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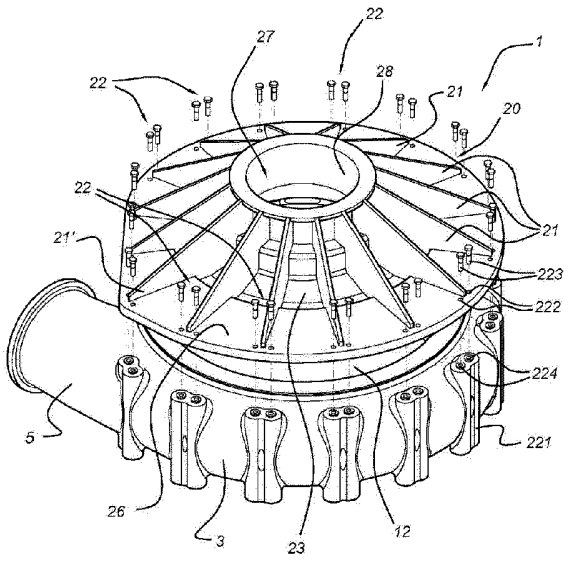
(54) **Pump and a method of manufacturing such a pump.**

(57) The invention relates to a pump housing (2) comprising a circumferential wall (3), a pump casing (20) and a shaft cover (40). The pump casing (20) is attached to the circumferential wall (3) by a plurality of connection means. The pump casing (20) comprises a central opening (27) to form an axial supply (14) of the pump housing (2) for material to be pumped. The circumferential wall (3) closes the pump housing (2) along its outer circumference. The pump (1) comprises a plurality of connection means (22) connecting the pump casing (20) to the circumferential wall (3). The connection means (22) are positioned in groups along the circumference of the pump housing (2), wherein the groups are regularly distributed along the circumference of the pump housing (2).



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Pump and a method of manufacturing such a pump

TECHNICAL FIELD

The invention relates to a pump, a pump housing and a method of manufacturing such as a pump and pump housing.

BACKGROUND

Centrifugal pumps are known, for instance from European patent applications EP1903216 and EP1906029. Such pumps can be used for dredging purposes, i.e. to pump slurry comprising water and dredged materials. An example of such a centrifugal pump is depicted in Fig.'s 1 and 2.

Fig.'s 1 and 2 schematically depict an example of such a known centrifugal pump 1, both Figures showing a cross-sectional view in different directions. The pump 1 comprises a pump housing 2 shaped like a volute (spiral casing). The pump housing 2 comprises a circumferential wall 3, a pump casing 20 and a shaft cover 40. The circumferential wall 3 comprises a spout-shaped outlet 5 attached tangentially to the circumferential wall 3 . The junction between the inner surface of the tangential outlet 5 and the inner surface of the circumferential wall 3 of the pump housing 2 defines what is known as a cutwater 4. The pump housing 2 also has an axial inlet 6, shown in Fig. 2.

The circumferential wall 3 may have a U-shaped or semicircular cross-section, comprising two (parallel) legs 31 extending in a radial inward direction and a middle part connecting the two legs forming the outer wall 32 of the circumferential wall. This outer wall 32 may be a straight part or may be curved.

The outer wall 32 spirals outwardly about the axial rotation axis A of the pump 1 (defined below) towards the tangential outlet 5.

A rotor 7 is attached in the pump housing 2 such that it may rotate about an axial rotation axis A. The rotor 7 comprises rotor blades 15, a shaft shield 11 and a suction shield 12. The rotor 7 also comprises a central boss 9 which may be fastened to a drive shaft (51). The shaft shield 11 extends from the central boss 9. The shaft shield 11 forms a first wall for delimiting the flow within the rotor 7. Axially set apart from the shaft shield 11, the rotor 7 has the suction shield 12 which defines a second wall for delimiting the flow within the rotor 7. The suction shield 12 has an axial supply 14 which is aligned with the axial inlet of the pump housing 2.

A plurality of rotor blades 15 are fastened between the shields 11, 12. In this illustrative embodiment, the rotor 7 comprises three rotor blades 15. The rotor blades 15 each extend substantially radial to the rotation axis A. Between the radial outer ends 17 of the rotor 7 and the inner surface of the circumferential wall 3 of the pump housing 2 there is a circumferential channel 19.

The circumferential wall 3 of the pump housing 2 substantially closes the inner space of the rotor 7 along its outer circumference between the shields 11, 12 and may have a rounded shape.

In order to provide a strong pump, the pump housing 2 further comprises a pump casing 20 and a shaft cover 40, both attached to the circumferential wall 3.

The pump casing 20 is attached to the pump housing 2, i.e. to the circumferential wall 3, by suitable connection means 22. The pump casing 20 has a central opening which may form the axial supply 14 or may surround the axial supply 14. The pump casing 20 may comprise a stepped part 23 and reinforcing ribs 21 (not shown in Fig.'s 1 and 2).

The shaft cover 40 is also attached to the circumferential wall 3 opposite the pump casing 20, by suitable connection means 42. The shaft cover 40 also has a central opening to allow a drive axis 51 of a pump motor 50 to be connected to the rotor 7.

During operation, the drive axis 51 and the rotor 7 rotate about the rotation axis A. Between the rotor blades 15, the mass to be pumped is forced radially outward into the pump housing 2 under the influence of centrifugal forces. Said mass is then entrained in the circumferential direction of the pump housing 2 toward the tangential outlet spout 5 of the pump housing 2. The pumped mass which, after leaving the rotor 7, is entrained in the circumferential direction of the pump housing 2 flows largely out of the tangential outlet of the pump housing 2. A small amount of the entrained mass re-circulates, i.e. flows along the cutwater 4 back into the pump housing 2.

When such pumps are used for dredging, the pumps may be subjected to extreme wear, especially the rotor 7 and the circumferential wall 3. Therefore preferably wear resistant material is used. However, these materials are in general not well suited for construction purposes, as they are usually brittle. An example of such a material is white cast iron such as maxidur.

As a result of the pumping, high pressure will be generated forcing the pump casing 20 outwardly. High loads may be transferred via connection means 22. From

Fig. 2 it can be seen that these loads may introduce a bending moment in the circumferential wall 3 of the pump housing 2, as the leg 31 to which the pump casing 20 is attached is forced in an outward direction. To prevent introducing a bending moment, or keeping the bending moment relatively small, in the circumferential wall 3 of the pump housing 2, it is known to position the connection means 22 more outwardly than shown in Fig. 2, i.e. along the outer circumference of the circumferential wall 3 of the pump housing 2, at the position where the circumferential wall 3 is relatively thick (seen in the direction of the connection means 22) and is thus able to take up high loads. An example of this is the LSA-S Series Slurry Pumps of GIW Industries.

This will result in lower stresses in the circumferential wall 3 of the pump housing 2 and reduces the chance of deformation of the circumferential wall 3.

Further examples of connection means provided along the outer circumference are provided by DE2541422A1, GB719285A and FR567370A.

SUMMARY

It is an object to provide a pump housing and pump which is stiffer, stronger and thus more efficient. It is also an object to provide an improved method of manufacturing such a pump housing and pump.

Therefore, according to a first aspect there is provided a pump housing comprising a circumferential wall, a pump casing and a shaft cover, wherein the pump casing is attached to the circumferential wall by a plurality of connection means, and wherein the pump casing comprises a central opening to form an axial supply of the pump housing for material to be pumped, the circumferential wall closing the pump housing along its outer circumference,

wherein the pump comprises a plurality of connection means connecting the pump casing to the circumferential wall,

characterized in that the connection means are positioned in groups along the circumference of the pump housing, wherein the groups are regularly distributed along the circumference of the pump housing.

By providing the connection means in groups, a group comprising two or more connection means, and distributing the groups at regular intervals along the circumference of the pump housing, a strong and stiff pump housing is created, which can also be manufactured in an advantageous way.

The groups may be pairs comprising two connection means, whereby a pair is defined as two connection means with a distance between those two connection means which is at least 1/2 the distance between each connection means of that pair to the next closest connection means. This ratio may preferably be 1/3 or even 1/5.

A group may also comprise more than two connection means, whereby a group is defined as a plurality of connection means whereby a largest distance between any two connection means of the group is at least 1/2 the distance between each connection means of that group to the next closest connection means of a different group. This ratio may preferably be 1/3 or even 1/5.

The term regularly distributed is used to indicate that the groups or pairs are distributed along the circumference of the pump housing at substantially constant angles when seen from a centre point of the pump housing, i.e. at angles α equal to 360/n, n being an integer greater than 1, for instance 2, 3, 4, 5, 6, 7, 8, ... The term substantially constant is used to indicate that the different angles deviate less than 5%, preferably less than 2% with respect to each other.

