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

(11) **EP 1 972 788 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
**24.09.2008 Bulletin 2008/39**

(51) Int Cl.:
***F04D 7/04*** *(2006.01)* ***F04D 29/42*** *(2006.01)*

(21) Application number: **07104824.3**

(22) Date of filing: **23.03.2007**

(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 MT NL PL PT RO SE SI SK TR**
Designated Extension States:
**AL BA HR MK RS**

(71) Applicant: **IHC Holland IE B.V.**
**3361 EP Sliedrecht (NL)**

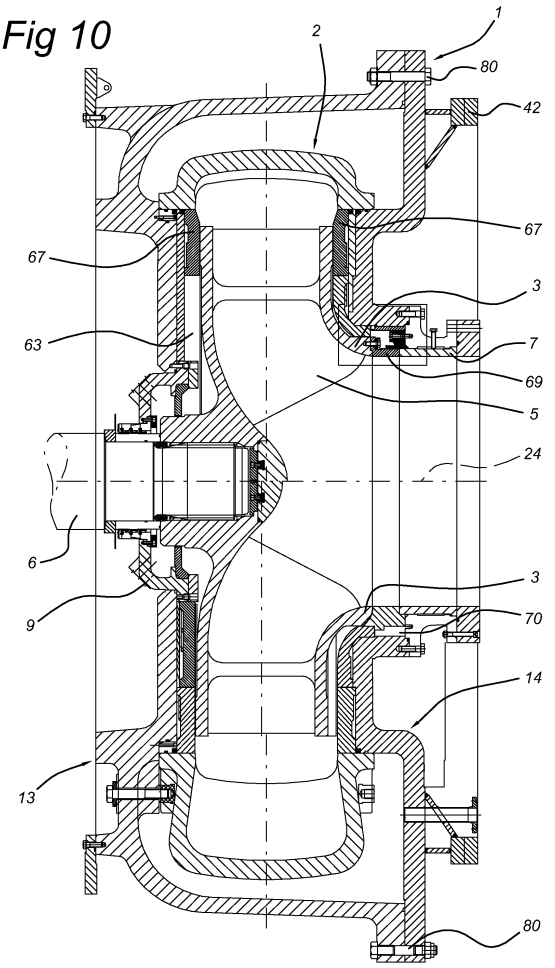
(72) Inventors:
- **van der Blom, Erik Christiaan**
  **3232 PA, Brielle (NL)**
- **Bugdayci, Hasan Hüseyin**
  **2993 PB, Barendrecht (NL)**
- **Koot, Jasper**
  **3533 GE, Utrecht (NL)**
- **Kanters, Edwin**
  **2611 NH, Delft (NL)**

(74) Representative: **Swinkels, Bart Willem**
**Nederlandsch Octrooibureau**
**P.O. Box 29720**
**2502 LS Den Haag (NL)**

# (54) Centrifugal pump housing having a flat single cover part

(57) The above mentioned invention is related to a centrifugal pump, comprising an outer casing, an inner casing contained in the outer casing, an impeller rotatably supported within the inner casing, an outer casing inlet concentrically arranged with respect to the impeller as well as a tangential outlet, said outer casing comprising a cup shaped part as well as a cover part mounted onto the cup shaped part. The cover part comprises a single element which extends as a unity continuously between the cup shaped part and the outer casing inlet.

*Fig 10*




EP 1 972 788 A1

## Description

**[0001]** The invention is related to a centrifugal pump, comprising an outer casing, an inner casing contained in the outer casing, an impeller rotatably supported within the inner casing, an outer casing inlet concentrically arranged with respect to the impeller as well as a tangential outer casing outlet, said outer casing comprising a cup shaped part as well as a cover part mounted onto the cup shaped part, which cover part comprises at least one reinforcement ring.

**[0002]** Such centrifugal pumps are known. The outer casing of said prior art centrifugal pump has an inlet cover which extends between the inlet and the cover part. Thus, said cover part has a relatively large opening, closed by the inlet cover. By removing said inlet cover, the opening in the cover part is made free which allows the impeller to be removed through said opening. Thus, the impeller may be exchanged without removing the cover part itself. Subsequently, the inlet cover is positioned again between the cover part and the inlet so as to close the outer casing.

**[0003]** Although this lay out of the centrifugal pump has advantages concerning the replacement of the impeller, certain disadvantages are associated to said lay out as well. Once the impeller has been removed from the outer casing through the opening in the cover part, the impeller has to be lifted away. However, this lifting action is hampered by the reinforcement ring which stands off from the cover part. Said reinforcement ring provides the relatively flat cover part with the required stiffnes, which is necessary so as to maintain the sealing action between the impeller and the inner surface of the cover part.

**[0004]** The object of the invention is therefore to provide a centrifugal pump of the type described before which does not have these disadvantages. This object is achieved in that that said cover part comprises a single element which extends as a unity continuously between the cup shaped part and the outer casing inlet.

**[0005]** The unitary lay out of the outer cover part makes it necessary to remove said cover part as a whole in case the impeller needs to be repaired or exchanged. However, as the cover part including the obstacle formed by the reinforcement ring which stands off from the cover part is completely out of the way, the room for handling the impeller is greatly improved. The unitary cover part according to the invention may be carried out in several ways; for instance the cover part may comprise a single plate element or a single layered element. Furthermore, the cover part may comprise several materials. According to a first possibility, said cover part comprises a plastic material .Such centrifugal pump is described in European patent application 06113796, which is non published prior filing. Pumps of this type can be used in dredging or mining operations. In those cases, the materials obtained may comprise highly abrasive components. Moreover, these materials may comprise lumps of material which, upon transportation through the inner casing in the process of pumping these materials, will generate considerable impact forces. Also, in the process of performing dredging or mining operations, pressure surges may occur within the inner casing.

**[0006]** For reason of this abrasive character of some of the materials, centrifugal pumps of this type need an inner casing which consists of a very hard material, for instance hardened steel or cast iron. Although materials such as cast iron and hardened steel have favorable characteristics for withstanding the abrasive character of the pumped materials, they are less fit for accommodating impact forces such as caused by pressure surges or when pumping lumps of materials. This is caused by the fact that materials such as hardened steel or cast iron cannot yield very well. This means that they are not able to adapt to this type of loading. As a consequence, there is a certain risk of ruptures occurring in the inner casing in those circumstances where pressure surges occur and lumps of materials are traveling through the inner casing. Subsequently, the materials being pumped may be flung into the surroundings, leading to unacceptable high risks.

**[0007]** With the aim of reducing these risks, the outer housing has been provided. As the aim of this outer housing is to contain any materials which may be flung out of a ruptured inner casing, said outer casing comprises a material which is well fit for accommodating the impacts generated by those materials. Thus, the outer casing is usually constructed from a tough and yieldable material. Furthermore, the outer casing is constructed in such a way that it is fit for maintaining an internal overpressure.

**[0008]** Having regard to the fact that the outer casing completely surrounds the inner casing, the dimensions thereof, and consequently its mass, are considerable. Also, the costs of such outer housing are appreciable, even more so in case of pumps with increased capacity. The amount of steel material involved in manufacturing the outer casing increases proportionally with the size of the centrifugal pump.

