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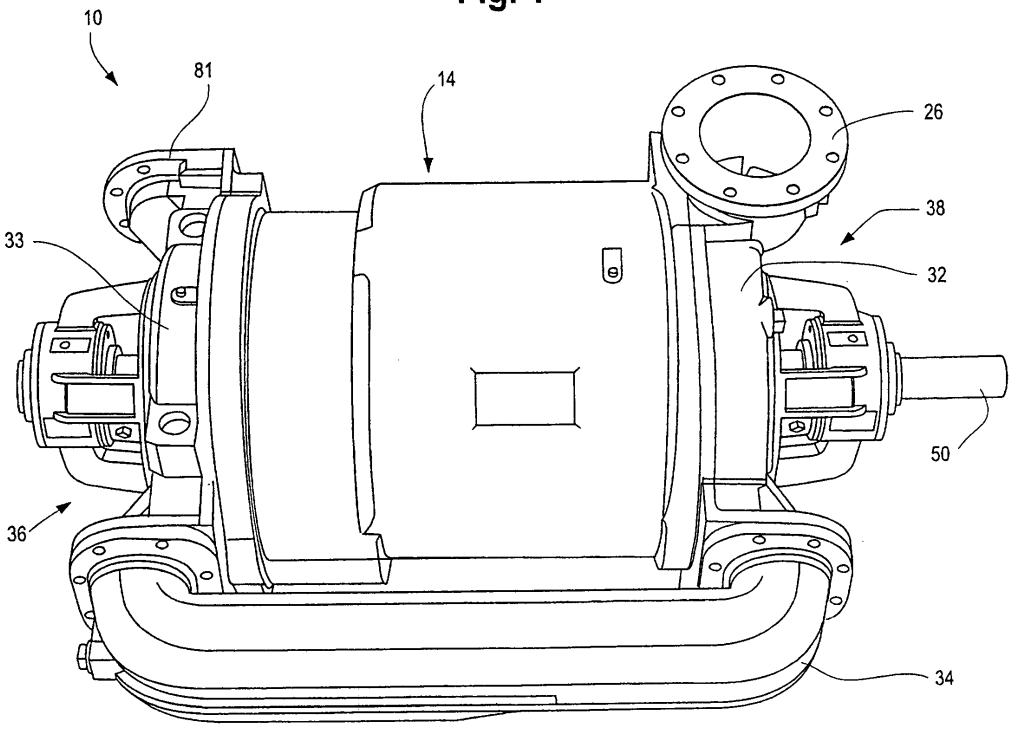
(54) **Two stage conical liquid ring pump having removable manifold, shims and first and second stage head o'ring receiving boss**

(57) A first head of a liquid ring pump has an inlet, an outlet, a shaft receiving aperture extending there through, and an internal end. The internal end includes a boss with a side wall. The boss is received by a pump body. An interstage manifold is removeably coupled to the pump without being integral with or connected to the pump body. An o-ring can be located between a side wall of the boss and an internal side wall of the body.

Fig. 1



EP 1 892 419 A2

Description

[0001] The present application claims priority from provisional application 60822147 filed August 11, 2006.

Field

[0002] The present disclosure concerns a liquid ring pump and more particularly, a conical two stage liquid ring pump.

Background:

[0003] The present disclosure is related to pumps. In particular, the present disclosure relates to two stage liquid ring pumps that are used to create a vacuum. Liquid ring pumps can be used in wet industrial environments and, as they are inherently low in friction, have a long service life. Liquid ring pumps remove air or gases by means of an impeller rotating freely in an eccentric casing. Operating liquid, usually water, is fed into the pump and is thrown by centrifugal force to form a moving ring along the internal casing wall, creating a sealed pumping chamber. Sealing liquid is also fed into the pump to seal interstices between the rotor and other parts. Industrial users employ these highly reliable pumps for a variety of uses, such as forming wet paper pulp into egg cartons and nursery planting containers, soil remediation where contaminated ground water is drawn by vacuum from the earth for treatment, and a host of other applications. Examples of liquid ring pumps can be found in U.S. Patent 4,521,161, Olsen et al. and 5,899,688, Shenoi. Both of the patents are hereby incorporated in this application by reference.

Summary:

[0004] A two-stage liquid ring pump, in accordance with the present disclosure, includes a two chambered body connected to a first stage head at a first end, and a second stage head at a second end. In the illustrative embodiments, the first and second stage heads each include an internal face, side or end. Each end is adapted to engage an opposite side of the body. At least one end has a surface designed to accept a plurality of gaskets that act as shims to enable one to set the clearance between the rotor and cones within the body. To enable the setting of clearance, shims are used to form an axial spacing between the internal face of the head and an end of the body. The clearances between the cones and the rotor are critical for maximum performance. The first and second stage heads also each include a circular rabbet or boss on their faces. The bosses are adapted to accept an o-ring to allow sealing in more demanding applications.

[0005] In the illustrative embodiments the first and second stage heads are interconnected by a removable interstage manifold that is separate from the body. The interstage manifold incorporates an air/water separation construction for improved efficiency. Use of a removable interstage manifold simplifies head and body castings for better core support, better castability and lower casting defect rates, resulting in lower costs. The interstage manifold has a varying cross-section design for separating air and water ejected from the first stage. The removable manifold allows for use of the o-rings on the heads. The removable manifold has flanges for o-ring or gasket sealing with corresponding flange faces on the heads. Through holes for the bolts in the flanges are sized to accommodate variations in end travel settings.

[0006] In the illustrative embodiments, a first stage cone includes an auxiliary discharge port consisting of two timed vent holes formed in the first stage cone. The vent holes provide low speed stability, which improves water handling capabilities and hydraulic noise reduction. The vent holes are positioned so that high vacuum capacity is not affected. The vent holes, also, under hogging conditions, at low vacuum, reduce excessive compression in the rotor buckets, thereby reducing peak power requirements at low vacuum.

[0007] Additional features of the present disclosure will become apparent to those skilled in the art upon consideration of the following detailed description of illustrative embodiments.

