Oct. 27, 1964 K. C. HOYT 3,154,019

SHAFTLESS SUBMERSIBLE PUMP

Filed Nov. 13, 1962

FIG. 1

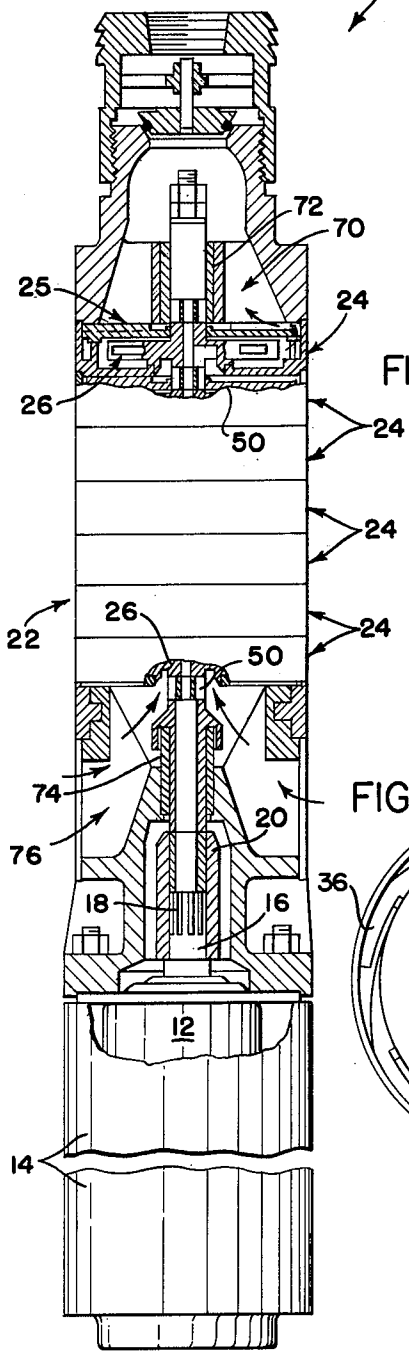


FIG. 2

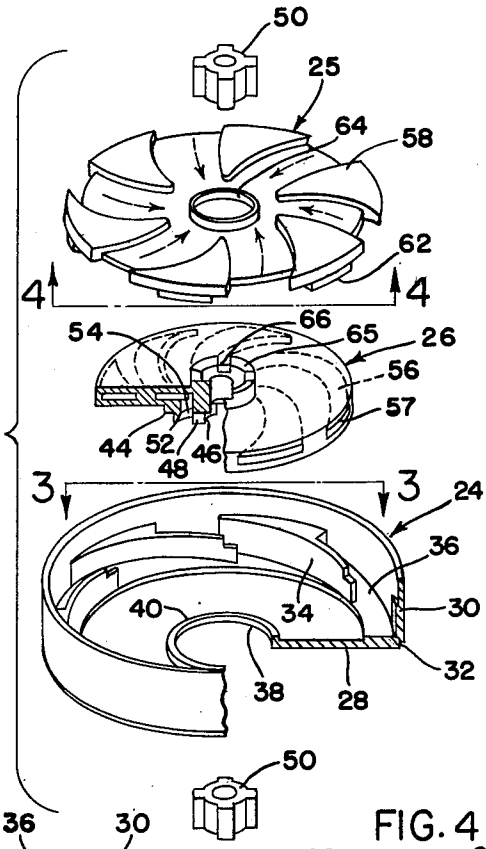


FIG. 3

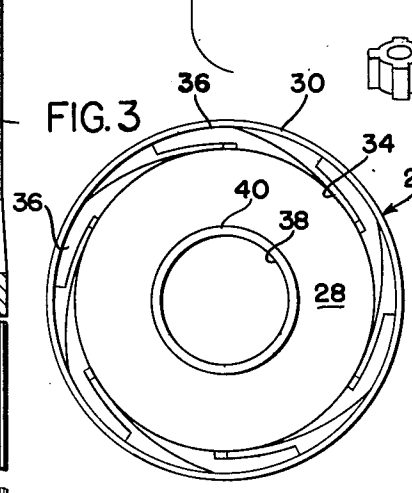
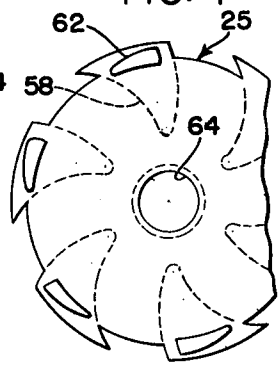


FIG. 4



INVENTOR.
KENNETH C. HOYT

BY
Fitzsimmons and Body
ATTORNEYS

United States Patent Office 3,154,019 Patented Oct. 27, 1964

3,154,019

SHAFTLESS SUBMERSIBLE PUMP

Kenneth C. Hoyt, Rogers, Ark., assignor to Crane Company, New York, N.Y., a corporation of Illinois

Filed Nov. 13, 1962, Ser. No. 236,937
13 Claims. (Cl. 103—87)

This invention pertains to an improved submersible pump and more particularly to a pump comprised of a stack of pumping units each having a diffuser and an impeller rotatably mounted therein.

