

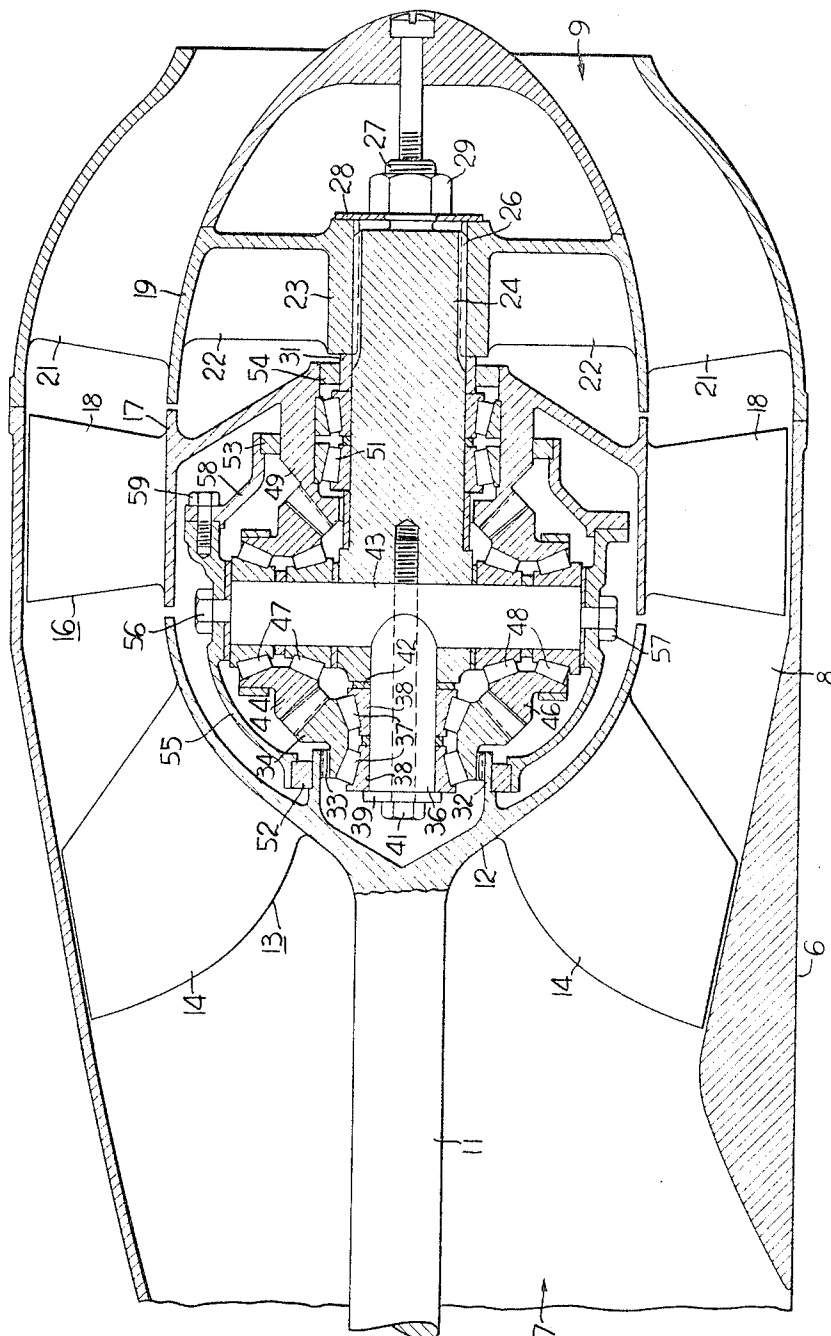
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POWER TRAIN FOR JET PROPELLED WATER CRAFT

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POWER TRAIN FOR JET PROPELLED WATER CRAFT

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This invention pertains to a multistage pump for supplying jet propulsion to a water craft and more particularly to the power train supplying torque to the individual pump stages.

In designing a jet propulsion unit for a boat, the following four results are desirable: (1) the boat must have sufficient initial thrust from a standstill position to pull a water skier out of the water; (2) the boat must be capable of obtaining reasonably high speeds to satisfy the desires of the boat buying public; (3) the propulsion means must be reasonably efficient; and (4) the propulsion means must be reasonably small so as not to require excessive space.

The first two of the above listed requirements can be satisfied if a large amount of water is pushed through a water confining passage at a high velocity. However, at standstill there is no ram effect due to motion of the boat; consequently, the specific energy available at the suction of the propulsion unit is low. Therefore, a mixed flow non-cavitating impeller is required to provide the initial thrust to the boat. Also, if the boat is of reasonably large size two pump stages are required. A two stage pump also satisfies the requirements of reasonably high boat speed, requirement (2), and reasonable efficiency, requirement (3). Requirement (4) is best served by using an axial flow impeller as the second stage impeller, and it is further served by making this axial flow second stage impeller rotate counter to the mixed flow first stage impeller. If these two impellers rotate in their respective opposite directions at the same speed, and if they are designed to absorb the same torque, the off flow from the two stage propulsion unit will be essentially axial. Therefore, counterrotation eliminates the need for diffuser blading between the first and second stages and aft of the second stage, greatly reducing the axial length of the propulsion pump.