According to an embodiment the pump casing comprises a plurality of reinforcing ribs positioned radially with respect to the central opening, wherein the connection means are positioned adjacent reinforcing ribs.

By providing the connection means adjacent the reinforcing ribs, the pump is stronger and stiffer, which is beneficial to the performance of the pump. The connection means hold the pump casing in position. The connection means are now positioned close to the reinforcing ribs, i.e. at a position where the pump casing is relatively strong. This results in an improved stress distribution, making the pump relatively strong and stiff.

The reinforcing ribs may extend from the axial supply towards the outer circumference of the pump casing. The ribs may have a triangular shape and may be orientated such that the height of the ribs reduces towards the outer circumference of the pump casing. There may be any suitable amount of ribs provided, such as eight, twelve or sixteen ribs. The ribs may be uniformly distributed.

The circumferential wall closes the pump housing along its outer circumference, but it will be understood that the circumferential wall may also comprise an outlet for the pumped materials.

The term adjacent is used to indicate that the distance taken along the perimeter of the pump casing between the connection means and the nearest reinforcing rib is at least 5 times smaller than the distance between the connection means and the second nearest reinforcing rib. Preferably, this distance may be at least 10 times smaller.

According to an embodiment the connection means of a group are positioned on opposite sides of the adjacent reinforcing rib.

The connection means forming a group or pair may be provided on opposite sides of the reinforcing ribs to provide a strong and symmetric construction. The connection means forming a pair may be positioned at the same distance from the associated reinforcing rib at opposite sides of the reinforcing rib.

Each reinforcing rib 21 may be provided with a pair of connection means 22, possibly with an exception for a minority of reinforcing ribs 21, e.g. one or two reinforcing ribs 21, which may be left without connection means 22 to meet certain constructional requirements or the like.

By placing connection means on either side of the reinforcing ribs the construction becomes even stiffer and the even stress distribution results in lower stresses.

Instead of pairs, groups of connection means may be provided, wherein a group comprises two, three, four or more connection means to provide an even stronger pump housing.

It is noted that although the connection means or pairs of connection means may be regularly distributed along the outer circumference, one or two connection means may be omitted, as already indicated above.

Such a distribution provides a relatively strong and stiff pump and simplifies the design and manufacturing process. The circumferential wall of the pump housing may be casted. The connection means, which may be bolt receiving structures provided on the outside of the outer circumference may also function as casting inlets for the casting material (such as liquid steel) during the casting process.

In case the connection means are provided in pairs, an additional advantage is provided. One casting inlet may then be provided for each pair. This allows a relatively large casting inlet, which is beneficial, as the casting material needs to be supplied to the mould sufficiently fast such that it can spread through the mould before it is solidified.

According to an embodiment the connection means are positioned along the outer circumference of the pump and connect the pump casing to a radial outer wall of the circumferential wall.

Providing the connection means along the outer circumference provides an even stronger and stiffer pump as bending moments in the circumferential wall, especially in the radial inwardly protruding legs of the circumferential wall are minimized and the connection means engage the circumferential wall at the outer wall, i.e. at a position where the circumferential wall is relatively thick in the axial direction.

According to an embodiment the connection means are formed by a connection member, such as a bolt, and bolt receiving holes provided on the circumferential wall and bolt receiving holes provided on the pump casing.

The connection member may be a screw bolt. One or both of the bolt receiving holes may comprise an inner thread to receive the screw bolt and hold the screw bolt in position. In order to provide a reliable inner thread a soft insert may be used. The material used for the pump housing is typically wear resistant material, i.e. it is hard but brittle, which is thus, mechanically and production wise, not well suited for threaded holes. An example of such a material is steel S235. To overcome this, a soft insert may be applied which is more suitable for providing an inner thread.

The bolt receiving holes provided on the circumferential wall and the bolt receiving holes provided on the pump casing are aligned with respect to each other.

According to an embodiment the circumferential wall comprises bolt receiving structures provided on the outer circumference of the circumferential wall.

The bolt receiving structures may protrude in a radial outward direction. The bolt receiving structures may be integrally formed with the circumferential wall. This provides a robust circumferential wall. This embodiment also provides advantages for the manufacturing process, as will be described in more detail below.

According to an embodiment each bolt receiving structure comprises at least two bolt receiving holes.

In order to prevent cracks and the like in the bolt receiving structures, the bolt receiving holes may not be positioned too close to each other, especially when soft inserts are used. As a consequence, the bolt receiving structures may not be too small. Such bolt receiving structures provide advantages in the manufacturing process. Also, such a design minimizes the amount of material that is needed.

According to an aspect there is provided a pump comprising a pump housing according to the above.

According to an aspect there is provided a circumferential wall of a pump housing, the circumferential wall comprises a spiral shaped outer wall and two inwardly protruding legs attached to the outer wall, wherein the circumferential wall comprises bolt receiving holes which are positioned in groups along the circumference of the circumferential wall, wherein the groups are regularly distributed along the circumference of the circumferential wall.

According to an aspect there is provided a method of manufacturing a circumferential wall for a pump housing, and wherein the circumferential wall comprises bolt receiving holes provided on the outside of the circumferential wall, wherein the method comprises:

- providing a mould for the circumferential wall, the mould comprising a plurality of casting openings,
- filling the mould with a liquid casting material by supplying the casting material to the mould via the casting openings,
- allowing the casting material to solidify in the mould,
- removing the mould,

characterized by the bolt receiving holes are positioned in groups along the circumference of the circumferential wall, wherein the groups are regularly distributed along the circumference of the circumferential wall.

According to an embodiment the circumferential wall comprises bolt receiving structures provided on the outer circumference of the circumferential wall, which bolt receiving structures coincide with the casting openings and/or function as risers during casting.

The design of the circumferential wall in combination with the positioning of the casting openings provides an advantageous method of manufacturing a circumferential wall. The bolt receiving structures, which may be formed as a structure protruding in a radial outward direction from the spiral shaped outer wall provides an optimal structure for the casting openings of the mould. Also, such bolt receiving structures are suitable to be used as risers, especially since the connecting means are provided in groups making the bolt receiving structures relatively large. Preferably, risers are not too small

as this will cause the casting material to solidify too quickly prohibiting the riser to function properly.

According to an embodiment each bolt receiving structure comprises at least two bolt receiving holes.

Such bolt receiving structures will typically be larger than bolt receiving structures for one bolt receiving hole, making these bolt receiving structures even more suitable to be used as casting inlets, as relative large quantities of casting material may be supplied into the mould via each cast opening, allowing a fast casting process.

According to an embodiment the casting material is one of steel, cast steel, grey or white cast iron.

BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments will now be described, by way of example only, with reference to the accompanying schematic drawings in which corresponding reference symbols indicate corresponding parts, and in which:

FIG. 1 and 2 schematically show two different cross-sectional views of a pump according to the prior art,

FIG. 3 schematically shows a perspective view of a pump housing according to an embodiment,

Fig. 4 schematically depicts a side view of a pump housing according to an embodiment,

FIG. 5 schematically depicts a detail of the pump housing according to an embodiment, and

Fig.'s 6a – b schematically depict a pump housing according to different embodiments.

The figures are meant for illustrative purposes only, and do not serve as restriction of the scope or the protection as laid down by the claims.

DETAILED DESCRIPTION

The embodiments will now be described with reference to the figures. Fig.'s 1 and 2 show a pump according to the prior art and were discussed above.

Fig. 3 shows an embodiment of a pump 1, a centrifugal pump, comprising a pump housing 2 with a circumferential wall 3, a pump casing 20 and a shaft cover 40 as

described above. The circumferential wall spirals outwardly to form a tangential outlet 5, as shown in the figures.

The pump housing 2 may be suitable for pumping a slurry comprising a mixture of water and dredged materials, such as sand, rocks etc. Therefore, the pump 1 is arranged to accommodate a rotor 7 comprising rotor blades 15, a shaft shield 11 and a suction shield 12 as described above.

The pump casing 20 is formed as a lid arranged to cover the pump housing 2 and provide the pump housing 2 with additional strength. The pump casing 20 has a substantially disc shaped part 26, although the disc shaped part 26 may not have a circular outer circumference, as it may deviate from a circular shape at the position of the outlet 5. In the centre of the pump casing 20 a central opening 27 is provided to allow mass to be pumped to enter the pump housing 2 via the axial inlet 6 and axial supply 14. At the central opening 27 an inlet conduit 28 may be formed as integral part of the pump casing 20, the inlet conduit 28 protruding from the pump casing 20 in the direction of the axial rotation axis A, away from the shaft cover 40 (not shown in Fig. 3). The inlet conduit 28 may form the axial inlet 6.