Brief Description of the Drawings:

[0008] The detailed description particularly refers to the accompanying figures in which:

[0009] Fig. 1 is a perspective view of a two-stage liquid ring pump having a two chambered body connected at a first end to a first stage head and, at a second end, to a second stage head, wherein the first and second stage heads are interconnected by a removable interstage manifold;

[0010] Fig. 2 is an irregular cross-sectional view taken along the pumps longitudinal axis and through the first stage inlet, showing the first and second chambers of the body and the first and second stage heads, and further showing a drive shaft extending through the body and heads, the shaft being coupled to a two stage rotor that is positioned between a pair of cones;

[0011] Fig. 3 is an exploded view of the liquid ring pump shown in Fig. 1;

[0012] Fig. 4 is a perspective view of the two-stage liquid ring pump with the body, shaft, and rotor removed from the pump to show the first stage cone with respect to the first stage head and further showing the flow of air and water through the interstage manifold;

[0013] Fig. 5 is a perspective view similar to Fig.4 but with the interstage manifold removed from the first and second stage heads, and further showing the two chambered inlet port on the second stage head that accepts air and water from the interstage manifold;

[0014] Fig. 6a is a perspective end view of the first stage cone conical member shown in Figure 4;

[0015] Fig. 6b is a side perspective view of the cone shown in Fig. 6a;

[0016] Fig. 6c is a side plan view of the cone shown in Fig. 6a

[0017] Fig. 7a is a perspective view of the interior side of the first stage head showing the air inlet port and the outlet port to the interstage manifold, the first stage head also showing the face for shimming and setting the clearance between the cone and the rotor and the circular rabbet or boss on the head for o-ring sealing;

[0018] Fig. 7b is a plan rear view of the exterior side of the first stage head;

[0019] Fig. 7c is a cross sectional view of the first stage head taken along view lines 7-7;

[0020] Fig. 7d is a plan view looking at the discharge port of the first stage head;

[0021] Fig. 8a is a plan front view of the interior side of the second stage head;

[0022] Fig 8b is a side perspective view of the interior side of the second stage head;

[0023] Fig. 8c is a cross sectional view of the second stage head taken along view lines 8-8;

[0024] Fig 9a is an end plan view of the interstage manifold;

[0025] Fig 9b is a cross sectional view of the manifold shown in Fig. 9a taken along view lines 9-9;

Detailed Description:

[0026] A two-stage liquid ring vacuum pump 10 adapted to handle large quantities of material carry over without affecting continuous air-flow is shown. Pump 10 includes a rotor 12 that is positioned eccentric relative to body 14. The body 14 has first chamber housing 16 enclosing chamber 16a. The body further has second chamber housing 18 enclosing chamber 18a. As viewed in Fig. 2, the first stage 38 is on the right side of the illustration and the second stage 36 is on the left side of the illustration. A manifold 34 joins the first and second stage.

[0027] The body 14 is adapted to house rotor 12 that includes an intermediate circular wall 48 which separates first stage 38 from second stage 36. The rotor 12 is coupled to drive shaft 49 and is rotated by shaft 49 when power is applied to input shaft 50. The rotor 12 includes first stage blades 52 and second stage blades 54. The rotor 12 and drive shaft 49 are positioned within body 14 so that space 56 is created within first chamber 16a, and space 58 is created within second chamber 18a.

[0028] Also positioned within body 14 are first and second stage cones 60, 62. First stage cone 60 is positioned in first chamber 16a and second stage cone 62 is positioned in second chamber 18a. First stage head 32 is coupled to body 14 at an end 201 of first stage housing 16. Second stage head 33 is coupled to body 14 at an end 206 of second stage housing 18, for example, see Fig. 2.

[0029] The first stage head or end shield 32 is adapted to be coupled to first chamber housing 16 of body 14. Face 79, of first stage head 32, includes a plurality of apertures 92 that permit first stage head 32 to be secured to first chamber housing 16 of body 14. The first stage face, end or side 79, has a surface 179, which is adapted to accept shims 200. The shims 200 create axial spacing or distance between and end wall 201 of first body 14 and internal face surface 179. The spacing is to set end travel clearance between cones 60, 62 and rotor 12. In conical liquid rings pumps, it is critical to properly set the clearance and travel between rotor 12 and first and second stage cones 60, 62. Failure to properly orient these components can cause premature wear and internal leaking which can reduce vacuum pump efficiency.

[0030] The first stage head 32 also includes a circular rabbet or boss 110 on face 79 that is adapted to accept an O-ring 202 to permit sealing between the first stage head 32 and body 14. The O-ring seals between the boss's circumferential side wall 203 and an inner side wall 204 towards an end of body 14. A groove 203a to receive the O-ring 202 is in the sidewall 203. An O-ring can be used since the interstage manifold is detachable from first stage head 32.

[0031] The first stage head 32 includes recess 80 that is adapted to accept flange 82 of first stage cone 60 as shown, for example, in Figs. 4 and 5. Recess 80 includes a plurality of apertures 84 that allow first stage cone 60 to be attached to first stage head 32. The first stage head 32 also includes a central opening 86 adapted to accept rotor shaft 49. The recessed portion is between aperture 86 and boss side wall 203. The first stage head also includes a seal water supply passage 88 to allow seal water to enter first stage cone passage 88a. The first stage head also includes air inlet 26 in fluid communication with inlet port 70. The first stage also includes discharge port 30 in fluid communication with discharge port opening 66.

[0032] The first stage head also includes a pair of bracket members 90 that permit pump 10 to be secured.

[0033] First stage cone 60 includes passage 20 into which inlet port 70 opens. The fist stage cone also includes main discharge port 64 opening into discharge port opening 66. First stage cone 60 further includes auxiliary discharge ports 68. Auxiliary discharge ports 68 include two timed vent holes for low speed stability, which improves water handling capabilities and results in hydraulic noise reduction. Auxiliary discharge ports 68 are positioned so that high vacuum capacity is not effected. The vent holes, also, under hogging conditions, at low vacuum, reduce excessive compression in the rotor buckets or spaces 28 between the blades of rotor 52. Correspondingly, peak power requirements at low vacuum are also reduced. The pump can operate at lower than normal tip speeds with these vent holes in the first stage cone The cone 60 also has 4 linearly aligned skew holes 67 to reduce hydraulic noise.

[0034] Second stage head or end shield 33 includes intake port 71a, 71b that includes a first chamber 71 a adapted to accept compressed air from interstage manifold 34 and second chamber 71 b which is adapted to

accept water from interstage manifold 34. Second stage head 36 also includes outlet port 81. The second stage head is adapted to be coupled to second chamber housing 18 of body 14.

[0035] The second stage head 33 includes a circular rabbet or boss 110a on face 79a that is adapted to accept an O-ring 202 to permit sealing between the second stage head 33 and body 14. An O-ring 202 can be used since interstage manifold is detachable from second stage head 33. The o-ring 202 seals in the same manner as in the first stage head, i.e., between boss 110a's side wall 207 and an internal side wall 208 of body 14. The o-ring sits in groove 210..

[0036] First and second stage heads 32, 33 include outboard bearing carriers 94, 96 that are adapted to the support drive shaft, as shown, for example, in Fig. 2. Bearing carriers 94, 96 include bearings 98, 100 that are adapted to support drive shaft 9. To seal first and second stage heads 32, 33 from leaking along drive shaft 49, seals 102, 104 are used in first and second stage heads 32, 33 between the rotor and the rest of the pump.

[0037] Both discharge port 30 and intake port 71 a, 71 b include mating faces 77, 78 that are adapted to accept an O-ring or gasket to seal ports 30, and 71a, 71b to interstage manifold 34. Mating faces 77, 78 can include a plurality of apertures 76 that are sized to accommodate variations in end travel settings of first and second stage heads 32, 33. Since interstage manifold 34 is removable, it provides the option of being made in lightweight and corrosion resistant materials for cost effective manufacture.

