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(71) Applicant: **CALPEDA S.p.A.**
I-36050 Montorso Vicentino (VI) (IT)

(72) Inventor: **Serafin, Carlo**
36100 Vicenza (IT)

(74) Representative: **Bonini, Ercole**
c/o STUDIO ING. E. BONINI SRL
Corso Fogazzaro 8
36100 Vicenza (IT)

(54) Guide wheel for centrifugal pumps

(57) The invention relates to a guide wheel for centrifugal pumps comprising guide ducts in a tendencially radial centripetal direction. Said guide wheel has inlet eyes arranged on the outside of the entrance edge of guide blades around the outer diameter of the impeller and axially extended up to an intermediate position between a wall adjacent to the impeller and a cover wall of the return portion of the guide ducts. Said guide blades are arranged around the outer diameter of the impeller without radial overlappings of the end portion of a guide blade with the initial portion of the subsequent guide blade.

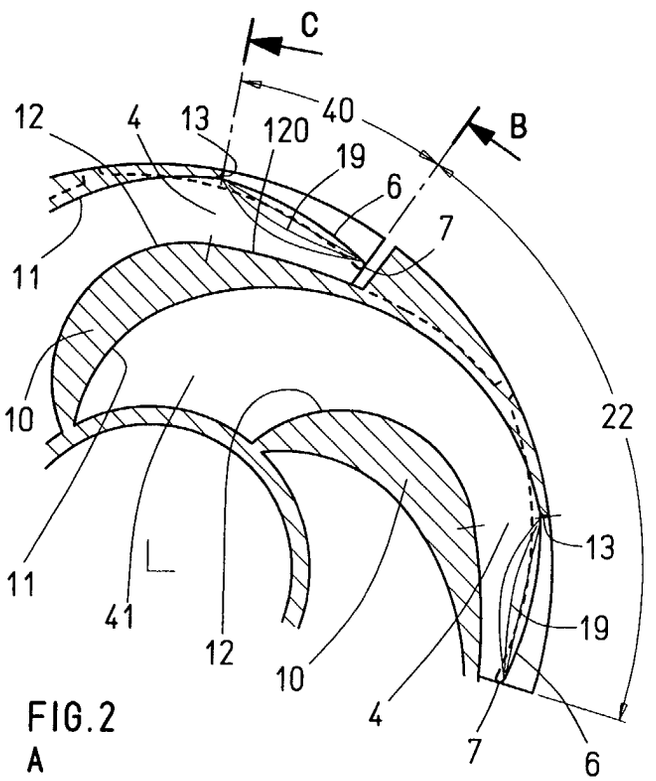

FIG.2
A

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Description

[0001] The present invention relates to a guide wheel for centrifugal pumps of the kind comprising a diffuser with return channels according to the preamble of claim 1, in an embodiment with reduced outer diameter particularly suited for self-priming pumps and/or suction lift operating pumps with fluids containing air or other gaseous substance.

[0002] A guide wheel for centrifugal pumps of the kind comprising a diffuser with return channels is also called guide rim, directing wheel, guide ring, diffuser with return channels or simply diffuser, highlighting the feature in any case present among its functions.

[0003] The term guide wheel will be however used in the present description.

[0004] It is well known that in a guide wheel with return channels the diffuser function with the distinctive feature of guiding the flow in a path with increasing cross sections in the flow direction, can be carried out in several ways, with hydraulically equivalent different embodiments with a design suitable for the materials and forming methods used and/or adapted to obtain other functions and/or to be contained within predetermined dimensional limits.

[0005] In the multistage pumps the main function of the return channels in a guide wheel is to convey the flow from the outlet of an impeller to the inlet of a following impeller. Besides said main function the complementary diffuser function may be also obtained with the return channels.

[0006] Some embodiments of multistage pumps are known in which, in order to reduce the outer diameter of the pump or increase the outer diameter of the impellers, so as to obtain the maximum use of a predetermined pump diameter, like for submersed pumps for wells, any bladed part around the periphery of each impeller is removed. In this case the diffuser function is carried out by an annular chamber without blades and with said return channels.

[0007] These embodiments are not suitable for self-priming pumps and/or pump arranged above the liquid to be lifted operating by suction lift with fluids containing air or other gaseous substance, in view of the lack of means adapted to collect and deviate quickly into the return channels the gaseous portion of the fluid coming out from the first impeller and/or from the subsequent impellers.

[0008] From the patent EP 0361328 of the same inventor it is known that a guide wheel with return channels may be applied also in a pump with only one impeller, of the self-priming type, with the main function of deviating the swirling flow at the impeller outlet, with a substantially radial centrifugal and/or tangential peripheral direction, to a substantially axial flow in the central part of the pressure chamber. This flow deviation in a pump with only one impeller reduces the rotational component, the swirling motion and flow velocity to make separation of air or other gaseous substance from the liquid easier, to improve the self-priming capability and reduce pump noise.

[0009] In order to reduce the pump diameter, an embodiment disclosed in said patent uses the return channels, added to a single impeller pump with said main function, also to carry out the complementary diffuser function so as to eliminate the conventional radial bladed diffuser with closed channels arranged around the impeller periphery. Around the impeller periphery instead inwardly open deflectors are arranged, of less radial dimension and axially inclined for deviating the gaseous portion of the fluid to the return channels.

[0010] With this known embodiment, only a portion of air or gas in the fluid going out from the impeller is deviated quickly to the return channels, while a portion is obliged to circulate with a centripetal motion by the centrifugal force of the liquid before the inlet eye in the return channels arranged on the periphery of the dividing wall between impeller and said return channels and this slows down air discharge from the pump.