**[0009]** With the aim of providing a solution to the problems of cost and weight of the centrifugal pumps in question, the non published prior European patent application proposes to provide an outer casing consisting of a plastic material. In this connection, the outer casing may either comprise two cup shaped outer casing halves, or a single cup shaped outer casing part and a generally flat cover part. As a consequence of its specific cup form, the cup shaped outer casing part has a dimensional stability which is sufficient even in case said part consists of a plastic material. It is well-known that in general a plastic material has a lower modulus of elasticity than a steel material, but nevertheless the cup form per se provides the required stiffness.

**[0010]** This is however different in the case of the cover part. Such cover part may have a generally flat shape. A flat part generally has a lower dimensional stability, which means that such part will more readily deform, e.g. bulge out when an internal overpressure reigns within the outer

casing, than the cup shaped outer casing part. Although small deformations are acceptable, and will even occur in an outer casing fully consisting of steel or cast iron material, the deformations as occur in a flat cover part may become too large. However, such large deformations are unacceptable, as the pumping efficiency will be greatly reduced thereby.

**[0011]** The object of the invention is therefore to provide a centrifugal pump of the type described before, which on the one hand is fit for application in the process of pumping abrasive materials and for withstanding impact loads, but which is less heavy and/or less costly. Furthermore, an object of the invention is to provide a pump housing having a cover part with a less complicated structure. This object is achieved in that the cover part comprises a single element which extends as a unity continuously between the cup shaped part and the outer casing inlet.

**[0012]** The single piece cover part, that is without the prior art removable inlet lid, can be carried out in a relatively simple way and with less cost. This is largely due to the fact that a separate inlet lid, which has to be connected to the main cover through a ring of bolt connections, has been omitted. For instance, the cover part may comprise a single plate element or a single layered element.

**[0013]** According to a first preferred embodiment, said cover part may comprise a plastic material. Preferably, the cover part comprises at least one reinforcement ring near the outer circumference of the cover part. By applying the reinforcement ring within the structure of the cover part, the stiffness thereof against out of plane deformations, is greatly increased. As a consequence, the cover part, when loaded by an internal overpressure within the outer casing, will only deform to an extent which is acceptable from an operational point of view. Thus, also a centrifugal pump having a cup shaped outer casing part and a generally flat cover part may comprise a plastic material in the cover part. Of course, the cup shaped outer casing part may comprise a plastic material as well, but in an alternative embodiment said cup shaped outer casing part may comprise a steel material or a cast iron material.

**[0014]** Preferably, at least a reinforcement ring is provided at or near the outer circumference of the cover part. Such reinforcement ring increases the resistance against radial enlargement of the outer casing under the influence of internal overpressures. The stiffening of the outer casing thus obtained also prevents the occurrence of internal leakages. More preferably, in the cover part which comprises a centrally located inlet opening, at least a reinforcement ring is provided at or near the inlet opening. In case overpressures occur within the outer casing, the reinforcement rings in question will be loaded by tensile forces, which forces can be accommodated conveniently by the closed form of the rings in question.

**[0015]** The stiffness of the cover part is favourably influenced in case one reinforcement ring is positioned adjacent one of the main sides of said cover part, and another reinforcement ring is positioned adjacent the other main side. Consequently, in a direction transverse with respect to said main sides, the reinforcement rings are positioned at a distance from each other.

**[0016]** As addressed before, the reinforcement ring or rings should be able to withstand deformations, in particular in circumferential direction. Thus, the hoop stiffness should be sufficiently high. In this connection, the reinforcement rings preferably comprise a fiber material. Such fiber material may for instance consist of carbon fibers or glass fibers, which are wound in circumferential direction.

**[0017]** Furthermore, the cover part comprises generally parallel main walls which are at the distance from each other. According to the invention, also said main walls may comprise a plastic material. In particular, the walls each may comprise a laminar structure. In this connection, the walls may comprise a composite material. As an example, reference is made to walls which comprise layers of fiber-reinforced plastic material. These layers may be oriented radially and/or tangentially. As an example, reference is made to an embodiment having 70% of tangentially oriented, and 30% of radially oriented fibers. Said fibers may comprise glass fibers or carbon fibers; also mixed fibers are possible. With the aim of improving the impact resistance of the outer casing, the glass fibers are positioned on the outside.

**[0018]** Additionally, the walls may be interconnected through a sandwich core. Such sandwich core may take several forms, for instance the walls may be interconnected through ribs. The orientation of the ribs may be manifold, for instance radially oriented, or they may cross each other. An outer peripheral circumferential ring may extend between the external circumferences of the walls. In case the walls each comprise a central opening, said central openings being aligned, an inner peripheral circumferential ring may extend between the inner circumferences, as defined by said central openings, of the walls.

**[0019]** According to a second possibility, the cover part comprise may a steel material. Also, a combination of steel and plastics material is possible, such as a laminate of steel and plastic sheets.

**[0020]** The invention will now be described further with reference to an embodiment of the centrifugal pump as shown in the drawings.

**[0021]** Figure 1 shows a view on the suction side of an embodiment of the pump according to the invention.

**[0022]** Figure 2 shows a cross-section according to II-II of figure 1.

**[0023]** Figure 3 shows a view in perspective of the pump.

**[0024]** Figure 4 shows a view in perspective of the pump with the cover detached.

**[0025]** Figure 5 shows a cross-section of the cover on a larger scale and in more detail, according to V-V- of figure 6.

**[0026]** Figure 6 shows a front view of the cover.

**[0027]** Figure 7 shows a cross-section of the cup shaped part of the outer casing.

**[0028]** Figure 8 shows detail VIII, concerning a seal, of figure 2 on an enlarged scale.

**[0029]** Figure 9 shows a detail concerning the seal of Figure 8 upon removal of the cover part.

**[0030]** Figure 10 shows a cross section to a further embodiment.

**[0031]** The centrifugal pump as shown in figures 1-4 comprises an outer casing 1, in which the inner casing 2 as visible in figures 2 and 4 is contained. Said inner casing 2 has a tangentially oriented outlet 4. An impeller 5, having a suction inlet 3,is rotatably supported within the inner casing 2 around axis 24 by means of a drive shaft 6. Said drive shaft 6 in turn is rotatably mounted in a support (not shown), and connected to a drive motor (not shown).

**[0032]** Similarly, the outer casing 1 has an outer casing inlet opening 7 which is coaxial to the inlet 3 of the impeller 5. As a result of the single unit lay out of the cover part 14, the diameter of the inlet opening thereof is smaller than the external diameter of the impeller 5. Opposite the outer casing inlet opening 7, the outer casing 1 has a shaft opening 8 through which the drive shaft 6 extends. By means of the lid 9, the drive shaft 6 is sealed with respect to the outer casing 1. Furthermore, the outer casing 1 has a tangentially oriented outer casing outlet opening 10, which is coaxial to the outlet 4 of the inner casing 2. Mounting supports 11 are arranged on the outer casing 1 so as to support the pump, for instance with respect to the deck of a ship. A pipe 12 (only the extreme end of which is shown in the figures) is positioned at a certain distance from the centrifugal pump 1. By means of an intermediate pipe piece (not shown), said pipe 12 can be connected to the inlet opening 7 of the outer casing 1, as shown in figure 4, and in particular to the suction mouth wear ring 68 which by means of the suction seal 69 is sealed with respect to the impeller 5. As will be clear, said intermediate pipe piece has been removed so as to enable the displaced position of the cover part 14 shown in figure 4.