[0038] The modular design of pump 10 permits gaskets to be used between the first stage internal face 79 and body end wall 201. The gaskets serve the dual purpose as shims 200 and gaskets 200 when the pump is used in general applications such as those applications used in the power industry. The modular design also permits the use of O-rings using the same casting, but with some additional machining, for more demanding applications, such as those applications in the chemical industry. In demanding industry applications, the shims 200 are used to set end travel only, and O-rings 202 are used to seal between the first stage head 32, second stage head 33 and body 14.

[0039] With a gasket only configuration , ie., no o-rings, the gaskets on the first or second stage head could also serve as shims for setting end travel clearance. Any gaskets/shims used on the second stage head would have to be configured to seal around conduit 205. Although the shims or gaskets used in this configuration would not interfere with the use of o-rings 202, in general, when one uses gaskets for sealing duty they do not want o-rings. Thus o-rings 202 would likely be omitted. Conversely when one uses o-rings for sealing they do not want to use gaskets for sealing duty. Any gaskets used would strictly serve as shims.

[0040] With an O-ring configuration, the shown second stage internal face end, or side 79a, having surface 179a, is not adapted to accept shims to allow for setting end travel between cones 60,62 and rotor 12. The operating liquid conduit 205 in the second stage head prevents the effective use of shims. The conduit is bordered by a groove 205a to accept an o-ring 209 . The o-ring 209 seals the conduit 205 to an end face 206 of body 14. A shim, if used, would interfere with the o-ring's ability to seal conduit 205 to end face 206. Therefore to allow for the use of shims on the second stage head 33, in an o-ring configuration, one would have to reconfigure the second stage head 33, so that it would be compatible with the use of shims. For instance, one could remove conduit 205 and use an alternative conduit configuration.

[0041] In operation the rotation of rotor 12 draws air or gas into inlet 26 of the first stage head and progresses in the direction shown by arrows 112. The air enters first cone passage 20 through inlet port 70. As rotation progresses, the liquid (not shown) from the liquid ring is forced into rotor buckets 28 compressing the air or gas, and a mixture of gas and liquid is then forced out of cone discharge port 64 through first stage head port 66 in the direction shown by arrows 114. The air and gas mixture is discharged from the first stage head through port 30 and enters interstage manifold 34 and progresses as shown by arrows 116.

[0042] As the air/gas mixture travels along manifold 34 the mixture enters an expanded region 42 which is characterized by a downwardly sloping ramp 44 leading to a bottom portion 46. The bottom portion is opposite the upper portion 47. In the expanded portion, the liquid portion of the mixture, falls towards the bottom 46 and the air remains above the liquid in upper portion 47. The separation occurs due to velocity reduction and gravity effects. The air enters second stage 33 through chamber 71a. The liquid enters second stage 33 through chamber 71b. Arrows 118 show the air passing from the manifold to the second stage. Arrows 120 show the water passing from the manifold into the second stage.

[0043] While embodiments have been illustrated and described in the drawings and foregoing description, such illustrations and descriptions are considered to be exemplary and not restrictive in character, it being understood that only illustrative embodiments have been shown and described and that all changes and modifications that come within the spirit of the invention are desired to be protected. The applicants have provided description and figures which are intended as illustrations of embodiments of the disclosure, and are not intended to be construed as containing or implying limitation of the disclosure to those embodiments. There are a plurality of advantages of the present disclosure arising from various features set forth in the description. It will be noted that alternative embodiments of the disclosure may not include all of the features described yet still benefit from at least some of the advantages of such features. Those of ordinary skill in the art may readily devise their own implementations of the disclosure and associated methods, without undue experimentation, that incorporate one

or more of the features of the disclosure and fall within the spirit and scope of the present disclosure and the appended claims.

Attention is directed to all papers and documents which are filed concurrently with or previous to this specification in connection with this application and which are open to public inspection with this specification, and the contents of all such papers and documents are incorporated herein by reference.

All of the features disclosed in this specification (including any accompanying claims, abstract and drawings), and/or all of the steps of any method or process so disclosed, may be combined in any combination, except combinations where at least some of such features and/or steps are mutually exclusive.

Each feature disclosed in this specification (including any accompanying claims, abstract and drawings) may be replaced by alternative features serving the same, equivalent or similar purpose, unless expressly stated otherwise. Thus, unless expressly stated otherwise, each feature disclosed is one example only of a generic series of equivalent or similar features.

The invention is not restricted to the details of the foregoing embodiment(s). The invention extends to any novel one, or any novel combination, of the features disclosed in this specification (including any accompanying claims, abstract and drawings), or to any novel one, or any novel combination, of the steps of any method or process so disclosed.

Claims

1. A liquid ring pump comprising:

a first head, said first head having an inlet, an outlet, a shaft receiving aperture extending there through, and an internal end, wherein said internal end includes a boss, said boss having a side wall;
a second head having an inlet, an outlet and an internal end;
a body having a first end coupled to said internal end of said first head and a second end coupled to said internal end of said second head, and wherein

said first end of said body receives said boss.

2. The liquid ring pump of Claim 1, wherein said first head outlet is removably coupled to a first end of an interstage manifold, and wherein
said second head is removably coupled to a second end of said interstage manifold.

3. The liquid ring pump of Claim 2, wherein said body is without said manifold integral thereto.

4. The liquid ring pump of Claim 1, wherein said first head is a first stage head.

5. The liquid ring pump of Claim 1, wherein said internal end of said first head has a shim receiving surface, said shim receiving surface not forming a surface of said boss.

6. The liquid ring pump of Claim 5, wherein the shim receiving surface has a plurality of apertures there through.

7. The liquid ring pump of claim 6, wherein a plurality of shims are between an end wall of said body and said shim receiving surface.

8. A head for a liquid ring pump, said head comprising;

an internal end wherein said internal end has a rabbet and a recessed portion, said rabbet has a side wall;
an inlet;
an outlet;
a shaft receiving aperture extending through said head, and wherein

said recessed portion is between said shaft receiving aperture and said rabbet side wall.