[0011] The embodiment disclosed in patents DE 3315350, IT 1176089, and US 4564334 provides for minimizing the pump diameter with directing channels or guide ducts, partially arranged around the impeller periphery, widened with diffuser function firstly in a radial direction outwardly and laterally in the axial direction and then in a radial direction inwardly. It is stated that with this known embodiment it is possible to obtain a ratio between outer diameter of the guide wheel generally indicated with D5 and the outer diameter of the impeller generally indicated with D2 between 1,1 and 1,4 and a reduction of the pump diameter between 10 and 15 percent.

[0012] With this known embodiment the possibility of further reducing the pump diameter is limited by the radial overlapping of the thickness of the end portion of a guide blade with the thickness of the initial portion of the subsequent blade at the inlet eye of the guide ducts and the arrangement of said inlet eye only in the annular space around the impeller, axially defined by the dividing wall between start of the guide ducts and the return channels downstream.

[0013] This known embodiment has frontally overlapping and crossing bladed parts, with outwardly radially curved blades frontally intersecting inwardly radially curved blades and each blade is frontally overlapped to portions of two subsequent channels arranged on different planes. This known configuration is difficult to be divided for a molding operation without undercuts.

[0014] This known embodiment with inversion of the bladed path from the outwardly radial direction to the inwardly radial direction, with possible interposition of an annular chamber without blades to balance different flows in the guide ducts, causes interruptions of the continuous guide of direction and velocity of the flow in the direction changes, with negative effects on efficiency and noise.

[0015] The object of the invention is to provide a guide wheel for a multistage centrifugal pump or a centrifugal pump with single impeller, comprising a diffuser with return channels, in an improved embodiment without the above mentioned drawbacks of either known embodiment.

[0016] The main object is to obtain a guide wheel with a reduced outer diameter particularly suited for self-priming pumps and/or suction lift operating pumps with fluids containing air or other gaseous substance, said guide wheel being capable to collect and convey quickly to the return channels the gaseous part of the fluid going out from the impeller.

[0017] Another object is to provide a guide wheel that can be produced with a molding operation without undercuts.

[0018] A further object of the invention is also to obtain the maximum efficiency and minimal noise of the pump with the constraints determined by said objects.

[0019] The above objects of the invention are attained with the new embodiment of the guide wheel for centrifugal pumps recited in claim 1).

[0020] The invention is described hereinafter by an illustrative example with reference to the accompanying sheets of drawings in which:

- Fig. 1 is a partial axial sectional view of a pump provided with an embodiment of the guide wheel according to the invention on plane indicated with B in Fig. 2;
- Fig. 2 is a partial cross sectional view of an embodiment of the guide wheel according to the invention at plane A of Fig. 1;
- Fig. 3 is a partial axial sectional view of the guide wheel on the plane indicated with C in Fig. 2;
- Fig. 4 is a partial development of the guide wheel seen from its outer diameter;
- Fig. 5 is a partial cross sectional view of the guide wheel according to the invention at plane D of Fig. 1;
- Fig. 6 shows a constructional modification in respect of Fig. 5;
- Fig. 7 shown another constructional modification in respect of Fig. 5;
- Fig. 8 is an enlarged detail along plane E of the cross sections of the guide wheel of the invention according to any of the illustrations of Figs. 5, 6, 7;
- Fig. 9 shows a constructional modification in respect of Fig. 8;
- Fig. 10 shows another constructional modification in respect of Fig. 8;
- Fig. 11 shows an enlarged detail of the guide wheel of Fig. 1;
- Fig. 12 shows the detail of Fig. 11 in a constructional modification;
- Fig. 13 shows another constructional modification in respect of Fig. 11; and
- Fig. 14 is an exploded partial view of an embodiment of the guide wheel of the invention.

[0021] As shown for instance in Figs. 1, 2 and 14 the guide wheel generally indicated with reference numeral 1, is arranged downstream an impeller 2 and inserted in a pump casing 3. Said guide wheel comprises a plurality of guide ducts 4 (also called directing channels, conveyance channels, diffusion ducts) each guide ducts having an initial portion 40 outwardly radially closed by a cylindrical wall 5 of the pump casing 3 containing the guide wheel 1.

[0022] The initial portion 40 of each guide duct 4 comprises a guide blade 6 (also called directing blade) radially curved outwardly to the cylindrical wall 5 of the pump casing 3, starting from an entrance edge 7 arranged around the outer diameter of the impeller 2.

[0023] Each guide duct 4 comprises a return portion 41 (also called return channel, recirculation channel, reconveyance channel) having a generally radial centripetal direction and axially arranged between a wall 8 adjacent to impeller 2 with the function of dividing the impeller 2 and the guide ducts 4, and a cover wall 9 and is defined by inwardly radially curved blades 10.

[0024] Fig. 1 shows an example of application of the guide wheel 1 with the return portion 41 of the guide ducts 4 arranged adjacent to the front plate and suction side of the impeller 2 in a single impeller pump. However this does not limit the scope of the invention. The guide wheel of the present invention indeed can be arranged also with the return channels adjacent to the back shroud on the rear side of an impeller or of the impellers of a multistage pump, with the guide wheel inserted in the stage casing and the guide ducts arranged downstream an impeller and upstream a subsequent impeller.

[0025] The walls 8, 9 of the guide wheel 1 axially defining the guide ducts in the centripetal radial direction, are arranged perpendicular to the impeller rotation axis as shown in Figs. 1 and 3. The walls 8 and 9 in a different embodiment may have a conical shape and/or portions curved in the axial direction.