**[0033]** The outer casing 1 consists of a cup shaped part 13 and a generally flat cover part 14. The mounting supports 11 addressed before are attached to said cup shaped part 13. The cover part 14 is supported, e.g. with respect to the deck of the ship, by means of the support structure 15. This support structure 15 comprises two A-frames 16, which by means of rollers 17 are displaceable to and fro on the rails 18. Onto the A-frames 16, a ring sector 19 is mounted which is concentric with respect to the axis 24. Said ring sector 19 comprises slits 20, within which pins 21 mounted on the cover part 2 are supported. Additionally, the cover part 2 comprises a bottom support sector rim 25 which is concentric with respect to the axis 24. Said bottom support sector rim 25 in turn is slidably held within bottom support sector profile 26, which has in cross-section a radially inward oriented U-shape. Thereby, the cover part 2 is rotatably supported around axis 24 between the fitted position shown in figures 1, 2 and 3, and the rotated, detached position as shown in figure 4. A wear plate 62 and a shoulder plate 66 are connected to the inner surface of the cover part 14, next to the impeller 2.

**[0034]** As shown in figure 4, the cover part 14 comprises a radially outward facing closure rim 22 which is positioned behind the bottom support sector rim 25 (see figure 2). Said closure rim 22 is partly of a slight spiral shape with respect to the axis 24, and comprises a spiral shaped portion 27 extending over about 270 degrees with respect to the axis 24, and a straight portion 28. The spiral shaped portion 27 ends at the top of the cover portion 2 which adjoins the outlet opening 10 in the cup shaped part 1. Furthermore, the closure rim 22 comprises a flange portion 57 which extends between the spiral shaped portion 27 and the straight portion 28, at the location of the tangential outlet 4. Said mounting flange is provided with a series of holes 58, the purpose of which will be described below.

**[0035]** The cup shaped part 13 is provided with a profile 23 of a similar spiral and straight shape, which profile 23 defines, as seen in figure 2, a U-shaped cross-section facing radially inward and defining a groove 33. Said profile has a spiral shaped portion 29 and a straight portion 30. As is clear from the figures 1-4, the profile does not extend over the full circumference of the cup shaped part 13. In particular, the circumferential portion 59 extending between the spiral shaped portion 29 of the profile 23, and the straight portion 30 of the profile 23, lacks said profile. Instead, said circumferential portion 59 comprises screw threaded holes, the purpose of which will be described below. A tooth wheel 31 is rotatably mounted on the spiral shaped part 29 of the profile 23, and a corresponding arc shaped tooth rack 32 is mounted on the cover part 14. Said tooth rack 32 is concentric with respect to the axis 24. A wear plate 63 and shoulder plate 67 are connected to the cup shaped part 13, next to the impeller.

**[0036]** Subsequently, the process of mounting the cover part 14 with respect to the cup shaped part 13 will be described, starting from figure 4. From the position as shown in figure 4, the cover part 2 is moved towards the cup shaped part 13 by means of the support structure 15. In this process, the rim 22 of the cover part 14 can move past the profile 23 of the cup shaped part 13, having regard to the rotated position of the cover part 14. Once the cover part 14 abuts the cup shaped part 13, and the tooth wheel 31 and the tooth rack 32 have come into engagement, the cover part 14 can be rotated. This rotation is obtained by rotating the tooth wheel 31, e.g. by means of an electric motor (not shown), whereby the tooth rack 32 together with the cover part 14 is rotated. The rim 22 of the cover part 14 now becomes gradually engaged in the groove 33 of the profile 23, whereby in particular the spiral shaped portion 27 of the rim 22 is moved into the spiral shaped portion 29 of the profile 23, and the straight portion 28 of the rim 22 is moved into

the straight portion of the profile 23. Finally, bolts 61 are inserted through the holes 58 in the flange portion 57 of the cover part 14, and threaded into the screw threaded holes 60 in circumferential portion 59 of the cup shaped part 13. Thus, a tight connection between the cover part 14 and the cup shaped part 13 is established.

**[0037]** Disasssembling of the cover part 14 from the cup shaped part 13 occurs in the opposite way. After removing the cover part 14, the impeller 5 may be exchanged, if necessary. Also, the wear plate 62 on the inner wall 35 of the cover part 14 may be removed, as well as the wear plate 63 (the latter one after removal of the impeller 2).

**[0038]** Both the cup shaped part 13 and the other part 14 are carried out in a plastic material. As shown in figure 5, the cover part 14 comprises an inner main wall 35 and an outer main wall 36, between which a core 37 is present which can also be carried out in a plastic material. In the embodiment shown, the inner main wall comprises an integral tubular part 38 (defining the inlet opening 7 of the centrifugal pump) onto which the pipe 12 (see figures 1-4) can be fitted by means of an intermediate pipe piece. Said tubular part 38 extends along and is connected to the opening 46 of the outer main wall 36. The outer main wall 36 comprises an axially extending edge 39 provided with a radially extending flange 40, connected to the corresponding radially extending flange 41 of the inner main wall 35. The flanges 40, 41 together constitute the rim 22 addressed before.

**[0039]** As a generally flat element such as the present cover part 14 has a limited rigidity with respect to loadings in a direction perpendicular to said element, the reinforcement rings 42, 43 have been provided. The outer reinforcement ring 42 is positioned against the inner surface of the axially extending edge 39, and extends between the main walls 35, 36. The inner reinforcement ring 43 is positioned against the outer surface of the tubular portion 38, and extends between the outer main wall 36 and a ridge 44 of the inner main wall 35.

**[0040]** In the embodiment shown, both rings 42, 43 are of a tubular shape, although other shapes are possible as well. The rings 42, 43 comprise a high strength fibre material, such as carbon fibres or glass fibres, which are wound in the circumferential direction. Thereby, the rings 42, 43 provide the cover part 14 with a considerable stiffness, which means that deformations of said cover part 14 under internal overpressure remain within acceptable limits during service of the centrifugal pump in question.

**[0041]** An important advantage of the cover part 14 according to the present invention is related to the fact that the dimension thereof in axial direction is limited in comparison to the axial dimension of the state of the art steel cover parts. Said steel cover parts are provided with reinforcement rings which extend from the outer main wall thereof, resulting in a considerable axial dimension of said cover part.

**[0042]** As shown in the cross-section of figure 76, the cup shaped part 13 of the outer casing 1 can consist of a plastic material as well. To that end, said cup shaped part 13 comprises an outer cup shaped element 50 an inner cup shaped and 51, each having a bottom 52 respectively 53 as well as walls 54 respectively 55. The walls 54, 55 are connected to each other, e.g. by gluing, whereas the bottom is 52, 53 interconnected through a core 56. Furthermore, the profile 23, comprising the inwardly facing U-shaped groove 33, is integral with the outer cup shaped element 50. By means of a connection 47 as contained in the cup shaped part 13 of the outer casing 1, an overpressure can be maintained within said outer casing 1.

