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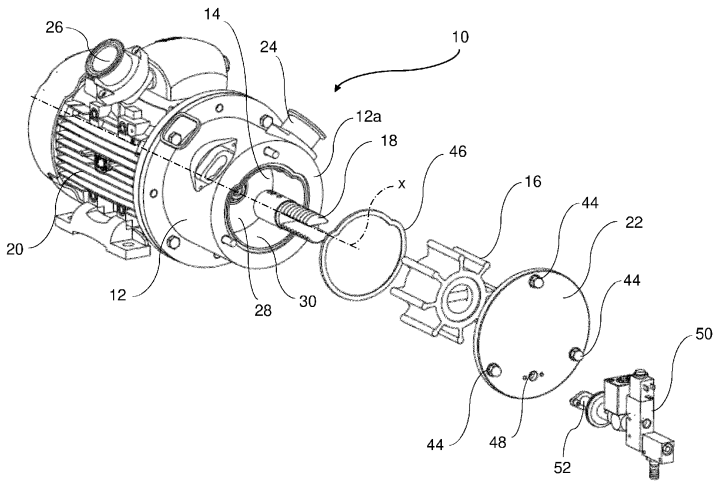
(54) FLEXIBLE IMPELLER PUMP

(57) A pump (10) is described comprising: a pump casing (12) defining internally a working chamber (14), an impeller (16) accommodated in the working chamber (14), a shaft (18) which is rotatably mounted about an axis of rotation (x) and on which the impeller (16) is mounted so as to be drivingly connected for rotation therewith, and a cover (22) fixed on a front side of the pump casing (12) to close the working chamber (14). The working chamber (14) is delimited radially by a lateral surface (30) having a profile with a variable radius with respect to the axis of rotation (x). The impeller (16) comprises a hub (32) and a plurality of blades (36) which extend radially outwards from the hub (32) and are made of a flexible material so as to be alternately deflected and released when the impeller (16) is driven by the shaft (18) into rotation about said axis of rotation (x). The cover (22) has, in a lower region thereof, a drain hole (48) for allowing the liquid contained inside the working chamber (14) to be discharged. The pump (10) further comprises closing means (50, 52, 54, 56, 58, 60) selectively controllable to close or open the drain hole (48) to prevent or allow, respectively, the flow of the liquid out of the working chamber (14) through the drain hole (48).

Fig. 1



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Description

Technical field of the invention

[0001] The present invention relates to a flexible impeller pump, particularly for use in the food and pharmaceutical sectors for pumping liquid and thick fluids.

State of the art

[0002] It is well known that flexible impeller pumps comprise a pump casing having a working chamber within which a flexible impeller, i.e. an impeller provided with flexible blades made of elastomeric material, which are dimensioned so as to remain with their free ends (radially outer ends) constantly in contact with the lateral surface of the working chamber, is rotatably mounted. The lateral surface of the working chamber has a variable radius profile, so that when the impeller rotates, the flexible blades, cooperating with the lateral surface of the working chamber, are alternately subject to bending and stretching, thus causing a suction effect.

[0003] The rules governing the design of machines and objects intended to come into contact with food liquids require the pump casing to be completely sanitised and drained after each processing cycle. This operation, which is possible with other types of pumps, has proved to be particularly difficult for flexible impeller pumps, which are widely used in the food and pharmaceutical sectors to transfer thick liquids. As mentioned above, the variable radius profile of the working chamber of the pump casing causes alternate bending and stretching of the flexible blades of the impeller, which makes this type of pump highly self-priming. On the other hand, it is precisely this feature (blades constantly in contact with the lateral surface of the chamber and little, if any, axial space between the chamber and the impeller) that does not allow to drain the pump completely at the end of the processing without disassembling it, i.e. without removing from the pump casing the cover that closes the working chamber, since the pump tends to "trap" the liquid between the impeller and the pump casing.

[0004] Flexible impeller pumps are, however, a particularly popular type of pump in the food and pharmaceutical industries because - as mentioned above - they have remarkable self-priming properties and are also easy to maintain. There is therefore a need to provide a system which allows a flexible impeller pump to be drained without having to disassemble the pump.

[0005] A flexible impeller pump having the features specified in the preamble of the enclosed independent claim 1 is known from US 2 843 049. A further example of a flexible impeller pump is described in US 5 178 567.

Summary of the invention

[0006] It is therefore an object of the present invention to provide a flexible impeller pump which can be drained without requiring disassembly of the pump, in particular without requiring removal of the cover from the pump casing.

[0007] This and other objects are fully achieved according to the present invention by a flexible impeller pump as defined in the enclosed independent claim 1.

[0008] Preferred embodiments of the pump according to the present invention are set forth in the dependent claims, the subject-matter of which is to be intended as forming an integral part of the following description.

[0009] In summary, the invention is based on the idea of providing, in the cover closing the working chamber of the pump casing, in particular in the lower region of that cover, a drain hole for allowing the discharge of the liquid contained inside the working chamber, said drain hole being normally closed by closing means, which may be formed by a manually removable cap or by a solenoid valve, advantageously provided with a Venturi-effect device, remotely controllable to allow the pump draining process to be automated. By virtue of the presence of a drain hole in the lower region of the pump cover, the liquid contained in the working chamber of the pump casing can be drained out of the pump casing without having to remove the cover, therefore in much easier and faster way than in the prior art. Furthermore, in case of use of a solenoid valve to control the opening and closing of the drain hole, the draining operation can be carried out without the need for manual intervention by an operator.

[0010] Moreover, a groove is provided on the inner side of the cover to connect the various spaces of the working chamber enclosed between pairs of adjacent blades of the impeller, so that when the pump has to be drained the liquid that is in the upper part of the working chamber can flow towards the lowest point of the working chamber and then flow out of the pump casing through the drain hole. In fact, due to the intrinsic design of the flexible impeller pumps, the impeller has the same width or axial dimension (i.e. the dimension along the axis of rotation) as the working chamber of the pump casing, so there is no space between the impeller and the walls of the working chamber. Instead, due to the presence of such a groove on the inner side of the cover, which is preferably annular in shape and has a radial extension such that the external radius of the hub of the impeller is comprised between the internal radius and the external radius of the groove, the liquid can flow from the upper part to the lower part of the working chamber to be from there expelled out of the pump casing through the drain hole, without the need to rotate the impeller (which would be dangerous for the integrity of the pump, since the flexible impeller is damaged when operating without liquid, even for a very short time, for example 15 seconds or more).

[0011] According to a further aspect of the invention, a slot configured to collect the liquid and convey it towards the drain hole is provided on the inner side of the cover in the area of the drain hole. In this way, it is ensured that the liquid collected in the lower part of the working chamber will flow out through the drain hole, thereby avoiding

the risk of obstruction of the drain hole in case the impeller stops with a blade placed exactly facing the drain hole.

