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(54) **A self-priming centrifugal pump**

Selbstansaugende Kreiselpumpe

Pompe centrifuge auto-amorçante

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(56) References cited:
EP-A- 0 361 328 **DE-A- 3 718 273**
US-A- 2 934 021 **US-A- 2 941 474**

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Description

[0001] The present invention relates to a self-priming centrifugal pump of the kind described in the preamble to claim 1.

[0002] Currently known self-priming centrifugal pumps have an intake conduit axially facing the impeller, downstream of which a diffuser, coaxial to the impeller itself, guides the pumped liquid into a delivery chamber which in many practical applications surrounds the intake conduit. An opening obtained in the intake conduit in correspondence with an area thereof, shaped as a Venturi tube, causes the liquid present in the delivery chamber, when the pump is started, to be thrust through the opening, thereby creating a vacuum at the start of the Venturi tube, which allows to aspirate from the inlet of the pump body any air present therein.

[0003] Currently known diffusers have a diffusion chamber that is delimited by two opposite walls, whereof one is oriented towards the impeller and another one towards the delivery chamber. Through the outer circumferential periphery of the wall oriented towards the impeller a plurality of openings are obtained, which allow the entry of the flow of liquid exiting the impeller into the diffusion chamber.

[0004] Also through the wall oriented towards the delivery chamber are generally obtained one or more holes which put the diffusion chamber in communication with the delivery chamber.

[0005] In a first known embodiment, described in US Patent 2 934 021, through the wall oriented towards the delivery chamber are obtained four groups of small holes. The four groups are then positioned above, below, and at the two sides of the axis of the impeller.

[0006] A second known embodiment of the diffuser is instead described in the patent EP 361 328.

[0007] In this embodiment, the diffuser has a single annular hole extending between the wall oriented towards the delivery chamber and the part of the intake conduit that is inserted internally to the delivery chamber itself (Figures 1 and 2).

[0008] Both known solutions described above, however, have the considerable drawback of a relatively high, and anyway not optimal, self-priming time of the pump.

[0009] As is well known, upon starting, in the pump starts to re-circulate the liquid present in the delivery chamber through the intake conduit. In this way, thanks to the Venturi tube conformation of the intake conduit, the pump gradually sucks in the air (or the gaseous fluid) present in the intake conduit upstream of the point shaped as a Venturi tube. The air which becomes mixed with the liquid in the intake conduit must subsequently be separated therefrom in correspondence with the delivery chamber to be ejected from the delivery conduit.

[0010] The self-priming time, for an equal length of the intake conduit (construed both as a conduit within the pump, and as a pipeline outside the pump, such as the suction pipe of a well), thus depends on the ability of the

pump to suck in the air present in the intake conduit, to separated from the liquid and to eject it through the delivery conduit.

[0011] As stated, currently known pumps have a relatively high self-priming pump, due to their mediocre ability to separate the air from the liquid inside the delivery chamber.

[0012] In this situation, the technical task constituting the basis of the present invention is to provide a self-priming centrifugal pump that overcomes the aforementioned drawbacks.

[0013] In particular, the technical task of the present invention is to provide a self-priming centrifugal pump that has a reduced self-priming time relative to currently known pumps.

[0014] The specified technical task and the objects set out herein are substantially achieved by a self-priming centrifugal pump as described in the accompanying claims.

[0015] Further features and the advantages of the present invention shall become more readily apparent from the detailed description of some preferred, but not exclusive, embodiments of a self-priming pump illustrated in the accompanying drawings, in which:

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- Figure 1 shows a front view of a detail of a diffuser of a self-priming centrifugal pump in accordance with the prior art;

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- Figure 2 shows a section view of the detail of Figure 1 according to the line II-II;

- Figure 3 shows a front view of a detail of a diffuser of a self-priming centrifugal pump constructed according to a first embodiment of the present invention;

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- Figure 4 shows a top view of the detail of Figure 3;

- Figure 5 shows a front view of a detail of a diffuser of a self-priming centrifugal pump constructed according to a second embodiment of the present invention;

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- Figure 6 shows a top view of the detail of Figure 5;

- Figure 7 shows a front view of the diffuser of Figure 3 with an additional element highlighted;

- Figure 8 shows a top view of the diffuser of Figure 7;

- Figure 9 shows a front view of the diffuser of Figure 5 with an additional element highlighted;

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- Figure 10 shows a top view of the diffuser of Figure 9;

- Figure 11 shows a front view of a detail of the diffuser of Figure 9;

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- Figure 12 shows a section view of the detail of Figure 11 according to the line XII-XII;

- Figure 13 shows a front view of the detail of the diffuser of Figure 7;

- Figure 14 shows a sectioned view of the detail of Figure 13 according to the line XIV-XIV; and

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- Figure 15 shows a schematic and partially sectioned side view of a self-priming centrifugal pump according to the present invention.

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[0016] With reference to the aforementioned figures, the reference number 1 globally designates a self-priming centrifugal pump according to the present invention (Figure 15).

[0017] The pump 1, shown in Figure 15, comprises a pump body 2 set horizontally side by side with an electric motor 3 provided with its own connection box 4.

[0018] Inside the pump body 2 are identified a delivery chamber 5, a pumping chamber 6 and an intake conduit 7.

[0019] In the pumping chamber 6 is mounted a motorised centrifugal impeller 8 (of a known type) rigidly connected to the shaft 9 of the electric motor 3.

[0020] The intake conduit 7 extends between an intake hole 10, obtained in an upper part of the pump body 2, and the pumping chamber 6 into which it opens in alignment with the axis of the impeller 8.

[0021] In its own intermediate portion shaped as a Venturi tube 11, the intake conduit 7 has a branch 12 open towards the delivery chamber 5.

[0022] The pumping chamber 6 is also peripherally in communication with the delivery chamber 5 through a diffuser 13 (Figures 7-10).