[0026] The guide wheel 1 is preferably formed by a first part consisting of the wall 8 adjacent to the impeller 2 and a second part consisting of the cover wall 9, connected to each other by known means. Each of these walls 8 and 9 is formed without undercuts. It is also possible the embodiment with the cylindrical wall 5 of the casing containing the guide wheel and the front cover wall 9 made as a single piece.

[0027] As shown in Fig. 2, each blade 10 radially inwardly curved, has a concave wall 11 generally tangent to the cylindrical wall 5 of the casing 3 and a convex wall 12 tangent to a lower diameter relative to the diameter on which said entrance edge 7 is arranged.

[0028] As shown in Figs. 1 and 2, the front side of the entrance edge 7 of the guide blade 6 arranged around the outer diameter of the impeller 2, has a side portion 70 facing a lower diameter on the wall 8 adjacent to impeller 2, up to a surface 120 tangent to the convex wall 12 of a blade 10 radially curved inwardly.

[0029] The inlet eye 14 (also called inlet opening, en-

try area, width of the inlet, inlet area, throat area) of each guide duct 4 is partially arranged on the outside of the entrance edge 7 of the guide blade 6 and is axially extended up to a position intermediate between the wall 8 adjacent to the impeller 2 and the cover wall 9.

[0030] The portion of the inlet eye 14 axially extended beyond the wall 8 adjacent to the impeller 2 is arranged on the surface 120 tangent to the convex wall 12 outside the return portion 41 of the guide duct 4 preceding in the flow direction.

[0031] The inlet eye 14 is radially defined outwardly by the cylindrical wall 5 of the casing 3.

[0032] At the start point 13 of the concave wall 11 the start section 15 of the return portion 41 of the guide ducts 4 is arranged as shown in Fig. 3.

[0033] As shown for instance in Fig. 4, the portion of the inlet eye 14 with the entrance edge 7 arranged around the outer diameter of the impeller 2, is connected to the start section 15 of the return portion 41 of the guide ducts 4 on the side of wall 8 by a deflecting wall 16 with the function of baffle for the flow deviation in the axial direction and arranged on the outer surface of said guide blade 6.

[0034] The portion of the inlet eye 14 axially extended beyond the wall 8 is connected to the start section 15 of the return portion 41 through a surface 17 axially inclined or curved to the cover wall 9 and arranged along the surface 120 tangent to the convex wall 12 of blade 10.

[0035] The inlet eye 14 is axially arranged between the position of surface 17 axially curved or inclined to the cover wall 9 at the start position of the front side of the entrance edge 7, 70 and the start position of the deflecting wall 16 to the wall 8 adjacent to the impeller 2.

[0036] The axially oriented surface 17 arranged on the cover wall 9 between the inlet eye 14 and the start section 15 of the return portion 41 of the guide ducts 4, continues upstream the inlet eye 14 with an initial portion 170 arranged on the wall 8 adjacent to the impeller 2. The front side of the entrance edge 7 around the outer diameter of the impeller 2 is transversally arranged perpendicular to the outlet opening of the impeller 2 as shown for instance in Fig. 4.

[0037] In order to orient the fluid to the axial deviation from the inlet eye 14 to the start section 15 of the return portion 41 of the guide ducts 4, the front side of the entrance edge 7 may be arranged transversally inclined relative to the outlet opening of the impeller 2, with an inclination in the circular flow direction, from the position of the side portion 70 of the entrance edge 7 to the start position of the deflecting wall 16.

[0038] One can see in Fig. 5 that the base with radial direction to the inside of the initial portion 170 of the surface axially oriented to the cover wall 9, is arranged on an profile 121 substantially corresponding to an upstream extension of the surface 120 tangent to the convex wall 12 of blade 10.

[0039] According to a version of the invention shown in Fig. 6, the initial portion 170 has a circular profile 122 on a diameter corresponding to the position of the portion of the inlet eye 14 axially extended beyond the wall 8 and beyond the entrance edge 7, 70.

[0040] According to another version of the invention shown in Fig. 7, the initial portion 170 has a profile 123 starting from a diameter lower than the diameter on which said portion of the inlet eye 14 axially extended beyond the wall 8 and beyond the entrance edge 7, 70 is arranged.

[0041] The initial portion 170 of the axially inclined or curved surface is preferably connected to the wall 8 with a rounded edge 18 with gradually variable, increasing and diminishing width, between the start of said axially inclined or curved surface 170 and said lateral entrance edge 70.

[0042] As shown by the illustrative embodiments of Figs. 5, 6 and 7, whose sections on planes E are shown in Figs. 8, 9 and 10 respectively, the rounded edge 18 may have a convex profile 180 as shown in Fig. 8 or alternatively the profile is that of a plane 181 inclined relative to the surfaces 8, 170 connected to each other as shown in Fig. 9. Moreover the profile may be concave 182 as shown in Fig. 10.

[0043] Alternatively the rounded edge 18 may have profiles with variable shape starting for instance with a concave profile 182 or plain profile 181 and ending on said lateral entrance edge 70 with a convex rounded portion 180.

[0044] The rounded edge 18 forms the entrance edge of the portion of the inlet eye 14 axially extended beyond the wall 8 adjacent to the impeller 2.

[0045] Starting from the inlet eye 14 at the position of the entrance edge 7 arranged around the outer diameter of the impeller 2, each guide duct 4 is radially defined by walls mainly having a continuous inward orientation.

