Fig. 1.

Fig. 2.

Fig. 3.

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This invention relates to a submersible motor-pump unit, and more particularly to an improved pump construction for a submersible motor-pump unit.

Submersible motor-pump units are employed for pumping gas or petroleum products from underground tanks to dispensing units located above the ground. In the conventional submersible motor-pump unit, the pump is located beneath the motor and the pump impellers are secured to the lower end of the motor shaft. A pump housing surrounds the impellers, and a series of diffuser sections are located within the housing between the impellers and serve to guide the liquid from one stage impeller to the next.

The present invention is directed to an improved pump construction for submersible motor-pump units which simplifies the manufacture and disassembly of the pump and improves the flow characteristics of the liquid being pumped. More specifically, the pump construction includes a series of impellers which are keyed to the lower end of the motor shaft. The pump housing is threaded onto an adapter connected to the lower end of the motor and surrounds the impellers. According to the invention, the pump housing is provided with a series of diffuser sections which are cast integrally with the housing and extend between the impellers. Each diffuser section is provided with a series of guide vanes and a baffle plate is secured to the vanes to provide a closed diffuser section which results in less turbulence in the liquid flow and a more efficient output.

An end cap is threaded onto the lower end of the pump housing and is provided with an inlet flange which bears against the series of impellers and maintains the impellers in position on the motor shaft.

By unthreading the end cap, the lower impeller can be readily removed for service or replacement and by unthreading the pump housing the upper impeller can be replaced. This results in a unit that can be more readily assembled and disassembled than the conventional motor-pump unit, for it requires only two elements to be unthreaded to completely disassemble the entire pump construction.

As an additional feature, the impellers are designed to provide improved flow characteristics for the liquid. Each impeller is provided with a series of generally curved blades which extend between upper and lower plates. The upper or top surface of the impeller converges toward the lower surface in a radial direction so that the cross-sectional area between the impeller blades remains substantially constant throughout the radial extent of the impeller. This serves to reduce cavitation and prevent disruption of fluid flow characteristics.

Other objects and advantages will appear in the course of the following description.

The drawings illustrate the best mode presently contemplated of carrying out the invention.

In the drawings:

FIGURE 1 is a longitudinal section with parts broken away of the motor-pump unit of the invention.

FIG. 2 is a transverse section, with parts broken away, taken along line 2—2 of FIG. 1.

FIG. 3 is a transverse section, with parts broken away, taken along line 3—3 of FIG. 1.

The drawings illustrate a submersible motor-pump assembly which can be used for pumping petroleum products from underground tanks to dispensing units located above ground. The motor-pump assembly includes a motor unit 1 which is located within an outer generally cylindrical, thin-walled shell 2. A discharge fitting 3 is connected by bolts 4 to the upper bearing housing 5 of the motor unit 1 and is provided with a series of liquid outlets 6 which communicate with passages 7 formed in the housing 5 of the motor unit. The liquid is conducted upwardly through the annular clearance 8 between the motor unit 1 and shell 2 and then flows through passages 7 and outlets 6 to the discharge conduit 9 threaded in the central opening in fitting 3.

Electrical energy is supplied to the motor unit 1 through electrical conduit 10 which is provided with a plug 11 engaged with socket 12 located in the upper bearing housing 5. The motor unit 1 and discharge fitting 3 are of conventional construction and in themselves form no part of the present invention.

An adapter ring 13 is secured to the lower bearing housing 14 of the motor unit 1 by a series of bolts 15 and the adapter is provided with a central opening 16 through which the motor shaft 17 projects. The adapter ring 13 is assembled with the passages 18 which communicate with the annular space 18 between the motor unit 1 and the shell 2.

The lower end 19 of the motor shaft 17 is splined and carries a pair of impellers 29 and 21. Each impeller is provided with a central hub 22 having a splined interior surface which is engaged with the splined shaft end 19. The splined connection prevents relative rotation between the motor shaft 17 and the impellers, yet permits the impellers to be moved axially along the shaft.

Each impeller 20 and 21 is provided with a generally sloping or convex upper surface 23 and a generally flat lower surface 24. The surface 20 is provided with a downwardly extending flange 25 which defines an inlet opening 26 through which the liquid is introduced into the respective impeller.

As best shown in FIG. 3, each impeller 20 and 21 is provided with a series of generally curved blades 27. The blades extend from a location adjacent the periphery of the impeller to a position adjacent the hub 22. As the upper surface 23 slopes or tapers toward the lower surface 24, the height or distance between the surfaces 23 and 24 progressively decreases in a direction radially outward. This decrease in height balances the increase in dimension between the adjacent blades 27 in a direction radially outward so that the cross-sectional area defined by surfaces 23 and 24 and adjacent blades 27 remain substantially constant in a direction radially outward of the impeller. By maintaining the cross-sectional area substantially constant, the cavitation is reduced and more uniform flow characteristics are provided which increases the efficiency of the pumping unit.

The impellers 20 and 21 are housed within a generally cylindrical housing 28 which is threadedly engaged with the lower end of the adapter ring 13. The housing 28 is sealed to the ring 13 by use of an O-ring seal 29 which is located within a circumferential recess formed in the outer surface of the ring 13.