The pump casing 20 comprises a stepped part 23 forming a transition between the disc shaped part 26 and the inlet conduit 28, making the pump casing 20 strong. Furthermore, a plurality of reinforcing ribs 21 are provided. Each reinforcing rib 21 is substantially perpendicular with respect to the disc shaped part 26 and each reinforcing rib 21 is orientated in a different radial direction.

Also provided is a shaft cover 40 forming the counterpart of the pump casing 20, positioned on the shaft side of the pump housing. The shaft cover 40 also comprises a central opening to allow the drive shaft 51 of motor 50 to pass through and drive the rotor 7 to rotate about axis A.

As shown in Fig. 3, the connection means 22 (connecting the pump casing 20 to the circumferential wall 3) are provided in groups, such as pairs, positioned regularly, i.e. at regular intervals. This will be explained in more detail below with reference to Fig. 6.

The connection means 22 are also positioned adjacent the reinforcing ribs 21. The term adjacent is used her to indicate that that the connection means 22 are positioned close to a reinforcing rib 21, for instance at least 5 times, preferably at least 10 times closer to the closest reinforcing rib 21 than to the second closest reinforcing rib 21.

The connection means 22 may also be positioned close to the outer circumference of the pump casing 20, such that the connection means 22 engage the circumferential wall 3 at the position of the radial outer wall 32. In this case, the term 'close to' is used to indicate that the distance between the connection means 22 and the outer circumference of the pump casing 20 is less than 25%, or preferably less than 10%, of the radius of the pump casing 20, measured from the centre of the central opening 27 to the outer circumference of the disc shaped part 26.

According to the embodiment shown in Fig. 3, the connection means 22 are provided in pairs, i.e. each reinforcing rib 21 has two associated, adjacent, connection means 20, which are provided symmetrically on both sides of the reinforcing rib 21. Of course, more than two connection means 22 may be provided in association with one reinforcing rib 21. In general, a group of connection means 22 may be provided in association with a reinforcing rib 21.

In Fig. 3, connection means 22 are provided for each reinforcing rib 21. However, according an embodiment, some reinforcing ribs 21 may be without associated connection means 22, for instance the reinforcing ribs 21' near the outlet 5.

The connection means 22 may be any suitable connection means 22, such as clamping devices clamping the pump casing against the circumferential wall 3 or clamping the pump casing 20 and the shaft cover 40 together squeezing them against the circumferential wall 3.

As shown in the Figures, the connection means 22 may be formed by a connection member 223, such as a bolt, and a corresponding bolt receiving hole 224 provided on the circumferential wall 3 and a bolt receiving hole 222 provided on the pump casing 20. This is shown in more detail in Fig. 5, showing part of the circumferential wall 3 and the pump casing 20.

The circumferential wall 3 may be provided with bolt receiving members or bolt receiving structures 221 provided on the outer circumference of the circumferential wall 3, protruding from the spiral outer shape of the outer wall 32 of the circumferential wall 3, and comprising bolt receiving holes 21. The dashed line L shown in Fig. 5 shows the contour of the circumferential wall 3 as it would be without the bolt receiving structure 221, clearly showing that the bolt receiving structure 221 protrudes from the outer wall of the circumferential wall 3.

One bolt receiving structure or structure 221 may comprise one or two bolt receiving holes 21.

The bolt receiving holes 222, 224 are parallel to the axial rotation axis A of the pump, i.e. parallel to the direction in which the internal pressure of the pump 1 will try to move the pump casing 20.

Fig. 5 further shows that the pump casing 20 may comprise annular slots 241 in which sealing members 242, such as O-rings, may be positioned to provide a fluid-tight connection between the circumferential wall 3 and the pump casing 20.

The circumferential wall 3 may be provided with soft inserts 228 which are suitable for forming a threaded bolt receiving hole 224 therein.

Fig. 4 shows a side view of the pump 1 in the direction of the axial supply 14. It can be seen that the reinforcing ribs 21 are all orientated in a different radial direction at regular mutual angles α. The reinforcing rib 21 or reinforcing ribs 21 close to the outlet 5 may be a bit longer or shorter in radial direction to follow the irregularity of the outer circumference of the pump casing 20 and the circumferential wall 3.

The distribution of the connection means 22 will now be explained in more detail with reference to Fig. 6a- b, showing a view of the pump housing 20 in the direction of the rotation axis A.

As shown, the connection means 22 may be positioned in groups, such as pairs (Fig. 6a) or in larger groups, for instance comprising four connection means 22, as shown in Fig. 6b. The groups are positioned along the circumference of the pump housing 2 and are regularly distributed along the circumference of the pump housing 2. A group may be defined as a number of connection means 22 that are relatively close to each other compared to other connection means 22 which thus not belong to that group. A group may be defined as a plurality of connection means 22 whereby a largest distance between any two connection means of the group (d1 in Fig. 6b) is at least 1/2 the distance between each connection means of that group to the next closest connection means of a different group (d2 in Fig. 6b). This ratio may preferably be 1/3 or even 1/5. This definition also applies to a group of two connection means 22. Fig. 6a also shows distances d1 and d2, whereby $d1 < \frac{1}{2}d2$, preferably $d1 < 1/3\ d2$ or $d1 < 1/5\ d2$.

The term regularly distributed is used to indicate that the groups are distributed along the circumference of the pump housing 2 at substantially constant angles α as

shown in Fig.'s 6a – b when seen from a centre point of the pump housing 2. In Fig.'s 6a – b there are sixteen groups at a mutual angle $\alpha = (360/16)°$. The term substantially constant is used to indicate that the different angles deviate less than 5°, preferably less than 2° with respect to each other.

Alternatively, the term regularly distributed may be used to indicate that the groups are distributed along the circumference of the pump housing 2 at substantially constant intervals. The term constant is used to indicate that these distances do not deviate more than 15%, preferably less than 10%.

According to an embodiment, the groups are regularly distributed along a substantial part of the circumference of the pump housing 2, whereby the substantial part of the circumference of the pump housing 2 forms at least 75% of the total circumference, so is at least 270°.

Manufacturing a pump 1 or a pump housing 2 as described above may involve casting one or more of the pump parts, such as the circumferential wall 3.

The bolt receiving structures 221 or bolt receiving structures provided on the outer circumference of the circumferential wall 3, protruding from the outer wall of the circumferential wall 3 allow for an advantageous casting process.

The casting mould is provided with casting openings to supply casting material into the mould. The bolt receiving structures 221 can be aligned with the casting openings of the mould providing an excellent structure for supplying the casting material into the casting mould. This saves material and thus cost with respect to supplying casting material at other positions.

Also, the bolt receiving structures 221 can advantageously function as risers. During the casting process, the casing material inside the mould will solidify and thus shrink. Risers can function as a buffer reservoir for casting material. Once the material inside the mould has shrunk, the space in between the mould and the shrunk casting material will be filled with casting material from the risers. The risers may not be too small, as this will cause the casting material to cool down relatively quickly compared to the cooling of the rest of the casting material in the mould.

Shaft cover

It is noted that all the configurations and embodiments of the connection means as described above may also be applied to the connection means 42 connecting the

shaft cover 40 to the circumferential wall 3. These connection means 42 may also be positioned in groups along the circumference of the pump housing 2, wherein the groups are regularly distributed along the circumference of the pump housing 2. The shaft cover 40 may comprises a plurality of reinforcing ribs positioned radially with respect to a central opening for the drive shaft, wherein the connection means 42 are positioned adjacent the reinforcing ribs. The connection means 42 of a group may be positioned on opposite sides of the adjacent reinforcing rib. The connection means may be positioned along the outer circumference of the pump 1 and connect the shaft cover 40 to a radial outer wall 32 of the circumferential wall 3. The connection means 42 may be formed by a connection member, such as a bolt, and bolt receiving holes provided on the circumferential wall 3 and bolt receiving holes provided on the shaft cover 40. The circumferential wall 3 may comprise bolt receiving structures provided on the outer circumference of the circumferential wall. Each bolt receiving structure may comprise two bolt receiving holes.

Advantages

The embodiments described provide a pump, which is relatively strong and stiff. The pump can be casted in an efficient way, still resulting in a pump which is strong and stiff.

The descriptions above are intended to be illustrative, not limiting. It will be apparent to the person skilled in the art that alternative and equivalent embodiments of the invention can be conceived and reduced to practice, without departing from the scope of the claims set out below.

