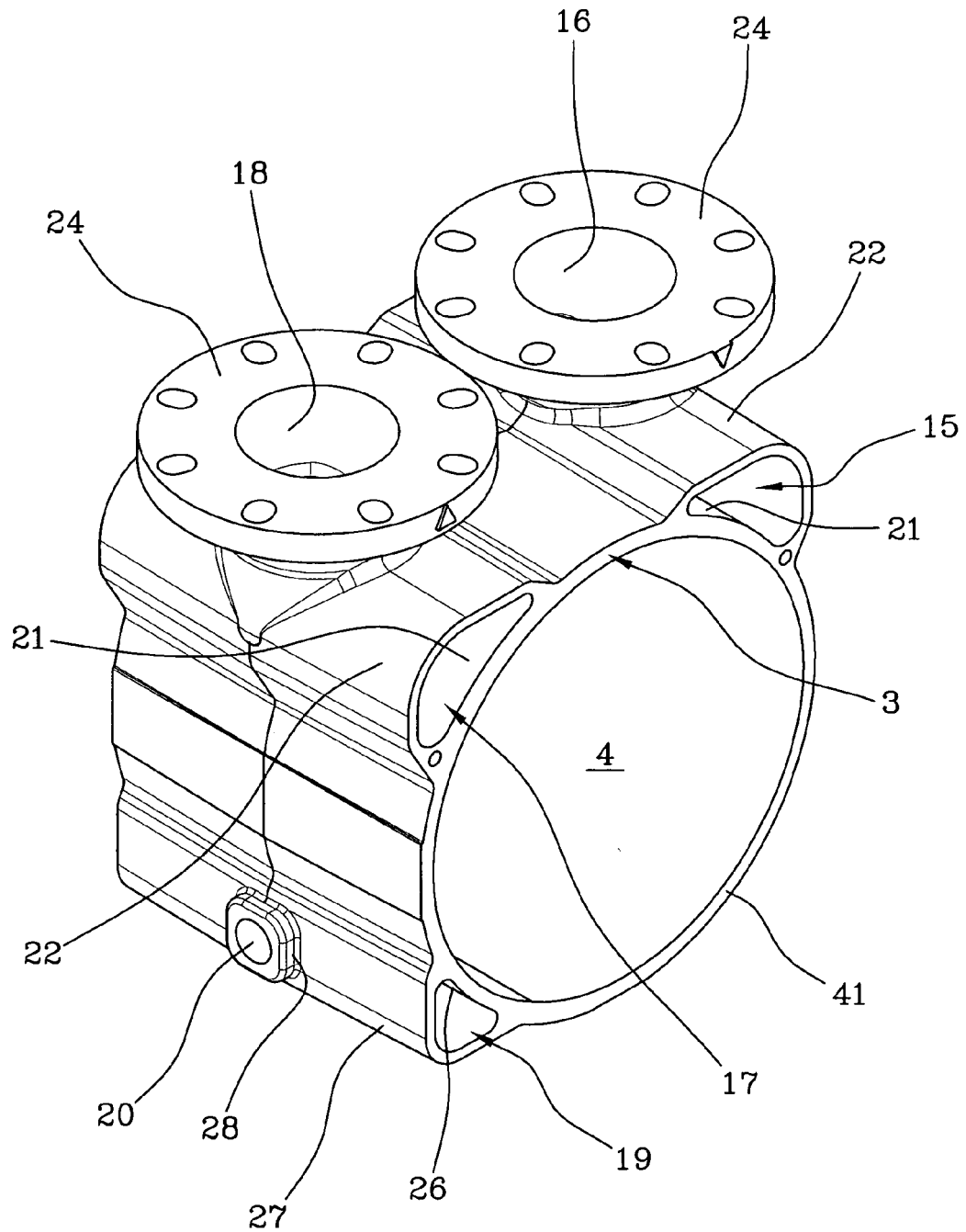


FIG 7

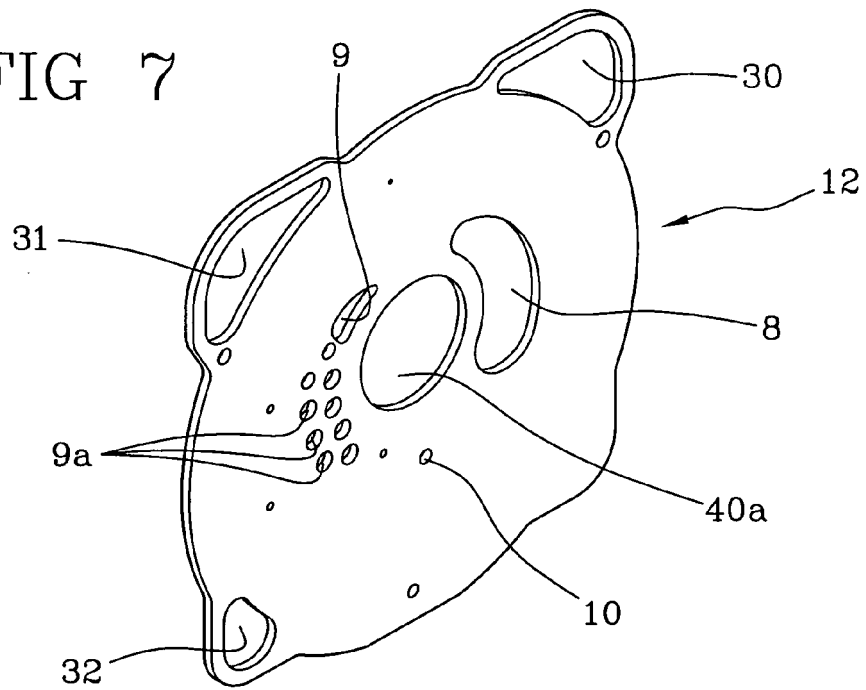
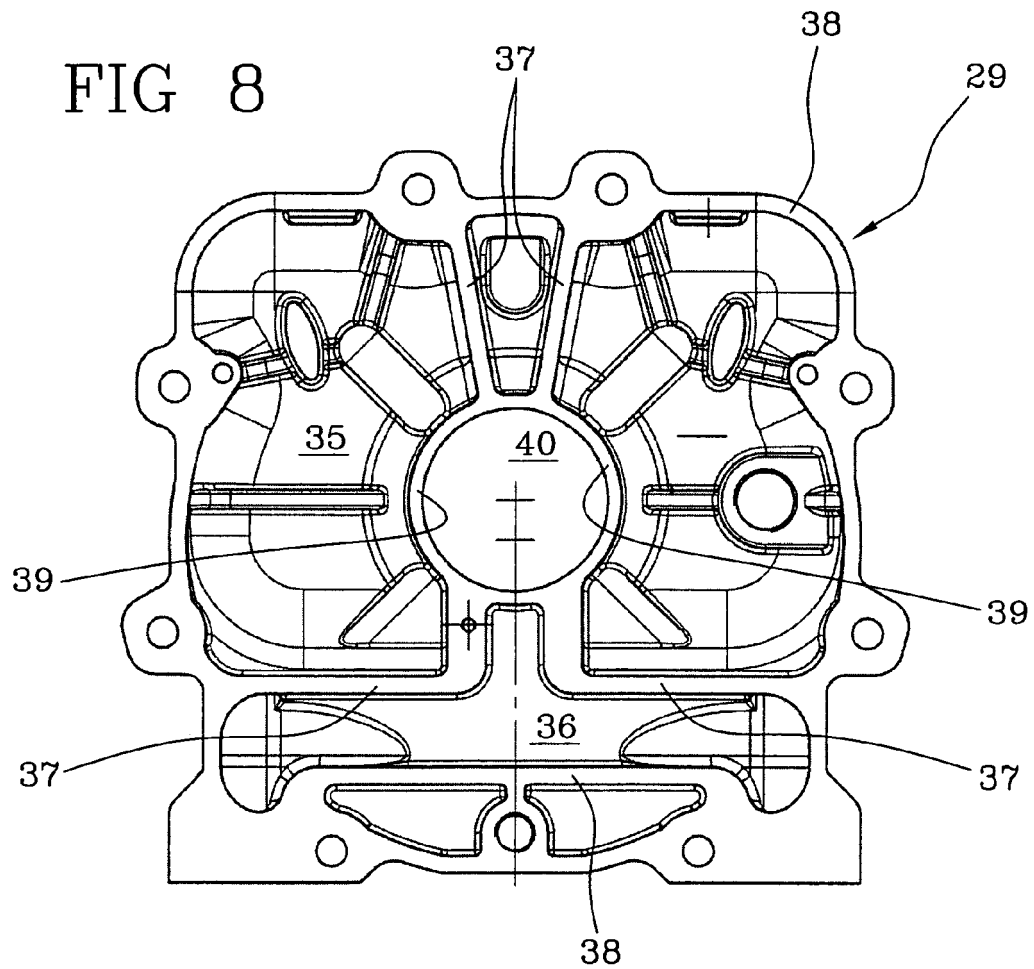


FIG 8





European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 06 42 5318

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 43 01 907 A1 (SIEMENS AG [DE]) 28 July 1994 (1994-07-28) * column 3, line 15 - line 40; figure 1 *	1-16	INV. F04C19/00
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			F04C
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 24 October 2006	Examiner Descoubes, Pierre
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**ANNEX TO THE EUROPEAN SEARCH REPORT
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EP 06 42 5318

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24-10-2006

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