

Nov. 11, 1969

E. A. HLINKA

3,477,384

SUBMERSIBLE MULTI-STAGE DIFFUSER TYPE PUMP

Filed Jan. 4, 1968

2 Sheets-Sheet 1

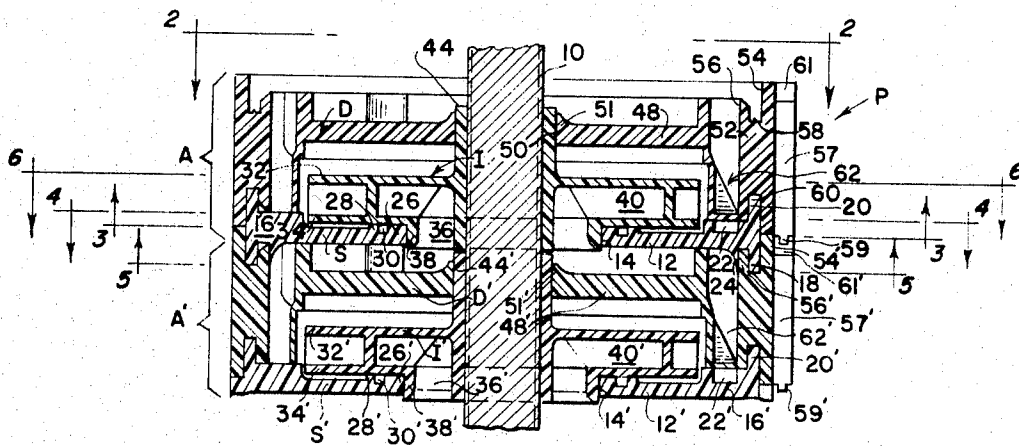


FIG. 1

FIG. 2

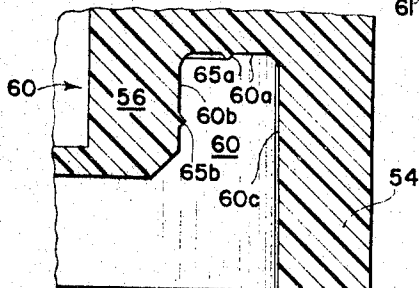
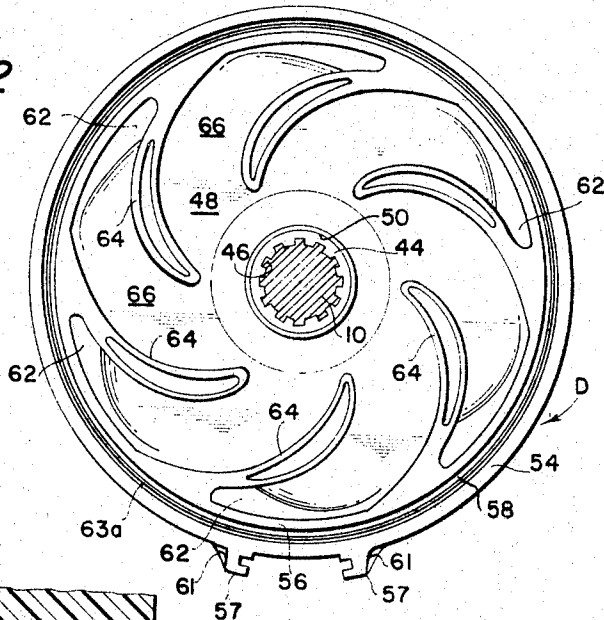


