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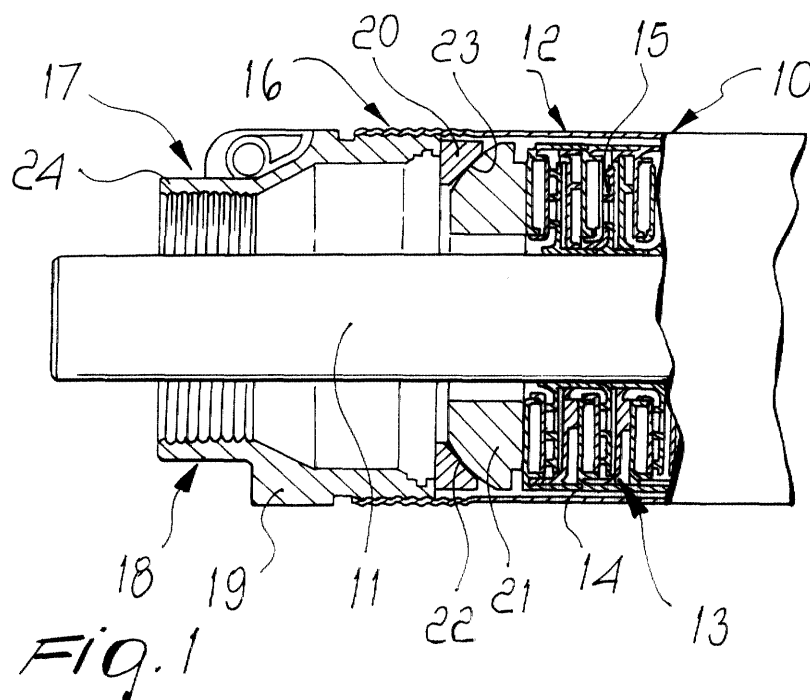
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(54) **Multistage pump**

(57) A multistage pump (10) comprising, in a tubular body (11), a plurality of diffusers (12) which are alternated with impellers (13), the diffusers (12) being stacked peripherally so as to form a diffuser casing (14), the impellers (13) being keyed on a shaft (15) arranged on the axis (16), a closure assembly (18) being associated with the tubular body (11) at the intake region (17) so as to lock the diffusers in the packed configuration. The pump (10) comprises two annular elements (22, 23) which are

interposed between the closure assembly (18) associated with the tubular body (11) and the corresponding head (21) of the diffuser casing (14), the mutually facing surfaces of the annular elements being shaped so as to form a contact with three degrees of freedom of rotation so as to allow adaptation with correction of any errors of co-planarity in the locking on the part of the closure assembly (18) on the head (21) of the diffuser casing (14).



Description

[0001] The present invention relates to a multistage pump.

[0002] It is known that multistage pumps, particularly submersed pumps, of the type comprising a plurality of diffusers alternated with impellers in a tubular body, have long been used successfully.

[0003] The diffusers are stacked peripherally so as to form a diffuser casing and the impellers are keyed on a shaft which is arranged on the axis and is coupled to an electric motor.

[0004] A closure assembly, constituted in practice by a check valve, is associated with the tubular body at the intake region, so as to lock the diffusers in a packed arrangement.

[0005] The body of the valve is in fact joined by way of a screw coupling to the tubular body, which conveniently has an internal thread which is usually formed by rolling (the tubular body is generally made of metal plate).

[0006] The precision with which the shaft, the diffusers and the various components of the pump are manufactured is generally higher than the precision used in the manufacture of the closure assembly and particularly of the surfaces (threads) for the mutual locking of said assembly and of the tubular body.

[0007] This entails that the packing of the diffusers, which ideally should be perfectly coaxial to the shaft of the impellers, in practice is often orientated along a slightly inclined direction.

[0008] This coaxiality error of course leads to considerable imbalances in the distribution of the closure forces, thereby compromising optimum centering between the diffuser casing and the impellers.

[0009] Therefore, there is the danger that the impellers may touch the diffusers as they rotate.

[0010] Merely by way of example, acceptable limits for positioning error in the mutual centering of the diffuser and the impeller are on the order of one tenth of a millimeter.

[0011] The aim of the present invention is to provide a pump which solves the above noted drawbacks of conventional models, particularly allowing precise centering and locking of the diffuser casing with respect to the impellers without however requiring particularly high-precision machining operations.

[0012] Within this aim, an important object of the present invention is to provide a pump which allows packing with a substantially axial thrust.

[0013] Another object of the present invention is to provide a pump which is substantially simple from the constructive point of view without compromising in any case ease of assembly as well as manufacturing times and costs.

[0014] Another object of the present invention is to provide a pump which nonetheless allows an optimum hydraulic performance which is fully competitive with re-

spect to that of commercially available pumps of a similar type.