In conventionally constructed pumps the pump units are driven from a common drive shaft which extends the length of the pump and is supported at its opposite ends by bearings. With such a construction, requiring exact alignment of the bearings, it is essential to maintain rigid manufacturing tolerances if each pumping unit is to operate freely, and for this reason expensive machining operations are required. Even so, the pump is seldom freely operable without a run-in period during which time the mating surfaces of the pump units are caused to accommodate with each other by mutual abrasion. The run-in period is time consuming, costly and retards production.

A primary object of the present invention is to provide a pump construction which uses in place of a continuous drive shaft, a series of individual drive elements between the impellers of adjoining units which permit adjustable movement of each impeller within its pumping unit to relieve frictional forces tending to impede free rotational impeller movement.

A further object of the invention is to provide a drive means wherein the impellers of a plurality of pumping units are driven in series i.e. a motor input force is communicated to one impeller and torque is thereafter transmitted from one impeller to the next through an interconnecting drive means.

A further object of the invention is to relieve frictional forces impeding free rotatable movement of each impeller in its pumping unit by using the water or other liquid being pumped as a lubriaction medium so that wear and friction are reduced.

A still further object of the invention is to achieve by means of the foregoing a substantial elimination of run-in time previously required before the pump was ready for use, and also to provide a pump construction which is easier to assemble because of less stringent requirements for axial alignment of the pumping units.

A still further object of the invention is to provide an impeller which can be accurately constructed as an injection molded part, making it both hydraulically and centrifugally balanced.

A significant feature of the present invention is that a part of the diffuser is adapted to form the outer casing of the pump thereby reducing pump structure to economize the construction and also to facilitate assembly of the pump.

Other objects and features of the invention will become apparent from a consideration of the following description which proceeds with reference to the accompanying drawings wherein:

FIGURE 1 is an elevation view of a submersible pump constructed in accordance with the present invention and shown with portions thereof broken away;

FIGURE 2 is an exploded perspective view with parts broken away of the components forming one complete pumping unit and part of a second unit;

FIGURE 3 is a plan view of one of the pump components looking in the direction of the arrows 3—3 in FIGURE 2; and,

FIGURE 4 is a fragmentary bottom plan view looking in the direction of the arrows 4—4 in FIGURE 2.

Referring now to the preferred embodiment of the invention, the pump 10 is driven by a motor 12 protectively encased in a sealed chamber 14 and having a stub drive shaft 16 with spline 18 and coupling 20 leading to the bottommost one of a plurality of pumping units 22 which are nested vertically to form the complete pump.

Each unit is comprised of a diffuser 24, a diffuser 25 and an impeller 26 through which water, or other liquid, is transferred successively from one unit to the next higher unit until it reaches the uppermost unit and is discharged.

The diffuser 24 comprises a bottom wall 28 and an outer cylinder wall 30 forming a section of the pump casing in which is provided a groove 32 which enables nesting of the parts 28 of each unit into a continuous watertight casing. A plurality of vanes 34 of diffuser 24 are curved radially and other surfaces 36 are curved axially upwardly to scoop the fluid vertically toward the next higher pump unit. A central opening 38 and wearing ring 40 provide a bearing for rotatable movement by the impeller 26 which has a mating wearing ring 44 in supporting engagement with portion 40.

A boss 46 of impeller 26 has tenons 48 which match with a driving dog 50 which communicates torque to the impeller 26. The fit between each dog 50 and tenon 48 is such as to permit slight floatable movement of the impeller 26 within diffuser 24. A bearing flange 52 of the impeller is free to cock slightly within opening 38 to permit this floatable adjustment.

The impeller 26 receives liquid through an annular passage 54 therethrough and imparts a centrifugal force thereto discharging the liquid through radial passages 56 and ports 57 and the liquid is raised by the diffuser 24 through its vanes 34 and then directed radially inwardly by the vanes 58 of the other diffuser 25. Diffuser 25 directs the flow radially inwardly as shown by the arrows in FIGURE 2, for entry into the next higher pumping unit via opening 38. The diffuser 25 has downwardly projecting portions 62 which mortise with diffuser 24 to prevent their relative rotation, and the central opening 64 receives a boss 65 having tenons 66 which match with the driving lugs of another dog 50 to transfer driving torque to the impeller in the next higher pumping unit.

The pumping force is thus transferred in series from one pumping unit to the next and the liquid is transferred from one unit to the next until reaching a discharge bowl 70 where there is a bearing sleeve 72, corresponding in construction with a bearing sleeve 74 in suction bowl 76. These bearings need not however be accurately located one relatively to the other because in place of a continuous length drive shaft extending the length of the pump and supported at its ends in the bearing sleeve 72, 74, dogs 50 form individual articulated drive connections for each impeller in its respective unit.

From the foregoing it will be appreciated that slight misalignments can occur between successive units and between the bearings without impeding free rotational movements of the impellers.

The impellers can be of plastic construction preferably of a composition permitting injection molding and may be of one piece or two piece construction. It is essential however to achieve as accurate a balance as possible i.e. precise symmetry so that while rotating they do not produce a pump imbalance.