[0023] In the illustrated embodiment, the intake conduit 7 and the delivery chamber 5 are positioned on the same side of the impeller 8 (but this solution is not mandatory), and the diffuser 13 is rigidly mounted between the inner wall of the pump body 2 and the outer wall of the intake conduit 7.

[0024] The diffuser 13, which is positioned downstream of the impeller 8 with reference to the flow of the liquid in the pump 1, is constituted mainly by a first and by a second wall 14, 15, substantially shaped as annuli, which identify between them a diffusion chamber 16 having, at least mainly, continuous annular development.

[0025] The first wall 14 (Figures 3-6) is oriented towards the impeller 8 whilst the second wall 15 (Figures 11-14) faces the delivery chamber 5 of the pump 1.

[0026] The communication between the pumping chamber 6 and the diffusion chamber 16 is assured by a plurality of openings 17 positioned along the outer circumferential periphery of the first wall 14, which allow the entry of the flow of liquid exiting the impeller 8 into the diffusion chamber 16.

[0027] In the diffusion 16 can be identified a first sector 18 and a second sector 19, one being a continuation of the other, in which the first sector 18 corresponds, in use, to the central upper portion of the ring defined by the diffusion chamber 16. In particular, in the illustrated embodiments, the diffuser 13 has, viewed frontally, annulus shape, and the first sector 18 can be frontally identified as the upper sector of said circular crown (Figures 7 and 9).

[0028] The second wall 15 is substantially closed in correspondence with the first sector 18 of the diffusion chamber 16, whilst it has one or more through holes 20 in correspondence with the second sector 19. Said through holes 20 have the purpose of putting in commu-

nication the second sector 19 of the diffusion chamber 16 with the delivery chamber 5, thus allowing the passage of the liquid in substantially axial direction.

[0029] Depending on the embodiments, in correspondence with the first sector 18 of the diffusion chamber 16, the second wall 15 can be either completely closed (Figures 9-12), or it can have, in correspondence with the summit part of the first sector 18 of the diffusion chamber 16, a small vent hole 21 to allow the exit of any air present in the diffusion chamber 16 towards the delivery chamber 5 (figures 7, 8, 13, 14).

[0030] The presence or absence of the vent hole 21 depends on the dimensioning of the diffuser 13. In particular when the extension of the first sector 18 is relatively high (Figure 13), the vent hole 21 is necessary to prevent air from accumulating in the upper part of the diffusion chamber 16. On the contrary, if the extension of the first sector 18 of the diffusion chamber 16 is relatively reduced (Figure 11), the presence of the hole 21 is not indispensable since any air accumulated in the upper part of the diffusion chamber 16 would in any case be driven towards the delivery chamber 5 by the liquid in swirling motion which flows inside the diffuser 13.

[0031] Advantageously, the through hole 20 (or the through holes 20 as the case may be) positioned in correspondence with the second sector 19 of the diffusion chamber 16 has elongated shape along the development of the second sector 19 itself, and covers most of the development thereof in order to maximise the flow of liquid from the diffusion chamber 16 to the delivery chamber 5.

[0032] The illustrated embodiments comprise a plurality of through holes 20, distributed in succession along an arc of circumference having for its centre the axis of the impeller 8, but other embodiments may also comprise a single through hole 20 with equivalent size and shape.

[0033] As shown in particular in Figures 3 through 6 which show the diffuser 13 without the second wall 15, in the illustrated embodiments, the diffuser 13 further comprises a plurality of spacers 22 interposed between the first and the second wall 14, 15, integral to the first wall 14 and positioned in correspondence with the external periphery of the diffusion chamber 16.

[0034] Since said spacers 22 intercept the flow of the liquid entering tangentially into the diffusion chamber 16, they can be shaped slightly arched in order to facilitate the commencement in the diffusion chamber of a motion with rotational component about the axis of the impeller 8.

[0035] As shown in Figures 8, 10 and 15, the diffusion chamber 16 in addition to developing in annular fashion about the axis of rotation of the impeller 8, also has a development component parallel to said axis in the direction of the delivery chamber 5. In essence the chamber therefore develops mainly along the lateral surface of a cone frustum with its conicity oriented towards the delivery chamber 5.

[0036] In the delivery chamber 5 are also present two vertical stiffening bulkheads 23 which contrast the swirl-

ing motion of the liquid about the intake conduit.

[0037] As regards the pump body 2, in the illustrated embodiment it has, in addition to the intake hole 10, also a delivery hole 24 and a filling hole 25 obtained in the upper part, and a discharge hole 26 obtained in the lower part, all in communication with the delivery chamber 5.

[0038] At the time of installation, the pump 1 is mounted with the axis of the impeller 8 preferably in horizontal position, although slightly inclined positions are admissible provided they do not compromise the self-priming operation. Moreover, the first sector 18 of the diffusion chamber 16 is in the highest position.

[0039] In this way, at the time the pump 1 is started, the liquid present inside the pump body 2 is made to flow cyclically between the delivery chamber 5, the intake conduit 7, the pumping chamber 6 and the diffusion chamber 16.

[0040] In correspondence with the Venturi tube 11, air coming from the intake conduit 7 is mixed with the liquid. Once the liquid reaches the delivery chamber 5, the air is released and reaches the delivery hole 24 to exit the pump 1.

[0041] The presence of a substantially closed sector of the second wall 15 in correspondence with the first sector 18 of the diffusion chamber 16 (the possible presence of the vent hole 21 has nearly no influence) causes, at the time the pump 1 is started (with liquid present only inside the pump body 2), the surface of the liquid inside the pump body 2 not to be directly involved by the flow of the liquid exiting the diffuser 13.

[0042] In this way the air bubbles which are separated from the liquid which exits the diffuser 13 through the through holes 20 do not find fluid flow to hinder their upward travel towards the delivery hole 24.

