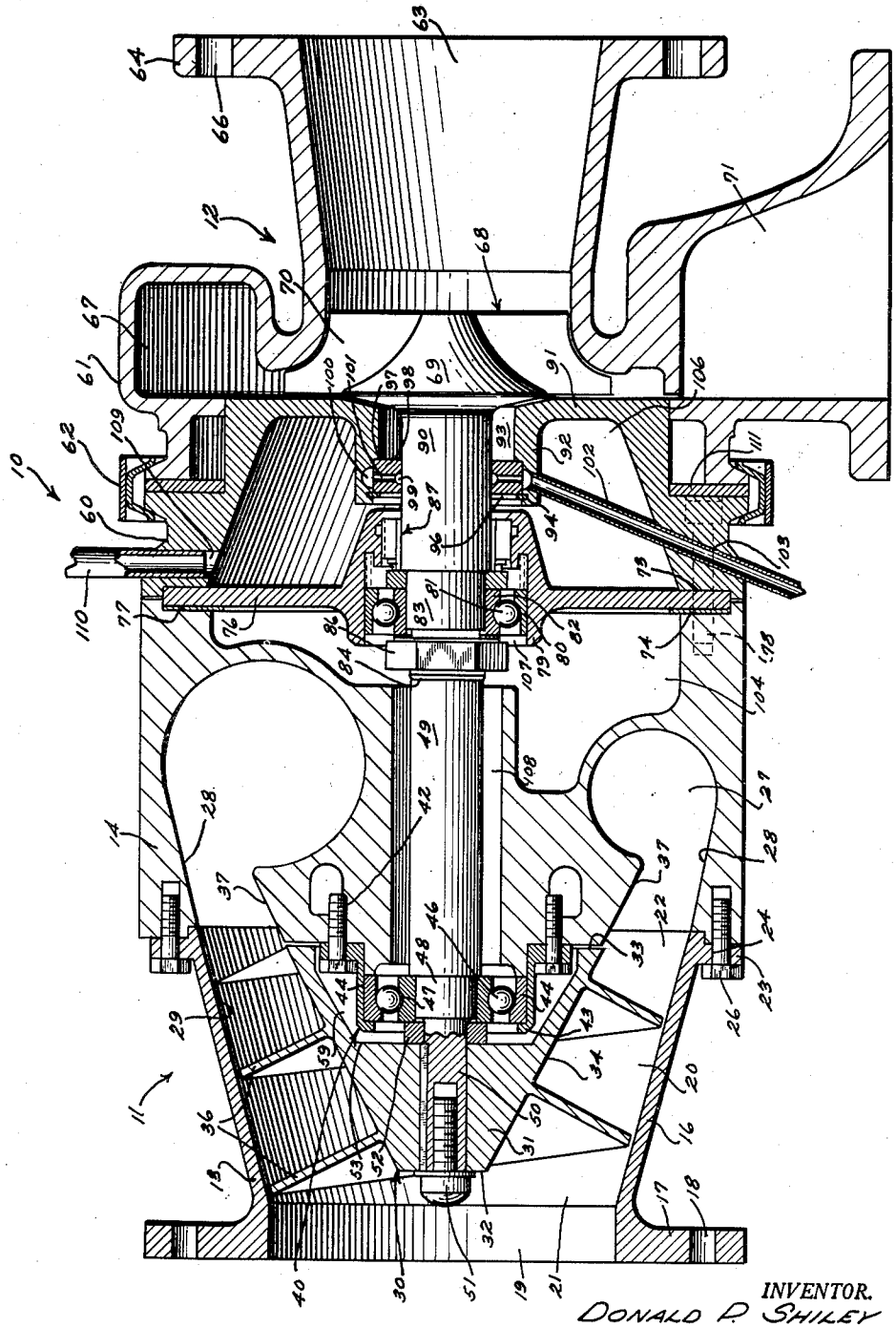
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TURBO PUMPING APPARATUS

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TURBO PUMPING APPARATUS

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This invention relates generally to pumping apparatus and more specifically relates to a pump including a conical pumping chamber with a voluted toroid at the large end of the pumping chamber arranged in tangential disposition with respect thereto whereby a conical screw vane impeller will effectively pressurize fluid in the pump under conditions of low suction and at high speed without cavitation.

It is an object of the present invention to provide a pumping apparatus which tolerates a low suction head at higher operating speeds.

Another object of the present invention is to provide a pumping apparatus which has an improved ability to operate under environmental conditions likely to produce increased quantities of vapor.

A further object of the present invention is to provide a pump which will overcome the centrifuging tendencies of most rotating dynamic type pumps and wherein the pump displays improved vapor swallowing ability.

Another object of the present invention is to provide a high speed pump which operates without objectionable cavitation.

