April 8, 1969 D. L. TREMAIN 3,437,045

SUBMERSIBLE PUMP

Filed Aug. 31, 1967

FIG-1

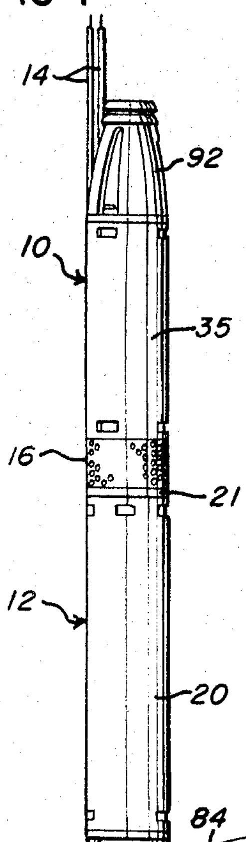


FIG-2

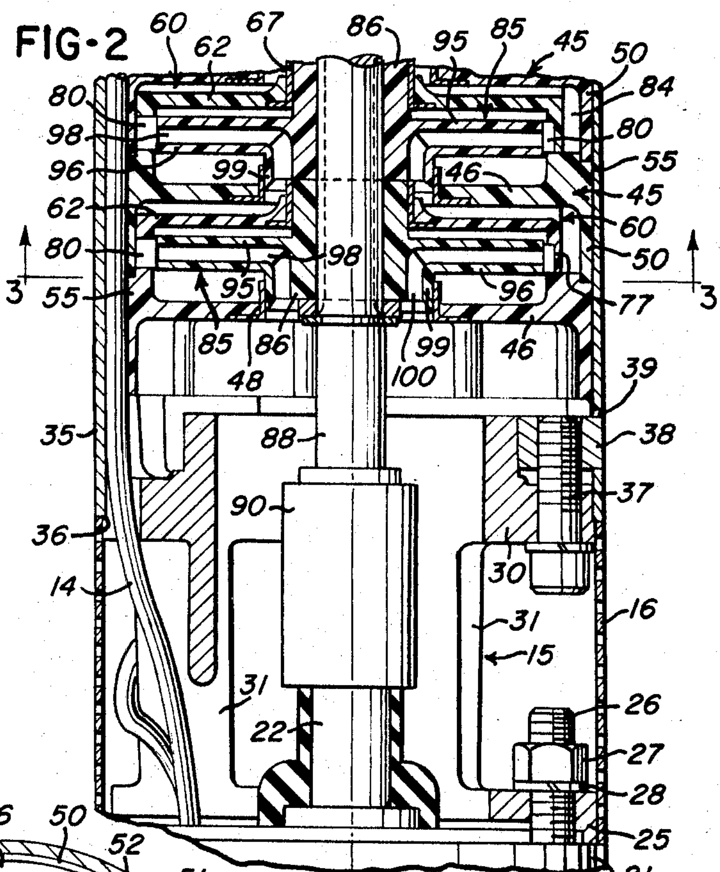


FIG-3

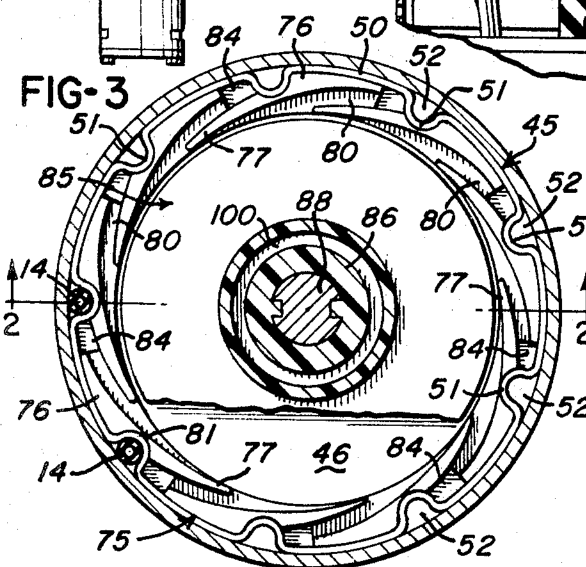


FIG-4

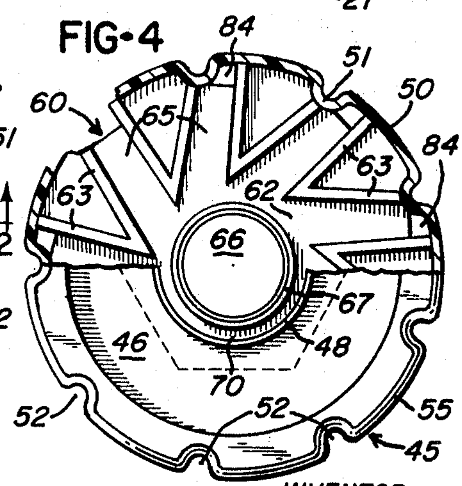
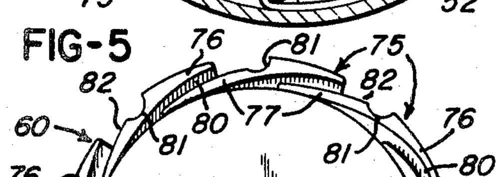


FIG-5



INVENTOR

DAVID L. TREMAIN

BY

Marechal, Biebel, French & Bugg

ATTORNEYS

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SUBMERSIBLE PUMP

David L. Tremain, Dayton, Ohio, assignor to The Tait Manufacturing Company, Dayton, Ohio, a corporation of Ohio

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U.S. Cl. 103—87 11 Claims

ABSTRACT OF THE DISCLOSURE

A submersible pump for a well casing wherein a motor is connected to an axially aligned multiple stage centrifugal pump has a plurality of stacked plastic cases with corresponding insert diffusers and impellers. The cases have generally cylindrical outer walls with a plurality of uniformly spaced axially extending external slots and are encased by a cylindrical shell for protecting the cases and motor leads extending within the slots, and each diffuser has peripherally spaced overlapping vanes cooperating to define diffusing passageways between the slots to provide for using maximum diameter cases and impellers.

Background of the invention

In a submersible multistage centrifugal pump and motor assembly such as disclosed in Patent No. 3,070,026, issued to the assignee of the present invention, and which is adapted to be lowered into a well casing so that the entire assembly is submerged substantially below the water level, the overall diameter of the assembly is determined by the inside diameter of the well casing. That is, the outside diameter of the pump assembly must be sufficiently smaller than the inside diameter of the casing to provide clearance for conveniently inserting the pump into the casing. In an assembly of predetermined overall diameter, however, it is highly desirable to use impellers with a diameter as large as possible to obtain maximum pressure increase within each stage of the pump.