[0043] On the contrary, in currently known pumps the surface of the liquid is always involved by a flow of liquid in swirling motion exiting the diffuser 13, parallel to the axis of the impeller 8. In this way, any air bubbles separating from the flow exiting the diffuser 13 in the low part of the delivery chamber 5 are intercepted by the swirling flow and brought into circulation again and again by the flow of liquid.

[0044] The present invention thus achieves important advantages.

[0045] The pump of the present invention assures a considerably shorter self-priming time than known pumps, thanks to its own ability to separate the air bubbles from the flow of liquid.

[0046] It should also be noted that the present invention is relatively easy to construct and that also the cost connected with the construction of the invention is not high.

[0047] The invention thus conceived can be subject to numerous modifications and variations, without thereby departing from the scope of the inventive concept that characterises it.

[0048] All details can be replaced by other, technically equivalent elements and in practice all materials em-

ployed, as well as the shapes and dimensions of the various components, may be any depending on requirements.

Claims

1. A self-priming centrifugal pump comprising

- a pump body (2);
- a motorised impeller (8) mounted internally to the pump body (2); and
- a diffuser (13) positioned downstream of the impeller (8), with reference to the direction of flow of a liquid in the pump (1), and having a first and a second wall (14), (15) defining between each other a diffusion chamber (16) having, at least mainly, continuous annular development, said first wall (14) being oriented towards said impeller (8) and said second wall (15) being oriented towards the delivery chamber (5) of the pump (1), said first wall (14) having a plurality of openings (17) positioned along its own outer circumferential periphery to allow the entry of the flow of liquid exiting the impeller (8) into the diffusion chamber (16), and said second wall (15) having at least a through hole (20) to put in communication the diffusion chamber (16) with the delivery chamber (5);

characterised in that said annular diffusion chamber (16) has a first sector (18) and a second sector (19), the one being a continuation of the other, said first sector (18) corresponding, in use, to an upper portion of said diffusion chamber (16), and **in that** said second wall (15) is substantially closed in correspondence with said first sector (18), said through hole (20) being obtained in correspondence with the second sector (19), to put in communication said second sector (19) of the diffusion chamber (16) with the delivery chamber (5).

2. A self-priming centrifugal pump as claimed in claim 1 **characterised in that** said through hole (20) has elongated shape along the development of the second sector (19) of the diffusion chamber (16).
3. A self-priming centrifugal pump as claimed in claim 1 or 2 **characterised in that** it has a single through hole (20) extending along most of the development of the second sector (19) of the diffusion chamber (16).
4. A self-priming centrifugal pump as claimed in claim 1 or 2 **characterised in that** said second wall (15) has a plurality of through holes (20) distributed along the development of said second sector (19) of the diffusion chamber (16).

5. A self-priming centrifugal pump as claimed in claim 4 **characterised in that** said plurality of holes is distributed along circumference arc.
6. A self-priming centrifugal pump as claimed in claim 1 **characterised in that** said diffuser (13) further comprises a plurality of spacers (22) interposed between the first and the second wall (14), (15) and positioned in correspondence with the outer periphery of the diffusion chamber (16).
7. A self-priming centrifugal pump as claimed in any of the previous claims, **characterised in that** said diffusion chamber (16) develops mainly along the lateral surface of a cone frustum with conicity oriented towards the delivery chamber (5).
8. A self-priming centrifugal pump as claimed in any of the previous claims, **characterised in that** said first sector (18) of the diffusion chamber (16) corresponds, in use, to a central upper portion of said diffusion chamber (16).
9. A self-priming centrifugal pump as claimed in any of the previous claims, **characterised in that** said second wall (15) has, in correspondence with the summit part of the first sector (18) of the diffusion chamber (16), a small vent hole (21) to allow the escape of any air present in the diffusion chamber (16) towards the delivery chamber (5).

Patentansprüche

1. Selbstansaugende Kreiselpumpe, enthaltend
 - einen Pumpenkörper (2);
 - ein angetriebenes Laufrad (8), montiert im Inneren des Körpers (2); und
 - einen Diffusor (13), unter Bezugnahme auf die Fliessrichtung einer Flüssigkeit in der Pumpe (1) stromabwärts des Laufrades (8) positioniert und eine erste und eine zweite Wand (14), (15) aufweisend, die zwischen sich eine Diffusionskammer (16) bilden, die wenigstens vorwiegend einen kontinuierlichen ringförmigen Verlauf hat, wobei die genannte erste Wand (14) zu dem genannten Laufrad (8) hin orientiert ist und die genannte zweite Wand (15) zu der Förderkammer (5) der Pumpe (1), wobei die genannte erste Wand (14) eine Anzahl von Öffnungen (17) aufweist, positioniert entlang ihrem äusseren Umlauf, um den Eintritt des Flusses der aus dem Laufrad (8) austretenden Flüssigkeit in die Diffusionskammer (16) zu erlauben, und wobei die genannte zweite Wand (15) wenigstens eine durchgehende Bohrung (20) aufweist, um die Diffusionskammer (16) mit der Förderkammer

(5) in Verbindung zu bringen;

dadurch gekennzeichnet, dass die genannte ringförmige Diffusionskammer (16) einen ersten Sektor (18) und einen zweiten Sektor (19) hat, wobei einer die Weiterführung des anderen ist, wobei der genannte erste Sektor (18) im Betrieb einem oberen Abschnitt der genannten Diffusionskammer (16) entspricht, und **dadurch**, dass die genannte zweite Wand (15) entsprechend dem genannten ersten Sektor (18) im wesentlichen geschlossen ist, wobei die genannte durchgehende Bohrung (20) entsprechend zu dem zweiten Sektor (19) erhalten ist, um den genannten zweiten Sektor (19) der Diffusionskammer (16) mit der Förderkammer (5) in Verbindung zu bringen.