Many other features, advantages and additional objects of the present invention will become manifest to those versed in the art upon making reference to the detailed description which follows and the accompanying sheet of drawings in which a preferred structural embodiment of a turbopump incorporating the principles of the present invention is shown by way of illustrative example.

On the drawings:

The single FIGURE of the drawings shows a cross-sectional view of a turbopump incorporating the principles of the present invention.

As shown on the drawings:

The turbopump of the present invention is shown generally at 10 and comprises a pumping unit shown generally at 11 and a motor for operating the pumping unit 11 which, in this particular embodiment, constitutes a turbine shown generally at 12.

The pumping unit 11 has a casing which comprises a plurality of fastened-together sections including an impeller casing 13 and a volute casing or housing 14.

The impeller casing or housing 13 has conical side walls 16 flanged as at 17 and apertured as at 18 to facilitate mounting to a suitable mounting pad. An inlet 19 is formed in the impeller housing 13 and the side walls 16 diverge outwardly away from the inlet, thereby to form a pumping chamber 20 having a small end 21 and a large end 22.

The impeller housing 13 is also flanged as at 23 which is, in turn, apertured as at 24 to accommodate a plurality of fasteners 26 for placing the impeller housing 13 in firm assembly with the volute housing 14.

The volute housing is formed with a volute 27 which constitutes a voluted toroid and which is particularly characterized by its tangential relation to the outside wall of the pumping chamber 20. In this regard, it will be noted the volute housing 14 is formed with a wall portion 28 which is disposed tangentially to the outside confines of the volute 27, which wall 28 is disposed in matching registry with the outside wall 29 of the pumping chamber 20 as provided in the impeller housing 13.

Disposed within the pumping chamber 20 is a generally conical impeller 30 having a hub 31 formed with a small end 32 and a large end 33 and conically tapered walls 34 having positioned thereon screw vanes shown at 36. The wall 34 thus extends in divergent relation to the small end 32 in the same general direction of divergence as the pumping chamber 20, however, it will be noted that the angle of the conical wall 34 is different than the angle of the wall 29 so that the cross-section of the annular space provided between the wall 29 and the wall 34 is actually convergent from the inlet end of the pump towards the large end of the pumping chamber as at 22.

In this connection, it will be noted that the volute housing 14 is formed with a wall 37 spaced inwardly of the wall 28 and disposed to lie in matching register with the wall 34 of the impeller 30. The wall 37 intersects the voluted toroid constituting the volute 27.

A bearing assembly shown generally at 40 includes a housing 41 connected in firm assembly to the volute housing 14 by a plurality of fasteners 42 and being flanged as at 43 to retain an outer race 44 of a ball bearing unit including a plurality of shiftable members 46 and an inner race 47. The inner race is engaged against a reduced section 48 of a shaft 49. The shaft 49 has a further reduced section as at 50 to which the hub 31 of the impeller 30 is connected by means of a fastener 51. A thrust washer 52 is interposed between a wall 53 formed at the bottom of a cavtiy 54 in the impeller 30, which cavity 54 is circumscribed by the side walls 34 of the impeller 30.

The tangential relationship between the voluted toroid 27 and the pumping chamber 20 appears to afford improved operating advantages which overcome the centrifuging tendencies of most rotating dynamic-type pumps so that the pump of the present invention displays extremely good vapor-swallowing ability.

Apparently the flow pattern established by the tangential relationship and the increase in the pumping chamber size results in a turbulence which occurs inside of the voluted toroid 27, thereby producing an improved bubble-swallowing action which results in the bubbles being placed back into solution.

In order to drive the pump of the present invention, a suitable motor means is provided which, in this form of the invention, includes the turbine 12. The turbine 12 includes a plurality of casing sections and there is provided a first casing section 60 and a second casing section 61 held together in firm assembly by a clamping mechanism shown generally at 62. The casing section 61 has a turbine inlet 63 flanged as at 64 and apertured as at 66 to facilitate mounting to a suitable structure.

The casing part 61 is also formed with a volute chamber 67 and a turbine wheel shown generally at 68 is rotatable in the volute chamber 67, the turbine wheel 68 including a hub 69 and a plurality of vanes 70.

Any suitable driving fluid may be used as a driving medium and the driving fluid from a source at increased pressure is supplied through the inlet 63 to drive the impeller 68, whereupon the spent fluid is exhausted through the volute 67 and an outlet shown at 71.

The casing section 60 is formed with a notched recess 73 and the volute housing 14 is likewise formed with a notched recess 74. Inserted within the notched recesses 73 and 74 and extending across the casing construction provided by the volute housing 14 and the casing section 60 is a partition member 76. A heat dam 77 comprising a gasket of thermal insulating material is also interposed between the partition 76 and the volute housing 14, thereby to retard the transfer of thermal energy between the casing and housing parts. The volute housing 14 and the casing sections 60 are retained in firm assembly

with one another by a plurality of fasteners shown generally at **78**.