CONCLUSIES

1. Pomphuis (2) omvattende een omtrekswand (3), een pompdeksel (20) en een asdeksel (40), waarbij de pompdeksel (20) is bevestigd aan de omtrekswand (3) door een veelheid van verbindingsmiddelen, en waarbij de pompdeksel (20) een centrale opening omvat voor het vormen van een axiale toevoer (14) van het pomphuis (2) voor te verpompen materiaal, waarbij de omtrekswand (3) het pomphuis langs zijn buitenomtrek sluit,

waarbij de pomp (1) een veelheid verbindingsmiddelen (22) omvat voor het verbinden van de pompdeksel (20) met de omtrekswand (3),

met het kenmerk dat de verbindingsmiddelen (22) in groepen gepositioneerd zijn langs de omtrek van het pomphuis (2), waarbij de groepen regelmatig verdeeld zijn langs de omtrek van het pomphuis (2).

2. Pomphuis (2) volgens conclusie 1, waarbij de pompdeksel (20) een veelheid verstevigingsribben (21) omvat welke radiaal gepositioneerd zijn ten opzicht van de centrale opening (27), waarbij de bevestigingsmiddelen aangrenzend aan de verstevigingsribben (21) zijn gepositioneerd.

3. Pomphuis (2) volgens conclusies 2, waarbij de verbindingsmiddelen (22) van een groep aan weerszijde van de aangrenzende verstevigingsrib (21) zijn gepositioneerd.

4. Pomphuis (2) volgens willekeurig welke van de voorgaande conclusies, waarbij de verbindingsmiddelen (22) langs de buitenomtrek van de pomp (1) zijn gepositioneerd en de pompdeksel (20) met een radiale buitenwand (32) van de omtrekswand (3) verbinden.

5. Pomphuis (2) volgens willekeurig welke van de voorgaande conclusies, waarbij de verbindingsmiddelen (22) gevormd worden door een verbindingsonderdeel (223), zoals een bout, en boutontvangstgaten (224) voorzien aan de omtrekswand (3) en boutontvangstgaten (222) voorzien op de pompdeksel (20).

6. Pomphuis (2) volgens conclusie 5, waarbij de omtrekswand (3) boutontvangststructuren (221) omvat voorzien op de buitenomtrek van de omtrekswand (3).

7. Pomphuis (2) volgens conclusie 6, waarbij elke boutontvangststructuur (221) ten minste twee boutontvangstgaten (224) omvat.

8. Pomp (1) omvattende een pomphuis (2) volgens willekeurig een van de voorgaande conclusies 1 – 7.

9. Omtrekswand (3) van een pomphuis (2), waarbij de omtrekswand (3) een spiraalvormige buitenwand (32) omvat en twee naar binnen uitstekende benen (31) welke aan de buitenwand (32) bevestigd zijn, waarbij de omtrekswand (3) boutontvangstgaten (224) omvat welke gepositioneerd zijn in groepen langs de omtrek van de omtrekswand, waarbij de groepen regelmatig verdeeld zijn langs de omtrek van de omtrekswand.

10. Werkwijze voor het vervaardigen van een omtrekswand voor een pomphuis (2), waarbij de omtrekswand (3) boutontvangstgaten (224) omvat voorzien op de buitenkant van de omtrekswand (3), waarbij de werkwijze omvat:
- verschaffen van een mal voor de omtrekswand (3), waarbij de wand een veelheid gietopeningen omvat,
- het vullen van de mal met een vloeibaar gietmateriaal door het toevoeren van het gietmateriaal aan de mal via de gietopeningen,
- het gietmateriaal vast laten worden,
- verwijderen van de mal,
gekenmerkt doordat de boutontvangstgaten (224) in groepen gepositioneerd zijn langs de omtrek van de omtrekswand (3), waarbij de groepen regelmatig verdeeld zijn langs de omtrek van de omtrekswand (3).

11. Werkwijze volgens conclusie 10, waarbij de omtrekswand (3) boutontvangststructuren (221) omvat verschaft op de buitenomtrek van de

omtrekswand (3), waarbij de boutontvangststructuren samenvallen met de gietopeningen en/of functioneren als opkomers tijdens het gieten.

12. Werkwijze volgens een van de conclusies 10 – 11, waarbij elke boutontvangststructuur (221) ten minste twee boutontvangstgaten (224) omvat.

13. Werkwijze volgens een van de conclusies 10 – 12, waarbij het gietmateriaal een is uit de groep omvattende: staal, gietstaal, grijs of wit gietijzer.