**[0043]** As shown in figures 8 and 9, an inflatable sealing ring 64 is present between the cover part 14 and the cup shaped part 13. Said sealing ring 64 is fitted within a slot 70 of the cup shaped part 13, which slot 70 opens out next to the groove 33 of the profile 23. Said slot 70, together with the sealing ring 64, extends fully around the circumference of the cup shaped part 13, so as to obtain the required tightness of the inner space of the outer casing 1. The sealing ring 64 is a labyrinth type sealing ring having a series of external ridges 71, which seal against the surface of the cover part 14.

**[0044]** The sealing action of the sealing ring 64 it is obtained by inflating said ring. The step of inflating is obtained by feeding a pressure gas into the internal chamber 65 of the sealing ring 64. In case the cover part 14 is removed from, or applied onto the cup shape part 13, first of all the sealing ring 64 is deflated by letting the pressure gas flow out of the chamber 65. Thus, any damage to the sealing ring 64 which might be caused by the movement of the other part 14, is prevented. The deflated state of the sealing 64 is shown in figure 9, which also shows the cover part 14 rotated in such a way that the spiral shaped portion 27 thereof has just been rotated out of the groove 33 of the profile 23 of the cup shaped part 13.

**[0045]** The embodiment of figure 10 shows a centrifugal pump with an external steel outer casing 1, in particular a steel cup shaped part 13 and a steel plate shaped cover part 14. Said cover part 14 stretches as a unity from the cup shaped part 13, in particular from the bolted connection 80, towards the inlet opening 7 of the outer casing 1. As a result, the cross sectional dimensions or diameter of the central opening 70 in the cover part 14 are smaller than the outer diameter of the impeller 5.

## Claims

**1.** Centrifugal pump, comprising an outer casing (1), an inner casing (2) contained in the outer casing (1), an impeller (5) rotatably supported within the inner casing (2), an outer casing inlet (7) concentrically arranged with respect to the impeller (5) as well as a tangential outer casing outlet (4), said outer casing (1) comprising a cup shaped part (13) as well as a cover part (14) mounted onto the cup shaped part

(13), which cover part (14) comprises at least one reinforcement ring (42, 43), **characterised in that** said cover part (14) comprises a single element which extends as a unity continuously between the cup shaped part (13) and the outer casing inlet (7).

**2.** Centrifugal pump according to claim 1, wherein the cover part (14) comprises a single plate element or a single layered element.

**3.** Centrifugal pump according to claim 1 or 2, wherein said cover part (14) comprises a plastic material.

**4.** Centrifugal pump according to claim 3, wherein at least a reinforcement ring (42) is provided at or near the outer circumference of the cover part (14).

**5.** Centrifugal pump according to claim 3 or 4, wherein the cover part (14) comprises a centrally located inlet opening (7), wherein at least a reinforcement ring (43) is provided at or near the inlet opening (7).

**6.** Centrifugal pump according to claims 4 and 5, the cover part (14) having opposite main sides (35, 36), wherein one of the reinforcement rings is positioned adjacent to one of said main sides, and the other of the reinforcement rings is positioned adjacent to the other main side.

**7.** Centrifugal pump according to claims 4 and 5, the cover part (14) having opposite main sides (35, 36), wherein in a direction transverse with respect to said main sides (35, 36) the reinforcement rings (42, 43) are positioned at a distance from each other.

**8.** Centrifugal pump according to any of claims 3-7, wherein the reinforcement rings (42, 43) comprise a fiber material.

**9.** Centrifugal pump according to claim 8, wherein the fiber material comprises carbon fiber.

**10.** Centrifugal pump according to claim 9 wherein the fiber material comprises glass fibers.

**11.** Centrifugal pump according to claim 9 or 10, wherein the fiber material is wound in circumferential direction.

**12.** Centrifugal pump according to any of claims 3-11, wherein the cover part (14) comprises generally parallel main walls (35, 36) which are at the distance from each other, said main walls (35, 36) comprising a plastic material.

**13.** Centrifugal pump according to claim 12, wherein the main walls (35, 36) each comprise a laminar structure.

**14.** Centrifugal pump according to claim 13, wherein the main walls (35, 36) comprise a composite material.

**15.** Centrifugal pump according to claim 13 or 14, wherein the main walls (35, 36) comprise layers of fiber-reinforced plastic material.

**16.** Centrifugal pump according to claim 15, wherein the main walls (35, 36) comprise radially and/or tangentially oriented layers.

**17.** Centrifugal pump according to any of claims 12 to 16, wherein the main walls (35, 36) are interconnected through a sandwich core (37).

**18.** Centrifugal pump according to any of claims 12 to 17, wherein the main walls (35, 36) are interconnected through ribs.

**19.** Centrifugal pump according to claim 18, wherein the ribs are radially oriented.

**20.** Centrifugal pump according to any of claims 12 to 19, wherein an outer peripheral circumferential ring (42) extends between or near the external circumferences (40, 41) of the main walls (35, 36).

**21.** Centrifugal pump according to any of claims 12 to 20, wherein the main walls (35, 36) each comprise a central opening (38, 46) said central openings being aligned, and an inner peripheral circumferential ring (43) extends between or near the inner circumferences, as defined by said central openings (38, 46), of the main walls (35, 36).

**21.** Centrifugal pump according to any of claims 3-20, wherein at least one reinforcement ring (42, 43) is contained within the contour of the cover part (14) as defined by the main walls (35, 36).

**22.** Centrifugal pump according to any of claims 3-21, wherein the outer casing (1) surrounds the inner casing (2) in a fluid tight way.

**23.** Centrifugal pump according to claims 1 or 2, wherein the cover part (14) comprises a steel material.

**24.** Centrifugal pump according to any of the preceding claims, comprising a sealing ring (64) between the cup shaped part (13) and the cover part (14), wherein said sealing ring (64) is expandable.

**25.** Centrifugal pump according to claim 24, wherein the sealing ring (64) comprises an internal chamber (65) which can be connected to a gas source for inflating the sealing ring (64).

**26.** Centrifugal pump according to any of the preceding claims, wherein the outer casing (1) comprises at least one connection (47) for maintaining an overpressure within said outer casing (1).

**27.** Centrifugal pump according to any of the preceding claims, wherein the outer casing (1) comprises a shaft cover (9) through which the shaft (6) extends in a fluid tight way.

**30.** Centrifugal pump according to any of the preceding claims, wherein the cover part (14) has a generally flat shape.

**31.** Centrifugal pump according to any of the preceding claims, wherein a wear plate (62) is provided on the inner surface of the cover part (14).

**32.** Centrifugal pump according to any of the preceding claims, wherein a wear plate (63) is provided on the inner surface of the cup shaped part (13).

**33.** Centrifugal pump according to claim 31 and 32, wherein shoulder plates (66, 67) are provided between the respective wear plates (62, 63) and the inner casing (2).

**34.** Centrifugal pump according to any of the preceding claims, wherein the cover part (14) overlaps the impeller (5), when seen in radial direction.