2. Selbstansaugende Kreiselpumpe nach Patentanspruch 1, **dadurch gekennzeichnet, dass** die genannte durchgehende Bohrung (20) eine verlängerte Form entlang dem Verlauf des zweiten Sektors (19) der Diffusionskammer (16) aufweist.
3. Selbstansaugende Kreiselpumpe nach Patentanspruch 1 oder 2, **dadurch gekennzeichnet, dass** sie eine einzige durchgehende Bohrung (20) hat, die sich entlang dem grössten Teil des Verlaufs des zweiten Sektors (19) der Diffusionskammer (16) erstreckt.
4. Selbstansaugende Kreiselpumpe nach Patentanspruch 1 oder 2, **dadurch gekennzeichnet, dass** die genannte zweite Wand (15) eine Anzahl von durchgehenden Bohrungen (20) aufweist, die entlang dem Verlauf des zweiten Sektors (19) der Diffusionskammer (16) verteilt sind.
5. Selbstansaugende Kreiselpumpe nach Patentanspruch 4, **dadurch gekennzeichnet, dass** die genannte Anzahl von Bohrungen entlang dem Kreisbogen verteilt ist.
6. Selbstansaugende Kreiselpumpe nach Patentanspruch 1, **dadurch gekennzeichnet, dass** der genannte Diffusor (13) ausserdem eine Anzahl von Abstandsstücken (22) enthält, eingesetzt zwischen der ersten und der zweiten Wand (14), (15) und positioniert entsprechend zu dem äusseren Umlauf der Diffusionskammer (16).
7. Selbstansaugende Kreiselpumpe nach einem beliebigen der vorstehenden Patentansprüche, **dadurch gekennzeichnet, dass** die genannte Diffusionskammer (16) vorwiegend entlang der seitlichen Oberfläche eines Stumpfkessels verläuft, mit der Konizität zu der Förderkammer (5) hin gerichtet.
8. Selbstansaugende Kreiselpumpe nach einem belie-

bigen der vorstehenden Patentansprüche, **dadurch gekennzeichnet, dass** der genannte erste Sektor (18) der Diffusionskammer (16) im Betrieb einem mittleren oberen Abschnitt der genannten Diffusionskammer (16), entspricht.

9. Selbstansaugende Kreiselpumpe nach einem beliebigen der vorstehenden Patentansprüche, **dadurch gekennzeichnet, dass** die genannte zweite Wand (15) entsprechend zu dem obersten Teil des ersten Sektors (18) der Diffusionskammer (16) eine kleine Entlüftungsbohrung (21) hat, um das Entweichen eventueller, in der Diffusionskammer (16) vorhandener Luft zu der Förderkammer (5) hin zu erlauben.

Revendications

1. Une pompe centrifuge auto-amorçante comprenant

- un corps de pompe (2) ;
- un impulseur motorisé (8) monté à l'intérieur du corps de pompe (2); et
- un diffuseur (13) positionné en aval de l'impulseur (8), par rapport à la direction de flux d'un liquide dans la pompe (1), et ayant une première et seconde paroi (14), (15) déterminant entre elles une chambre à diffusion (16) ayant, au moins principalement, un développement annulaire continu, ladite première paroi (14) étant orientée vers ledit impulseur (8) et ladite seconde paroi (15) étant orientée vers la chambre de refoulement (5) de la pompe (1), ladite première paroi (14) ayant une pluralité d'ouvertures (17) positionnées le long de sa circonférence périphérique externe pour permettre l'entrée du liquide sortant de l'impulseur (8) dans la chambre à diffusion (16), et ladite seconde paroi (15) ayant au moins un trou traversant (20) pour mettre en communication la chambre à diffusion (16) et la chambre de refoulement (5);

caractérisée en ce que ladite chambre à diffusion annulaire (16) présente un premier secteur (18) et un second secteur (19), l'un étant la continuation de l'autre, ledit premier secteur (18) correspondant, lors de l'utilisation, à une portion supérieure de ladite chambre à diffusion (16), et **en ce que** ladite seconde paroi (15) est substantiellement fermée au niveau dudit premier secteur (18), ledit trou traversant (20) étant placé au niveau du second secteur (19), pour réaliser une communication entre ledit second secteur (19) de la chambre à diffusion (16) et la chambre de refoulement (5).

2. Une pompe centrifuge auto-amorçante selon la revendication 1, **caractérisée en ce que** ledit trou traversant (20) présente une forme allongée placée le

long du second secteur (19) de la chambre à diffusion (16).

3. Une pompe centrifuge auto-amorçante selon la revendication 1 ou 2, **caractérisée en ce qu'elle** a un seul trou traversant (20) s'étendant sur presque toute la longueur du second secteur (19) de la chambre à diffusion (16).
4. Une pompe centrifuge auto-amorçante selon la revendication 1 ou 2, **caractérisée en ce que** ladite seconde paroi (15) présente une pluralité de trous traversants (20) distribués sur le long dudit second secteur (19) de la chambre à diffusion (16).
5. Une pompe centrifuge auto-amorçante selon la revendication 4 **caractérisée en ce que** ladite pluralité de trous est distribuée le long d'un arc de circonférence.
6. Une pompe centrifuge auto-amorçante selon la revendication 1, **caractérisée en ce que** ledit diffuseur (13) comprend une pluralité d'entretoises (22) posées entre la première et la seconde paroi (14), (15) et positionnées au niveau de la circonférence externe de la chambre à diffusion (16).
7. Une pompe centrifuge auto-amorçante selon n'importe laquelle des revendications précédentes, **caractérisée en ce que** ladite chambre à diffusion (16) se développe principalement le long de la surface latérale d'un tronc de cône dont la conicité est orientée vers la chambre de refoulement (5).
8. Une pompe centrifuge auto-amorçante selon n'importe laquelle des revendications précédentes, **caractérisée en ce que** ledit premier secteur (18) de la chambre à diffusion (16) correspond, lors de l'utilisation, à une portion centrale supérieure de ladite chambre à diffusion (16).
9. Une pompe centrifuge auto-amorçante selon n'importe laquelle des revendications précédentes, **caractérisée en ce que** ladite seconde paroi (15) présente, au niveau de la partie constituant le sommet du premier secteur (18) de la chambre à diffusion (16), un petit orifice (21) qui permet à l'air présent de s'échapper dans la chambre à diffusion (16) vers la chambre de refoulement (5).