Fig 1

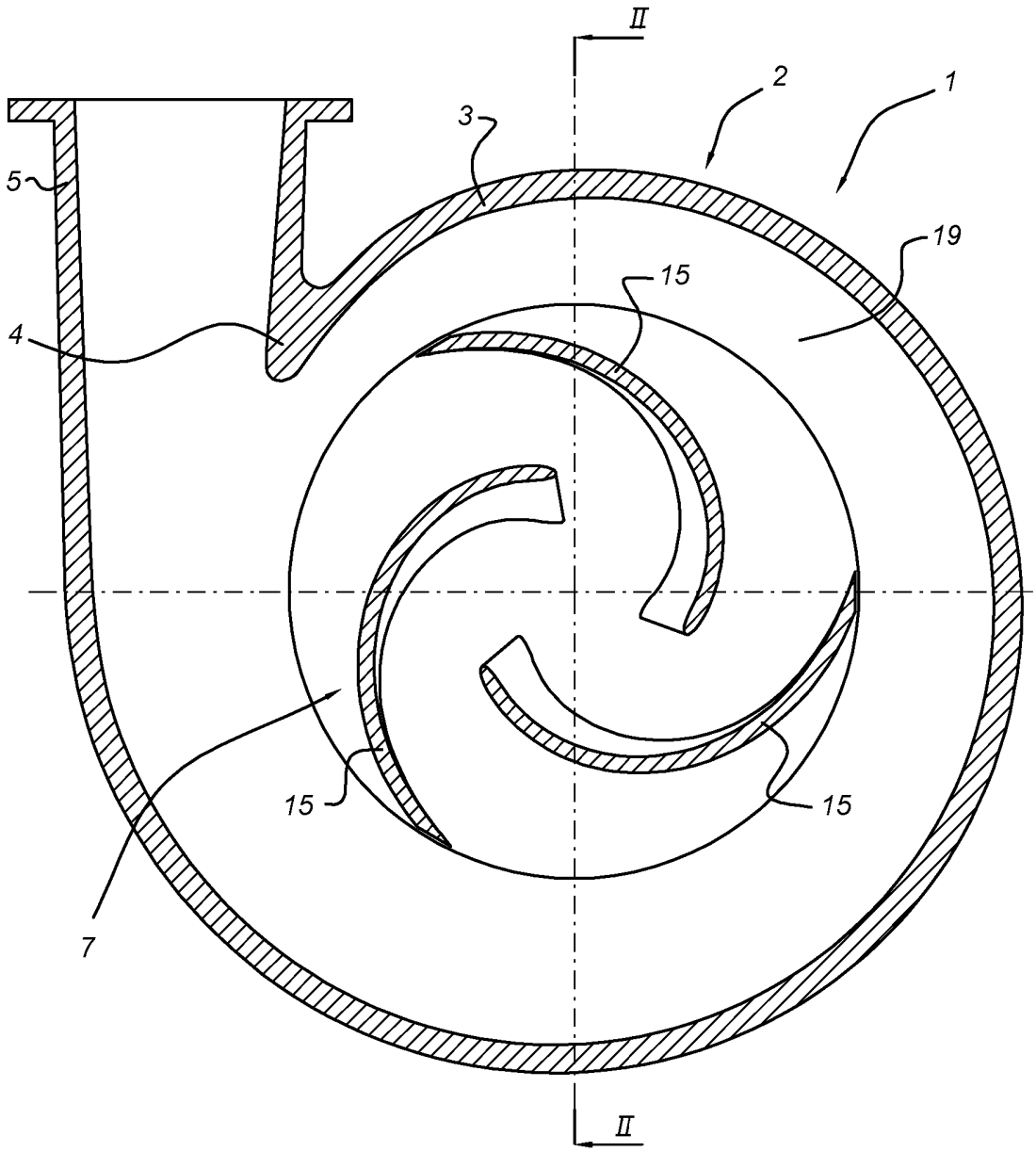

Fig 2

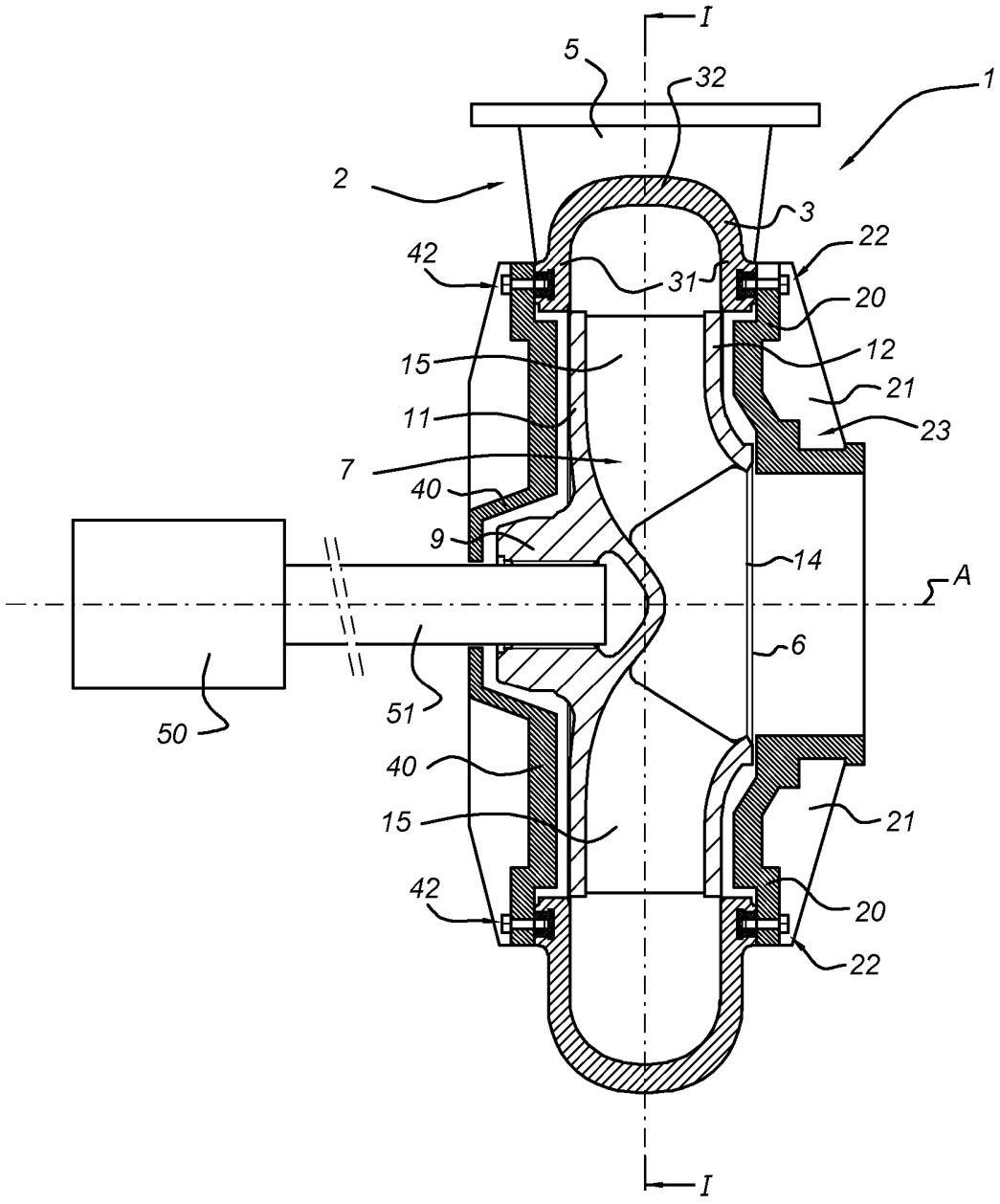
I
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Fig. 3