As best shown in FIG. 1, the upper edge of housing 28 is provided with a shoulder 30 and the lower end of the motor shell 2 bears against the shoulder so that the peripheral surface of housing 28 is flush with the outer surface of motor shell 2. The motor shell 2 is sealed to the adapter ring 13 by an annular seal 31 which is also located within a recess formed in the adapter ring 13.

According to the invention, the pump housing 28 is provided with an internal diffuser ring 32 which is cast integrally with the housing 28. The diffuser ring 32 ex-
tends radially inward between the impellers 20 and 21 and is provided with a series of generally curved vanes 33 which serve to guide and diffuser the liquid from the lower impeller 20 to the upper or second stage impeller 21.

In addition to the diffuser ring 32, an annular baffle disc 34 is provided with a series of generally curved vanes 33 and is provided with a series of generally curved vanes 33 and thus provides a closed diffuser section which reduces the turbulence and provides a more uniform flow of liquid to the second stage impeller 21.

The inner annular edge of baffle disc 34 is provided with a flange 36 which is disposed around the hub 32 of impeller 20.

The lower end of the pump is enclosed by an end cap 37 which is threadable to the lower end of the pump housing 28. The end cap 37 is provided with an inlet opening 38 which communicates with a central passage 39 defined by the annular flange 40. Flange 40 has a slightly greater internal diameter than the external diameter of the flange 25 bordering the opening 26 of the impeller 20 so that the flange 25 will be located radially inward of the flange 40.

In operation, the liquid to be pumped is drawn into the pump through the opening 38 in end cap 37 and flows through passage 39 to opening 26 of the first stage impeller 20. The liquid is then thrown radially outward by the blades of the impeller and passes inwardly between the diffuser vanes 33 to the inlet 26 of the second stage impeller 21. The impeller 21 throws the liquid outwardly and it passes through the passages 18 in the adapter ring 13 into the annular clearance 8 between the shell 2 and the motor unit 1. The liquid then flows through the passages 7 and outlets 6 to the discharge conduit 9 leading above ground.

The present invention provides a pump construction which can be assembled and disassembled with a minimum amount of labor. By merely unthreading the end cap 37 from the housing 28, access can be had to the lower impeller 29 and by unthreading the housing 28 from the ring 13, the upper impeller 21 can be removed from the motor shaft.

The construction reduces the number of parts in that the pump housing is formed integrally with the diffuser ring. In a conventional unit, a series of diffuser sections are stacked within an outer pump housing, while in the present construction the diffuser ring is an integral part of the pump housing so that only a single element is required.

The baffle 34 which is secured to the vanes 33 of the diffuser ring serves to produce a less turbulent flow of liquid and a more efficient output. In addition, the impellers 20 and 21 are shaped so that the cross-sectional area between the impeller blades is substantially constant throughout the radial extent of the impeller. This again serves to prevent cavitation and provides a more uniform flow of liquid through the pump assembly.

While the above description is directed to the use of the pump construction in a submersible motor-pump unit, it is contemplated that the pump construction can be employed with any type of conventional multi-stage pumping unit.

Various modes of carrying out the invention are contemplated as being within the scope of the following claims particularly pointing out and distinctly claiming the subject matter which is regarded as the invention.

We claim:

1. In a pump construction, a rotatable shaft, a series of impellers mounted on the shaft for rotation therewith, said impellers being freely movable on said shaft in an axial direction, a generally cylindrical housing disposed radially outward of the impellers and having a diffuser section extending radially inward between said impellers, and an end cap threadedly engaged with the outer end of said housing and having an annular portion spaced radially between the axis of said shaft and the housing and portion disposed to bear against an axially facing surface on the outermost impeller in said series to retain said impellers on said shaft, said cap having an inlet opening providing communication with the outermost impeller and liquid being moved by said outermost impeller through the diffuser section to the next impeller in the series.

2. In a pump construction, rotatable shaft, a series of impellers mounted on said shaft for rotation therewith, said impellers being freely disposed on said shaft with respect to axial movement, a generally cylindrical housing disposed radially outward of the impellers and having a diffuser section extending radially inward between said impellers, and an end cap threadedly engaged with the outer end of the housing and having an annular disposed to bear against an axially facing surface on the outermost impeller in said series of retain said impellers on said shaft, the outer end of the housing being free of radially extending abutments whereby the outermost impeller can be slipped from the shaft after removal of said end cap.

3. In a pump construction, a rotatable shaft, a series of impellers with each impeller having a central hub mounted on the shaft for rotation therewith, said impellers being freely disposed on said shaft movement in an axial direction, a generally cylindrical housing disposed radially outward of the impellers and having a diffuser section extending radially inward between said impellers, and an end cap threadedly engaged with the outer end of said housing and having an axial inlet opening, said end cap having an annular bearing portion located between said inlet opening and the housing, the outermost impeller in said series having an axially facing surface disposed to bear against said annular bearing portion to retain said impellers on said shaft, and the entire outer end surface of the hub of said outermost impeller being exposed whereby the outermost impeller can be slipped from the shaft after removal of said end cap.

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ROBERT M. WALKER, Primary Examiner,
UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,298,318

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It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 4, line 13, strike out "portion"; line 27, before "disposed" insert -- portion --; line 29, for "of" read -- to --; line 40, for "threadedlyl" read -- threadedly --.

Signed and sealed this 7th day of November 1967.

(SEAL)
Attest:

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