As disclosed in the above patent, the multi-stage pump includes a plurality of cup-like pump cases each of which encloses a plastic molded impeller having a bottom inlet. A plastic molded diffuser is attached to each case and has diffusing vanes for directing the discharged flow of water from one impeller to the inlet of the next impeller thereabove while converting the velocity head into pressure head. The cases are retained in their stacked relation by a series of axially extending tie bolts which sandwich the cases between the lower intake housing mounted on the motor and the upper discharge housing connected to the lower end of a discharge pipe.

It is desirable to protect the motor leads extending downwardly along the outer surface of the pump from rubbing against the inner surface of the well casing. As shown in the above patent, the leads are commonly protected by an elongated shield which is attached to the outer surface of the pump. Another way of protecting the leads is to confine all of them within an axially extending slot formed within the pump cases and surround the cases with a cylindrical metal shell as disclosed in Patent No. 2,667,128, also assigned to the assignee of the present invention.

Summary of the invention

The present invention is directed to an improved submersible pump of the type outlined above, and which particularly provides for using maximum diameter impellers within a pump assembly of predetermined overall diameter for obtaining optimum pump performance, and which also provides for protecting the power supply leads extending to the motor. In accordance with a preferred embodiment of the invention, each pump case is constructed of a suitably rigid plastic and includes a radial wall having a central inlet opening and a generally cylindrical outer wall of substantially uniform thickness. The outer wall has a series of uniformly spaced axially extending depressions which define external grooves or slots each of sufficient size to receive a single motor lead. Thus on a pump assembly wherein the motor has an internal starting switch, only two of the slots are used for motor leads, whereas in a unit having a remote relay-type starting switch, three or four of the slots may be used. Thus the motor leads are separately inserted within the slots and are protected along with the plastic pump cases by a cylindrical metal shell surrounding the cases.