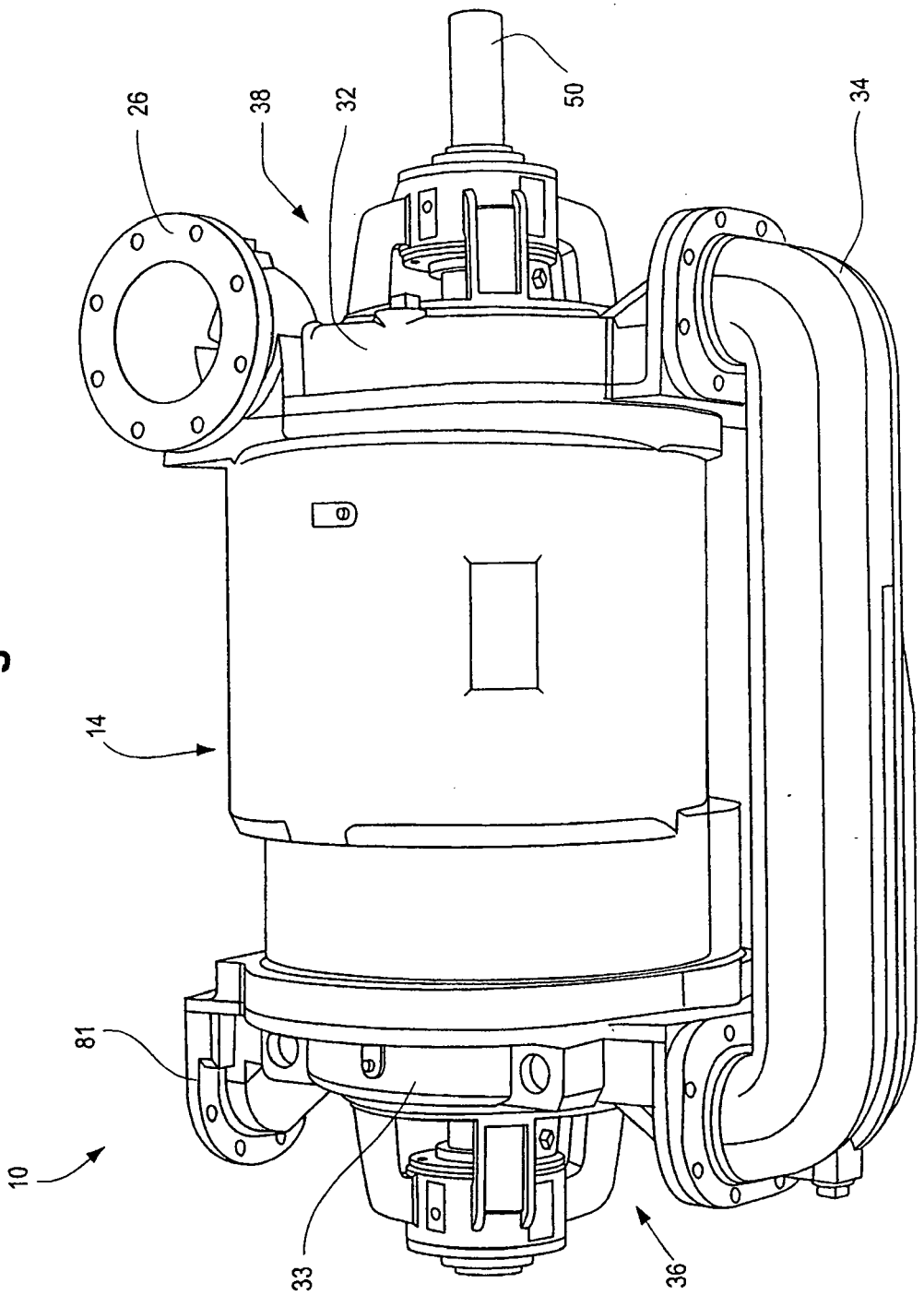
9. The head of claim 8, wherein said head is a first stage head of a two-stage liquid ring pump and wherein said head includes a manifold mating flange at said outlet.

10. The head of claim 8, wherein said head is a second stage head of a two-stage liquid ring pump, and wherein said head includes a manifold mating flange at said inlet, and wherein said inlet is separated into an air receiving chamber and a liquid receiving chamber.

11. The head of claim 8, wherein said rabbet side wall has a groove therein.

12. The head of claim 8, wherein said internal end has a shim receiving surface, said boss between said shim receiving surface and said recessed surface.