**35.** Centrifugal pump according to any of the preceding claims, wherein the cover part (14) has a central opening (70), the cross sectional dimensions of which are smaller than the outer diameter of the impeller (5).

Fig 1

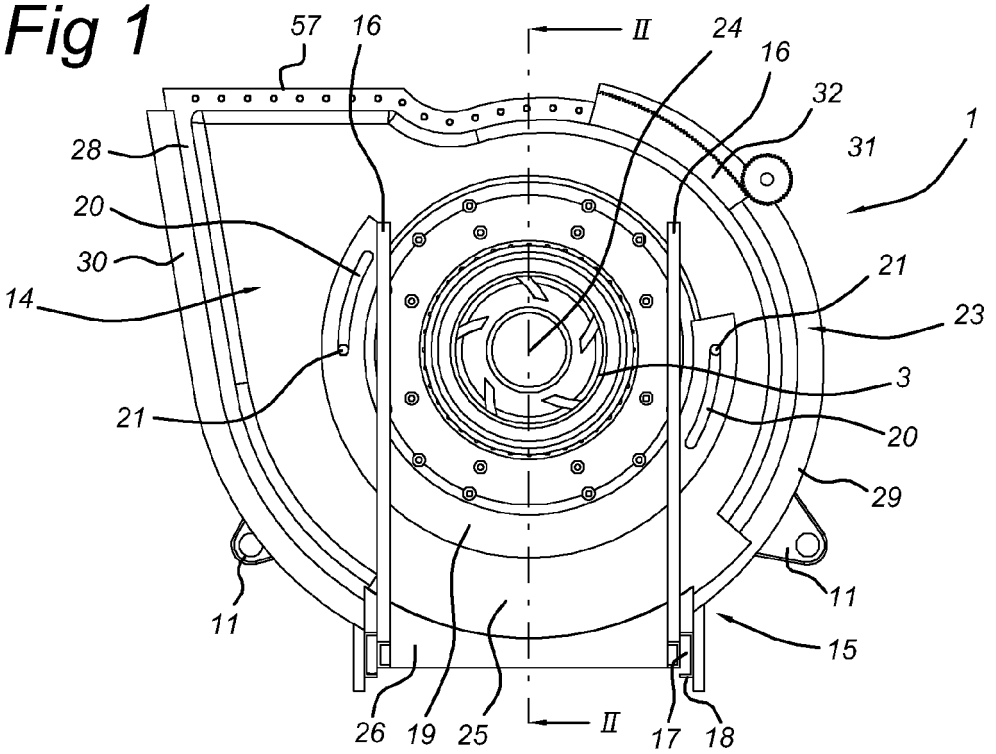

57
16
II
24
16
32
1
31
28
20
30
14
21
23
3
21
20
29
11
11
15
26
19
25
II
17
18

Fig 2

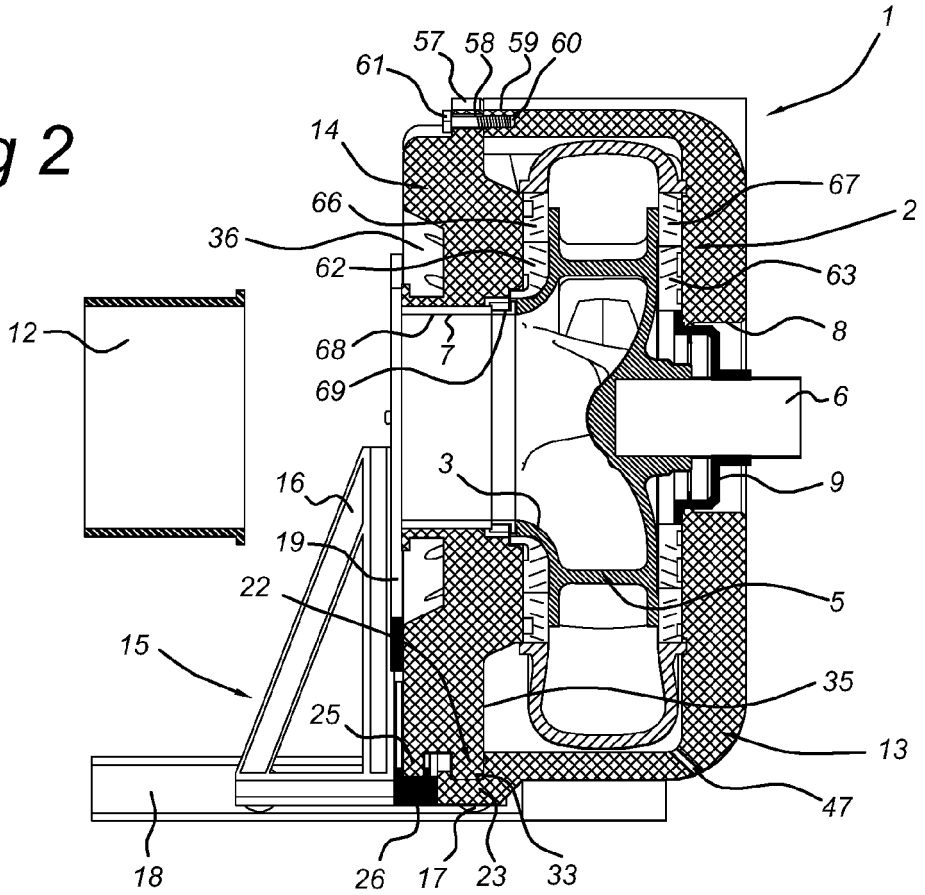

1
57
58
59
60
61
14
67
66
2
36
62
63
12
68
7
8
69
6
3
9
16
19
22
5
15
35
25
13
47
18
26
17
23
33