[0046] Each guide duct 4 has an external profile with a circular curve along the cylindrical wall 5 of the casing 3 and an inward curve along the concave wall 11 of a blade 10 and an internal profile with a preferably inward continuous orientation along the tangential surface 120 and along the convex wall 12 of a blade 10.

[0047] Preferably starting from the inlet eye 14 at the position of the entrance edge 7 arranged around the outer diameter of impeller 2, each guide duct has the dimensions of the flow passage cross section increasing only in a radial inward direction.

[0048] The portion of the fluid entering the inlet eye 14 outside the entrance edge 7 on the outer surface of the guide blade 6 takes a slightly diverging direction relative to the direction of the portion of fluid entering the position axially shifted and arranged on a lower diameter on the tangential surface 120.

[0049] In order to obtain as much as possible a swirl free flow at the intersection of said different directions, the guide blade 6 may be laterally connected to the wall 8 adjacent to the impeller 2 on the outside of the surface 120 tangent to the convex wall 12, with a bevel 19 from

the entrance edge 7, 70 to the end portion of the outer surface of the guide blade 6 defined by the deflecting wall 16 to the start section 15 of the return portion 41 of the guide duct 4.

[0050] As shown for instance in Fig. 11, the connection between the guide blade 6 and the wall 8 may be carried out in the form of a rounded bevel 190 of gradually variable increasing and diminishing width in the flow direction.

[0051] As shown for instance in Fig. 12, the lateral portion 70 of the entrance edge may be inclined, said inclination connecting the guide blade 6 to the wall 8 adjacent to the impeller 2, outside the surface 120 tangent to the convex wall 12 with a gradually variable inclination 191 in the flow direction, from the lateral entrance edge 70 to the start section 15 of the return portion 41 of the guide duct 4.

[0052] As shown for instance in Fig. 13, the lateral portion 70 of the entrance edge may be curved to its transversal portion 7 with a curve 192 extending to the start section 15 of the return portion 41 of the guide duct 4, from the base of the deflecting wall 16 on the guide blade 6 to the base of the wall 8 on the surface 120 tangent to the convex wall 12.

[0053] As shown for instance with a dot and dash line in Fig. 11, in order to obtain as much as possible a swirl free flow at the intersection of said different directions, a dividing rib or anti vortex rib 20 may be inserted between the portion of fluid coming from the guide blade 6 and the portion of fluid coming from the axially shifted underlining position.

[0054] Starting from said inlet eye 14 the widening of the cross sections of the guide ducts with diffuser function may start.

[0055] Preferably in the initial portion 40 of the guide duct 4, the area of the flow passage cross sections is kept substantially constant from said inlet eye 14 up to said start section 15 of the return portion 41 of the guide ducts 4.

[0056] In order to balance the possible presence of residual swirls at the intersection of said different directions, more particularly in case there is no dividing rib or anti vortex rib 20 or a baffle between said portions of fluid coming from different positiosn at the inlet eye 14, the area of the flow passage cross section can be increased at the zone of said intersection in the initial portion 40 of the guide duct 4.

[0057] As said initial portion 40 of the guide duct 4 has a continuous variation of shape of its cross sections and intersections of different flow directions which are negative for the diffuser function, the widening of the cross sections with diffuser functions is mainly and preferably carried out in the return portion 41 of the guide ducts 4, beginning from said start section 15 of said return portion 41, where the flow takes uniform direction and velocity.

[0058] Said surface 17, 170 axially oriented to said cover wall 9 and starting on said wall 8 adjacent to the impeller 2 upstream the inlet eye 14, is radially defined outwardly by said cylindrical wall 5 of the casing 3 containing the guide wheel 1.

[0059] Said guide blade 6, whose outer side is defined by said deflecting wall 17, has its inner side facing the impeller 2, radially curved up to said cylindrical wall 5 of the casing 3.

[0060] As shown for instance in Figs. 2 and 5, said guide blade 6 has an angular development 21 less than the circular sector 22 between two subsequent entrance edges 7 of the guide blades 6 arranged around the outer diameter of the impeller 2. With this configuration there are no radial overlappings of the thickness of the end portion 23 of a guide blade 6 with the thickness of the initial portion 7 of the subsequent guide blade.

[0061] The initial portion 40 of the guide ducts 4 arranged in the flow direction between said entrance edge 7 and said start position 13 of the return portion 41 of the guide ducts 4 and an upstream portion 24 of said entrance edge 7 up to the position of the end portion 23 of the preceding guide blade, are radially closed outwardly by said cylindrical wall 5 of the casing 3.

[0062] A guide wheel comprising a diffuser with return channels with the configuration according to the invention has several advantages.

[0063] In a pump made with the guide wheel of the invention, the ratio between the outer diameter of the guide wheel D5 and the outer diameter of the impeller D2 is reduced to 1.09 while it was 1.3 in another pump with the same impeller but provided with a conventional diffuser with radial peripheral blades, so as to obtain a reduction of the pump diameter of more than 16 percent.

[0064] The reduced radial extension of the guide wheel of the invention is obtained with inlet eyes of the guide ducts axially extended beyond the wall adjacent to the impeller.

[0065] The reduction of the ratio between the outer diameter of guide wheel D5 and the outer diameter of the impeller D2 is also obtained avoiding radial overlappings of the end portion of a guide blade with the thickness of the initial portion of the subsequent guide blade in the annular space around the outer diameter of the impeller, so as to reduce the radial space required for the inlet eye on the outside of the entrance edge.

[0066] Said inlet eyes arranged on the outside of said entrance edge of the guide blades around the outer diameter of the impeller, transversally to the outlet of the impeller, are axially extended up to an intermediate position between said wall adjacent to the impeller and the front cover wall of the guide ducts, starting from a lower diameter relative to the diameter on which said entrance edge is arranged.