[0012] According to an embodiment of the invention, the shaft on which the impeller is mounted has, on the outer surface thereof, a helical groove. Thanks to the presence of this groove, the liquid which would otherwise be trapped between the shaft and the impeller can flow towards the cover to be discharged from the working chamber of the pump casing through the drain hole.

[0013] Furthermore, it is advantageous that the connection fittings provided on the pump casing for the inlet and outlet of the liquid, and more particularly the seal gaskets mounted on these connection fittings, have a profile as similar as possible to that of the respective openings in the pump casing, so as to avoid, or at least reduce, any stagnation of liquid in the area of these connection fittings. In particular, the seal gaskets provided on the inlet and outlet fittings of the pump casing have a profile such that they touch at least one side of each opening provided in the pump casing. Thanks to this further measure, it is ensured that the liquid is discharged from the pump casing as completely as possible, since liquid stagnation, which in the pumps according to the prior art normally occurs at the seats for the inlet and outlet fittings of the pump casing, is avoided or at least reduced. Further features and advantages of the present invention will become evident from the following detailed description, given purely by way of non-limiting example.

Brief description of the drawings

[0014] In the following detailed description of the invention, reference will be made to the Figures of the accompanying drawings, where:

- Figure 1 is an exploded view of a flexible impeller pump according to an embodiment of the present invention;
- Figure 2 is a front view of the pump of Figure 1, wherein the cover has been removed from the pump casing;
- Figure 3 is a front view of the impeller of the pump of Figure 1;
- Figure 4 is a perspective view of the shaft of the pump of Figure 1;
- Figure 5 is a top view of the pump of Figure 1;
- Figure 6 is a section view of the pump of Figure 1, taken along the section plane indicated with VI-VI in Figure 5;
- Figure 7 is a front view of the inner side of the cover of the pump of Figure 1;
- Figure 8 is an enlarged scale view of detail A of Figure 6;
- Figure 9 is an enlarged scale view of detail B of Figure 6;
- Figure 10 is a front view, partially sectioned, of the pump of Figure 1; and
- Figure 11 shows in detail one of the two connection fittings of the pump of Figure 1, according to the point of view indicated by arrow F in Figure 10.

Detailed description

[0015] With reference first to Figure 1, a flexible impeller pump according to an embodiment of the present invention is generally indicated 10.

[0016] The pump 10 basically comprises a pump casing 12 defining internally a working chamber 14, an impeller 16 accommodated in the working chamber 14, a shaft 18 which is rotatably mounted about an axis of rotation x to be driven into rotation by a motor 20 (in particular an electric motor) and on which the impeller 16 is mounted so as to be drivingly connected for rotation therewith, a cover 22 fixed on the front side of the pump casing 12 to close the working chamber 14, and a pair of connection fittings 24 and 26 mounted on the pump casing 12 to put an inlet tube and an outlet tube (not shown), respectively, into communication with the working chamber 14, for the introduction of the liquid into the working chamber 14 and for the discharge of the liquid from the working chamber 14, respectively.

[0017] With reference also to Figures 2 and 6, the working chamber 14 is delimited axially (i.e. in the direction of the axis of rotation x) between a back wall 28, which extends substantially perpendicular to the axis of rotation x, and an inner side 22a of the cover 22, and radially by a lateral surface 30. As is clearly shown in Figure 2, the lateral surface 30 has a profile which for a first portion thereof (for example, for an angle of approximately 180°, that might also be larger or smaller than 180°) is an arc of a circle having its centre on the axis of rotation x and for the rest has a radius varying with the angle, but remaining constantly smaller than the radius of the first portion of the profile. In the proposed embodiment, the aforementioned first portion is the lower portion of the profile of the lateral surface 30 of the working chamber 14, while the remaining portion of the profile with a variable radius is the upper portion, i.e. the portion arranged on the side of the connection fittings 24 and 26.

[0018] Referring in particular to Figures 2 and 3, in a per-se-known manner the impeller 16 comprises a hub 32, having an internal bore 34 into which the shaft 18 is inserted, and a plurality of elastically flexible blades 36 extending radially outwards from the hub 32. The blades 36 are made of elastomeric material, in particular an elastomeric material for food use, so as to bend and stretch

alternately as a result of the cooperation with the lateral surface 30 of the working chamber 14 when the impeller 16 is driven by the shaft 18 into rotation about the axis of rotation x.

[0019] As can be observed in the front view of Figure 2, the blades 36 which are in the region of the upper portion of the lateral surface 30 of the working chamber 14 are in fact inflected due to the reduction of the radial distance between the base of the blades 36 and the lateral surface 30, while the blades 36 which are in the region of the lower portion of the lateral surface 30 with a circumferential arc profile are not inflected (or, more generally, less inflected than the previous ones), remaining however with their free ends, i.e. their radially outer ends, in contact with the lateral surface 30.

[0020] With reference to Figure 6, the blades 36 have the same width or axial dimension (i.e. the dimension along the axis of rotation x) as the working chamber 14, so that each pair of adjacent blades 36 defines a closed compartment with the back wall 28 of the working chamber 14 and with the inner side 22a of the cover 22. This allows, as it is known, the pump 10 to work as a self-priming pump.

[0021] In the embodiment proposed herein, the hub 32 comprises an inner hub portion 32a, which is rotationally coupled to the shaft 18, and an outer hub portion 32b, rigidly connected to the inner hub portion 32a so as to be drivingly connected for rotation therewith about the axis of rotation x. Preferably, the outer hub portion 32b integrally forms the blades 36 and is therefore made of the same elastomeric material as the latter. More preferably, the inner hub portion 32a and the outer hub portion 32b, including the blades 36, form a single moulded body and are therefore made of the same elastomeric material.

[0022] Furthermore, according to an embodiment of the invention, in order to ensure the rotational coupling between the impeller 16 and the shaft 18, the hub 32 comprises a rotation driving member 38 which extends diametrically through the inner bore 34 and, in the mounted condition of the impeller 16 on the shaft 18, is inserted into a diametrical slit 40 of complementary shape provided in the shaft 18, as shown in Figures 3 and 4. Preferably, the rotation driving member 38 is integrally formed with the inner hub portion 32a.

[0023] Figure 4 also shows a helical groove 42 which is provided on the outer surface of the shaft 18, or rather on the outer surface of the portion of the shaft 18 on which the impeller 16 is intended to be mounted. Thanks to such a groove, a helical passage is created between the shaft 18 and the hub 32 of the impeller 16 through which the liquid can flow when the pump casing 12 is to be drained.

[0024] Referring now also to Figures 6 and 7, in addition to Figure 1, the cover 22 is fixed to a front side 12a of the pump casing 12, for example by means of screws 44 or similar threaded connecting members inserted into respective holes 45 provided in the cover 22, so as to close the working chamber 14 of the pump casing 12 from the front side.