Fig 3

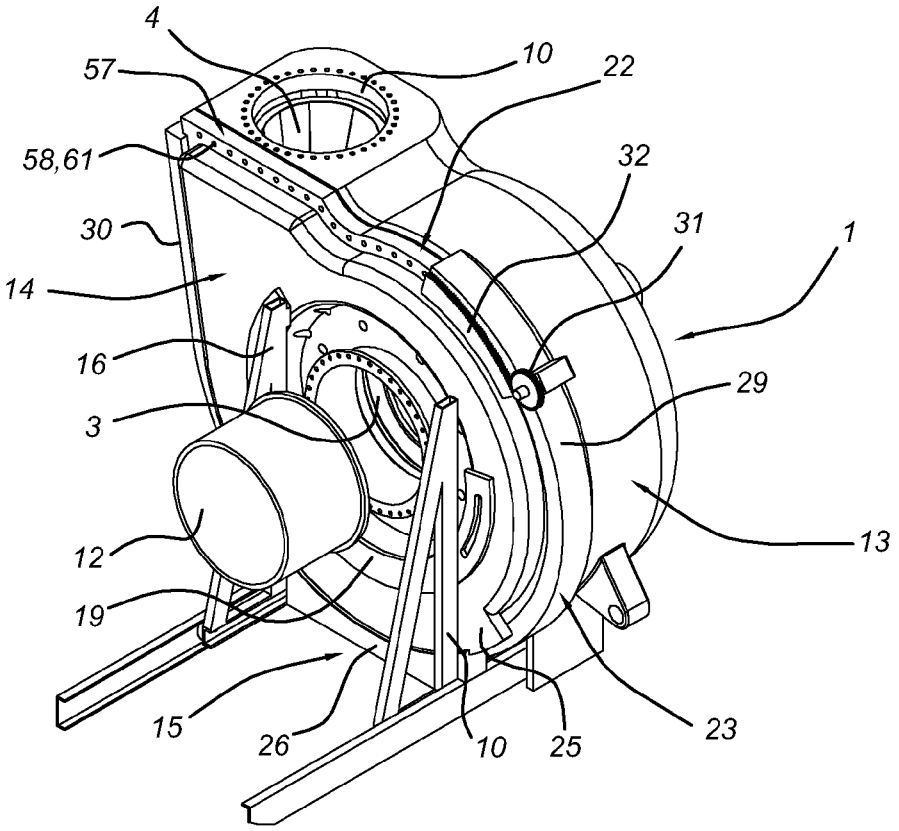

4
57
10
22
58,61
32
30
31
1
14
16
29
3
13
12
19
15
26
10
25
23

Fig 4

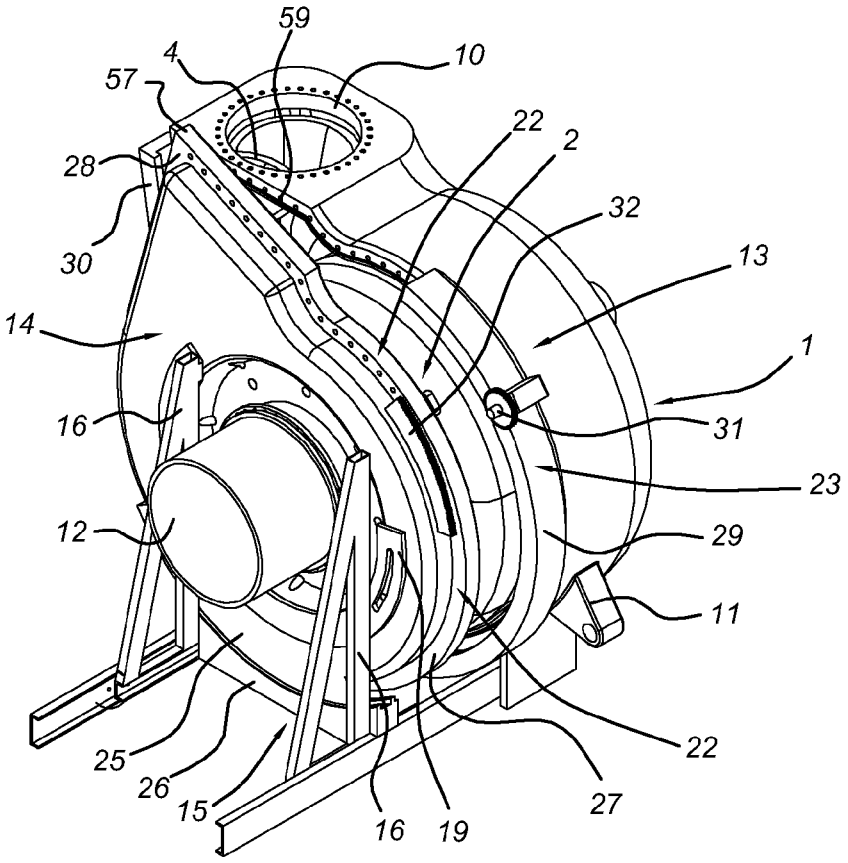

59
4
57
10
22
2
28
32
30
13
14
1
16
31
23
12
29
11
25
26
15
16
19
27
22

Fig 5

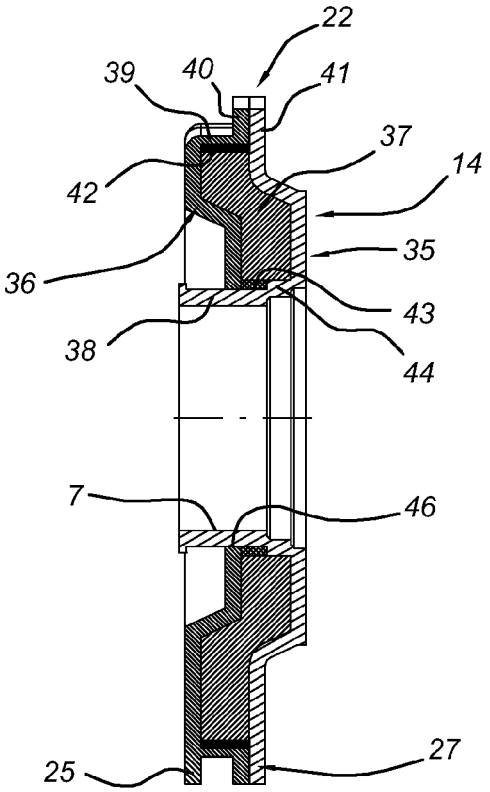



Fig 6

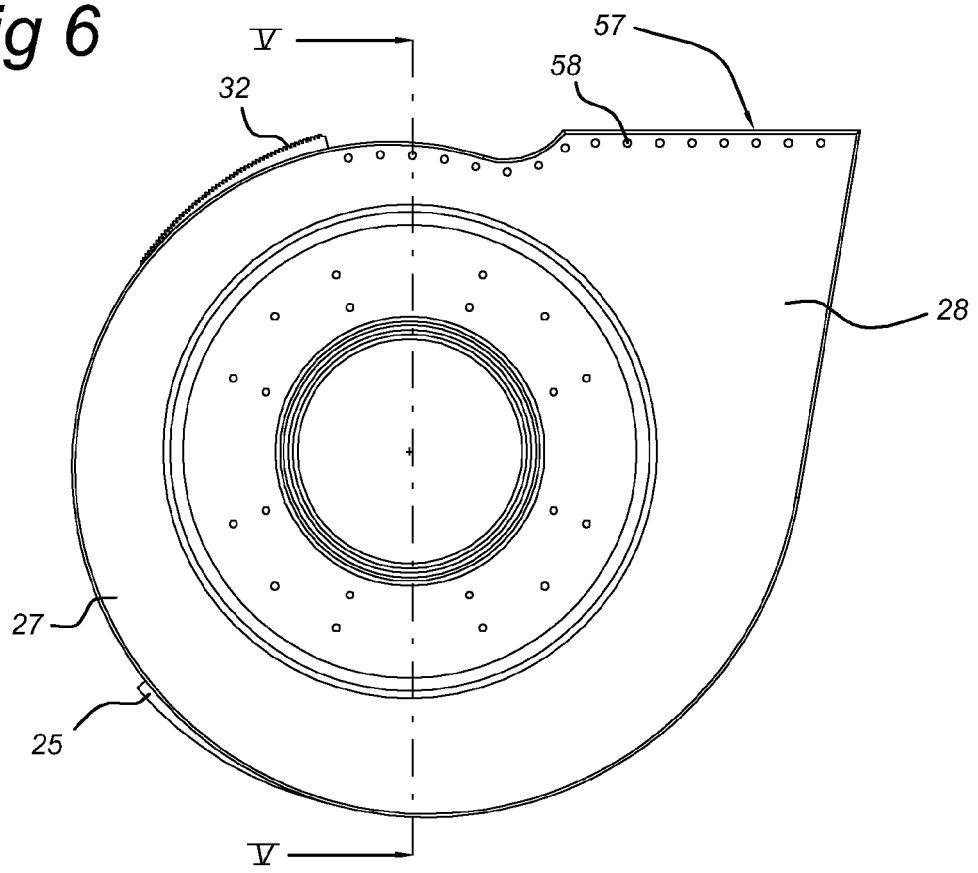


Fig 7

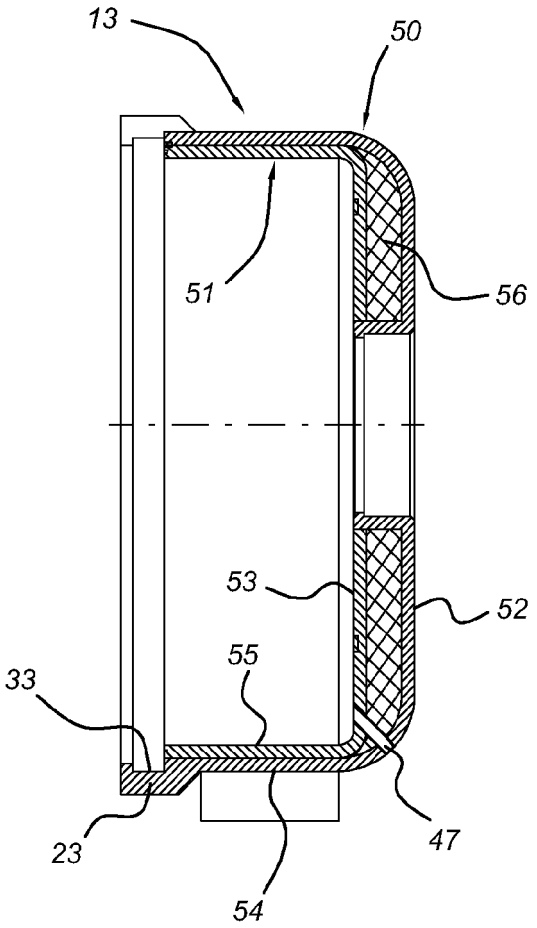



Fig 8

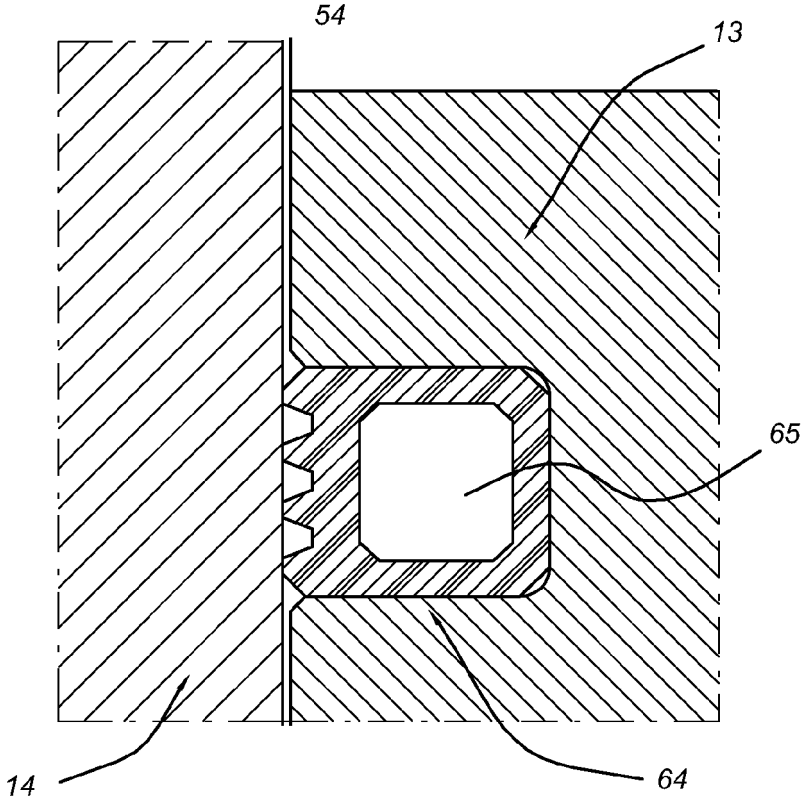


Fig 9

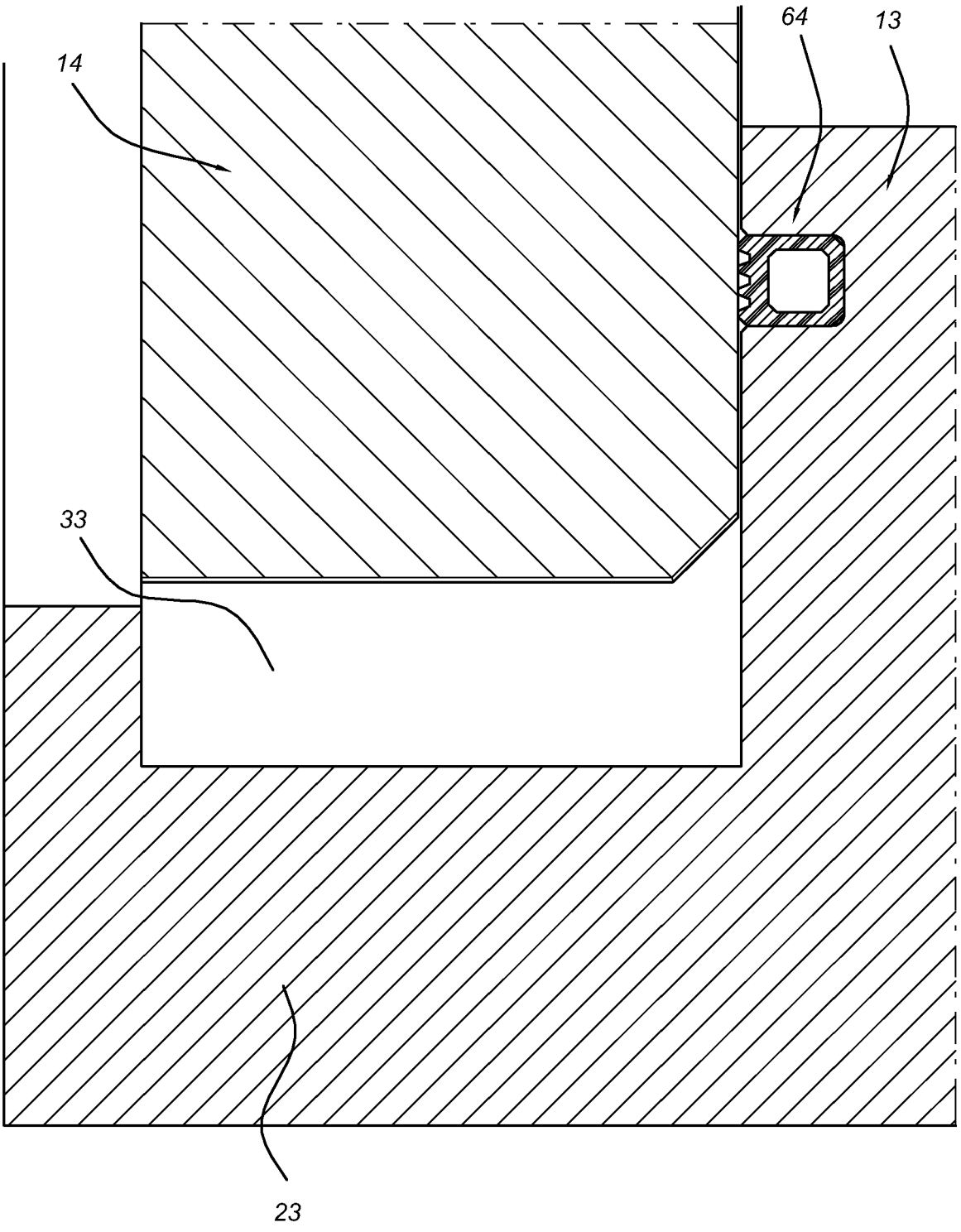
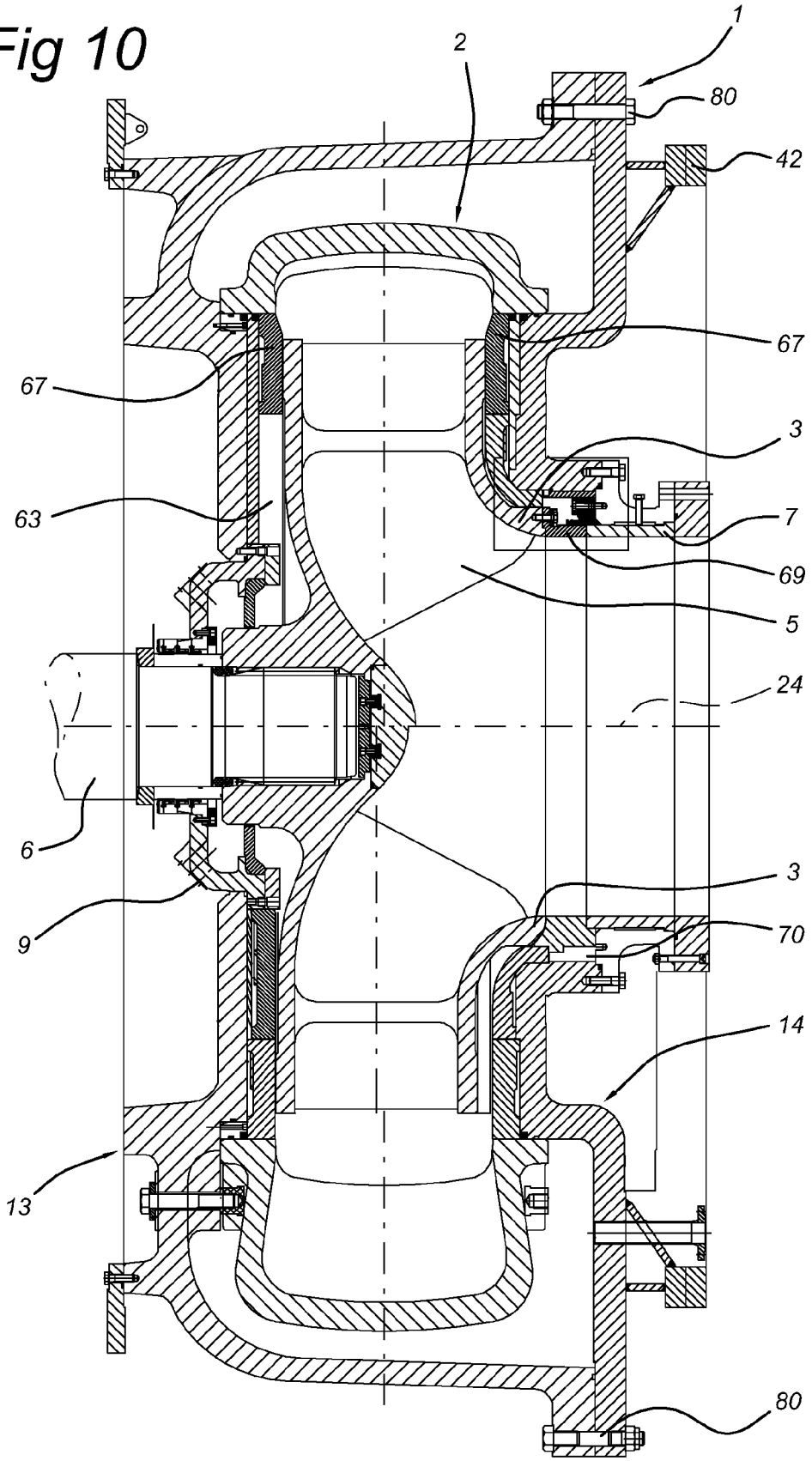


Fig 10



European Patent Office

# EUROPEAN SEARCH REPORT

Application Number
EP 07 10 4824

## DOCUMENTS CONSIDERED TO BE RELEVANT

| Category | Citation of document with indication, where appropriate, of relevant passages | Relevant to claim | CLASSIFICATION OF THE APPLICATION (IPC) |