Fig. 1



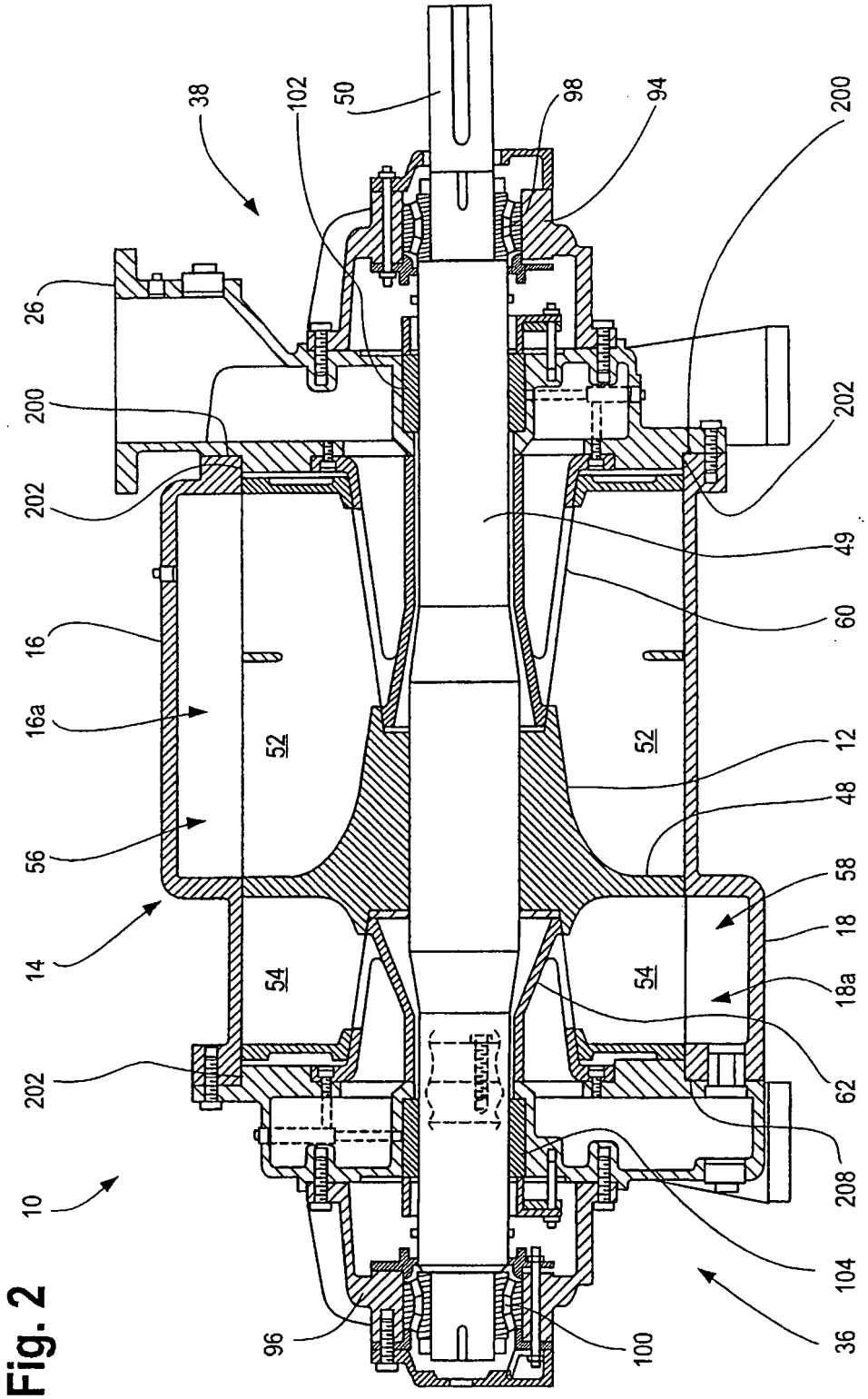

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Fig. 2

Fig. 3

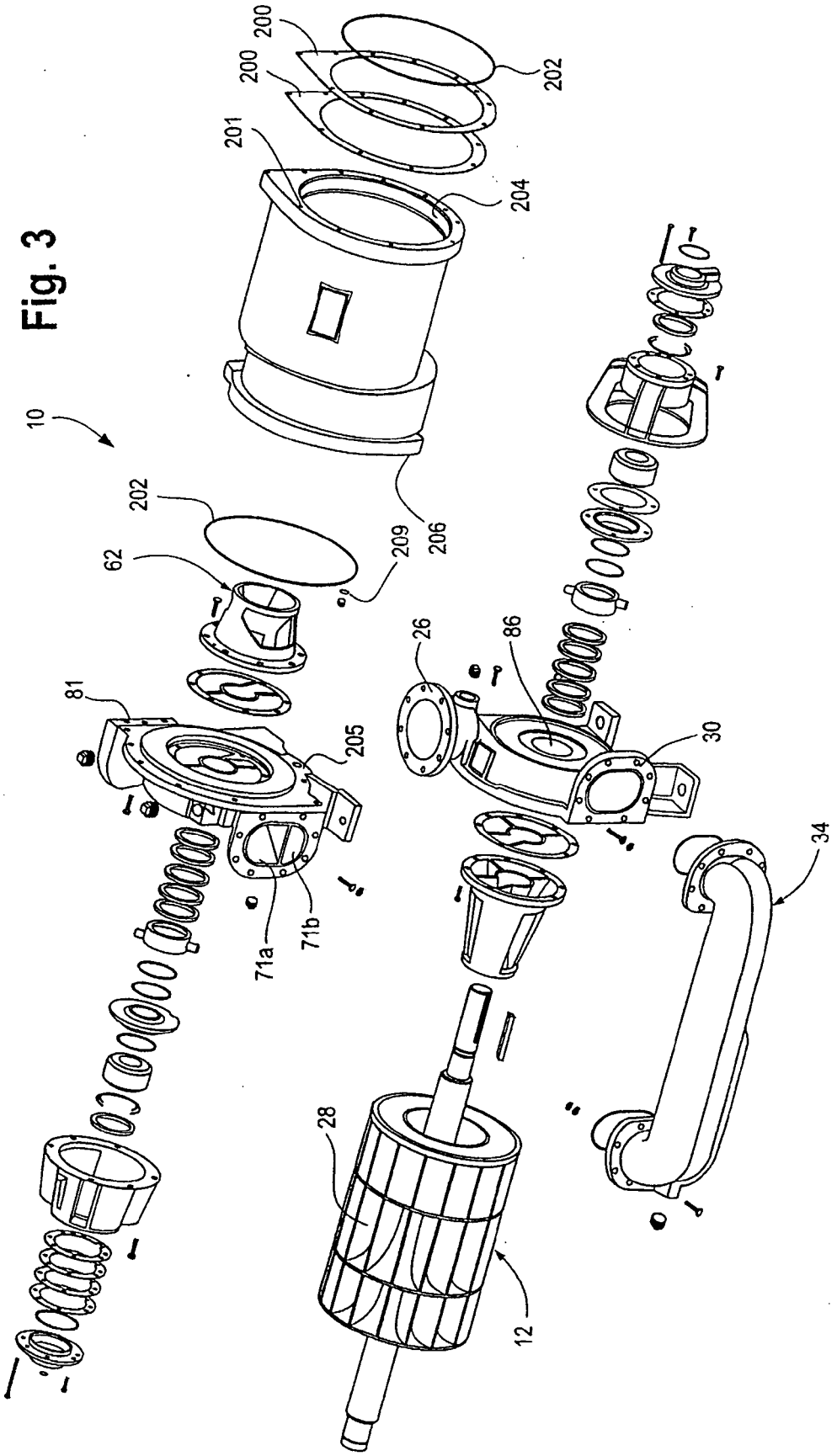
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Fig. 4