FIG. 7

INVENTOR
EDWARD A. HLINKA

BY *Gene D. Watson*

ATTORNEY

Nov. 11, 1969

E. A. HLINKA

3,477,384

SUBMERSIBLE MULTI-STAGE DIFFUSER TYPE PUMP

Filed Jan. 4, 1968

2 Sheets-Sheet 2

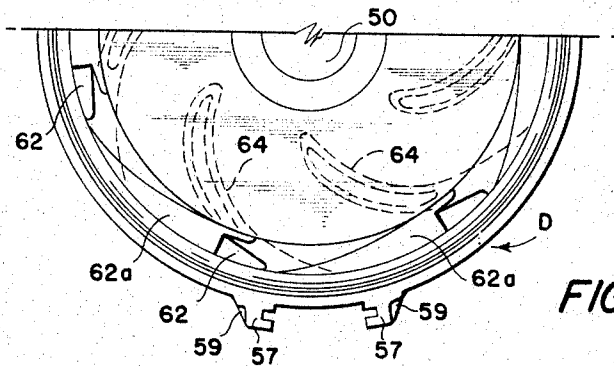


FIG. 3

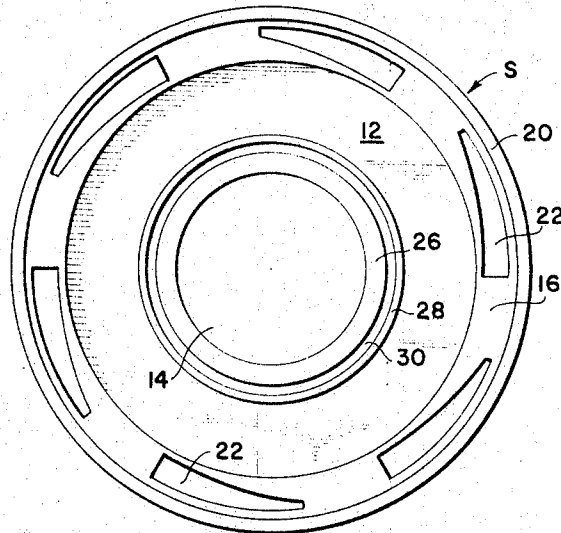


FIG. 4

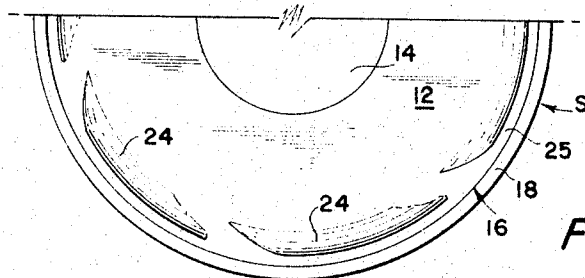


FIG. 5

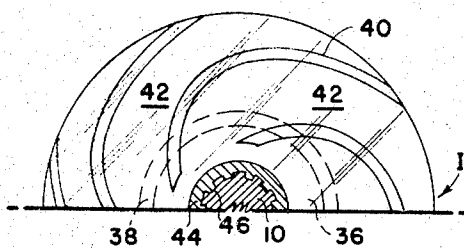


FIG. 6

INVENTOR
EDWARD A. HLINKA

BY *Gene D. Watson*

ATTORNEY

1

3,477,384

SUBMERSIBLE MULTI-STAGE DIFFUSER
TYPE PUMP

Edward A. Hlinka, Westchester, Ill., assignor to Dempster Industries Inc., Beatrice, Nebr., a corporation of Nebraska

Filed Jan. 4, 1968, Ser. No. 695,716

Int. Cl. F04d 1/06, 13/14, 29/08

U.S. Cl. 103—102

6 Claims

ABSTRACT OF THE DISCLOSURE

A submersible multi-stage type pump wherein the stages themselves and the members making up the stages are fitted together through and complementary shaped flange arrangement. Continuous crush rings formed on the surface of the grooves serve to seal the stages against pressure leakage.

The present invention relates to fluid pumps and more particularly to submersible pumps of the multi-stage, diffuser type.

A problem common to multi-stage, diffuser type pumps which are used in submerged pumping operations is that of sealing against water pressure around the periphery of each stage in the areas where the stages come together. In operation, pumps of the diffuser type build up pressure internally and thus it is essential that an adequate pressure seal be effected so that pressure is not lost.

It is an object of the present invention, therefore, to provide a submersible, multi-stage centrifugal pump in which an effective pressure seal is achieved.

It is a further object of the present invention to provide a pump of the type described wherein the component parts of the individual stages are relatively few in number and of relatively simple construction.

In accordance with the invention these and other objects not specifically enumerated are achieved through the provision of a multi-stage centrifugal pump wherein the joining of the stages is effected through interfitting of complementary surfaces of the components. Supplemental sealing means on the surface of at least one of the components insure a pressure tight fit. In accordance with a presently preferred embodiment of the invention the sealing means comprise crush rings which extend continuously around at least one surface defining an annular groove or recess in one of the components. The crush rings protrude into the recess and are contacted when a complementary flange formed on another component is received into the recess, thereby providing a pressure seal. As the pressure head in the pump is built up the crush rings are brought more firmly into contact with the flange. Greater elastic deformation of the rings takes place under these circumstances and thus the efficacy of the seal provided by the rings increases with increased pressure.

Other objects, features and advantages of the present invention will become apparent upon consideration of the following description of the drawings, wherein:

FIGURE 1 is a sectional view of two stages of a submersible pump constructed in accordance with the present invention.