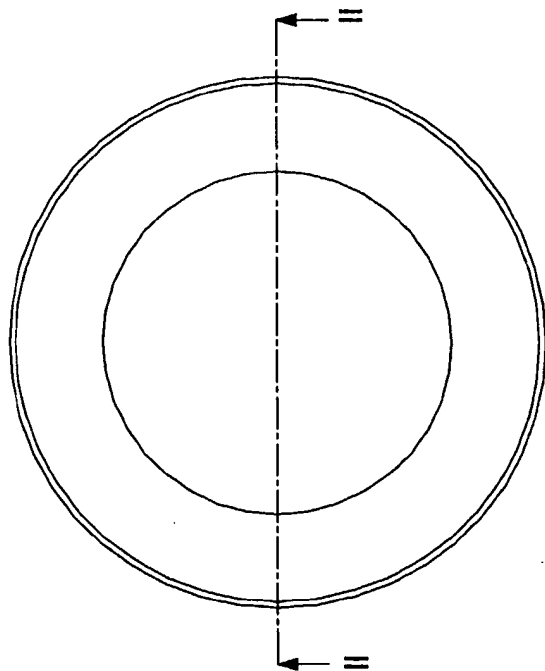


FIG. 1

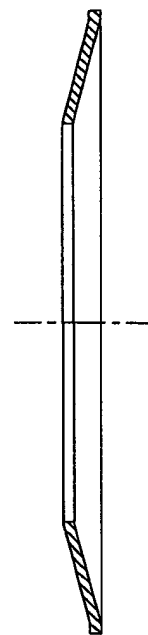


FIG. 2

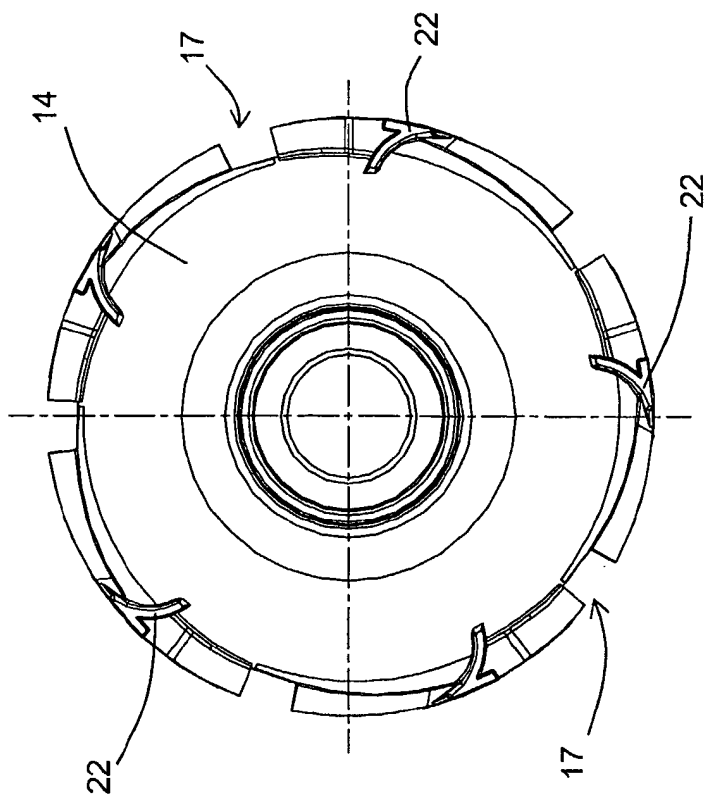


FIG. 3

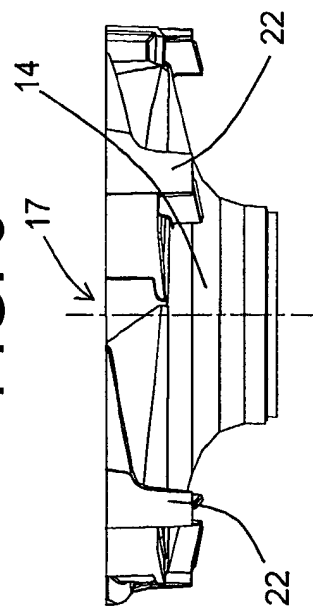