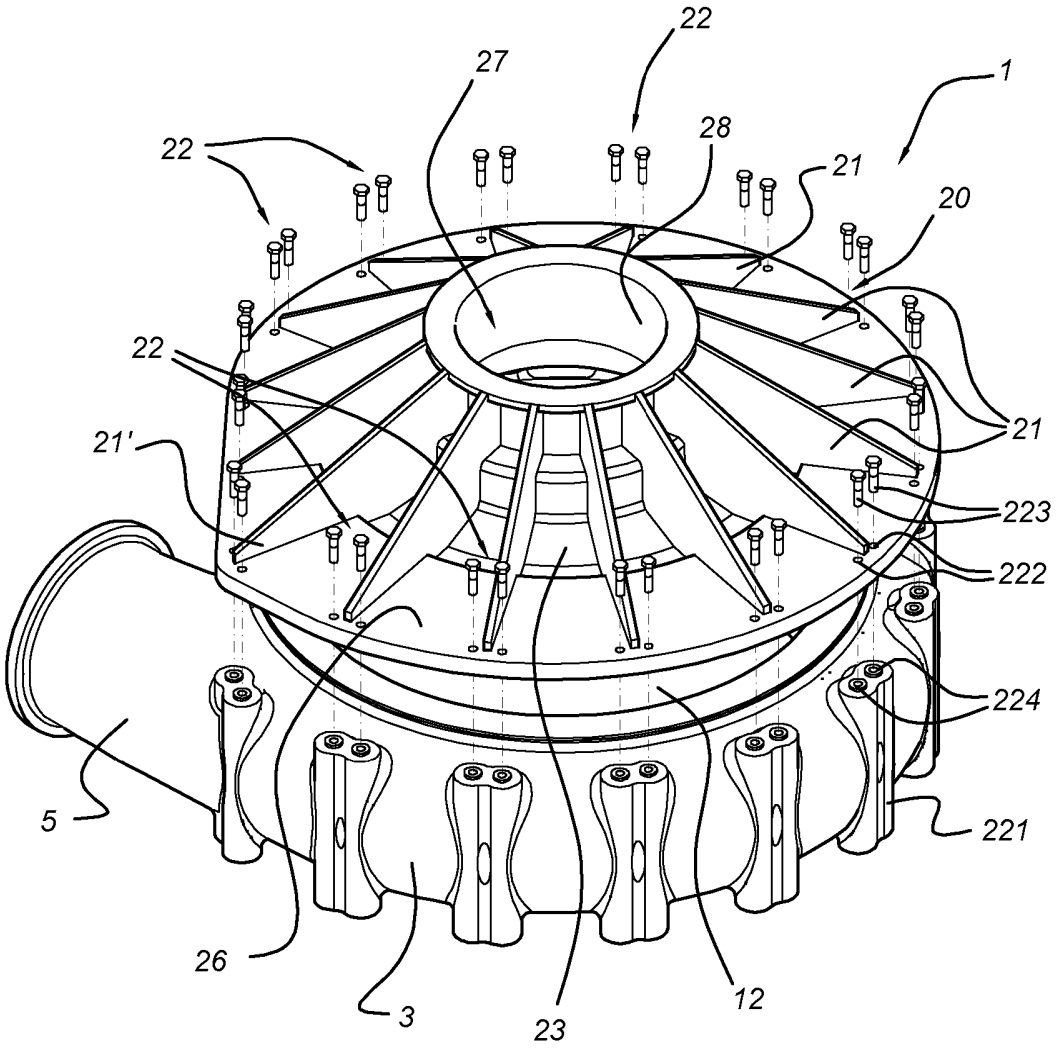


Fig. 4

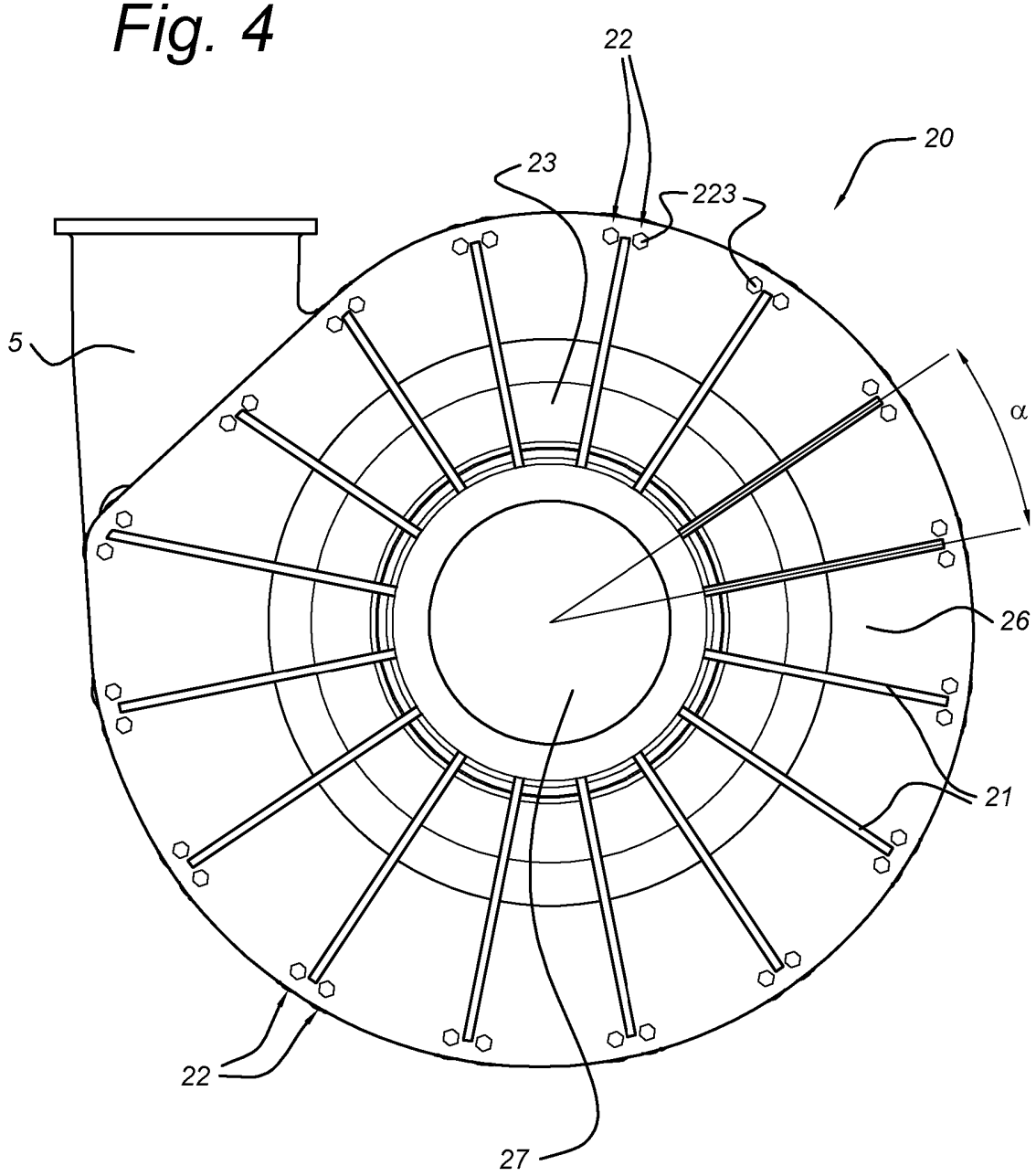


Fig. 5

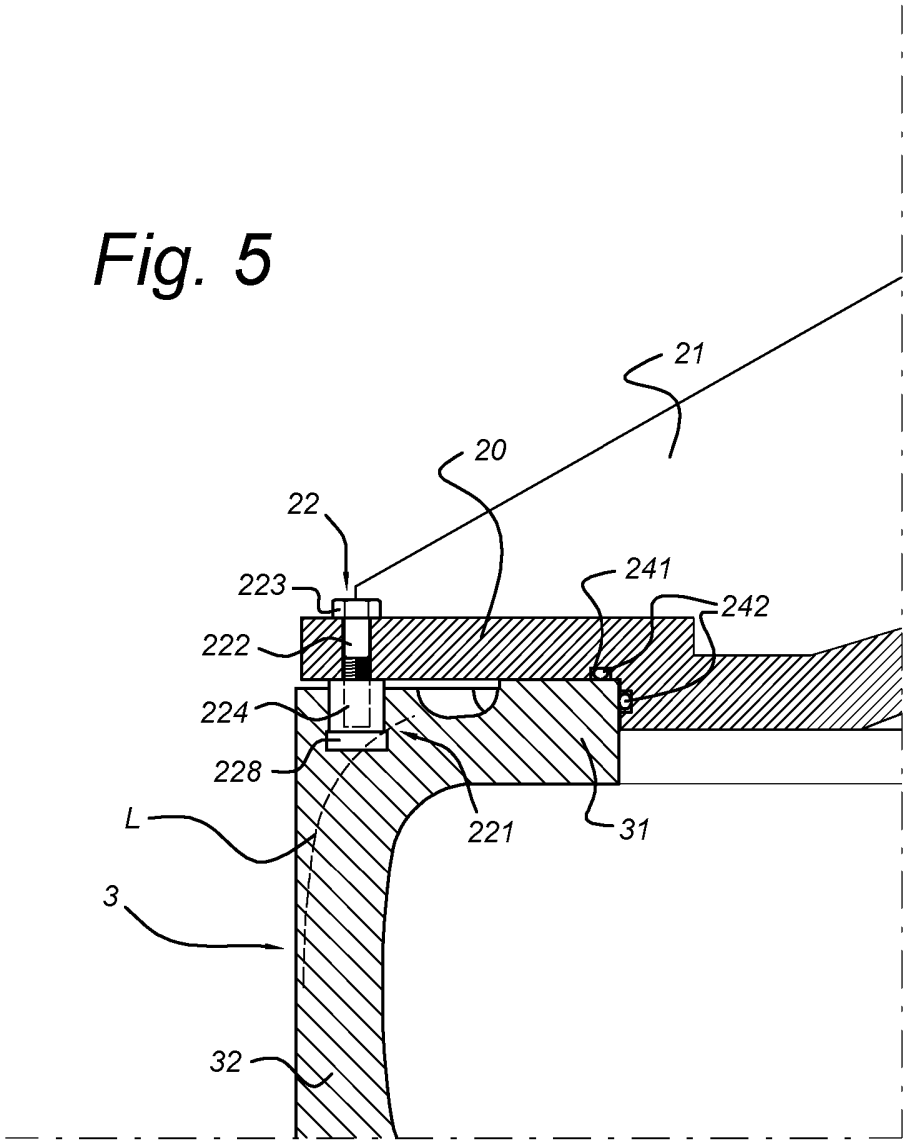


Fig. 6a

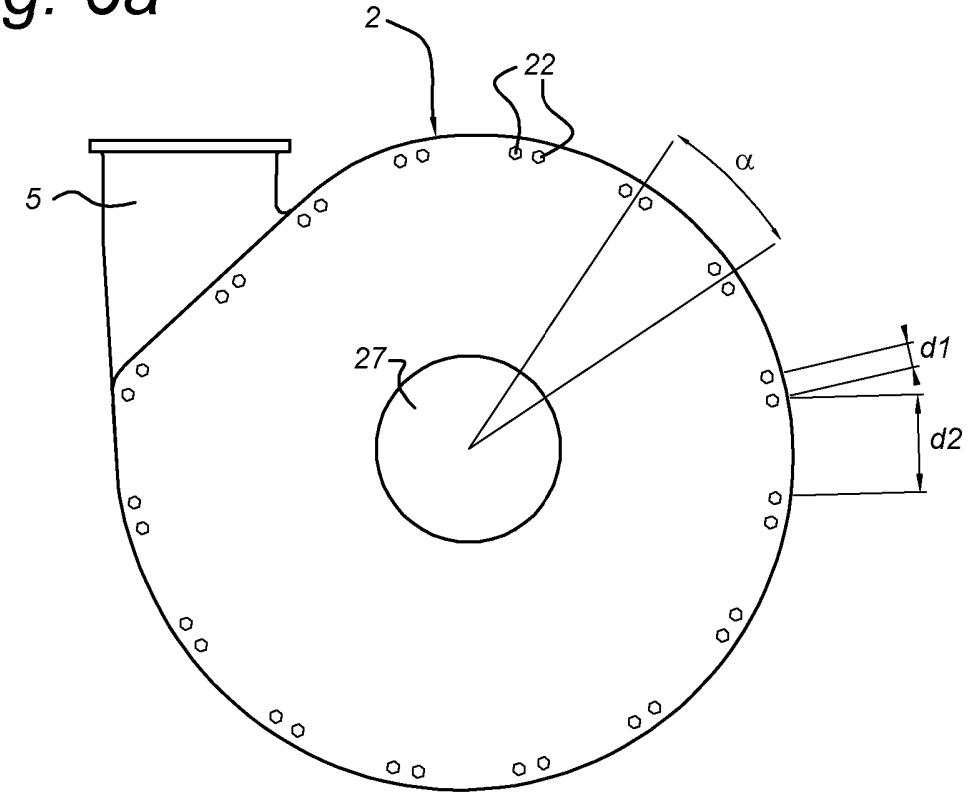
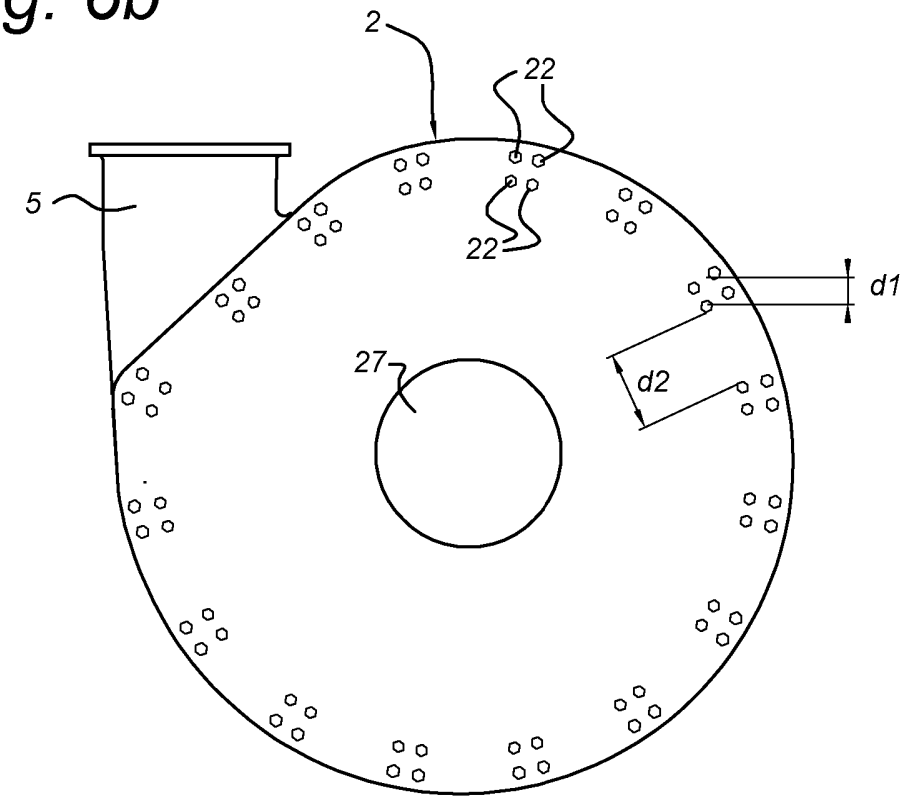