FIGURE 2 is a sectional view taken generally along line 2—2 of FIGURE 1 showing the upper surface of a diffuser member.

FIGURE 3 is one-half of a sectional view taken generally along line 3—3 of FIGURE 1 (with the shaft and impeller omitted) showing the lower surface of a diffuser member.

FIGURE 4 is a sectional view taken generally along line 4—4 of FIGURE 1 (with the shaft and impeller omitted) showing the upper surface of a spacer member.

2

FIGURE 5 is one-half of sectional view taken generally along the line 5—5 of FIGURE 1 (with the shaft and impeller omitted) showing the lower surface of a spacer member.

FIGURE 6 is one-half of a sectional view taken generally along 6—6 of FIGURE 1 showing the impeller member.

FIGURE 7 is a detail of a portion of a diffuser member showing a pair of crush rings.

FIGURE 1 shows two stages denoted A and A' of a diffuser-type submersible pump assembly, generally indicated by reference P, in accordance with a presently preferred embodiment of the invention. The number of stages utilized will depend on the pressure requirements of a particular operation. For example, as many as 32 stages or more may be required in a conventional application. The overall operation of a diffuser-type pump is well known in the art and will be described here only very briefly for the sake of completeness. Such pumps include a prime mover (not shown) which drives a pump such as shaft 10, and inlet means (not shown) for passing water into the lower section of the pump assembly. The pump may further include a valve (not shown) located at the delivery end of the pump for controlling the delivery of water under pressure after the water has passed through the stages of the pump assembly P. The construction and operation of the individual stages will be set forth in detail hereinbelow.

Each stage of the pump assembly P comprises a diffuser member denoted D, a spacer member denoted S and an impeller member denoted I, each of which is preferably constructed of a suitable thermoplastic. The individual members are substantially identical for each stage and corresponding elements in stage A' are given the same numbers primed as the elements of stage A.

The spacer members which are best seen in FIGURES 1, 4 and 5 generally comprise a flat annular disc 12 including a circular central opening 14, and an annular rim 16. Rim 16 includes a pair of outer, upstanding flange members 18 and 20 which extend perpendicularly outward in opposite directions from the surface of disc member 12. Rim 16 includes a plurality of recesses 22 formed in the upper surface thereof. Recesses 22 are of generally triangular configuration and are equally spaced around rim 16 as shown in FIGURE 4.

Referring to FIGURE 5, the lower surface of disc 12 includes a plurality of equally spaced upright members 24 which together with flange 18 form a discontinuous recess or groove 25 around circumference of disc 12. As can best be seen in FIGURE 1 members 24 include, in cross section, a curved portion and a straight-line portion, the straight-line portion facing lower flange 18. The function of the curved portion of members 24 will be discussed hereinafter.

A pair of concentric annulus members 26 and 28 are provided on the upper surface of disc 12 around the periphery of central opening 14. Annulus members 26 and 28 form a circular groove 30 concentric with central opening 14.

The construction of the individual impeller members I and I' can best be seen in FIGURES 1 and 6. The impellers are of the enclosed type, impeller I having upper and lower shrouds 32 and 34, respectively. An enlarged eye 36 is provided in lower shroud 34 and a relatively short peripheral skirt member 38 depends down from the portion of lower shroud 34 defining eye 36. A plurality of curved, radial vanes 40 disposed between and separating upper shroud 32 and lower shroud 34 define passageways 42 (best seen in FIGURE 6) which serve to direct liquid outwardly from eye 36. An elongated hub member 44, formed integrally with upper shroud 32, is located at the center of impeller I. Hub 44 includes

internal splines 46 which serve to mount the impeller I on pump shaft 10. Shaft 10 causes rotation of impeller I so that liquid passing through the eye 36 is discharged, by means of centrifugal force, through the ends of passageways 42. The interfitting of the impeller I, the spacer S and the diffuser member D with each other and with the elements of a preceding or subsequent stage will be described in detail hereinbelow.

The construction of the diffuser member D can best be seen in FIGURES 1, 2 and 3. The diffuser D is generally of disc-like construction and includes an inner disc member 48 having a central opening 50 which receives the upper portion of hub member 44 of impeller I. An upstanding peripheral flange member 51 formed on the upper surface of disc 48 surrounds the end portion of hub 44. Diffuser D further includes peripheral wall arrangement 52. Wall arrangement 52 includes an outer wall member 54, which forms the outer wall of the pump assembly, and a circumferential flange member 56 located inwardly of said outer wall 54.