[0025] A sealing gasket 46 is advantageously provided between the inner side 22a of the cover 22 and the front side 12a of the pump casing 12 and extends around the entire perimeter of the working chamber 14 so as to prevent liquid leakage from the working chamber. Preferably, as shown in Figures 1 and 2, the sealing gasket 46 has a profile identical to that of the lateral surface 30 of the working chamber 14. This makes it possible to avoid, or at least minimise, the stagnation of liquid in the gap between the front face 12a of the pump casing and the inner side 22a of the cover 22.

[0026] The cover 22 has, in a lower region thereof, a drain hole 48 for allowing the liquid contained in the working chamber 14 to be discharged. More precisely, the drain hole 48 is vertically aligned with the centre of the cover 22, i.e. vertically aligned with the axis of rotation x in the mounted condition of the cover 22 on the pump casing 12. Furthermore, the drain hole 48 is positioned at a distance from the centre of the cover 22 such that it faces, in the mounted condition of the cover 22 on the pump casing 12, the lowest area of the working chamber 14, in particular with its farthest point from the centre of the cover 22 placed at a distance from the centre of the cover 22 equal to, or slightly greater than, the radius of the lower circumferential arc portion of the profile of the lateral surface 30 of the working chamber 14. It is thus ensured that all the liquid present in the working chamber 14 can flow out of that chamber through the drain hole 48, when the pump casing 12 has to be drained.

[0027] As shown in Figures 6 and 7, in the area of the drain hole 48 there is provided, on the inner side 22a of the cover 22, a slot 49 having a width greater than the diameter of the drain hole 48, and also greater than the thickness of the blades 36 of the impeller 16, so as to allow the liquid to flow out of the working chamber 14 through the drain hole 48 even in case the impeller 16 stops with one of its blades 36 positioned exactly in front of the drain hole 48.

[0028] The drain hole 48 is normally closed by closing means, which may for example be simply formed by a plug, manually removable by an operator when it is necessary to drain the pump casing 12.

[0029] In the embodiment proposed herein, on the other hand, the closing means are formed by a solenoid valve 50, advantageously provided with a Venturi-effect device, which is remotely controllable to allow the pump draining process to be automated, thus without the need for manual intervention by an operator. The solenoid valve 50 is in this case connected to the drain hole 48 by means of a connection fitting 52. As shown in Figure 9, the connection fitting 52, at its cover-side end, forms a coupling portion 54 which is inserted into the drain hole 48, with a sealing gasket 56 placed in between, as well as a mounting flange 58 which is removably fixed, for example by means of screws 60, to the cover 22.

[0030] With reference now to the detailed view of Fig-

ure 8, on the inner side 22a of the cover 22 there is provided an annular groove 62 arranged so as to put the spaces defined between adjacent pairs of blades 36 of the impeller 16 into liquid communication with each other. More specifically, the groove 62 has a radial extension such that the external radius R_E of the hub 32 of the impeller 16 is comprised between the internal radius r_i and the external radius r_E of the groove 62. As can be observed in Figure 8, the groove 62 has a very small depth, preferably in the order of tenths of a mm (for example 0,3 mm), so that the groove 62 does not adversely affect the self-priming properties of the pump 10, but allows, when it is necessary to drain the pump, the liquid to flow from the upper part to the lower part of the working chamber 14 to be drained from there out of the pump casing 12 through the drain hole 48.

[0031] Finally, with reference to Figures 10 and 11, as well as to Figure 5, the pump casing 12 has one or more inlet openings 64 (two inlet openings 64, in the embodiment proposed herein) for the inlet of the liquid into the working chamber 14 and one or more outlet openings 66 (two outlet openings 66, in the embodiment proposed herein) for the outlet of the liquid from the working chamber 14. At the inlet openings 64 there is mounted on the pump casing 12 an inlet connection fitting 24 to which the aforementioned inlet tube is intended to be connected, and at the outlet openings 66 there is mounted on the pump casing 12 an outlet connection fitting 26 to which the aforementioned outlet tube is intended to be connected. The connection fittings 24 and 26 are partially inserted into respective seats 68 and 70 of the pump casing 12, and a sealing gasket 72 is mounted between each connection fitting 24, 26 and the respective seat 68, 70 (in Figures 10 and 11, only the sealing gasket associated with the outlet connection fitting 26 is shown). As shown in Figure 11, each gasket 72 has a profile such that it touches at least one side of each of the openings 64 and 66 so as to avoid, or at least minimise, any stagnation of liquid in the seats 68 and 70 around the openings 64 and 66. In the embodiment proposed herein, only one sealing gasket 72 surrounding both inlet openings 64 is provided and only one sealing gasket 72 surrounding both outlet openings 66 is provided, but more sealing gaskets might also be provided, one for each inlet opening and one for each outlet opening, in which case each gasket would advantageously have a profile corresponding to that of the respective opening.

[0032] As can be seen from the above description, a pump according to the present invention ensures that the pump casing can be completely drained without the need to remove the cover. Furthermore, in case of use of a solenoid valve as a means for controlling the opening/closing of the drain hole, the draining operation can be controlled automatically without the need for the intervention by an operator.

[0033] The present invention has been described herein with reference to a preferred embodiment thereof. It is to be understood that other embodiments may be envisaged that share with the one described herein the same inventive core, as defined by the scope of protection of the enclosed claims.

[0034] For example, the feature that the shaft has, on the outer surface thereof, a helical groove defining with the hub of the impeller a helical passage might be envisaged independently of the feature that the cover has on its inner side, in the area of the drain hole, a slot having a width greater than the diameter of the drain hole and greater than the thickness of the blades of the impeller, as well as independently of the feature that an inner side of the cover has a groove for putting spaces of the working chamber enclosed between pairs of adjacent blades of the impeller into communication with each other. Therefore, the present invention also relates to a pump comprising:

- a pump casing defining internally a working chamber,
- an impeller accommodated in the working chamber,
- a shaft which is rotatably mounted about an axis of rotation and on which the impeller is mounted so as to be drivingly connected for rotation therewith, and
- a cover fixed on the front side of the pump casing to close the working chamber, wherein the working chamber is delimited radially by a lateral surface having a profile with a variable radius with respect to said axis of rotation,

wherein the impeller comprises a hub and a plurality of elastically flexible blades which extend radially outwards from the hub and are configured to cooperate with the lateral surface of the working chamber so as to be alternately deflected and released when the impeller is driven by the shaft into rotation about said axis of rotation,
wherein the cover has, in a lower region thereof, a drain hole for allowing liquid contained inside the working chamber to flow out of the same,
wherein the pump further comprises closing means selectively operable to close or open the drain hole to prevent or allow, respectively, the flow of the liquid out of the working chamber through the drain hole, and
wherein the shaft has, on the outer surface thereof, a helical groove defining a helical passage with the hub of the impeller.