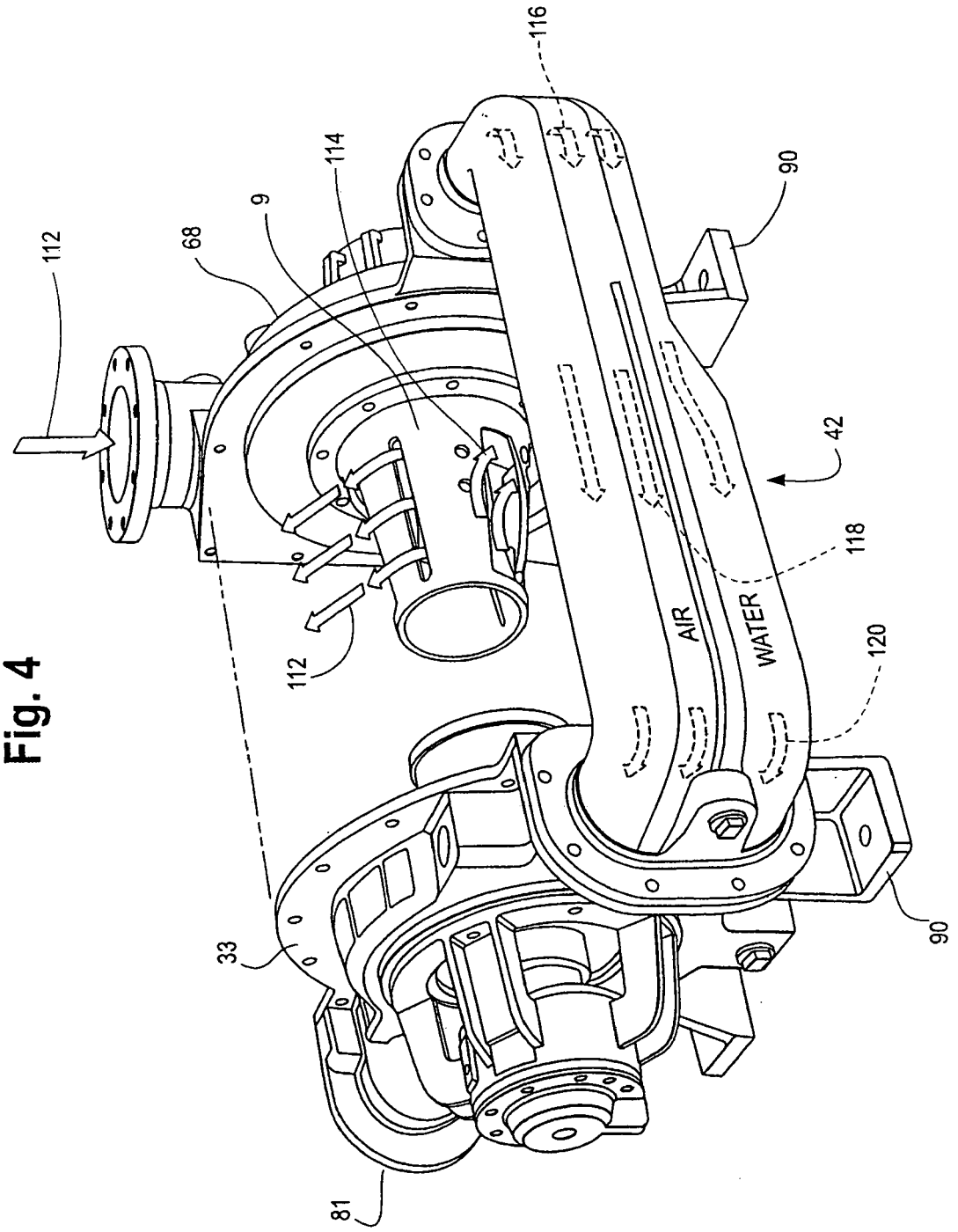


Fig. 5

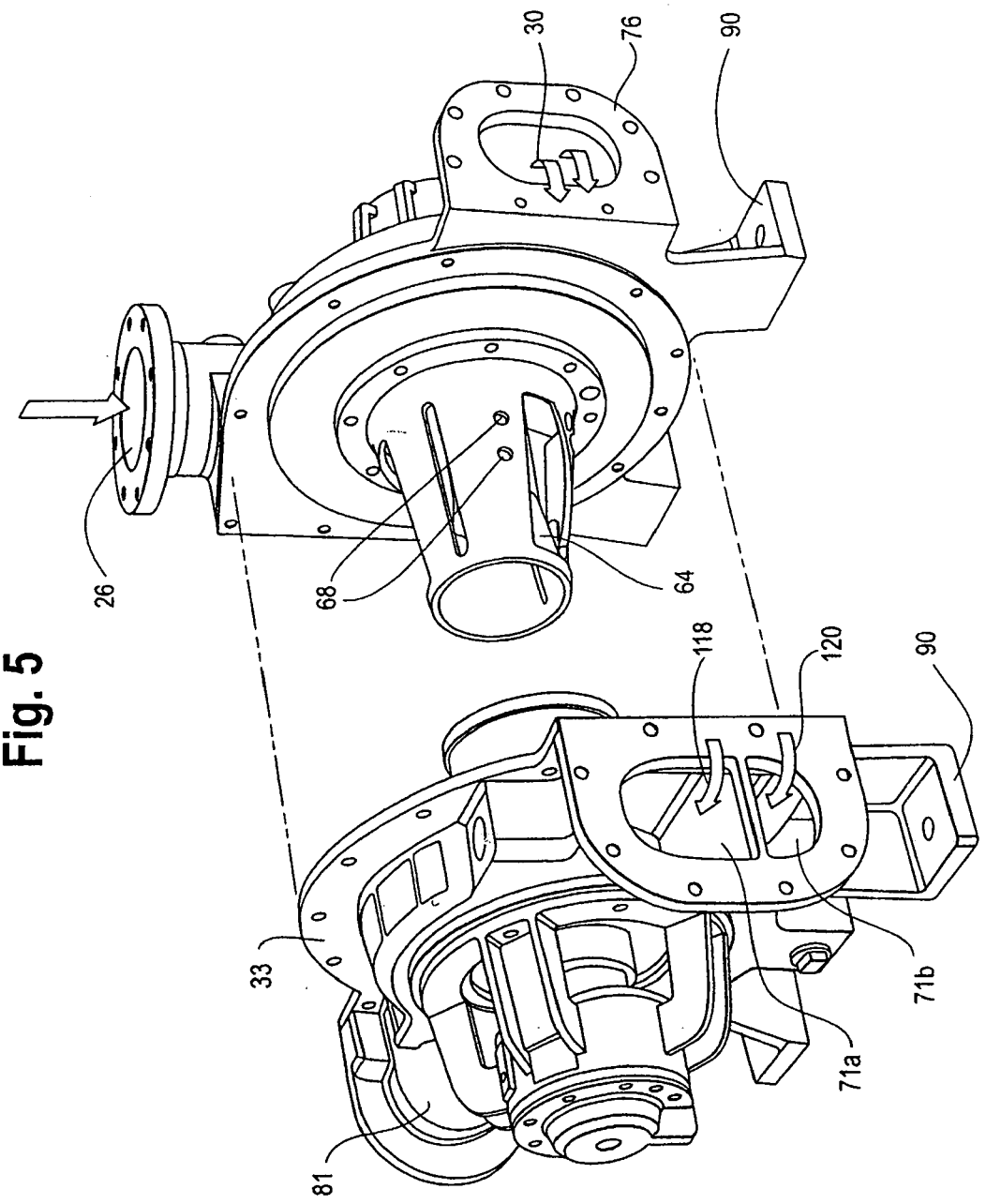


Fig. 6c

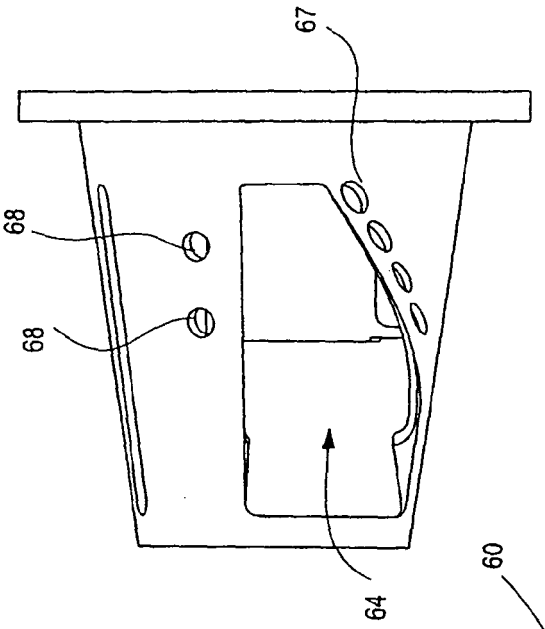


Fig. 6b

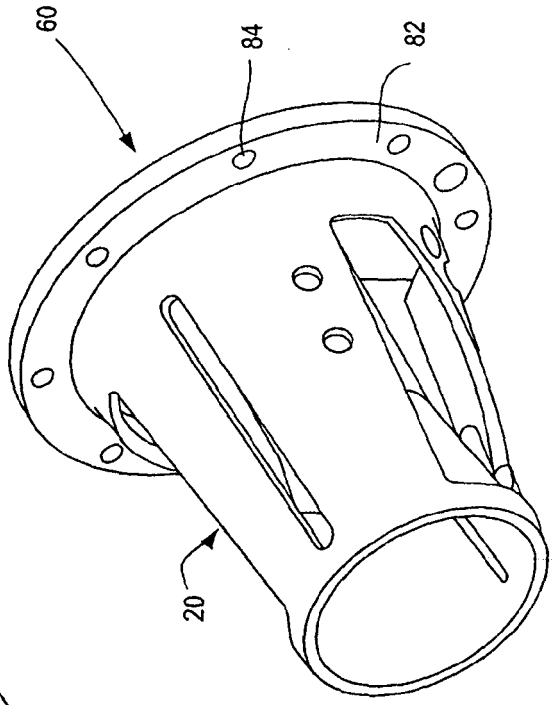


Fig. 6a

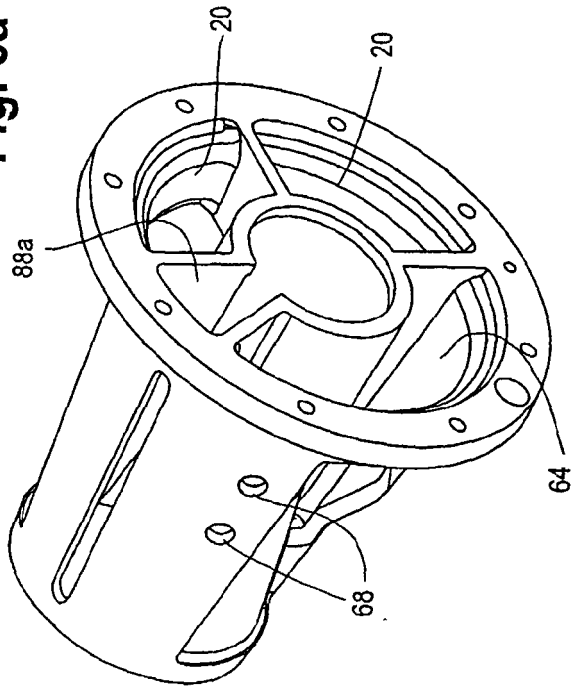


Fig. 7b