FIG. 4

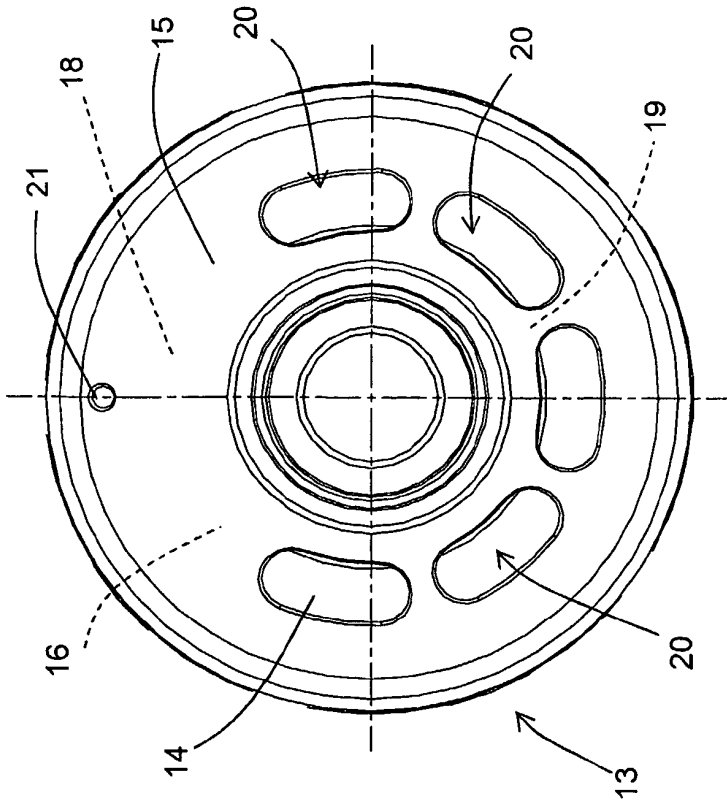


FIG. 7

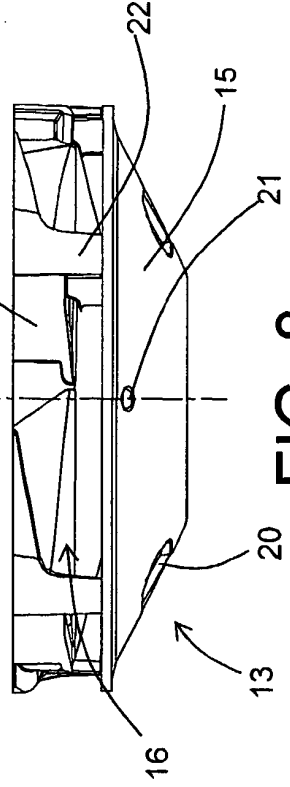


FIG. 8

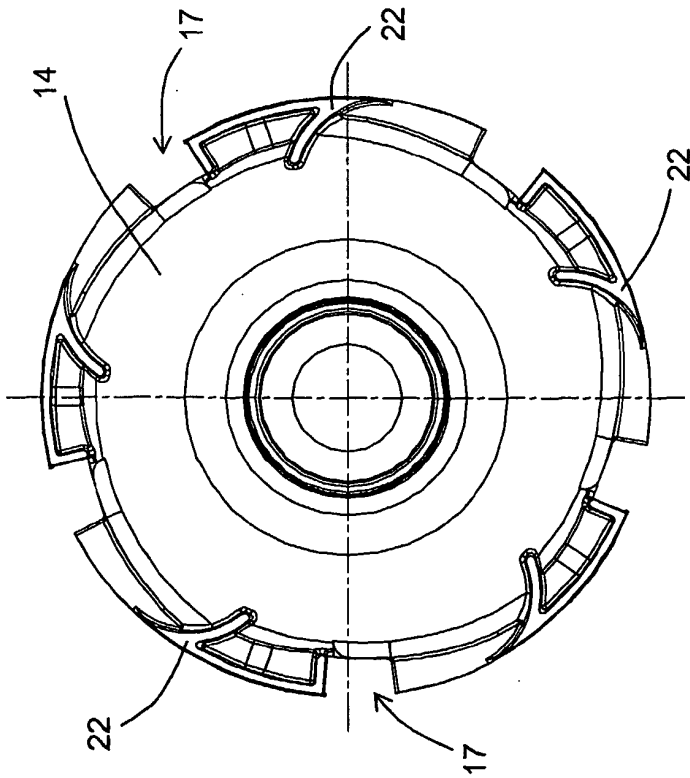


FIG. 5

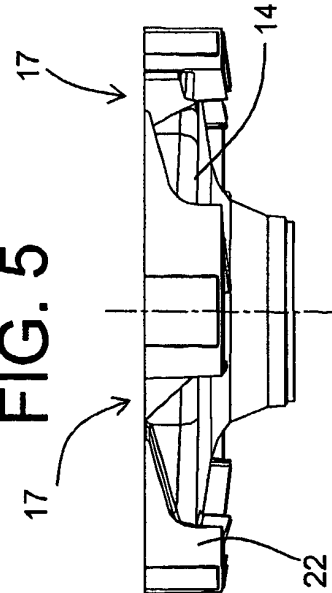