[0015] Another object of the present invention is to provide a pump which can be manufactured with conventional technologies and systems.

[0016] This aim and these and other objects which will become better apparent hereinafter are achieved by a multistage pump comprising, in a tubular body, a plurality of diffusers which are alternated with impellers, the diffusers being stacked peripherally so as to form a diffuser casing, the impellers being keyed on a shaft arranged on the axis, a closure assembly being associated with said tubular body at the intake region so as to lock the diffusers in the packed configuration, said pump being characterized in that it comprises two annular elements which are interposed between said closure assembly associated with said tubular body and the corresponding head of said diffuser casing, the mutually facing surfaces of said annular elements being shaped so as to form a contact with three degrees of freedom of rotation so as to allow adaptation with correction of any errors of co-planarity in the locking on the part of said closure assembly on said head of the diffuser casing.

[0017] Further characteristics and advantages of the present invention will become better apparent from the description of four embodiments thereof, illustrated only by way of non-limitative example in the accompanying drawings, wherein:

Figure 1 is a partially sectional orthographic projection view of part of a pump according to the invention, in a first embodiment;

Figure 2 is a partially sectional orthographic projection view of a pump according to the invention, in a second embodiment;

Figure 3 is a partially sectional orthographic projection view of part of a pump according to the invention, in a third embodiment;

Figure 4 is a partially sectional orthographic projection view of part of a pump according to the invention, in a fourth embodiment.

[0018] With particular reference to Figure 1, a pump according to the invention, in a first embodiment thereof, is generally designated by the reference numeral 10.

[0019] In particular, the multistage pump 10 comprises, in a tubular body 11, a plurality of diffusers 12 alternated with impellers 13.

[0020] The diffusers 12 are stacked peripherally so as to form a diffuser casing 14, and the impellers 13 are keyed on a shaft 15 which is arranged on the axis 16 and is connected to an electric motor which is not shown for the sake of simplicity.

[0021] A closure assembly 18 is associated with the tubular body 11 at the intake region 17 and is constituted in practice by a check valve 19 (of which the figures illustrate only the body 20 for the sake of simplicity) so

as to lock the diffusers 12 in a packed arrangement.

[0022] According to the invention, two annular elements, respectively a first element 22 and a second element 23, are interposed between the body 20 of the valve 19 which is screwed onto the tubular body 11 and the corresponding head 21 of the diffuser casing 14; their mutually facing surfaces are shaped so as to form a contact with three degrees of freedom of rotation, so as to allow adaptation with correction of any errors of co-planarity in the locking, on the part of the body 20 of the valve 19, on the head 21 of the diffuser casing 14.

[0023] The first annular element 22 rests flat against the body 20 and the second annular element 23 rests flat against the head 21 of the diffuser casing 14.

[0024] The flat resting against the head 21 provides two degrees of freedom of translational motion and allows positioning adjustments according to its arrangement.

[0025] The same type of resting may be provided between the first element 22 and the body 20.

[0026] In particular, in this first embodiment the second element 23 has portions of the annular surface 24 which are shaped so as to form portions of an imaginary sphere within which it is inscribed as a whole, while the first element 22 has portions of the annular surface 25 which are shaped so as to form portions of an imaginary cone which it circumscribes.

[0027] With particular reference to Figure 2, a pump according to the invention, in a second embodiment, is generally designated by the reference numeral 110.

[0028] In particular, also the pump 110 is entirely similar to the above-described pump 10 and comprises a tubular body 111 which accommodates a plurality of diffusers 112 which are alternated with impellers 113.

[0029] In particular, the pump 110 differs from the pump 10 in that the two annular elements, designated here by the reference numerals 122 and 123, have a different shaping of the facing surfaces.

[0030] In particular, the second element 123 has outer portions of the annular surface 124 which are shaped so as to form portions of an imaginary sphere within which it is inscribed as a whole, while the first element 122 has portions of the inner annular surface 125 which are shaped so as to form portions which are likewise of an imaginary sphere which it circumscribes as a whole.

[0031] With particular reference to Figure 3, a multi-stage submersed pump according to the invention is generally designated by the reference numeral 210 in a third embodiment.

[0032] In particular, also the pump 210 is fully similar to the above-described pump 10, in that it comprises a tubular body 211 which accommodates a plurality of diffusers 212 which are alternated with impellers 213.

[0033] In particular, the pump 210 differs from the pump 10 in that the two annular elements, designated here by the reference numerals 222 and 223, have a different shaping of their facing surfaces.

[0034] More specifically, the second annular element

223 has outer annular surface portions 224 which are shaped so as to form portions of an imaginary toroidal solid, while the first annular element 222 has inner annular surface portions 225 which are shaped so as to form portions of an imaginary sphere which it circumscribes.