|---|---|---|---|
| X | DE 629 780 C (J E NAEHER ACT GES)<br>11 May 1936 (1936-05-11)<br>* the whole document *<br>* figure 1 * | 1-35 | INV.<br>F04D7/04<br>F04D29/42 |
| X | FR 1 314 736 A (GABBIONETA R.)<br>11 January 1963 (1963-01-11)<br>* the whole document *<br>* figure 1 * | 1-35 | |
| A | DE 827 590 C (FELIX LEHMANN)<br>10 January 1952 (1952-01-10)<br>* the whole document * | 1-35 | |
| A | DE 10 2005 019654 A1 (IHC HOLLAND NV [NL])<br>19 January 2006 (2006-01-19)<br>* the whole document * | 1-35 | |
| | | | TECHNICAL FIELDS SEARCHED (IPC) |
| | | | F04D |

The present search report has been drawn up for all claims

| Place of search | Date of completion of the search | Examiner |
|---|---|---|
| The Hague | 20 September 2007 | Ingelbrecht, Peter |

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 07 10 4824

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.

20-09-2007

| Patent document cited in search report | Publication date | Patent family member(s) | Publication date |
|---|---|---|---|
| DE 629780 C | 11-05-1936 | NONE | |
| FR 1314736 A | 11-01-1963 | NONE | |
| DE 827590 C | 10-01-1952 | NONE | |
| DE 102005019654 A1 | 19-01-2006 | BE 1016507 A3 | 05-12-2006 |
| | | GB 2413604 A | 02-11-2005 |
| | | NL 1026041 C2 | 27-10-2005 |

EPO FORM P0459

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

## REFERENCES CITED IN THE DESCRIPTION

*This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.*

### Patent documents cited in the description


- EP 06113796 A **[0005]**