The partition **76** has an enlarged center boss **79** in which is carried an outer race **80** of a ball bearing assembly including a plurality of shiftable members **81** and an inner race **82** carried on a bearing section **83** of the shaft **49**. The shaft **49** is threaded as at **84** and receives a fastening nut **86** which abuts against the inner race **82** to assist in retaining the assembly. A shaft seal shown generally at **87** is also contained within the boss **79** and effects a seal against the peripheral surface **90** of the shaft **49**.

The casing section **60** is further provided with a radially inwardly extending wall **91** terminating in an axial boss **92** having an enlarged axial opening **93**. The boss **92** is recessed as at **94** to receive a retaining ring **96**. Retained within the boss **92** by the ring **94** and a shoulder **97** is a slipper-type seal shown generally at **98**. The slipper-type seal has an annular recess **99** formed therein which is communicated with an annular recess **100** formed in the boss **92** by a plurality of radially extending apertures **101**. A gaseous fluid purge, for example, a helium gas purge, can be effected by connecting a passage-forming conduit **102** to the boss **92** at the recess **100**, which conduit **102** is directed to the outside of the pump through the casing section **60**, as shown at **103**.

It will be noted that the volute housing **14** is cored out to form a recess **104**, while the casing section **60** is likewise cored out to form a recess **106**. Thus, the recess **104** and the recess **106** together form a plenum chamber communicating with the bearing assembly **80**, **81**, **82** via an opening **107** formed in the boss **79**. Moreover, the volute housing **14** is provided with an enlarged through opening **108** which extends between the bearing assembly **40** and the recess **104** or plenum chamber. The gaseous fluid present in the plenum chamber **104** through leakage is available to lubricate the bearing assemblies. In this regard the casing section **60** has an opening **109** formed therein which receives a venting conduit **110** by means of which a gaseous lubricating fluid may be vented from the plenum chamber **104**, **106** for insuring a flow of the fluid which has had lubricating contact with the bearing assemblies.

A heat dam made of thermally conductive material also be interposed between the casing section **60** and the casing section **61** and a suitable washer constituting such a heat dam is shown at **111**. Accordingly, the partition **76** as well as the washer **74** and the washer **111** operate as heat dams to retard the transfer of thermal energy between the pump unit **11** and the turbine unit **12** when in operation.

Although minor modifications might be suggested by those versed in the art, it should be understood that I wish to embody within the scope of the patent warranted hereon all such modifications as reasonably and properly come within the scope of my contribution to the art.

I claim as my invention:

1. A pump comprising
an impeller casing having
conical side walls disposed at an angle with respect to the impeller axis of rotation and converging toward a center inlet at one end of said impeller casing,
a pump shaft in said casing having
a hub carrying
rotatable screw vanes in said impeller casing, the angle between said screw vanes and the center line of the pump shaft being such that at flows on or about rated flow the separation forces tending to separate fluid and vapor approach zero,
whereby bubbles of vapor will tend to maintain a constant spacing from the impeller casing,
a volute casing at the discharge end of said impeller casing,
said volute casing having a toroidal volute formed therein and including
an impeller discharge passage formed with an inside wall disposed to lie in matching register with said hub and intersecting said volute,
thereby making the minimum diameter of the volute smaller than the diameter of the impeller hub at the impeller discharge,
the outside wall of said impeller casing and an outside wall of said impeller discharge passage being tangent to said volute,
whereby vapor is swept out of the volute by a moving stream of liquid.

2. A pump as defined in claim 1,
a turbine connected to said impeller casing,
a turbine wheel in said turbine having a shaft connected to said hub,
casing means forming a plenum between said turbine and said pump,
means forming a partition extending across said plenum and including bearing means disposed between the inner portions of said partition and said shaft,
and means to leak a lubricant fluid into said plenum for lubricating the bearings,
said casing means having a boss formed therein surrounding said shaft,
a slipper-type seal in said boss engaging said shaft,
and passage forming means in said casing means and at said boss for flushing said slipper-type seal with a purging fluid.

3. A pump as defined in claim 1,
a turbine connected to said impeller casing,
a turbine wheel in said turbine having a shaft connected to said hub,
casing means between said turbine and said pump,
said casing means having a boss formed therein surrounding said shaft,
a slipper-type seal in said boss engaging said shaft,
and passage-forming means in said casing means and at said boss for flushing said slipper-type seal with a purging fluid.

4. A pump as defined in claim 2, and
heat dams made of thermal insulating material inserted in said casing means to retard transfer of thermal energy from the turbine to the pump.

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