FIG. 6

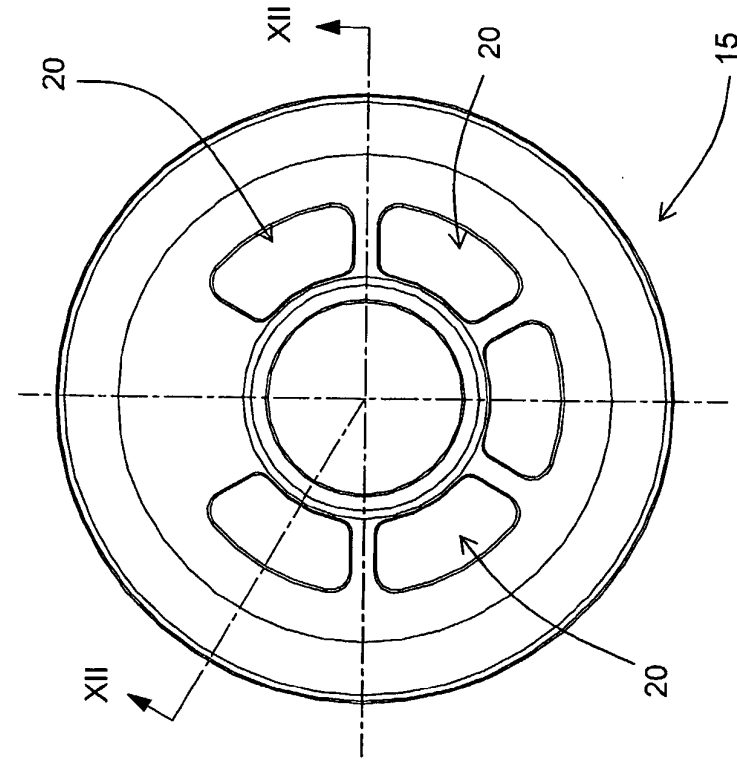


FIG. 11

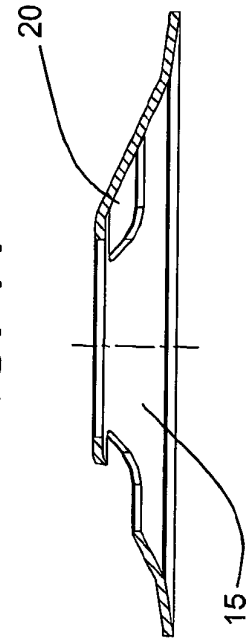


FIG. 12

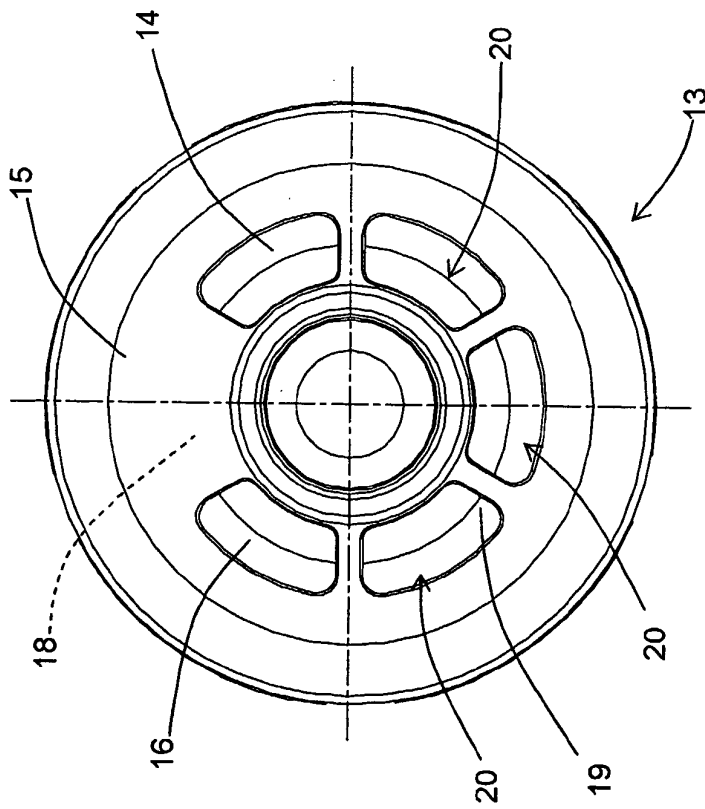


FIG. 9