[0067] Said axial extension of the inlet eyes has a surface axially oriented to said cover wall up to the start section of the return portion of the guide duct. Said surface axially oriented to said cover wall starts upstream the inlet eye. This configuration allows the minimum inclination of said surface oriented to the cover wall so as

to arrange a portion of the fluid going out from the impeller to be naturally deflected, with a minimal axial deviation, to the portion of the inlet eye axially shifted relative to the position of the impeller outlet.

[0068] A rounded edge between said axially curved or inclined surface and said wall adjacent to the impeller makes easier the discharge of the gaseous portion circulating in the lateral space between the impeller and said adjacent wall.

[0069] The portion of fluid entering the inlet eye outside the entrance edge is deviated into the return channel by a deflecting wall on the guide blade. Besides said entrance edge, said guide blade directs the fluid to the return channel, avoiding that the centrifugal force of the liquid causes any existing gaseous portion to circulate with a centripetal motion before entering said return channel.

[0070] With the described embodiment a guide wheel is obtained with a reduced outer diameter particularly suited for self-priming pumps and/or suction lift operating pumps with fluids containing air or other gaseous substances, suited to collect and convey quickly to the return channel and the pump outlet, the gaseous portion of the fluid going out from the impeller.

[0071] The configuration of the channels and guide blades allows the production of the guide wheel of the invention with connected elements formed by molding without undercuts.

[0072] The walls and/or surfaces of the guide wheel of the invention tend to convey uniformly the flow with a continuous deflection from the peripheral tangential direction to a tendencially radial centripetal direction. With the guide wheel of the invention it is possible to obtain a conveyance of the fluid in a path with gradual variation of the shape of its cross sections, with continuous guide of the flow direction and velocity, with smooth surfaces for the fluid flow obtained by molding without finishing operations, balancing the possible losses due to the arrangement of the inlet eye of the guide ducts contained in a narrow radial space around the outer diameter of the impeller.

[0073] With the described embodiment it is possible to carry out all the conditions to obtain, with the constraints set forth by the objects of the inventions, the maximum operating efficiency and the minimum noise in all the working conditions, even in presence of air or other gaseous substance in the liquid.

[0074] Other constructional versions, adaptations for particular applications by modifying the shape, the position, the dimensions or the number of the illustrated or described elements, combining in a different way elements of the guide wheel with other elements of the pump, removing some illustrated elements or adding others, using the same or equivalent essential features of the mentioned teachings to obtain substantially the same results, should be intended as falling within the meaning and the scope of protection set forth in the appended claims.

Claims

1. A guide wheel (1) for centrifugal pumps comprising a plurality of guide ducts (4), each guide duct comprising:

- an initial portion (40) radially outwardly closed by a cylindrical wall (5) of the casing (3) containing said guide wheel;
- a return portion (41) in a tendencially radial centripetal direction, axially arranged between a wall (8) adjacent to the impeller (2) and a cover wall (9), defined by radially inwardly curved blades (10);
- a guide blade (6) radially outwardly curved to said cylindrical wall (5) starting from an entrance edge (7) arranged around the outer diameter of the impeller;
- a deflecting wall (16) axially oriented to said wall adjacent to the impeller, arranged along the outer surface of said guide blade;
- an inlet eye (14) arranged outside said entrance edge and beyond a lateral portion (70) of said entrance edge, arranged on said wall adjacent to the impeller on a lower diameter relative to the diameter on which said entrance edge is arranged around the outer diameter of the impeller;

characterized in that:

a) said inlet eye is axially extended up to an intermediate position between said wall adjacent to the impeller and said cover wall;
b) the portion of said axially extended inlet eye is radially arranged inwardly on a surface (120) tangent to the convex wall (12) of the blade (10) outside the return portion (41) of the preceding guide duct in respect of the flow direction;
c) said axial extension of said inlet eye is defined by a surface (17) axially oriented to said cover wall and arranged along said surface tangent to said convex wall up to the start section (15) of the return portion of the guide duct;
d) said surface (170) axially oriented to said cover wall starts on said wall adjacent to the impeller upstream said inlet eye;
e) said guide blade has an angular development (21) lower than the circular sector (22) between two subsequent entrance edges of the guide blades arranged around the outer diameter of the impeller, without radial overlappings of the thickness of the end portion (23) of a guide blade with the thickness of the initial portion (7) of the subsequent guide blade.

2. A guide wheel according to claim 1) **characterized in that** the base (121, 122, 123) in the inwardly ra-

dial direction of the initial portion (170) of the surface axially oriented to said cover wall arranged upstream said entrance edge, is connected to said wall adjacent to the impeller with a rounded edge (18, 180, 181, 182) between start of said surface axially oriented to said cover wall and said lateral portion (70) of the entrance edge.

3. A guide wheel according to claim 1) **characterized in that** said guide blade (6) is laterally connected to said wall adjacent to the impeller on the outside of said surface (120) tangent to said convex wall (12), with a rounded bevel (19, 190, 191) from said entrance edge (7, 70) to said start section (15) of the return portion of the guide duct.

4. A guide wheel according to claim 1) **characterized in that** said guide blade (6) is laterally connected to said wall adjacent to the impeller on the outside of said surface (120) tangent to said convex wall (12), with a curve (192) from the base of said deflecting wall (16) on said guide blade to the base of the portion of said wall adjacent to the impeller on said surface tangent to said convex wall, from said entrance edge (7, 70) to said start section (15) of the return portion of the guide duct.