Claims

1. Pump (10) comprising

- a pump casing (12) defining internally a working chamber (14),

- an impeller (16) accommodated in the working chamber (14),
- a shaft (18) which is rotatably mounted about an axis of rotation (x) and on which the impeller (16) is mounted so as to be drivingly connected for rotation therewith, and
- a cover (22) fixed on the front side of the pump casing (12) to close the working chamber (14),

wherein the working chamber (14) is delimited radially by a lateral surface (30) having a profile with a variable radius with respect to said axis of rotation (x), and

wherein the impeller (16) comprises a hub (32) and a plurality of elastically flexible blades (36) which extend radially outwards from the hub (32) and are configured to cooperate with the lateral surface (30) of the work chamber (14) so as to be alternately deflected and released when the impeller (16) is driven by the shaft (18) into rotation about said axis of rotation (x),

wherein the cover (22) has, in a lower region thereof, a drain hole (48) for allowing liquid contained inside the working chamber (14) to flow out of the same, and

wherein the pump (10) further comprises closing means (50, 52, 54, 56, 58, 60) selectively operable to close or open said drain hole (48) to prevent or allow, respectively, the flow of the liquid out of the working chamber (14) through said drain hole (48), **characterized in that** the cover (22) has on an inner side (22a) thereof, in the area of said drain hole (48), a slot (49) having a width larger than the diameter of said drain hole (48) and larger than the thickness of the blades (36) of the impeller (16), and

in that the inner side (22a) of the cover (22) has a groove (62) arranged to put spaces of the working chamber (14) enclosed between pairs of adjacent blades (36) of the impeller (16) into communication with each other.

2. Pump according to claim 1, wherein said drain hole (48) is vertically aligned with said axis of rotation (x) in the mounted condition of the cover (22) on the pump casing (12).

3. Pump according to claim 1 or claim 2, wherein said drain hole (48) is positioned at such a distance from the centre of the cover (22) as to be placed, in the mounted condition of the cover (22) on the pump casing (12), in front of the lowest region of the working chamber (14).

4. Pump according to any one of the preceding claims, wherein said closing means (50, 52, 54, 56, 58, 60) comprise a solenoid valve (50), provided in particular with a Venturi-effect device.

5. Pump according to claim 4, further comprising a connection fitting (52) through which the solenoid valve (50) is connected to the drain hole (48), said connection fitting (52) forming, at a cover-side end thereof, a coupling portion (54) which is inserted into the drain hole (48), with a sealing gasket (56) placed in between, as well as a mounting flange (58) which is releasably attached to the cover (22).

6. Pump according to any one of the preceding claims, wherein the shaft (18) has, on an outer surface thereof, a helical groove (42) defining a helical passage with the hub (32) of the impeller (16).

7. Pump according to any one of the preceding claims, wherein the groove (62) on the inner side (22a) of the cover (22) is of annular shape and has a radial dimension such that the external radius of the hub (32) of the impeller (16) is comprised between the internal radius and the external radius of said groove (62).

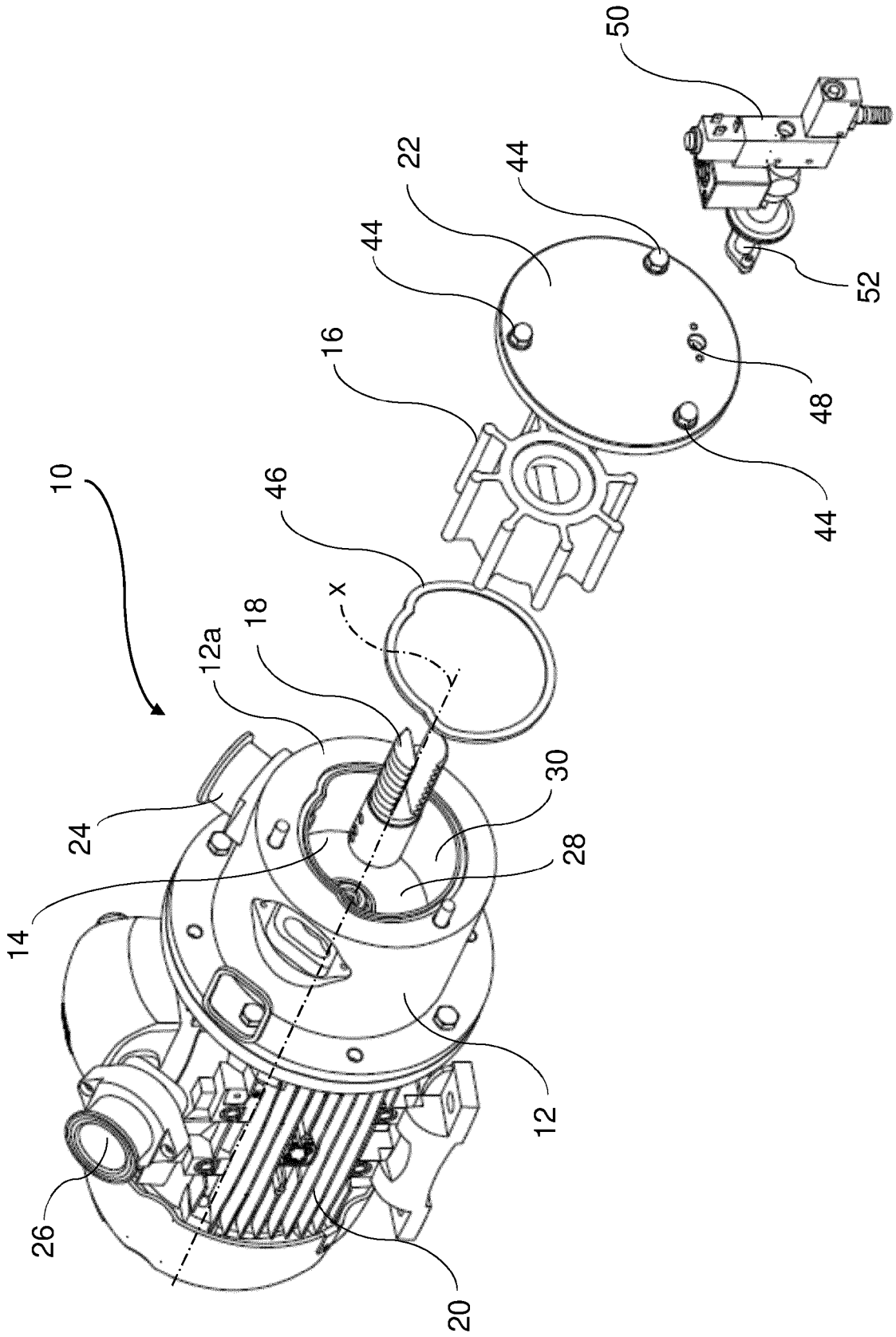
8. Pump according to any one of the preceding claims, further comprising a sealing gasket (46) which is interposed between the inner side (22a) of the cover (22) and a front side (12a) of the pump casing (12) and extends around the entire perimeter of the working chamber (14) with a profile identical to that of the lateral surface (30) of the working chamber (14).