[0035] With particular reference to Figure 4, a pump according to the invention is generally designated by the reference numeral 310 in a fourth embodiment.

[0036] In particular, also the pump 310 is fully similar to above-described pump 10, in that it comprises a tubular body 311 which accommodates a plurality of diffusers 312 alternated with impellers 313.

[0037] In particular, the pump 310 differs with respect to the pump 10 in that the two annular elements, here designated by the reference numerals 322 and 323, have a different shaping of their facing surfaces.

[0038] In particular, in this case the second element 323 has outer surface portions 324 which are shaped so as to form portions of an imaginary sphere in which it is inscribed, while the first annular element 322 has inner annular surface portions 325 which are shaped so as to form portions of an imaginary toroidal solid.

[0039] In practice it has been observed that the present invention has achieved the intended aim and objects.

[0040] In particular, the interposition of a coupling between said annular elements with three degrees of freedom of rotation allows to easily adapt the closure thrust produced by the closure element or by another equivalent closure system, even in the presence of coaxiality and centering errors, so that the overall thrust on the diffuser arrives fully balanced and uniform.

[0041] It is possible to provide the contact of the two annular elements at least on an annular region rather than on a point, as occurs in current pumps (where all the closure force is discharged).

[0042] The torques produced by the forces discharged onto the annular contact region partially compensate each other so as to induce a smaller displacement of the elements to be coupled, the diffuser casing and the tubular body (the error is compensated by the second annular element 23, 123, 223, 323).

[0043] All this allows precise centerings of the diffuser casing with respect to the impellers, with a consequent increase in the geometric accuracy of the surfaces that form the fluid passage ducts and therefore with a considerable increase in performance in terms of overall efficiency.

[0044] It should also be noted that this solution does not complicate substantially the structure of the pump, thus ensuring excellent economies of production even for large production runs.

[0045] It should also be noted that the pump according to the invention allows considerable flexibility in application, since it is possible to provide in practice a closure assembly of any kind optionally also associated with valves arranged at the intake.

[0046] The present invention is susceptible of numerous modifications and variations; in particular, the surfaces of the two facing and coupled elements can in practice be any as long as they provide between them a coupling which is free according to the three degrees of freedom of rotation; more specifically, combinations between conical, spherical and toroidal surfaces can be advantageously conceived.

[0047] Other technical details may further be replaced with other technically equivalent elements.

[0048] The materials and the dimensions may be any according to requirements.

[0049] The disclosures in Italian Patent Application No. PD2000A000163, from which this invention claims priority, are incorporated herein by reference.

[0050] Where technical features mentioned in any claim are followed by reference signs, those reference signs have been included for the sole purpose of increasing the intelligibility of the claims and accordingly such reference signs do not have any limiting effect on the scope of each element identified by way of example by such reference signs.

Claims

1. A multistage pump comprising, in a tubular body, a plurality of diffusers which are alternated with impellers, the diffusers being stacked peripherally so as to form a diffuser casing, the impellers being keyed on a shaft arranged on the axis, a closure assembly being associated with said tubular body at the intake region so as to lock the diffusers in the packed configuration, **characterized in that** it comprises two annular elements which are interposed between said closure assembly associated with said tubular body and the corresponding head of said diffuser casing, the mutually facing surfaces of said annular elements being shaped so as to form a contact with three degrees of freedom of rotation so as to allow adaptation with correction of any errors of co-planarity in the locking on the part of said closure assembly on said head of the diffuser casing.
2. The pump according to claim 1, **characterized in that** in at least one of said annular elements the contact for coupling with the corresponding closure assembly or diffuser casing head occurs between planes having two degrees of freedom of translational motion.
3. The pump according to claim 1, **characterized in that** one of said annular elements has annular surface portions which are shaped so as to form portions of an imaginary sphere in which it is inscribed as a whole, while the other annular element has annular surface portions which are shaped so as to

form portions of an imaginary cone which it circumscribes.

4. The pump according to claim 1, **characterized in that** one of said annular elements has outer annular surface portions which are shaped so as to form portions of an imaginary sphere in which it is inscribed as a whole, while the other annular element has inner annular surface portions which are shaped so as to form portions which likewise belong to an imaginary sphere which it circumscribes as a whole.
5. The pump according to claim 1, **characterized in that** one of said annular elements has outer annular surface portions which are shaped so as to form portions of an imaginary toroidal solid, while the other annular element has inner annular surface portions which are shaped so as to form portions of an imaginary sphere which it circumscribes.
6. The pump according to claim 1, **characterized in that** one of said annular elements has outer surface portions which are shaped so as to form portions of an imaginary sphere in which it is inscribed, while the other annular element has inner annular surface portions which are shaped so as to form portions of an imaginary toroidal solid.