5. A guide wheel according to claim 1) **characterized in that** the flow passage area in said start section (15) of the return portion of the guide duct, corresponds substantially with the flow passage area in said inlet eye (14), the widening of the cross sections with diffuser function being mainly carried out in said return portion of the guide duct.

6. A guide wheel according to claim 1), **characterized in that** said surface axially oriented to said cover wall and starting on said wall adjacent to the impeller upstream said inlet eye, is radially outwardly defined by said cylindrical wall (5) of the casing containing the guide wheel.

7. A guide wheel according to claim 1), **characterized in that** said initial portion (40) of the guide ducts arranged in the flow direction between said entrance edge (7) and the start position (13) of the return portion of the guide ducts and the upstream portion (24) of said entrance edge up to the position of said end portion (23) of the preceding guide blade are radially outwardly closed by said cylindrical wall (5) of the casing containing the guide wheel.

8. A guide wheel according to any of the preceding claims **characterized in that** the ratio between the outer diameter of the guide wheel (D5) and the outer diameter of the impeller (D2) is lower than 1.1.

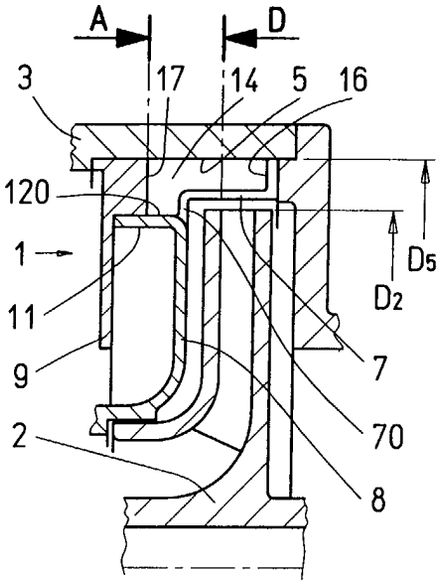