9. Pump according to any one of the preceding claims, wherein the pump casing (12) has at least one inlet opening (64) and at least one outlet opening (66) in communication with the working chamber (14), wherein the pump (10) further comprises an inlet connection fitting (24) mounted on the pump casing (12) in the region of said at least one inlet opening (64) to put an inlet tube into fluid communication with the working chamber (14) through said at least one inlet opening (64), at least one sealing gasket (72) interposed between the inlet connection fitting (24) and the pump casing (12) around said at least one inlet opening (64), an outlet connection fitting (26) mounted on the pump casing (12) in the region of said at least one outlet opening (66) to put an outlet tube into fluid communication with the working chamber (14) through said at least one outlet opening (66), and at least one sealing gasket (72) interposed between the outlet connection fitting (26) and the pump casing (12) around said at least one outlet opening (66), wherein said sealing gaskets (72) are shaped and arranged so as to touch at least one side of a respective inlet opening (64) or of a respective outlet opening (66).

10. Pump unit comprising a pump (10) according to any one of the preceding claims and a motor (20), in particular an electric motor, operatively connected to

the shaft (18) to drive the shaft (18) into rotation about said axis of rotation (x).

Fig. 1



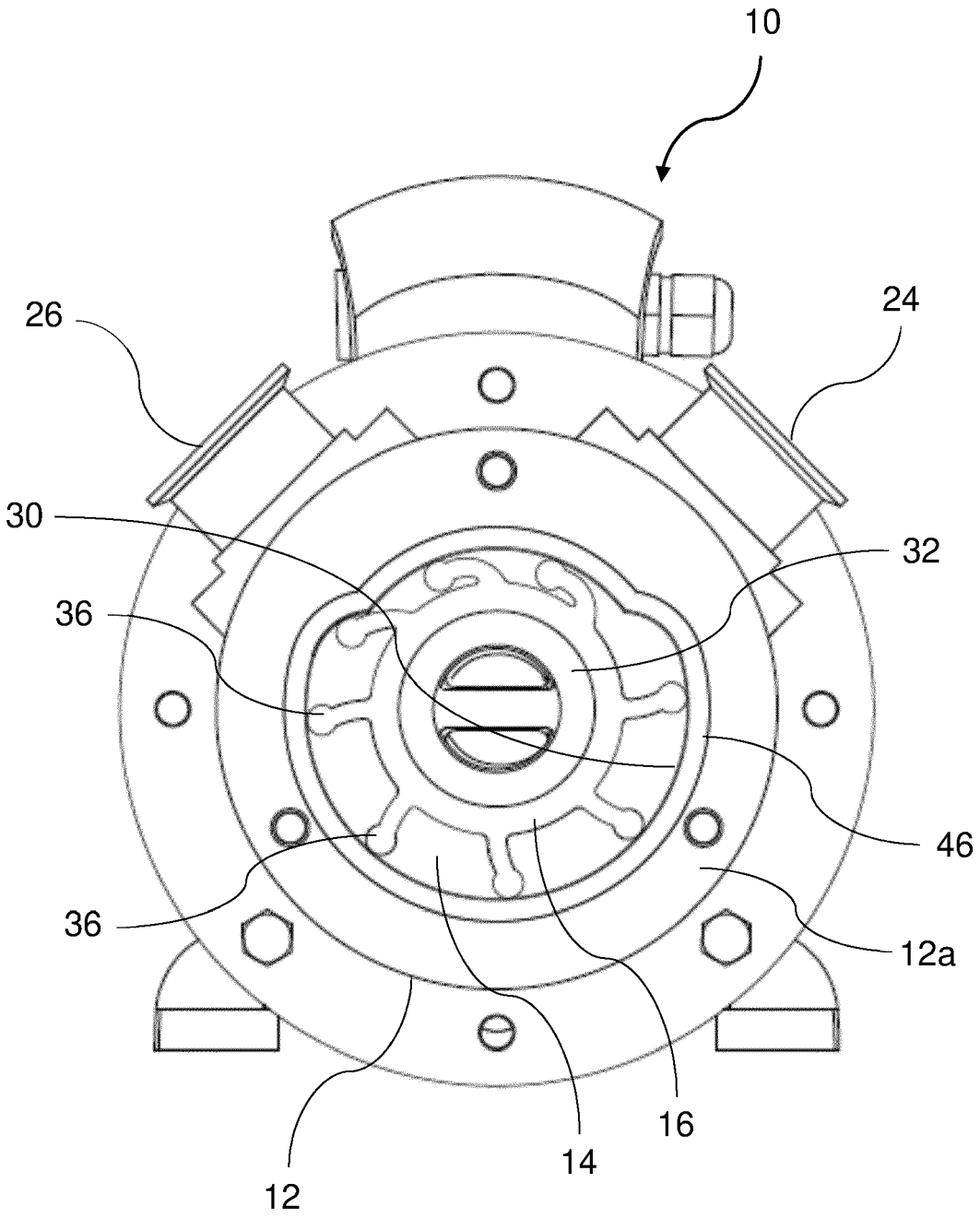


FIG. 2

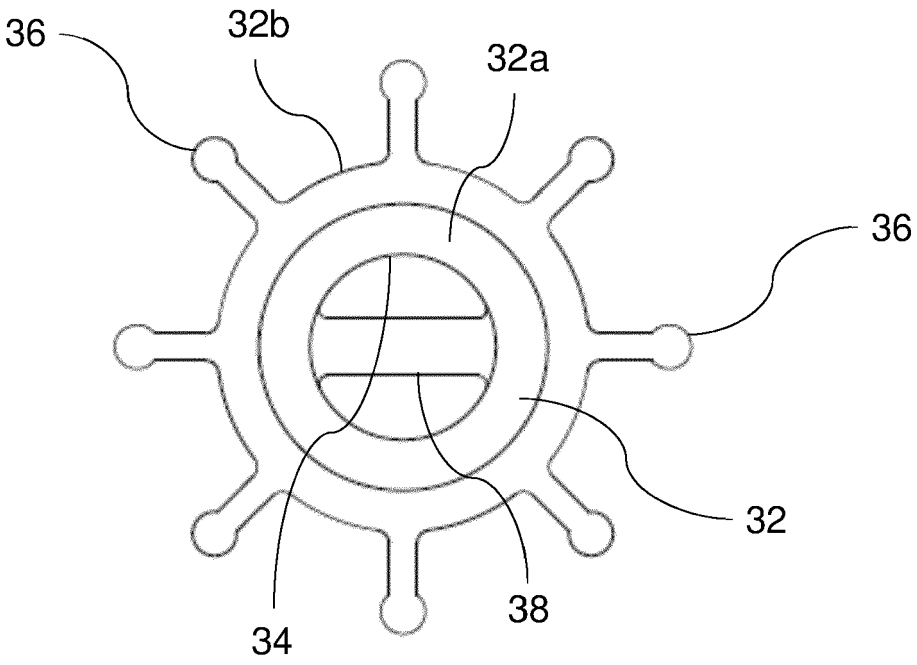


FIG. 3

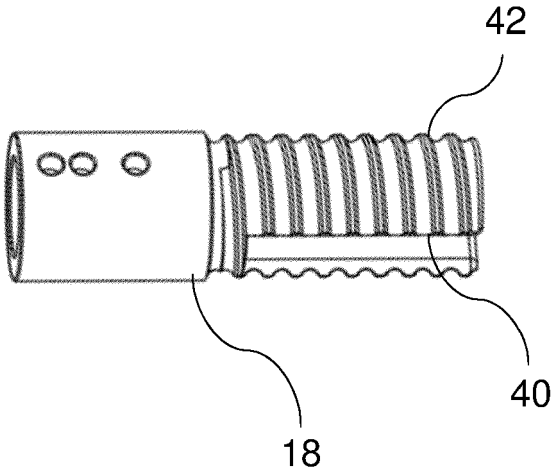


FIG. 4

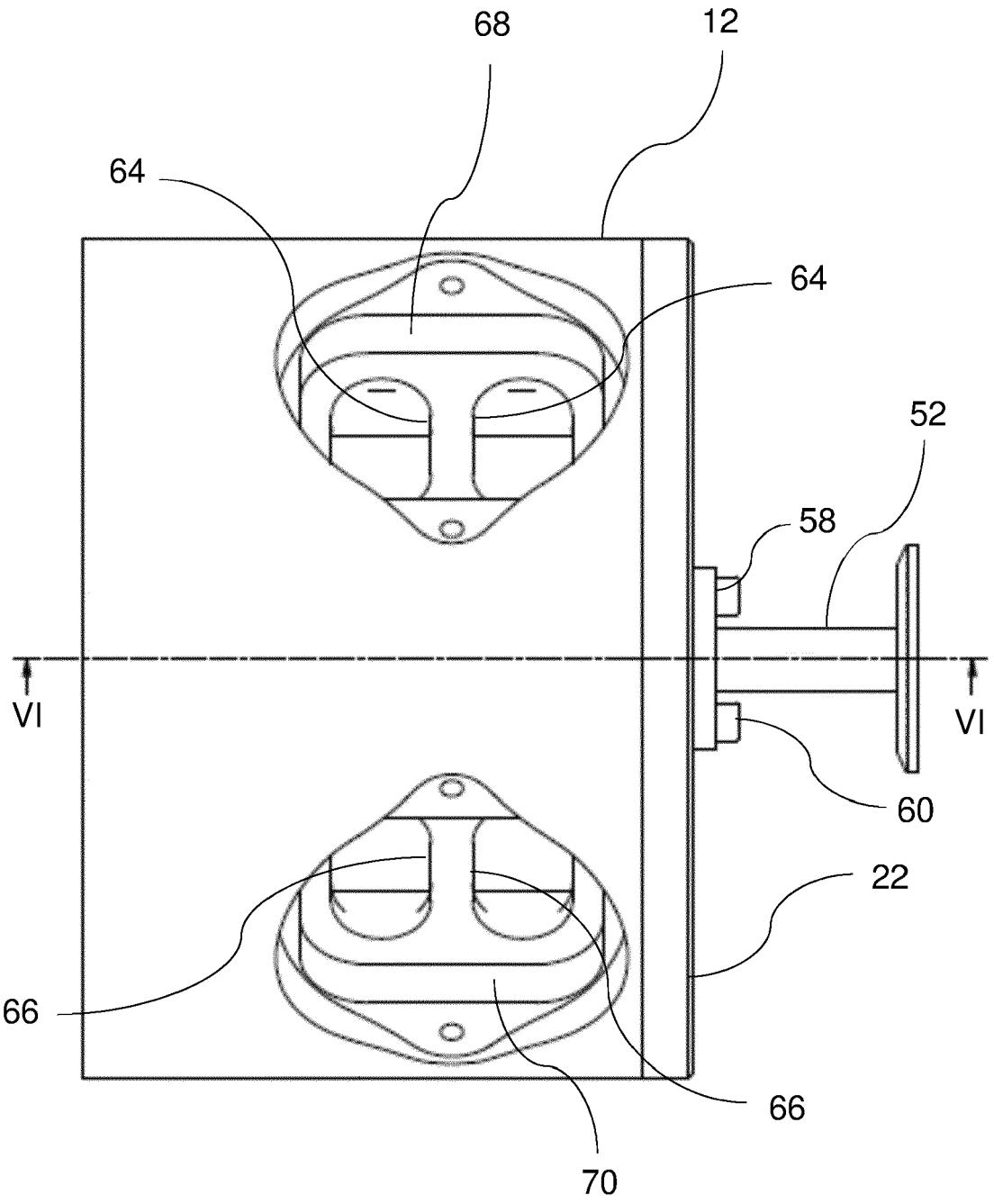


FIG. 5

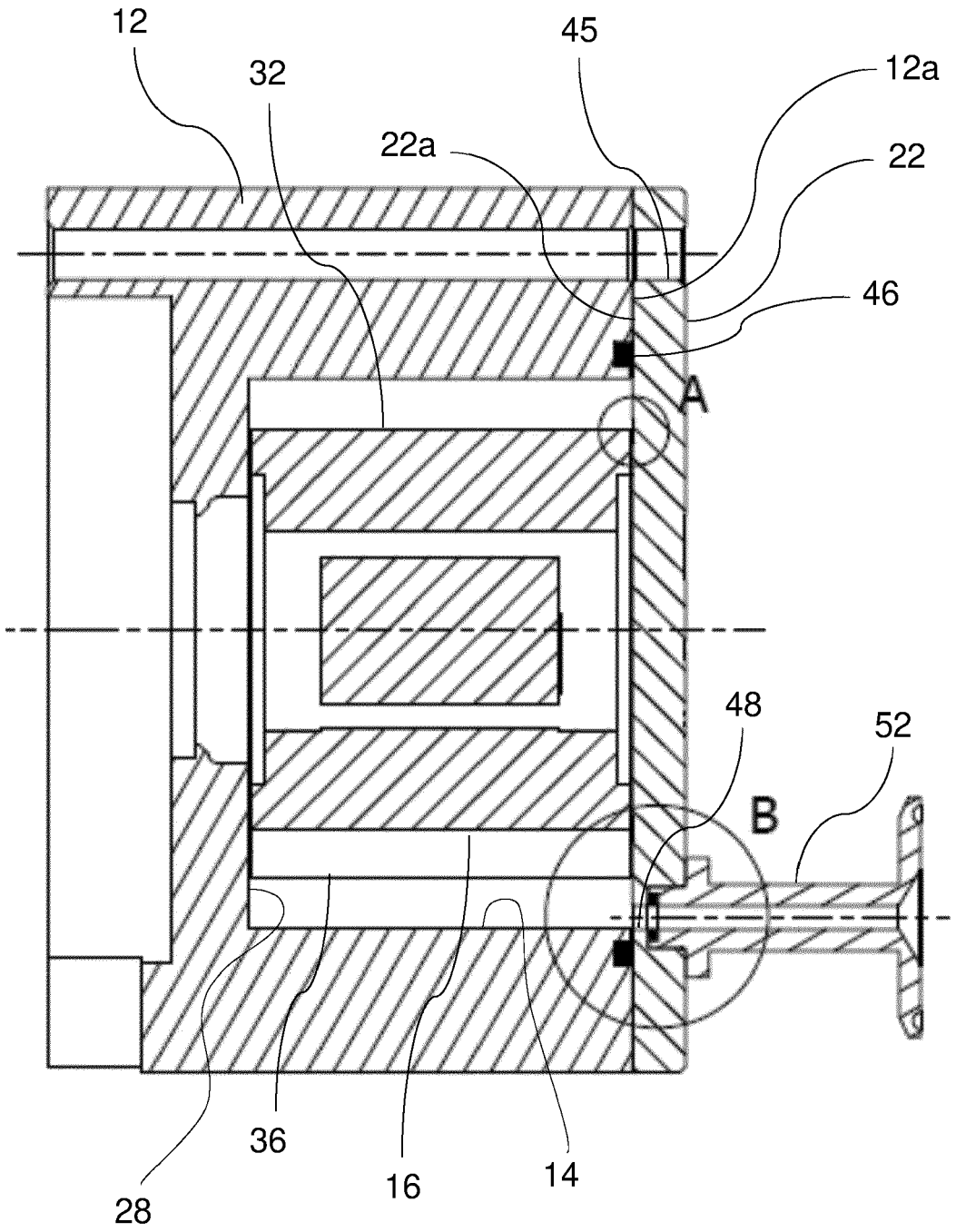


FIG. 6

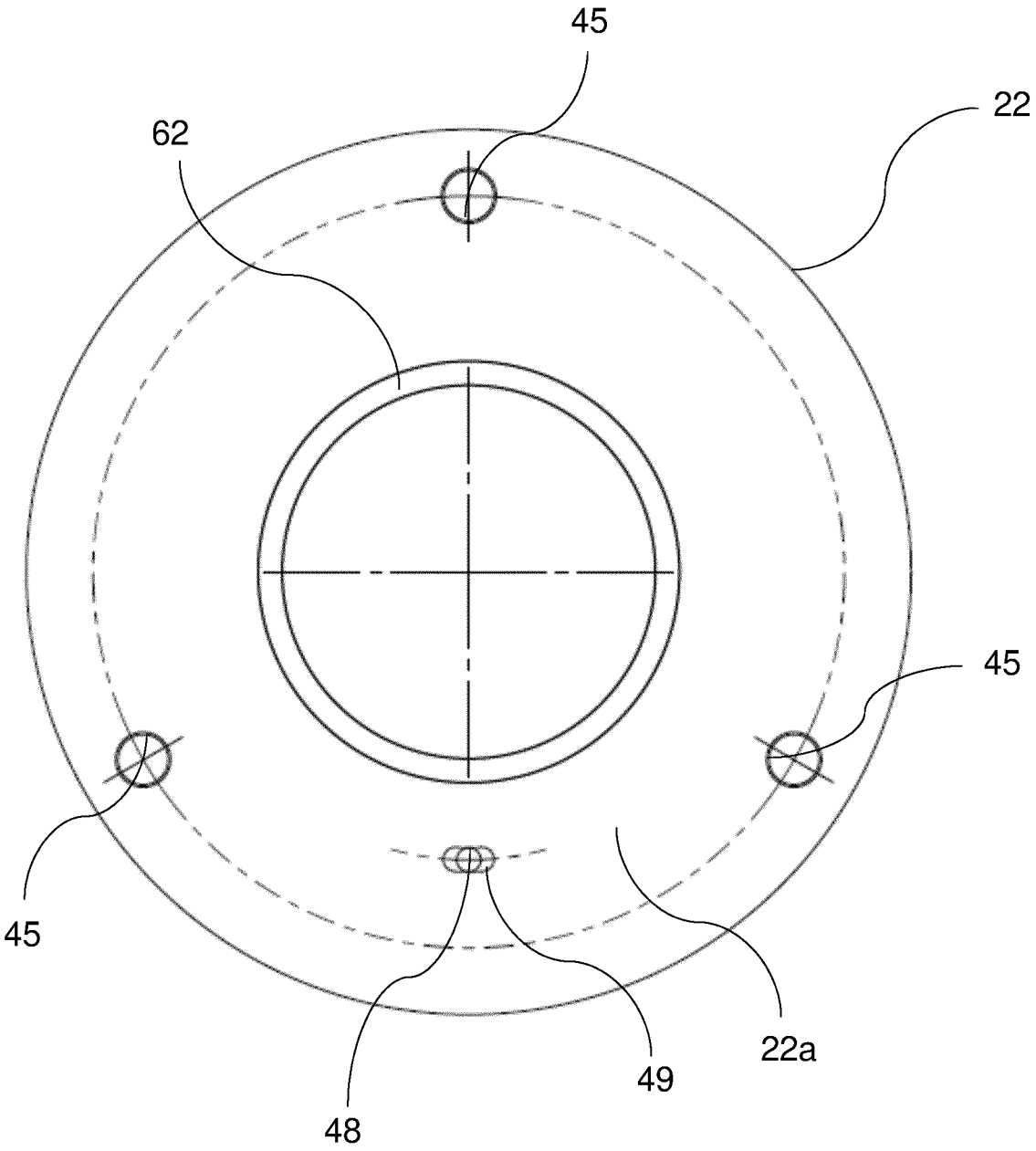


FIG. 7

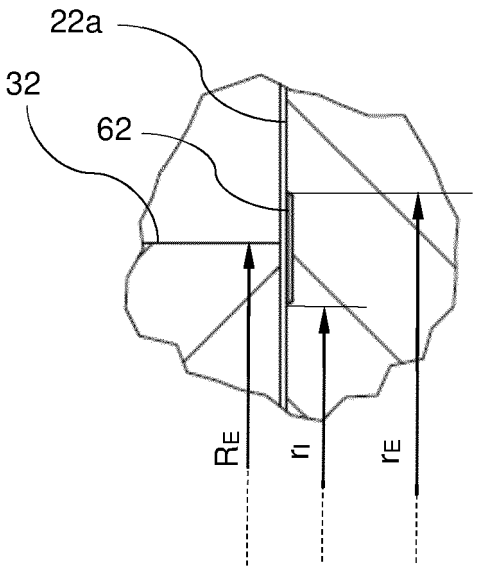


FIG. 8

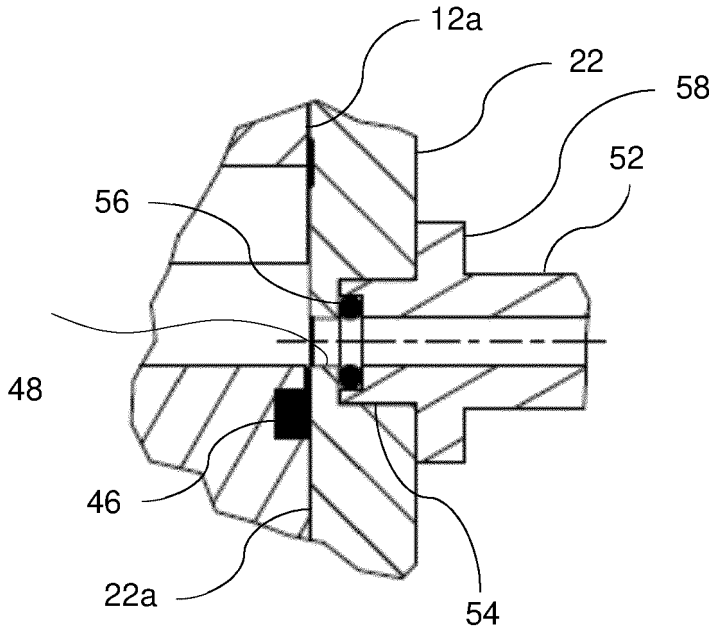


FIG. 9

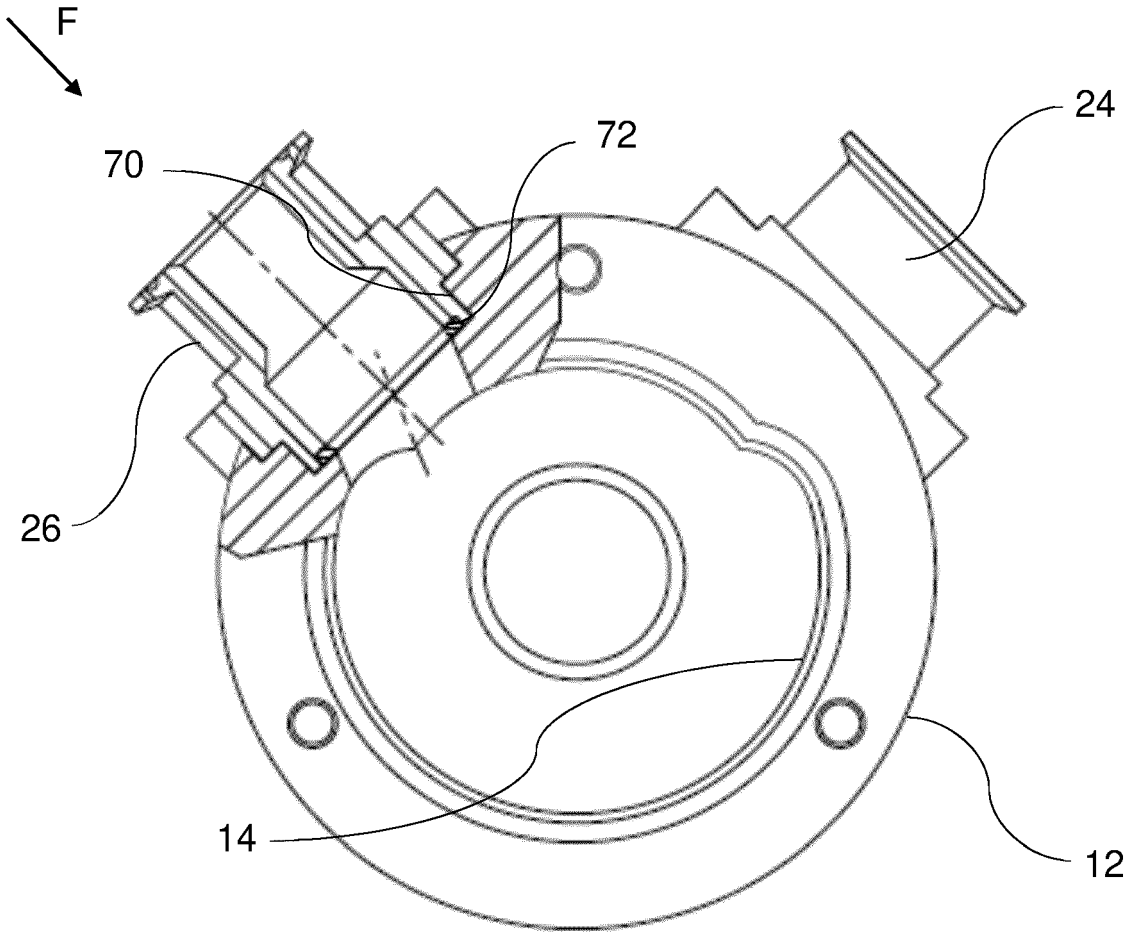


FIG. 10

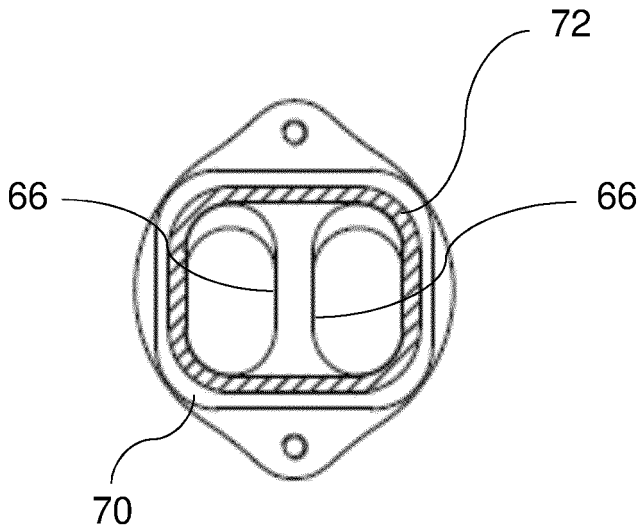


FIG. 11

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EUROPEAN SEARCH REPORT

Application Number
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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	US 2 843 049 A (DAVID SHERWOOD) 15 July 1958 (1958-07-15) * column 2, line 22 - line 42; figures 1,2 *	1-10	INV. F04C5/00 F04C15/06
A	US 5 178 567 A (MONDEK MARTIN J [US]) 12 January 1993 (1993-01-12) * column 4, line 28 - line 39; figures 4,6 *	1-10	

TECHNICAL FIELDS SEARCHED (IPC)

F04C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	30 May 2022	Durante, Andrea

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30-05-2022

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2843049 A	15-07-1958	NONE	
US 5178567 A	12-01-1993	NONE	

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- US 2843049 A **[0005]**
- US 5178567 A **[0005]**