A diffuser is positioned within each case and includes a series of peripherally spaced overlapping vanes which project axially from a radial wall to form a volute-shaped radially diffusing passageway between each pair of adjacent depressions or slots within the corresponding case. These passageways are connected to corresponding generally radially extending diffusing passageways defined between the radial wall of each case and the adjacent radial wall of the corresponding diffuser.

With each case and diffuser constructed in accordance with the invention, significantly larger diameter cases and impellers can be used within a pump of predetermined overall diameter so that maximum pressure increase can be obtained within each stage of the pump. Furthermore, the motor leads extending along the side of the pump are protected without any sacrifice in impeller diameter.

Other features and advantages of the invention will be apparent from the following description, the accompanying drawings and the appended claims.

Brief description of the drawings

FIG. 1 is an elevational view of a submersible pump constructed in accordance with the invention;

FIG. 2 is an enlarged fragmentary view of the pump in axial section generally on the line **2—2** of FIG. 3;

FIG. 3 is a radial section taken generally on the line **3—3** of FIG. 2;

FIG. 4 is a top view of one of the cases in the pump of FIGS. 1–3 with a portion broken away to show the top side of the diffuser mounted therein; and

FIG. 5 is a fragmentary bottom view of one of the diffusers in the pump of FIGS. 1–3.

Description of preferred embodiments

The submersible pump assembly shown in FIG. 1 generally includes a pump **10** of the multistage centrifugal type, a motor **12**, motor leads **14**, and an intake housing **15** (FIG. 2) which serves to connect the pump **10** rigidly to the motor **12**. A cylindrical screen **16** surrounds the intake housing **15** and serves to filter the water flowing into the pump **10**.

The motor **12** includes a cylindrical casing **20** connected to an upper bearing bracket **21** from which a shaft **22** projects upwardly into the intake housing **15**. The housing **15** includes a lower base portion **25** having a series of holes for receiving corresponding studs **26** projecting upwardly from the bearing bracket **21**. Nuts **27** and lock washers **28** secure the intake housing **15** rigidly to the bearing bracket **21**.

The intake housing **15** includes an upper flange portion **30** which is integrally connected to the base portion **25** by a series of axially extending ribs **31**, and the pump **10** includes an outer cylindrical shell **35** having its lower end seated on an external peripheral shoulder **36** formed on the flange portion **30**. The pump shell **35** is rigidly secured to the intake housing **15** by a series of screws **37** which project through axially extending holes formed within the flange **30** and engage corresponding square nuts **38** projecting outwardly into corresponding openings **39** formed within the lower end portion of the shell. Tightening of the screws **37** draws the lower end of the shell **35** firmly against the shoulder **36** of the intake housing.

Referring to FIGS. 2 and 3, a plurality of cup-shaped pump cases **45** are arranged in stacked relation within the pump shell **35** with the lower case seated on the upper flange portion **30** of the intake housing **15**. Each case **45** is molded from a rigid plastic material and includes a radial wall **46** (FIGS. 2 and 4) having a central opening defined by a cylindrical lip **48** of a sheet metal ring inserted into the mold prior to molding the case.

The generally cylindrical outer wall **50** of each case **45** is of uniform thickness and provided with a series of uniformly spaced axially extending depressions or U-shaped portions **51** each defining a corresponding U-shaped slot **52**. As shown in FIG. 3, each slot **52** has a depth approximately equal to the diameter of a motor lead **14**. Referring to FIG. 2, two motor leads **14** extend upwardly from the motor **12** within two of the slots **52** and are retained therein by the pump shell **35**. As mentioned above, when additional leads are required for the motor **20**, additional slots **52** are used so that only one lead is confined within each slot.