Longitudinal flange members 57 which extend perpendicularly outwardly of outer wall 54 interfit with similar flanges on like diffuser members to provide interlocking of the stages. As is shown in FIGURE 1 longitudinal flanges 57 include peripherally spaced tab members 59 located at the lower end thereof which extend beyond the lower surface of the diffuser member D. Tabs 59 fit closely into recesses or notches 61' formed in the upper end of the flanges 57' of the next stage A'. Tabs 59 are generally triangular in cross section (see FIGURE 3) with the inner surfaces thereof contacting the complementary shaped surfaces of notches 61' (FIGURE 2 illustrates the shape of corresponding notches 61 of diffuser D).

Outer wall 54 and flange 56 define upper and lower peripheral recesses or grooves 58 and 60, respectively. A detail of a lower groove 60 is shown in FIGURE 7. The nature of the grooves 58 and 60 will be discussed in some detail hereinbelow. A plurality of ducts 62 are spaced around the inner face of flange 56 and form passages communicating at the lower end thereof with the outputs of passageways 42 of the impellers I and extending curvedly upward to the upper surface of disc member 48. As can best be seen in FIGURE 2 the upper surface of disc member 48 is provided with a plurality of curved, radially extending vanes 64 which communicate with the outlet portions of ducts 62. Vanes 64 form passageways 66 which lead into central portions of the diffuser D. The curved surface of the peripheral flange 51 aids in providing smooth travel of the liquid up to the eye corresponding to eye 36 of the next impeller stage. The ducts 62 are of decreasingly narrow radial cross-section progressing from their lower openings as is evidenced in FIGURE 3 by the generally triangular shape of the lower portions 62a of ducts 62. Portions 62a are flat and with the stages assembled are positioned opposite and abut with the similarly shaped recesses 22 of rim 16 of spacer member S.

Continuing with the interfitting of parts of the three members comprising each stage, as can best be seen in FIGURE 1, impeller I is generally supported by a corresponding spacer S. The lower shroud 34 of impeller I rests on the raised annulus members 26 and 28 provided on the upper surface of spacer S with the downwardly depending skirt member 38 disposed within central opening 14. The lower edge of hub 44 lies flush with the lower edge of skirt 38 while the upper portion of hub 44 is received in the central opening 50 in diffuser member D as described hereinbefore. The lower edge of hub 44 contacts the upper edge of the hub 44' of the next stage A' (see FIGURE 1). From the foregoing it can be seen that impeller I is situated within a hollow bounded by the upper surface of spacer S and the lower surface of diffuser member D and the output ends of the radial passageways 42 communicate with the lower inlet portions of ducts 62.

The spacer member S and diffuser D are fitted together

through the interfitting of complementary shaped surfaces on the two members. Referring to FIGURE 1, outer flange 20 of spacer S fits into the lower peripheral groove 60 formed by wall 54 and flange 56 of diffuser D. Flange 20 is of such a length that the upper edge surface thereof contacts the inner surface 60a (see FIGURE 7) of recess 60 and of such a width that the opposite faces thereof contact the corresponding surfaces 60b and 60c, respectively, of recess 60. The lower flange 18 of spacer I similarly fits into the upper groove 58' formed by flange 56' and outer wall 54' of diffuser D' of the adjacent stage. The length of the portions of the outer wall 54 immediately outward of the rim 16 of spacer S is such that the lower edge of wall 54 of diffuser D of stage A contacts the upper edge of outer wall 54' of the stage A' as seen in FIGURE 1.

A further interfitting of complementary surfaces takes place between flange 56' of diffuser D' of the next stage A' and the discontinuous groove 25 formed by flange 18 and the plurality of upright members 24 of spacer S. The curvature and the extent of the curved portion of upright members 24 is such as to complement and complete the passages formed by ducts 62' of diffuser member D' in the area of the communication of those passages with the passageways (corresponding to passageways 66) formed by the vanes (corresponding to vanes 64) located on the upper surface of diffuser disc 48'.