The pump in operation is remarkably frictionless not only because of the self-adjusting qualities of the impellers but also because each impeller is lubricated at its bearing surfaces by the liquid. Both these factors account not only for low wear but eliminate altogether or greatly reduce run-in time and downtime for service and

repair. It has also been found that power savings are realized because of reduced friction losses.

A separate pump casing is eliminated by virtue of the outer cylindrical walls of each part 28 of the diffuser 24 which nest together and form a continuous watertight casing.

Although the present invention has been described in connection with only one selected example embodiment it will be understood that this is exemplary not limitative of the invention. Such changes as those skilled in the art can make to suit individual design requirements and which come within the scope of the present disclosure are intended to be included within the scope of the following claims as equivalents of the invention.

Having thus described my invention, I claim:

1. The improved submersible pump constructed of a plurality of linearly stacked pumping units comprising:

(*a*) a plurality of segmented means having complementary end portions and each having an outer cylinder wall and opposite end portions proportioned to fit within the complementary end portions of adjacent segmented means to provide an enclosed continuous pump chamber;

(*b*) means forming a part of said segmented means for channeling centrifugally driven liquid successively from one segmented means to the next in a vertically upward line of travel;

(*c*) a rotatable impeller mounted for turning one within each of said pumping units and including a hub adapted for receiving torque input force and portions positioned to receive fluid from a lower level pumping unit and an outlet from which fluid is ejected under force and directed by said channeling means to a higher unit;

(*d*) and driving means for communicating torque from one impeller to the next so that said impellers are rotated in unison by torque communicated in series from one impeller to the next through the hub portions thereof and which permit limited relative movements of each impeller within its associated segmented means;

(*e*) whereby slight axial misalignment is permitted of said pumping units while still permitting relatively free turning movement of its respective impeller.

2. The improved pump as set forth in claim 1 wherein said impellers are constructed of injection molded plastic material to provide centrifugally and hydraulically balanced running conditions.

3. The improved pump as set forth in claim 1 wherein each impeller is floatably mounted within its respective pumping unit to provide individual centering action of each impeller therein.

4. The improved pump as set forth in claim 1 including complementary bearing surfaces formed between the hub of said impeller and a central opening of its respective pumping unit through which said hub extends to receive driving torque from said driving means provided between successive ones of said pumping units.

5. The improved pump as set forth in claim 4 including complementary wear surfaces forming vertical support bearing means between the relatively rotatable hub of each impeller and an opposed surface surrounding the central opening in said pumping unit.

6. The improved pump as set forth in claim 4 wherein said bearing surfaces are exposed to liquid transferred vertically from one pumping unit to the next to receive antifriction lubrication therefrom.

7. The improved pump as set forth in claim 1 including nonrotatable diffuser means having vanes which receive the fluid as it moves upwardly under the action of said impellers and directs such fluid inwardly where it enters the next higher pumping unit through apertures located in the hub portion of the associated impeller in said next higher unit.

8. The improved pump as set forth in claim 7 including cooperative locking members on said nonrotatable diffuser means and segmented means to hold then against relative turning and to maintain nonrotative movement when said impellers are rotating therebetween.

9. The improved pump as set forth in claim 7 wherein said nonrotatable diffuser means is proportioned to fit within the outer cylindrical wall of each segmented means and forms together therewith a closed pumping compartment for the impeller which rotates therein.

10. The improved pump as set forth in claim 1 wherein said driving means is constituted by an irregularly shaped outer periphery member forming a torque-transmitting connection between the adjacent ends of said impellers and permitting slight relative angular movements of each impeller which is thereby individually floatable within its pumping unit.

11. The improved submersible pump construction formed of a stack of interfitting pumping units, comprising:

(*a*) a diffuser having guide vanes for directing a stream of liquid along prescribed longitudinal and radial paths whereby the liquid is channeled upwardly from one unit to the next higher unit;

(*b*) an impeller mounted for rotatable movement in each pumping unit and including channel surfaces for receiving liquid and imparting momentum thereto; and,

(*c*) articulated driving means forming a drive connection between adjoining impellers of adjacent ones of said units to provide driving force communicated in series from one impeller to the next;

(*d*) whereby each impeller is adapted for individual floated movement in its respective unit to reduce friction and run-in time for the pump.

12. The pump construction in accordance with claim 11 wherein said driving means is comprised of a spline-and-sprocket providing limited angular movement of each impeller which is thereby floatably driven in its respective unit.

13. The pump construction in accordance with claim 11 wherein said impeller is both centrifugally and hydraulically balanced within its pumping unit and is lubricated for rotatable movement therein by the flow of liquid received during pumping action.

References Cited in the file of this patent

UNITED STATES PATENTS

2,161,695	Bigelow et al.	June 6, 1939
2,603,073	Nield	July 15, 1952
2,630,341	Downey	Mar. 3, 1953
2,764,099	Wernert	Sept. 25, 1956
2,831,432	Mann	Apr. 22, 1958

FOREIGN PATENTS

717,035	Great Britain	Oct. 20, 1954