It is, therefore, a general object of the invention to provide a jet propulsion means for a water craft having both a mixed flow impeller and an axial flow impeller.

An additional object of the subject invention is to provide a propulsion system for a water craft of the hereinbefore described type wherein the two impellers rotate in opposite directions.

An additional object of the subject invention is to provide a propulsion system for a water craft of the hereinbefore described type wherein the power train for imparting torque to the impellers is extremely compact.

An additional object of the subject invention is to provide a propulsion means for a water craft of the hereinbefore described type with torque transmitting means between the impellers which is adequately sealed from the water.

These and other objects of the subject invention will become more fully apparent as the following description is read in light of the attached drawing, wherein:

The figure is a cross sectional view of a propulsion means for a water craft constructed in accordance with one modification of the invention.

Referring to the drawing, the lower portion of the water craft may be utilized as the outer wall 6 of a water confining passageway 8. The inlet end 7 of the water confining passageway 8 is constructed to receive water from an opening (not shown) in the bottom of the boat.

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The discharge end 9 of the water confining passageway converges to provide a nozzle for the water jet.

In this particular embodiment, a drive shaft 11 connected to a power means such as a gasoline engine (not shown) may be provided with an annular hub 12 integrally formed at the end thereof. The hub 12 is in effect the hub of a mixed flow impeller 13 having a plurality of conventional mixed flow vanes 14 attached thereto in circumferentially spaced relative relationship. An axial flow impeller 16 having a hub 17 is positioned in downstream relation to the mixed flow impeller 13. The axial flow impeller 16 has a plurality of circumferentially spaced vanes 18 attached thereto.

A discharge end 9 of the propulsion means is provided with a streamlined hub 19. Also provided in the discharge end are a series of circumferentially spaced streamlined struts 21. These struts are rigidly connected to the outer wall 6 of the water confining passageway 8. Connected to the inner ends of the struts 21 may be a plurality of radially disposed support ribs designed 22. A hub 23 which may be integrally formed with the ribs 22 supports a horizontally disposed main shaft 24. This shaft 24 may be connected to the hub 23 in any conventional manner and is herein shown as having a splined connection 26 to prevent relative rotation therebetween. For purposes of illustration, the hub and shaft are held against relative axial movement by means of a stud 27 threaded into one end of the shaft 24. A thrust washer 28 is rigidly held against one end of the hub 23 by means of a nut 29. The shaft and hub may be held against relative axial movement in the opposite direction by means of a collar 31 rigidly connected to the shaft 24 on the other side of the hub 23.

In order to provide rotation to the impeller 16, the drive shaft 11 may be provided with an annular sleeve 32 having internal splines 33 thereon. An externally splined hub on a bevel gear 34 is received within the splines 33 of the sleeve 32. The bevel gear 34 may be supported for rotation on a reduced portion 36 of the main shaft 24 by means of tapered roller bearings 37. An inner race 38 of the roller bearings 37 is held on the reduced shaft portion 36 by means of a thrust washer 39 fastened to the end of the shaft 36 by means of a bolt 41. The other end of the inner race may be held against axial movement by means of a shoulder 42 provided at the end of the reduced shaft portion 36.

A countershaft 43 is rigidly connected to the main shaft 24 in any conventional manner and is disposed in transverse relation thereto. A pair of spaced bevel idler gears 44 and 46 are rotatably connected to the countershaft 43 in any conventional manner such as by the tapered roller bearings 47 and 48 respectively. The bevel gears 44 and 46 are in mesh with and driven by the drive gear 34. A driven gear 49 may be formed integrally with the hub 17 of the axial impeller 18. This hub is provided with gear teeth in mesh with and driven by the idler bevel gears 44 and 46. The driven gear 49 is rotatably supported on the main shaft 24 in any conventional manner such as by tapered roller bearings 51. The torque transmitting mechanism described provides rotation in one direction to the mixed flow impeller 13 and opposite rotation to the axial flow impeller 16. This opposite rotation of the two impellers is accomplished by a single set of idler gears because the idler gears rotate in planes disposed at right angles to the planes of the drive and driven gears.