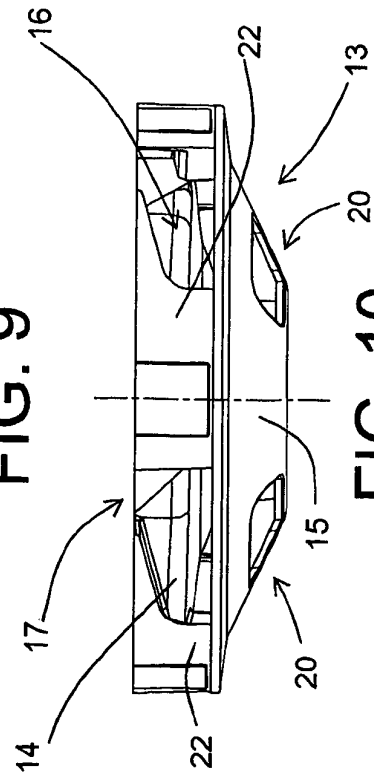


FIG. 10

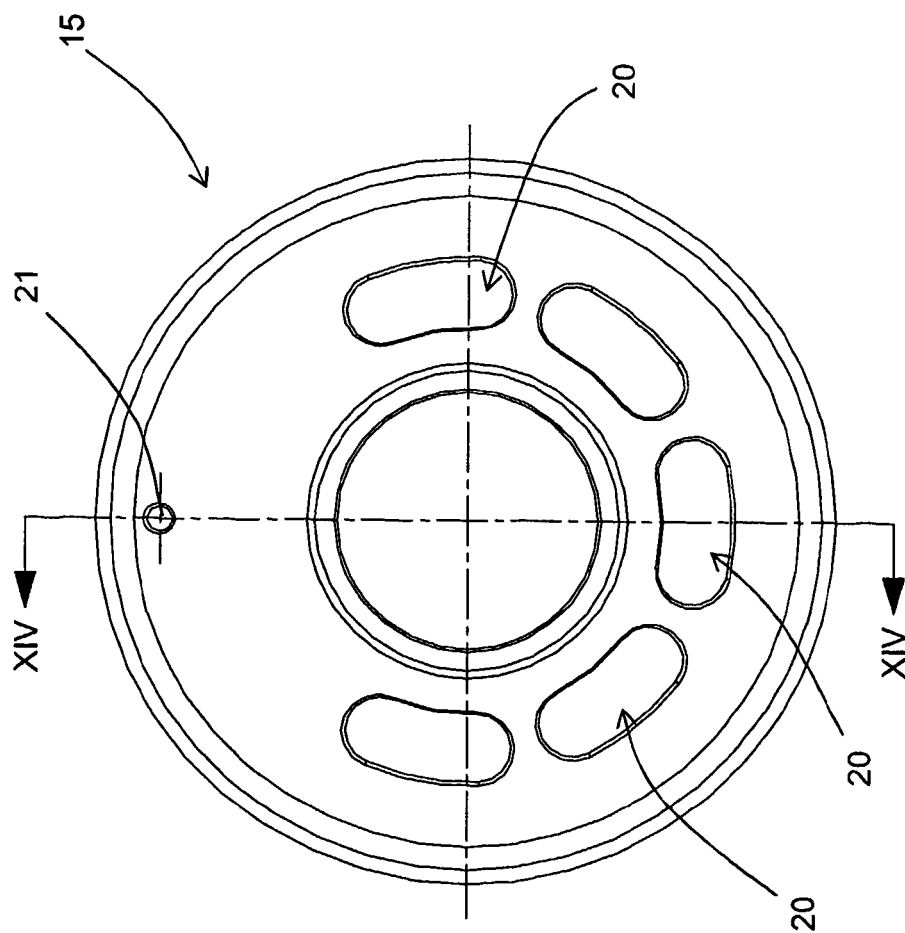


FIG. 13

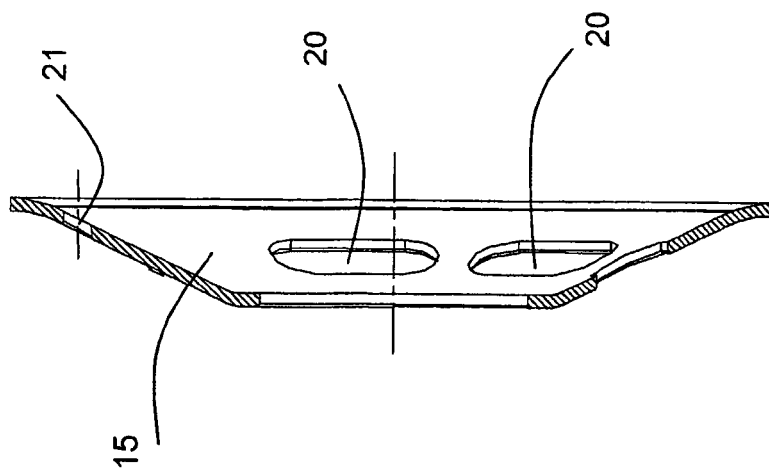


FIG. 14

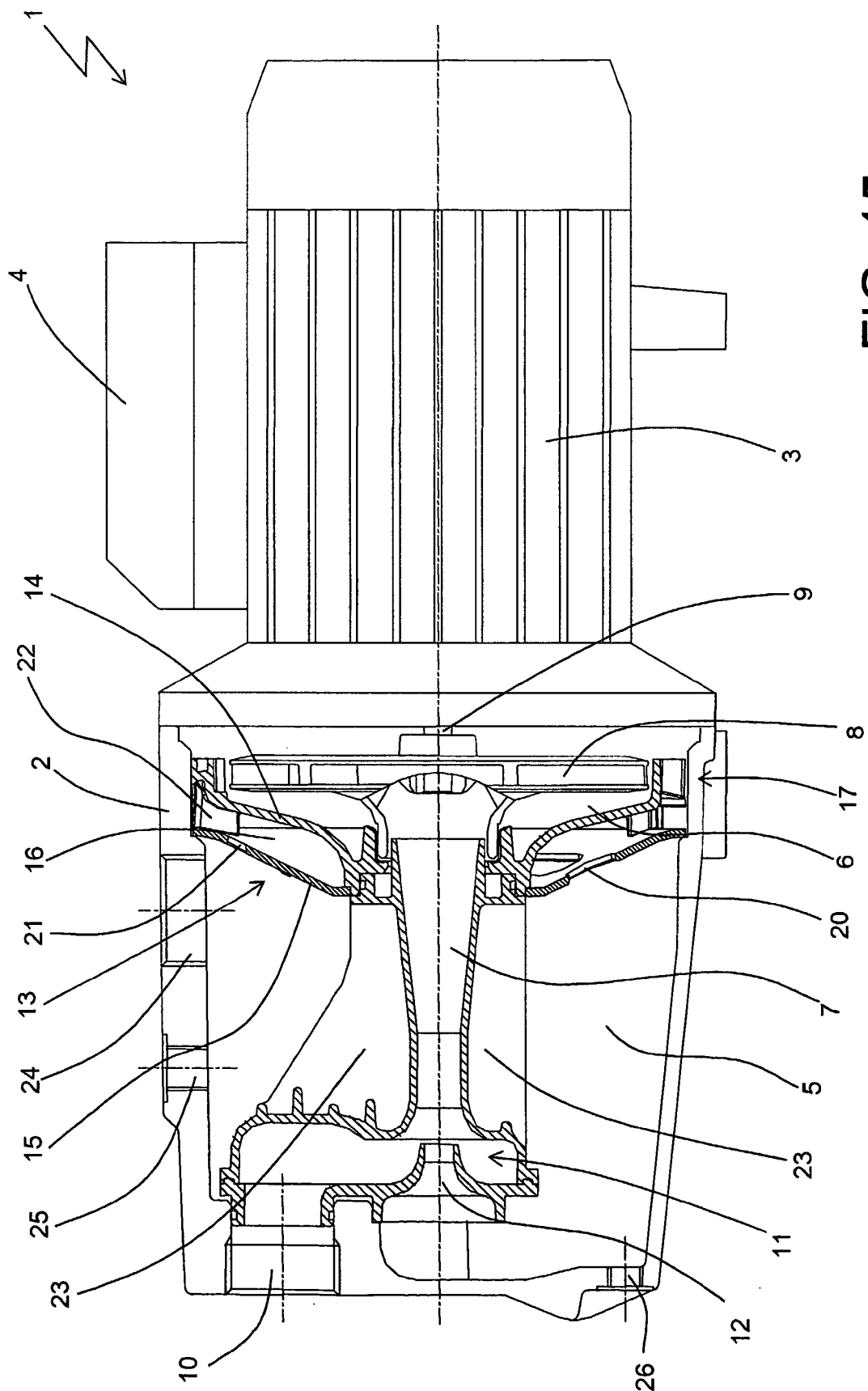


FIG. 15