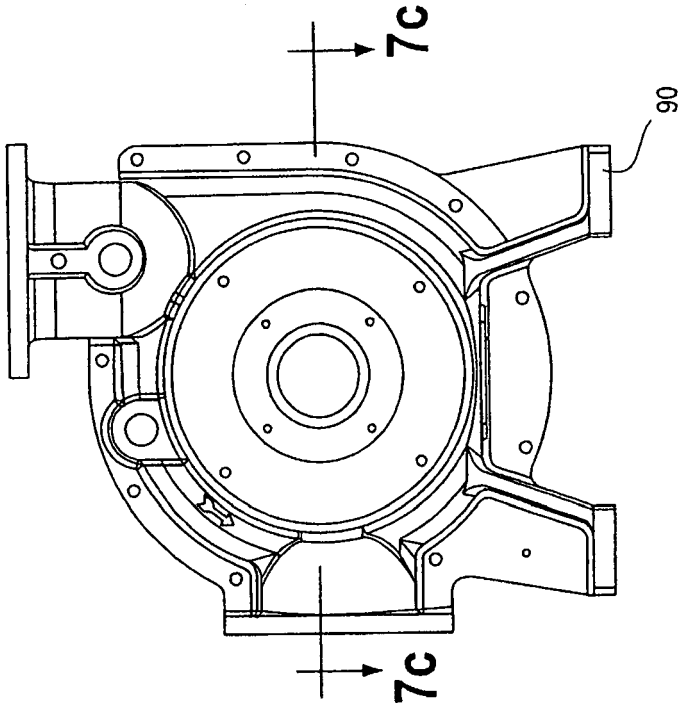


Fig. 7a

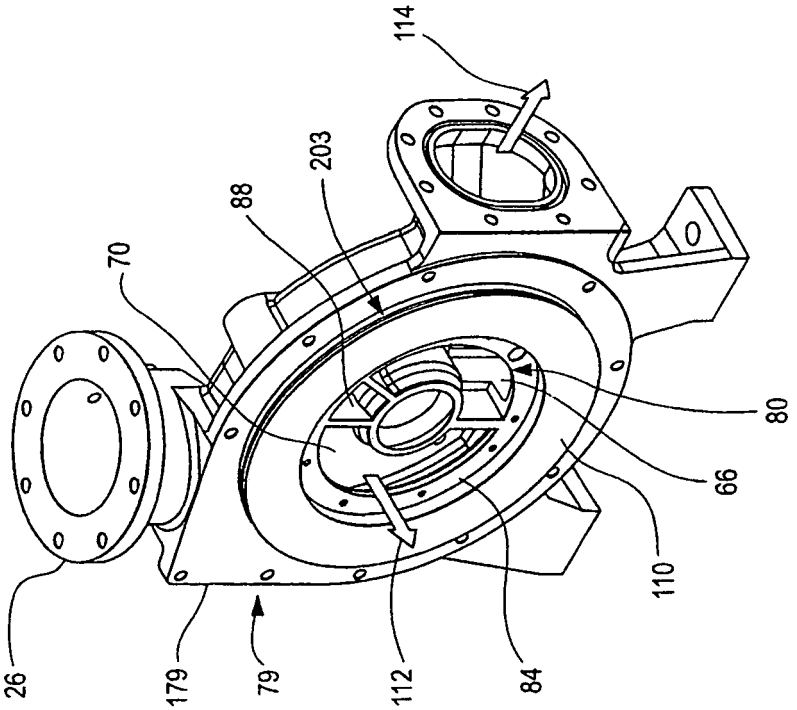


Fig. 7d

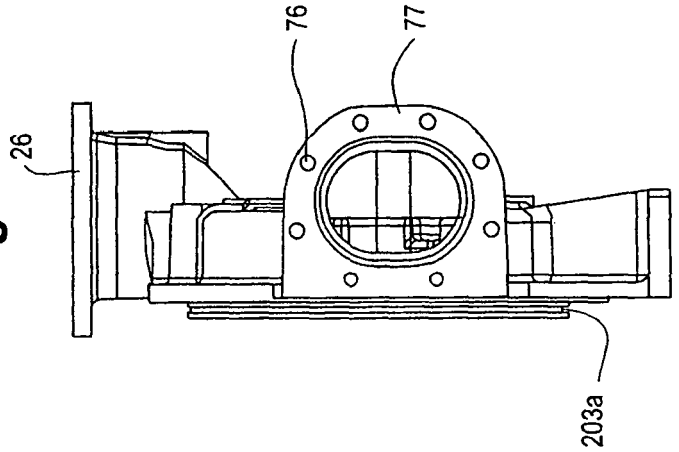


Fig. 7c

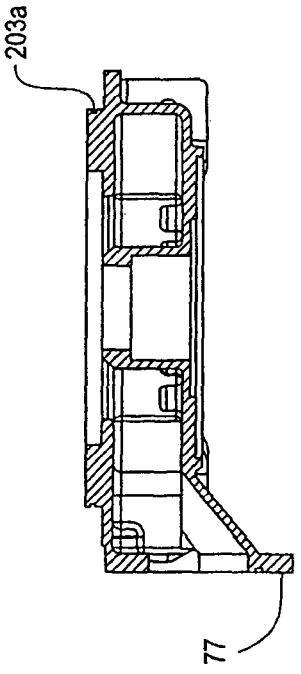


Fig. 8c

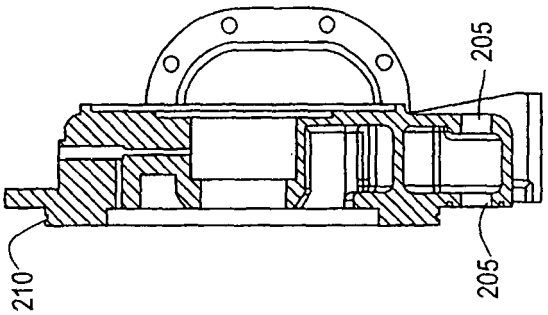


Fig. 8a