A peripheral step or shoulder **55** (FIG. 2) is formed within the upper end portion of each case **45**, and the shoulder extends around each of the U-shaped portions **51** so that the cases **45** nest together in a positive interfitting aligned relation and are thereby prevented from rotating relative to each other. As mentioned above, the slots **52** are uniformly spaced within the outer wall **50** of each case **45**, and thus the cases can be stacked without any particular orientation except for the aligning of the slots **52**.

A diffuser **60** molded of rigid plastic is mounted within each of the pump cases **45** and includes a radial wall **62** which is spaced from the radial case wall **46** by a series of V-shaped ribs **63** cooperating with the radial walls **46** and **62** to define a plurality of generally radially extending uniformly arranged passageways **65** (FIG. 4). The passageways **65** increase in cross-sectional area towards the center to provide further diffusion of velocity head into pressure head. A central opening **66** (FIG. 4) is formed within the radial wall **62** of each diffuser **60** by the cylindrical lip **67** of a sheet metal ring inserted within the mold prior to molding the diffuser. The lip **67** is concentric with the lip **48** and is smaller in diameter to define an annular passageway **70**.

Referring to FIGS. 3 and 5, a series of uniformly spaced peripheral vanes **75** project downwardly from the radial wall **62** of each diffuser **60**. Each vane includes an outer portion **76** (FIG. 3) which is positioned between an adjacent pair of U-shaped portions **51** of the case outer wall **50** and a thinner integral lip portion **77** which is spaced radially inwardly from the portion **76** of the adjacent vane **75** to form a volute-shaped radial diffusing passageway **80** therebetween. Each vane **75** also includes an axially extending part-cylindrical surface **81** (FIG. 5) which receives the adjacent U-shaped portion **51** of the outer wall **50** and thereby prevents relative rotation of each diffuser **60** within its corresponding case **45**.

As shown in FIG. 5, there is a space **82** located between each adjacent pair of vanes **75** and adjacent the outer ends of each passageway **65** so that when each diffuser **60** is assembled into its corresponding case **45**, each space **82** forms an axially extending passageway or port **84** (FIG. 3) adjacent each of the U-shaped portions **51** of the diffuser outer wall **50**. The passageways **84** interconnect the outwardly diffusing passageways **80** with the corresponding inwardly diffusing passageways **65**.

A centrifugal impeller **85** is positioned within each of the pump cases **45** and has a cylindrical hub portion **86** which extends through the central opening **66** of the corresponding diffuser in close fitting relation to the cylindrical lip **67**. All of the impellers are mounted on a splined pump shaft **88** with the hub portions **86** in stacked relation, and the lower end of the pump shaft **88** is connected to the motor shaft **22** by a suitable coupling **90**. The upper end portion of the pump shaft **86** is rotatably supported by a bearing (not shown) supported within a discharge housing **92** secured to the upper end portion of the pump shell **35**.

As shown in FIG. 2, each impeller **85** includes a radial wall **95** projecting from its hub portion **86** and an annular radial wall **96** spaced from the wall **95** by a series of curved vanes **98**. A cylindrical wall **99** projects downwardly from the radial wall **96** of each impeller **85** into the opening defined by the cylindrical lip **48** projecting upwardly from the adjacent radial wall **46** of the corresponding case **45**. The wall **99** of each impeller cooperates with the hub portion **86** to define an annular inlet **100**.

In operation, the water flows through the cylindrical screen **16** surrounding the intake housing **15** and enters the inlet **100** of the lowermost impeller **85**. The water is discharged from this impeller into the volute-shaped diffusing passageways **80** and then flows axially through the ports **84** and radially inwardly through the diffusing passageways **65** to the inlet **100** of the next above impeller **85**. The water repeats this flow path through each successive stage of the pump causing a progressive increase in pressure until it is discharged through the discharge housing **92**.

From the drawings and the above description, it can be seen that a multi-stage submersible pump constructed in accordance with the invention provides several desirable features and advantages. For example, by forming the uniformly spaced small slots **52** within the pump cases **45** and separating the motor leads **14** with a single motor lead in each slot, the motor leads are encased by the cylindrical pump shell **35** and are thereby protected from being damaged when lowering the pump assembly into a well casing.