Fig. 6b



SAMENWERKINGSVERDRAG (PCT)

RAPPORT BETREFFENDE NIEUWHEIDSONDERZOEK VAN INTERNATIONAAL TYPE

IDENTIFICATIE VAN DE NATIONALE AANVRAGE	KENMERK VAN DE AANVRAGER OF VAN DE GEMACHTIGDE
	P6039195NL
Nederlands aanvraag nr. **2008180**	Indieningsdatum **25-01-2012**
	Ingeroepen voorrangsdatum
Aanvrager (Naam) **IHC Holland IE B.V.**	
Datum van het verzoek voor een onderzoek van internationaal type **14-04-2012**	Door de Instantie voor Internationaal Onderzoek aan het verzoek voor een onderzoek van internationaal type toegekend nr. **SN 57990**

I. CLASSIFICATIE VAN HET ONDERWERP (bij toepassing van verschillende classificaties, alle classificatiesymbolen opgeven)

Volgens de internationale classificatie (IPC)

F04D7/04

II. ONDERZOCHTE GEBIEDEN VAN DE TECHNIEK

Onderzochte minimumdocumentatie

Classificatiesysteem	Classificatiesymbolen
IPC	**F04D**

Onderzochte andere documentatie dan de minimum documentatie, voor zover dergelijke documenten in de onderzochte gebieden zijn opgenomen

III.	☐	**GEEN ONDERZOEK MOGELIJK VOOR BEPAALDE CONCLUSIES**	(opmerkingen op aanvullingsblad)
IV.	☐	**GEBREK AAN EENHEID VAN UITVINDING**	(opmerkingen op aanvullingsblad)

ONDERZOEKSRAPPORT BETREFFENDE HET RESULTAAT VAN HET ONDERZOEK NAAR DE STAND VAN DE TECHNIEK VAN HET INTERNATIONALE TYPE

Nummer van het verzoek om een onderzoek naar de stand van de techniek
NL 2008180

A. CLASSIFICATIE VAN HET ONDERWERP
INV. F04D7/04
ADD.

Volgens de Internationale Classificatie van octrooien (IPC) of zowel volgens de nationale classificatie als volgens de IPC.

B. ONDERZOCHTE GEBIEDEN VAN DE TECHNIEK

Onderzochte miminum documentatie (classificatie gevolgd door classificatiesymbolen)
F04D

Onderzochte andere documentatie dan de mimimum documentatie, voor dergelijke documenten, voor zover dergelijke documenten in de onderzochte gebieden zijn opgenomen

Tijdens het onderzoek geraadpleegde elektronische gegevensbestanden (naam van de gegevensbestanden en, waar uitvoerbaar, gebruikte trefwoorden)
EPO-Internal, WPI Data

C. VAN BELANG GEACHTE DOCUMENTEN

Categorie °	Geciteerde documenten, eventueel met aanduiding van speciaal van belang zijnde passages	Van belang voor conclusie nr.
X	WO 2009/149511 A1 (WEIR MINERALS AUSTRALIA LTD [AU]; SMITH GLENN RAYMOND [AU]; FOREMAN MI) 17 december 2009 (2009-12-17)	1-8, 10-13
A	* bladzijde 9, regel 28; figuren 1,2,6 * * bladzijde 11, regels 20-29 *	9
A	EP 1 413 761 A2 (BOC TECHNOLOGIES LTD [JP] BOC EDWARDS JAPAN LTD [JP] EDWARDS JAPAN LTD) 28 april 2004 (2004-04-28) * samenvatting; figuren 1,3-18 *	1,9,10

☐ Verdere documenten worden vermeld in het vervolg van vak C.

☒ Leden van dezelfde octrooifamilie zijn vermeld in een bijlage

° Speciale categorieën van aangehaalde documenten

"A" niet tot de categorie X of Y behorende literatuur die de stand van de techniek beschrijft

"D" in de octrooiaanvrage vermeld

"E" eerdere octrooi(aanvrage), gepubliceerd op of na de indieningsdatum, waarin dezelfde uitvinding wordt beschreven

"L" om andere redenen vermelde literatuur

"O" niet-schriftelijke stand van de techniek

"P" tussen de voorrangsdatum en de indieningsdatum gepubliceerde literatuur

"T" na de indieningsdatum of de voorrangsdatum gepubliceerde literatuur die niet bezwarend is voor de octrooiaanvrage, maar wordt vermeld ter verheldering van de theorie of het principe dat ten grondslag ligt aan de uitvinding

"X" de conclusie wordt als niet nieuw of niet inventief beschouwd ten opzichte van deze literatuur

"Y" de conclusie wordt als niet inventief beschouwd ten opzichte van de combinatie van deze literatuur met andere geciteerde literatuur van dezelfde categorie, waarbij de combinatie voor de vakman voor de hand liggend wordt geacht

"&" lid van dezelfde octrooifamilie of overeenkomstige octrooipublicatie

Datum waarop het onderzoek naar de stand van de techniek van internationaal type werd voltooid	Verzenddatum van het rapport van het onderzoek naar de stand van de techniek van internationaal type
14 september 2012	

Naam en adres van de instantie	De bevoegde ambtenaar
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	de Martino, Marcello

1

ONDERZOEKSRAPPORT BETREFFENDE HET RESULTAAT VAN HET ONDERZOEK NAAR DE STAND VAN DE TECHNIEK VAN HET INTERNATIONALE TYPE

Informatie over leden van dezelfde octrooifamilie

Nummer van het verzoek om een onderzoek naar de stand van de techniek: NL 2008180