Referring to FIGURE 7, a pair of crush rings 65a and 65b are shown formed on surfaces 60a and 60b, respectively, of groove 60. The crush rings 65a, 65b comprise continuous annular protuberances which project into the recess and which extend entirely around the corresponding surfaces 60a, 60b of the recess 60. Similar rings are provided on the inner surfaces of groove 58 one of which, crush ring 63a, may be seen in FIGURE 2. As can best be seen in FIGURES 2 and 7 the crush rings are circular in configuration and triangular in cross-section and, as stated, extend around the entire groove circumference. When corresponding flange 20 is fitted into recess 60 as set forth above, crush rings 65a, 65b are contacted and elastically deformed to a limited extent so that pressurized fit between the spacer member S and diffuser member D is achieved. Referring to FIGURE 1 it can be seen that pressure losses through leakage must take place through a path formed between the interfitting surfaces of the spacer S and diffuser D and between the mating outer walls of two diffusers D and D'. Therefore, by providing crush rings 65a, 65b as described hereinbefore, the leakage path between the diffuser D and the spacer S is destroyed and an effective seal is provided. As flange 20 is fitted more firmly into recess 60 as where the pressure head of the pump is built up, better contact between flange 20 and crush rings 65a, 65b is effected together with greater elastic deformation of the rings and thus the efficiency of the continuous seals formed along the lines of the two rings is improved. The present invention therefore provides the maximum sealing effect under circumstances where such maximum sealing is required, namely, when the pressure built up in the stages of the pump assembly is the greatest. Of course, arrangements of the crush rings other than that shown and described are possible. For example, only a single ring might be used and such a ring might be located in a projecting flange rather than in a recess as shown.

It can be seen from the foregoing that the present invention provides a pump assembly wherein the stages are made up of relatively few parts and wherein a simple yet extremely effective interfitting between the parts making up the stages as well as between the stages themselves is achieved. Close interfitting between diffuser members is achieved through the tab and notch arrangement on the outer flanges and the abutment of the outer walls while interfitting between the spacers and diffusers is achieved through the arrangement of the spacer flanges and the diffuser grooves and to a lesser extent through

the arrangement of the discontinuous groove-forming upright members of the spacers and the inner flanges of the diffusers. The continuous crush rings formed on certain of the elements as described provide a pressure seal between the stages.

It will be understood by those skilled in the art that the embodiment of the invention shown and described herein is subject to various other modifications without departing from the scope and spirit of the invention. Accordingly, it should be understood that the invention is not limited by the exemplary embodiment shown and described but rather only by the subjoined claims as construed in light of the foregoing specification and drawings.

Having thus described my invention in accordance with the patent statutes, I claim:

1. A submersible pump comprising a plurality of diffuser stages arranged in a stacked relationship, said diffuser stages each comprising a plurality of component members, said plurality of component members comprising an impeller member, a first member comprising a diffuser member having curved duct means formed thereon and a surface contour comprising a circular outer rim having first and second annular grooves therein, and a second member comprising a disc-shaped spacer member having a surface contour comprising first and second oppositely-extending outer flange members complementary to and interfitting with said surface contour of said first member, said first groove receiving said first flange member and said second groove receiving a flange member of a spacer member of the stage adjacent thereto, and said second flange fitting into a groove formed in a diffuser member of the stage adjacent thereto, said first member further comprising sealing means located on said surface contour for contacting said complementary surface contour to effect a pressure seal between said first and second members, said sealing means comprising a first continuous ring member formed on one surface of each of said first and second grooves and extending along said one surface for the entire distance said surface contour and said complementary surface contour are in contact.

2. A submersible pump in accordance with claim 1 wherein said spacer member includes means formed on one surface thereof for completing the curvature of the ducts formed in a diffuser member of an adjacent stage

and for forming, together with one of said flange members of said spacer member, a discontinuous groove for receiving a flange member formed on the diffuser member of said adjacent stage.

3. A submersible pump in accordance with claim 2 wherein said impeller member includes a shroud means and hub means, said shroud means resting on one surface of said spacer member and said hub means extending through a central opening in said diffuser member.

4. A submersible pump in accordance with claim 1 wherein said sealing means further comprises a second continuous ring member formed on a second surface of each of said first and second grooves and extending along said second surface for the entire distance said surface contour and said complementary surface contour are in contact.

5. A submersible pump in accordance with claim 1 wherein said first component member includes additional means formed on the outer surface thereof for interfitting with a like component member of the next stage.

6. A submersible pump in accordance with claim 5 wherein said additional means comprises an outwardly extending longitudinal flange including at least one tab member located at one end thereof and extending beyond the adjacent transverse surface of said first component member and a notch means formed in said flange at the other end thereof, said tab member fitting in a corresponding notch means formed in a like component member of the stage adjacent thereto and said notch means receiving a corresponding tab member of a like component member of the stage adjacent thereto.

References Cited

UNITED STATES PATENTS

963,539	7/1910	Forward	103—108
1,817,776	8/1931	Sipe	277—208
3,116,696	1/1964	Deters	103—108
3,158,295	11/1964	McConaghy	103—108

HENRY F. RADUAZO, Primary Examiner

U.S. Cl. X.R.

103—108, 111