FIG.1
B

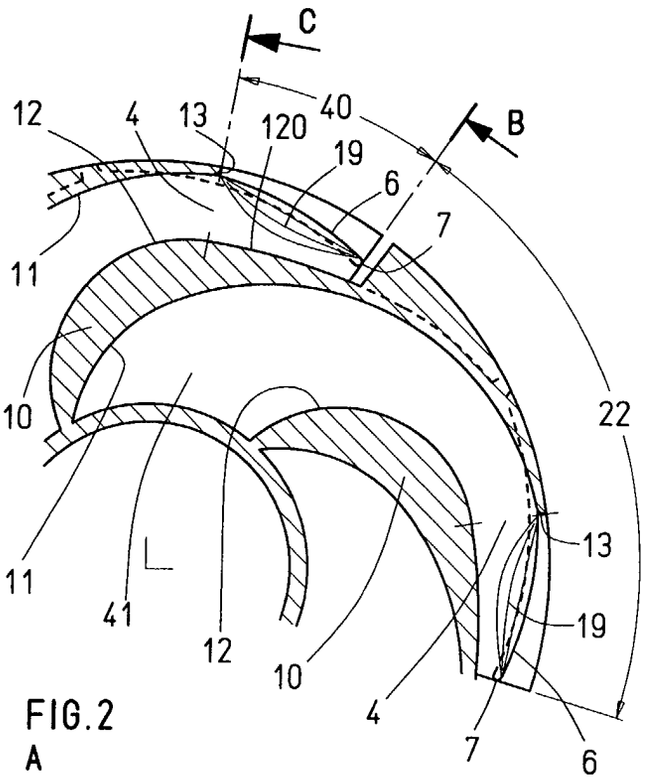

FIG.2
A

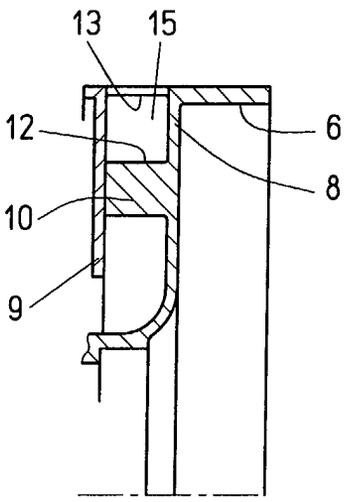

FIG.3
C

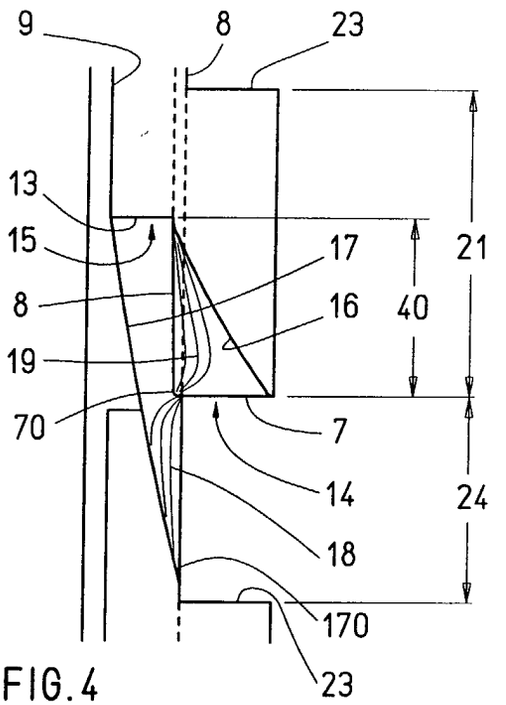

FIG.4

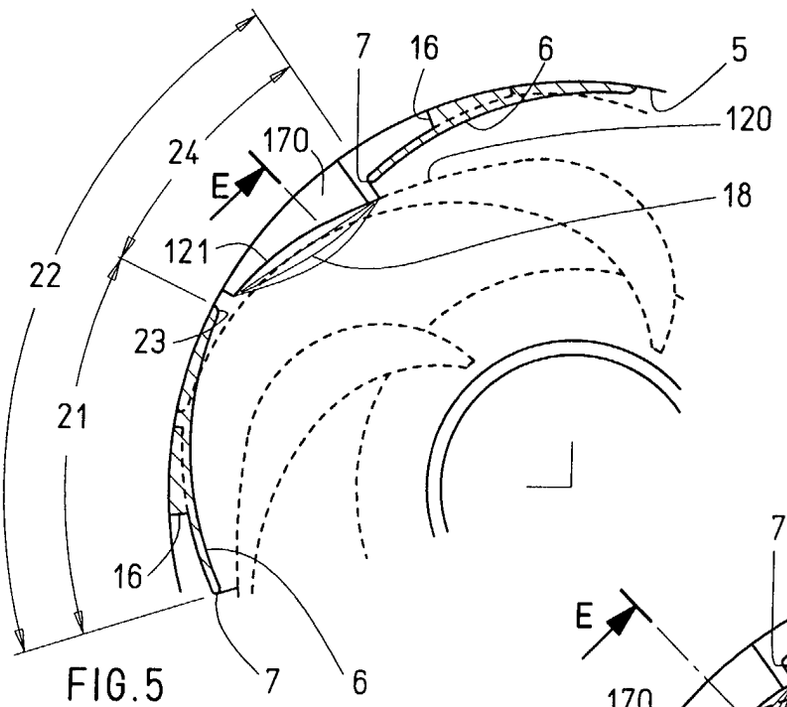

FIG.5
D

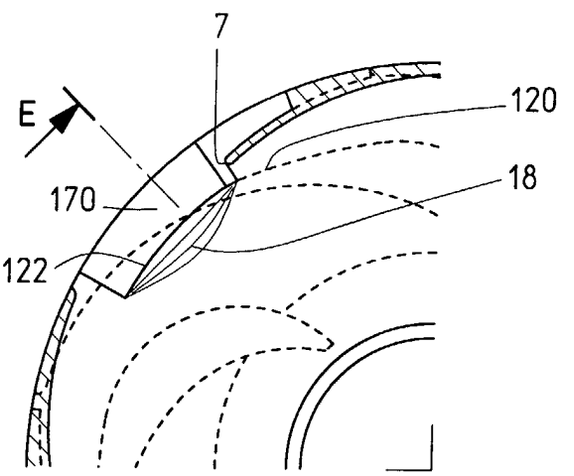

FIG.6
D

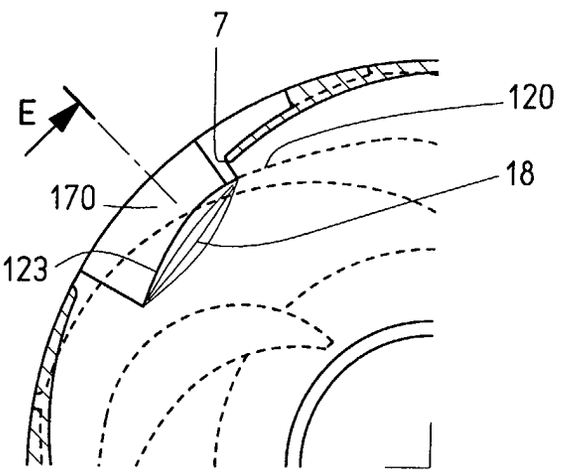

FIG.7
D

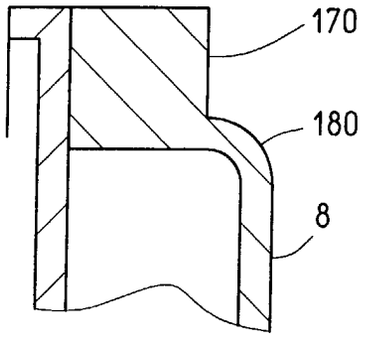

FIG.8
E

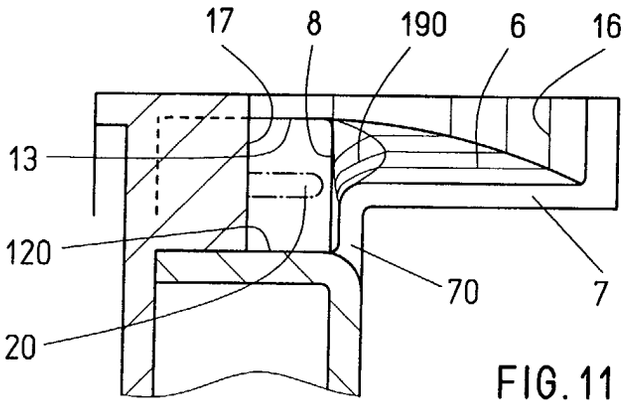

FIG.11
B

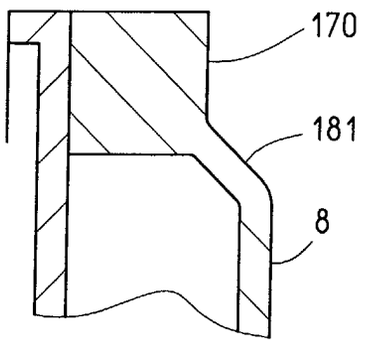

FIG.9
E

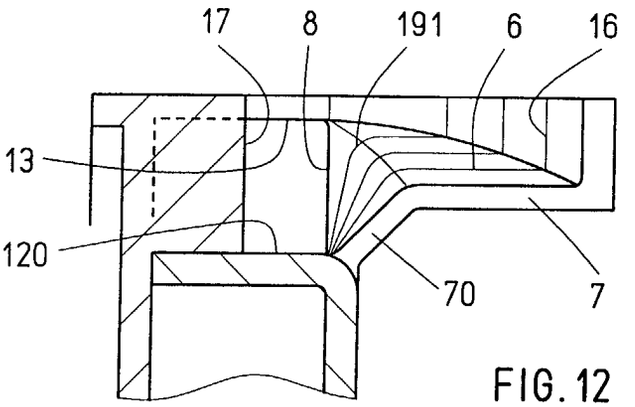

FIG.12
B

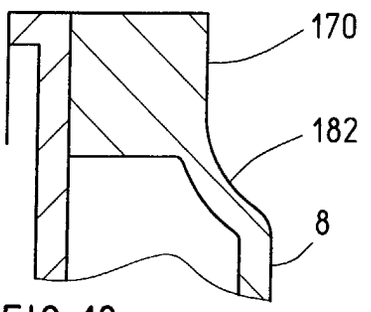

FIG.10
E

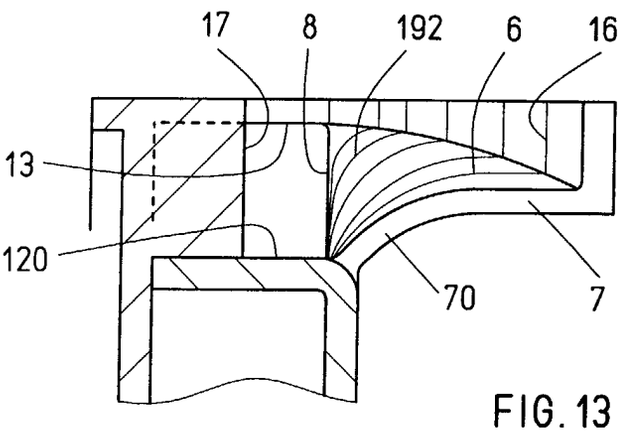

FIG.13
B

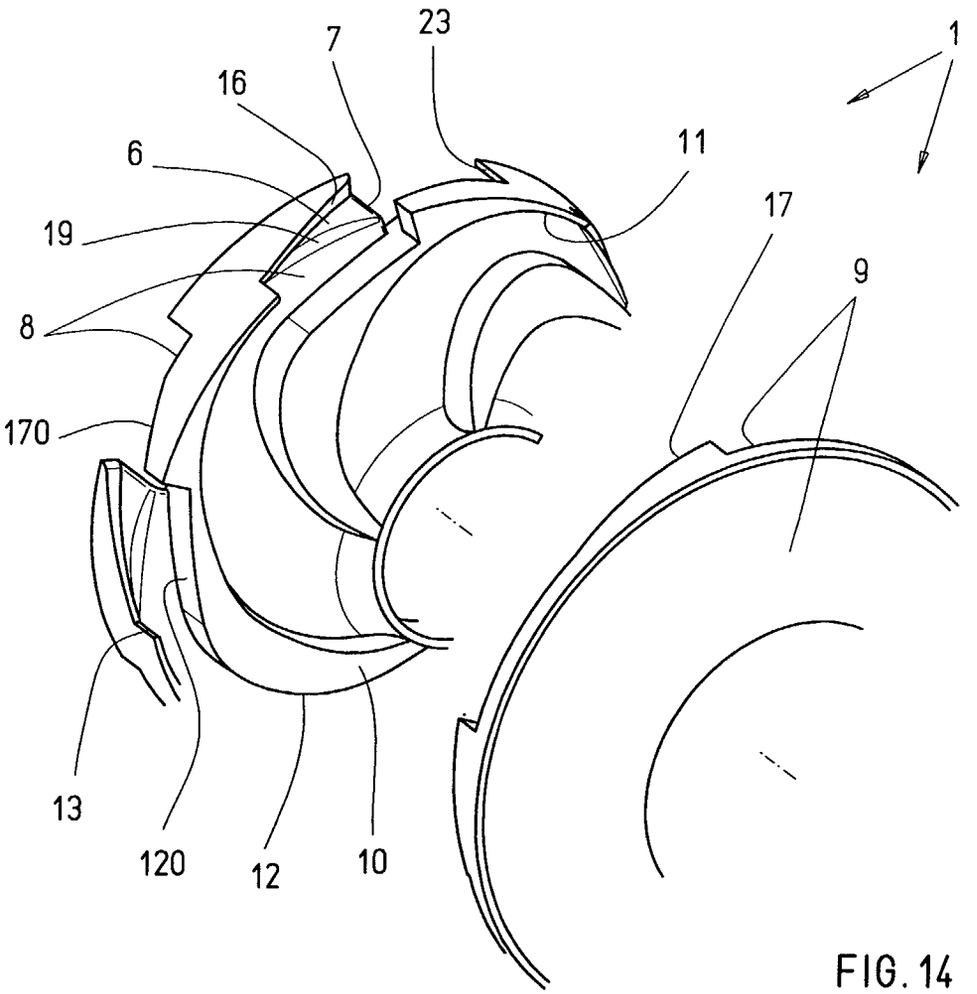

FIG. 14