In het rapport genoemd octrooigeschrift	Datum van publicatie	Overeenkomend(e) geschrift(en)	Datum van publicatie
WO 2009149511	A1 17-12-2009	AR 072131 A1	04-08-2010
		AR 072132 A1	04-08-2010
		AR 072137 A1	11-08-2010
		AR 072364 A1	25-08-2010
		AU 2009257192 A1	17-12-2009
		AU 2009257193 A1	17-12-2009
		AU 2009257194 A1	17-12-2009
		AU 2009257195 A1	17-12-2009
		AU 2009257196 A1	17-12-2009
		CA 2726846 A1	17-12-2009
		CA 2726849 A1	17-12-2009
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		CA 2727554 A1	17-12-2009
		CN 102066764 A	18-05-2011
		CN 102066765 A	18-05-2011
		CN 102066769 A	18-05-2011
		CN 102066770 A	18-05-2011
		CN 102105700 A	22-06-2011
		EA 201170008 A1	30-08-2011
		EA 201170009 A1	30-08-2011
		EA 201170010 A1	30-08-2011
		EA 201170011 A1	30-08-2011
		EA 201170012 A1	30-08-2011
		EP 2315947 A1	04-05-2011
		EP 2315948 A1	04-05-2011
		EP 2315949 A1	04-05-2011
		EP 2324248 A1	25-05-2011
		EP 2324250 A1	25-05-2011
		PE 00302011 A1	09-02-2011
		PE 00312011 A1	09-02-2011
		PE 00322011 A1	11-02-2011
		PE 01582011 A1	04-03-2011
		PE 06572011 A1	16-09-2011
		US 2011142599 A1	16-06-2011
		US 2011164841 A1	07-07-2011
		US 2011164973 A1	07-07-2011
		WO 2009149511 A1	17-12-2009
		WO 2009149512 A1	17-12-2009
		WO 2009149513 A1	17-12-2009
		WO 2009149514 A1	17-12-2009
		WO 2009149515 A1	17-12-2009
EP 1413761	A2 28-04-2004	EP 1413761 A2	28-04-2004
		JP 4484470 B2	16-06-2010
		JP 2004162696 A	10-06-2004
		KR 20040036594 A	30-04-2004
		US 2004081569 A1	29-04-2004

Agentschap NL
Ministerie van Economische Zaken, Landbouw en Innovatie

WRITTEN OPINION

File No.	Filing date *(day/month/year)*	Priority date *(day/month/year)*	Application No.
SN57990	25.01.2012		NL2008180

International Patent Classification (IPC)
INV. F04D7/04

Applicant
IHC Holland IE B.V.

This opinion contains indications relating to the following items:

- ☒ Box No. I Basis of the opinion
- ☐ Box No. II Priority
- ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☐ Box No. IV Lack of unity of invention
- ☒ Box No. V Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- ☐ Box No. VI Certain documents cited
- ☒ Box No. VII Certain defects in the application
- ☒ Box No. VIII Certain observations on the application

Examiner
de Martino, Marcello

Application number

WRITTEN OPINION

NL2008180

Box No. I Basis of this opinion

1. This opinion has been established on the basis of the latest set of claims filed before the start of the search.

2. With regard to any **nucleotide and/or amino acid sequence** disclosed in the application and necessary to the claimed invention, this opinion has been established on the basis of:

   a. type of material:

   ☐ a sequence listing

   ☐ table(s) related to the sequence listing

   b. format of material:

   ☐ on paper

   ☐ in electronic form

   c. time of filing/furnishing:

   ☐ contained in the application as filed.

   ☐ filed together with the application in electronic form.

   ☐ furnished subsequently for the purposes of search.

3. ☐ In addition, in the case that more than one version or copy of a sequence listing and/or table relating thereto has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.

4. Additional comments:

Box No. V Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty	Yes:	Claims	3, 4, 6, 7, 9, 12, 13
	No:	Claims	1, 2, 5, 8, 10, 11
Inventive step	Yes:	Claims	9
	No:	Claims	1-8, 10-13
Industrial applicability	Yes:	Claims	1-13
	No:	Claims	

2. Citations and explanations

see separate sheet

Application number
NL2008180

WRITTEN OPINION

Box No. VII Certain defects in the application

see separate sheet

Box No. VIII Certain observations on the application

see separate sheet

Re Item V.

1 **Independent claim 1:**

With regard to the clarity objections stated under point 7.2, prior art document WO-A-2009149511 (D1) (see Figures 1, 2, 6) discloses a pump housing comprising:

- a circumferential wall 60, 66,

- a pump casing 24, 26 and

- a shaft cover (implicitly included within the casing 24, 26, e.g. the circumferential contour of central opening 28), wherein:

  - the pump casing 24, 26 is attached to the circumferential wall 60, 66 by a plurality of connection means (see note 1), and wherein

  - the pump casing 24. 26 comprises a central opening 28 to form an axial supply of the pump housing for material to be pumped (see note 2),

  - the circumferential wall 60. 66 closing the pump housing along its outer circumference 66, wherein:

    - the pump comprises a plurality of connection means (pins 63 and screws) connecting the pump casing 24, 26 to the circumferential wall 60, 66, wherein the connection means (pins 63 and screws) are positioned in groups along the circumference of the pump housing, wherein the groups are regularly distributed along the circumference of the pump housing.

Note 1: Not only the screws being inserted into the apertures 64, but also the liner locating pins 63 inserted into the apertures 62 can be interpreted as "connection means" (compare also the description, page 11, lines 20 to 29).

Note 2: Compare also description, page 9, line 28 disclosing the use of the pump as a slurry pump.

Therefore, all the features of independent claim 1 are known from document D1.

Thus, the subject-matter of independent claim 1 is not novel.

2 **Independent claim 9:**

Document D1, which is considered to represent the most relevant state of the art with regard to independent claim 9, discloses (see Figures 1, 2, 6) a circumferential wall 60, 66 from which the subject-matter of claim 9 differs in that it further comprises:

- a spiral shaped outer wall and
- two inwardly protruding legs attached to the outer wall, wherein:
    - the circumferential wall comprises bolt receiving holes which are positioned in groups along the circumference of the circumferential wall, wherein the groups are regularly distributed along the circumference of the circumferential wall.

The problem to be solved may be therefore regarded as to provide an improved attachment connection between scroll casing parts.

There is no indication in the prior art that would prompt the skilled person to solve the problem as proposed in claim 1. In particular, it is not disclosed to provide the groups of bolt receiving holes on a spiral shaped circumferential wall. Therefore the skilled person would not arrive to this solution without inventive skills.

Thus, the subject-matter of claim 9 appears to be novel and inventive.

3 **Independent method claim 11:**

Prior art document D1 (see Figures 1, 2, 6) discloses a method of manufacturing a circumferential wall 60, 66 for a pump housing, wherein the circumferential wall 60, 66 comprises bolt receiving holes 62, 64 (see note 3) provided on the outside of the circumferential wall 60, 66, wherein the method comprises:

- providing a mold for the circumferential wall, the mold comprising a plurality of casting openings (see note 4),
- fitting the mold with a liquid casting material by supplying the casting material to the mold via the casting openings (see note 4),
- allowing the casting material to solidify in the mold (see note 4),
- removing the mold (see note 4), wherein

- the bolt receiving holes 62, 64 are positioned in groups along the circumference of the circumferential wall 60, 66, wherein the groups are regularly distributed along the circumference of the circumferential wall 60, 66.

Note 3: The general word "bolt" in the expression "bolt receiving holes" must not necessarily refer only to screw receiving holes, but also to pin receiving holes.

Note 4: The pump housing part 56 with the circumferential wall 60, 66 can be obviously manufactured by lathing or also by molding. In case of molding the part 56, the skilled person knows how to carry out the molding relevant actions. Thus, these actions are implicitly included in the disclosures of the document D1.

Therefore, all the features of independent claim 10 are known from document D1.

Thus, the subject-matter of independent claim 10 is not novel.

4 **Dependent claims:**

The dependent claims 2 to 8 and 11 to 13 do not appear to contain any additional features which, in combination with the features of any claim to which they refer, could form subject-matter which is new and involves an inventive step, the reasons being as follows (compare D1, Figures 1, 2, 6):

The additional features of dependent claims 2, 5, 8 and 11 are known from prior art document D1.

The additional features of dependent claims 3, 4, 6, 7, 12 and 13 appear to be a matter of normal design and do not lead to any surprising effect.

5 The industrial applicability of the claimed subject-matter is self-evident.

Re Item VII.

6 The attention of the applicant is also drawn to the following:

The document D1 has not been acknowledged in the description.

Re Item VIII.

7 The claims 1 and 9 are not clear.

7.1 For the skilled person, the expressions "housing" and "casing" are synonyms. However, in claim 1 these two expressions are used for different items with different reference signs, namely the reference signs 2 and 20.

7.2 The expression:

"... the circumferential wall (3) closing the pump housing (2) along its outer circumference ..." in the preamble of claim 1 is ambiguous, as the pronoun "its" can either refer to the circumferential wall or the pump housing.

Namely, this expression can be interpreted either as:

a) "... the circumferential wall (3) closing the pump housing (2) along the outer circumference of the circumferential wall" or as

b) "... the circumferential wall (3) closing the pump housing (2) along the outer circumference of the pump housing".

The subject-matter of the claim has been interpreted as under point a).

7.3 Although claims 1 and 9 have been drafted as separate independent claims, it is possible to formulate only one independent claim with corresponding dependent claims. The aforementioned claims therefore lack conciseness.