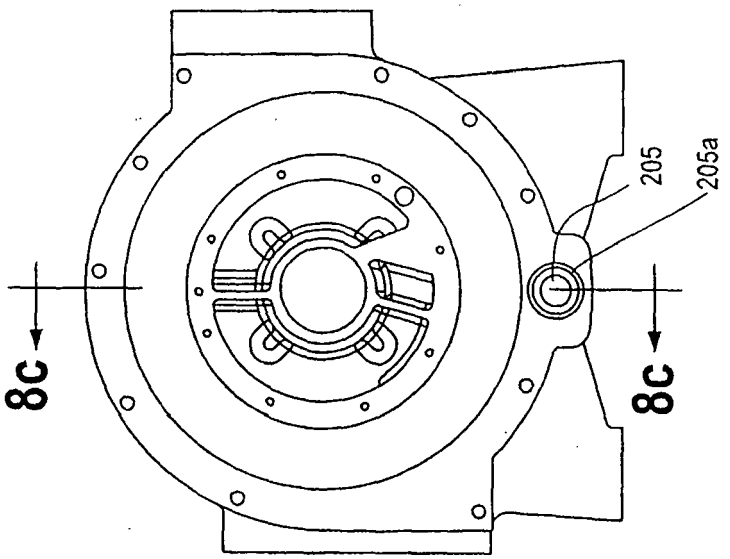
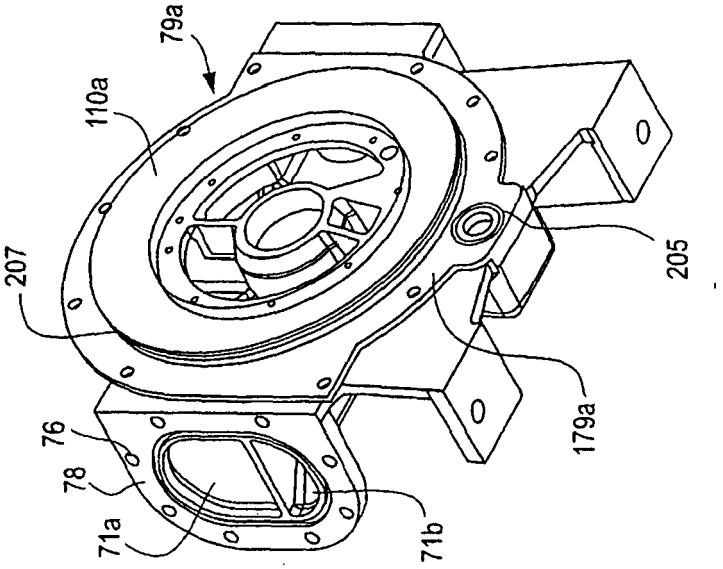


Fig. 8b



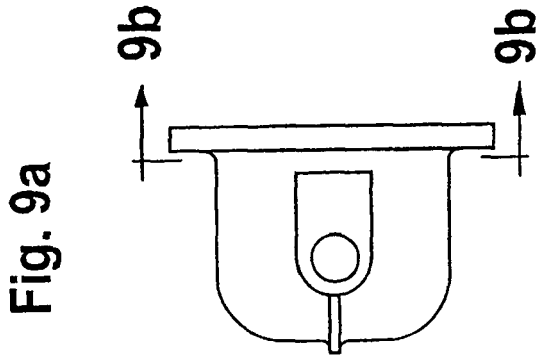


Fig. 9a

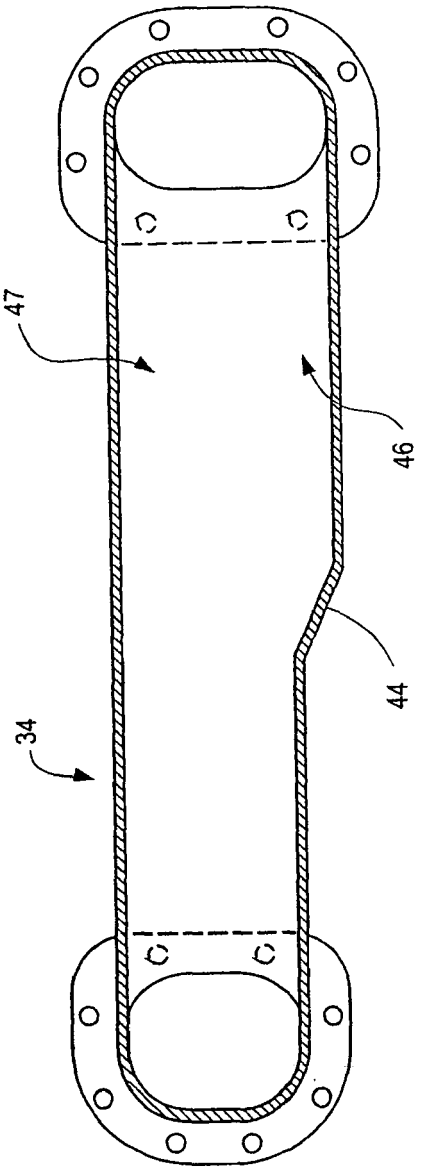


Fig. 9b

REFERENCES CITED IN THE DESCRIPTION

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