Furthermore, with the overlapping diffuser vanes **75** so arranged that the radially diffusing passageways **80** and corresponding ports **84** are positioned between the U-shaped outer wall portions **51** defining the slots **52**, the high velocity discharge of water from each impeller **85** is diffused to a lower velocity, higher pressure flow between the slots **52**. Thus the water discharged from each impeller is diffused and directed to the next adjacent stage in an annular area which is usually occupied by only the motor leads. As a result, the case and diffuser construction of the invention provide for using maximum diameter impellers so that maximum pressure increase can be obtained within each stage of the pump.

While the form of apparatus herein described constitutes a preferred embodiment of the invention, it is to be understood that the invention is not limited to this precise form of apparatus, and that changes may be made therein without departing from the scope of the invention which is defined in the appended claims.

What is claimed is:

1. In a submersible water pump assembly adapted to be lowered into a well casing and including an electric motor having a shaft projecting from one end, a multistage pump secured to said end of said motor and including a series of pump cases arranged in aligned stacked relation, each said case including a generally cylindrical outer wall, a centrifugal impeller positioned within each said case, and means connecting said impellers to said motor shaft, the improvement comprising means defining a plurality of generally axially extending peripherally spaced slots within said outer walls of said cases, diffuser means defining a corresponding plurality of diffusing pasageways located between said adjacent pair of said slots, and a plurality of power supply leads extending to said motor through a plurality of said slots to provide for using maximum diameter said cases and impellers within said well casings

for obtaining optimum pressure increase within each stage of said pump.

2. A pump assembly as defined in claim **1** wherein each said slot has a cross sectional area sufficient to receive only one of said leads.

3. A pump assembly as defined in claim **1** including a cylindrical shell surrounding said pump cases for protecting said cases and said leads within said slots.

4. A pump assembly as defined in claim **1** wherein said outer wall of each said pump case is substantially uniform in thickness and has a plurality of circumferentially spaced axially extending U-shaped portions projecting inwardly to define said slots, and said diffuser means comprising an annular diffuser disposed within each said case and having a plurality of peripherally paced vanes projecting outwardly between said U-shaped portions to define a corresponding plurality of radially diffusing said passageways between said slots.

5. A pump assembly as defined in claim **4** wherein said vanes of each said diffuser each includes means defining a cavity therein for receiving the adjacent said U-shaped portion of the corresponding said case to prevent relative rotation between each said diffuser and its corresponding said case.

6. A pump assembly as defined in claim **4** wherein said vanes of each said diffuser each includes integral first and second portions, said first portion of each said vane extending adjacent said outer wall between said U-shaped portions and radially overlapping said second portion of an adjacent said vane to define a volute-shaped said passageway.

7. A pump assembly as defined in claim **4** including means defining a corresponding plurality of peripheral spaced recesses within each said diffuser between said vanes for receiving said U-shaped portions of the corresponding said case, and each said recess forming a generally axially extending passageway adjacent one of said U-shaped portions and connected to the corresponding said radially diffusing passageway.

8. A pump assembly as defined in claim **7** including means defining a corresponding plurality of generally radially extending passageways within each said case connected to the coresponding said axially extending said passageways, and said latter passageways each having an increasing cross-sectional area in an inwardly direction to provide additional diffusing.

9. A pump assembly as defined in claim **4** wherein each said case and the corresponding said diffuser include an annular radial wall arranged in parallel spaced relation; and a plurality of V-shped ribs annularly arranged between each adjacent pair of corresponding said walls to define a corresponding plurality of generally radially extending diffusing passageways.

10. A pump assembly as defined in claim **4** including means defining a peripheral external shoulder extending around said outer wall and corresponding said U-shaped portions of each said case for receiving the adjacent said case in interfitting nested relation and thereby provide positive alignment of said cases.

11. A pump assembly as defined in claim **1** wherein said slots are uniformly spaced around the periphery of said cases.

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ROBERT M. WALKER, *Primary Examiner.*

U.S. Cl. X.R.

103—108; 310—87