The torque transmitting mechanism including the bearings and gears are sealed from the water flowing through the propulsion means by the annular mechanical seals 52, 53 and 54. The seal 52 is supported in an annular opening provided in the end of the annular seal housing

55 and is held in water sealing engagement with the outer peripheral surface of the annular sleeve 32. The seal housing 55 is releasably connected to opposite ends of the countershaft 43 in any convenient manner such as by bolts 56 and 57. The seal housing 55 may be constructed in one unit; however, it is herein shown as comprising an additional annular end housing 58 to assist in assembly of the torque transmitting mechanism. The end housing 58 may be connected to the seal housing 55 in any conventional manner and is herein shown as being connected thereto by means of circumferentially spaced bolts 59 threaded into tapped holes provided in a flange at the end of the seal housing 55. The end housing 58 is sealed to the hub of the driven gear 49 by the seal 53. The bearing 51 is sealed from the water by the seal 54 placed between the impeller hub 17 and the collar 31.

From the above description it can be seen that a very compact and novel propulsion means have been provided. The torque transmitting mechanism provides opposite rotation to both impellers in a minimum amount of space. Furthermore, the seal housing arrangement provides adequate protection of the torque mechanism from the water flowing through the restricted passage in a very uncomplicated manner.

With this pump arrangement, the desirable low speed characteristics of the mixed flow impeller are utilized to provide the boat with a quick starting characteristic and the axial flow impeller provides the boat with the desirable high speed characteristics. With this arrangement applicant has devised a propulsion means which satisfies the four requirements mentioned at the beginning of this description. That is, (1) the boat must have sufficient initial thrust from a standstill position to pull a water skier out of the water. This requirement is satisfied by the two stage pump having a mixed flow impeller for the first stage.

(2) and (3) The boat must be capable of obtaining reasonably high speeds to satisfy the desires of the boat buying public and must accomplish this with reasonable efficiency. These requirements are satisfied by both the mixed flow impeller and especially the axial flow impeller which is most efficient at high speeds when sufficient water is being forced to the axial impeller.

(4) The propulsion means must be reasonably small so as not to require excessive space. This requirement is satisfied by the novel arrangement of the torque transmitting mechanism which provides opposite rotation to the two impeller units in a small and water sealed space. With this arrangement, of oppositely rotating impellers, it is not necessary to provide diffuser vanes between the impellers.

Although only one embodiment of the subject invention has been herein shown and described, it will be obvious to those skilled in the art that other modifications are possible without departing from the spirit of this invention, and such other modifications as come within a reasonable interpretation of the appended claims are intended to be covered.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A propulsion means for a water craft comprising: walls defining a water confining passage having an inlet end and a discharge end; a first pump impeller disposed within said passage for drawing water therein through said inlet end; a drive shaft connected to said first impeller for rotating same in one direction; a main shaft; means rigidly supporting said main shaft in axial alignment with said drive shaft; a driven gear rotatably supported on said main shaft; a second impeller positioned within said passage in downstream relation to said first impeller and connected to said driven gear for rotation

therewith; a drive gear rotatably supported on said main shaft in axially spaced relation to said driven gear and connected for rotation with said drive shaft; and means providing a torque transmitting connection between said drive and driven gears including a transversely extending countershaft supported by said main shaft between said drive and driven gears and having an idler gear rotatably supported by said countershaft in torque transmitting engagement with both said drive and driven gears.

2. A propulsion means for a water craft comprising: walls defining a water confining passage having an inlet end and a discharge end; a first pump impeller disposed within said passage for drawing water into said passage through said inlet end; a drive shaft connected to said first impeller for rotating same in one direction; a plurality of circumferentially spaced radially directed support means connected to the inner periphery of said passage adjacent said discharge end; a main shaft rigidly supported by said support means in axial alignment with said drive shaft; a driven gear supported for rotation on said main shaft; a second impeller positioned within said passage between said first impeller and said flow vanes and connected to said driven gear for rotation therewith; a drive gear rotatably supported on said main shaft in axially spaced relation to said driven gear and connected for rotation with said drive shaft; and means providing a torque transmitting connection between said drive and driven gears including a transversely extending countershaft supported by said main shaft between said drive and driven gears and an idler gear rotatably supported by said countershaft in torque transmitting engagement with both said drive and driven gears.

3. A propulsion means for a water craft comprising: walls defining a water confining passage having an inlet end and a discharge end; a first pump impeller disposed within said passage for drawing water into said passage through said inlet end; a drive shaft connected to said first impeller for rotating same in one direction; a main shaft; means rigidly supporting said main shaft in axial alignment with said drive shaft; a driven gear rotatably supported on said main shaft; a second impeller positioned within said passage in downstream relation to said first impeller and connected to said driven gear for rotation therewith; a drive gear rotatably supported on said main shaft in axially spaced relation to said driven gear and connected for rotation with said drive shaft; means providing a torque transmitting connection between said drive and driven gears including a transversely extending countershaft supported by said main shaft between said drive and driven gears and an idler gear rotatably supported by said countershaft in torque transmitting engagement with both said drive and driven gears; and a seal housing releasably connected to opposite ends of said countershaft and enclosing said drive, driven and idler gearing, said housing having bores in the opposite ends thereof, one end bore providing a fluid seal about said drive shaft and the opposite end bore providing a fluid seal about said main shaft.

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