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3,098,464

PROPULSION UNIT FOR SHALLOW DRAFT BOATS OR THE LIKE

Filed April 10, 1962

2 Sheets-Sheet 1

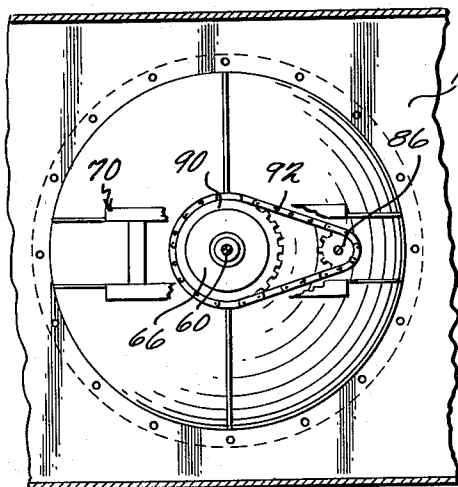
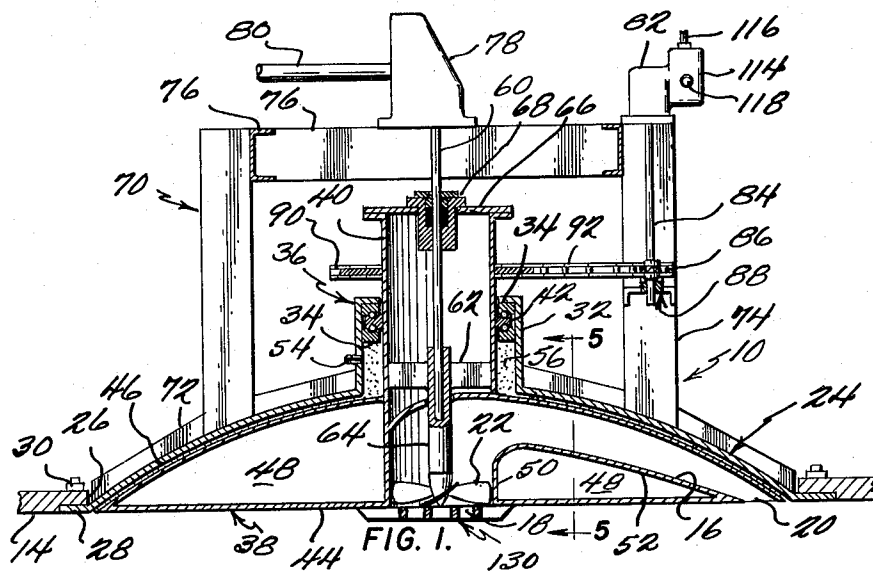


FIG. 3.

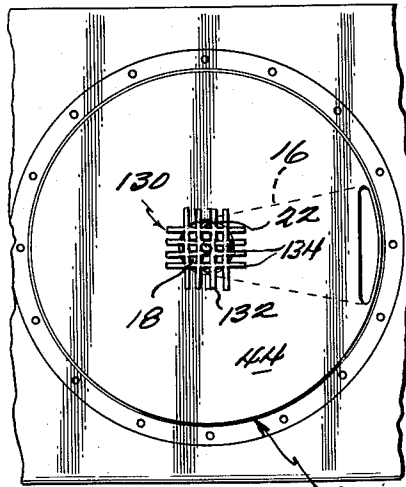


FIG. 4.

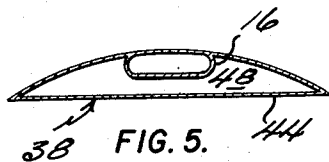


FIG. 5.

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2 Sheets-Sheet 2

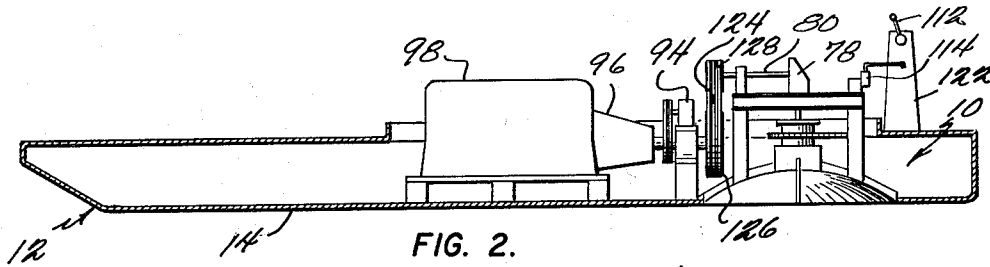


FIG. 2.

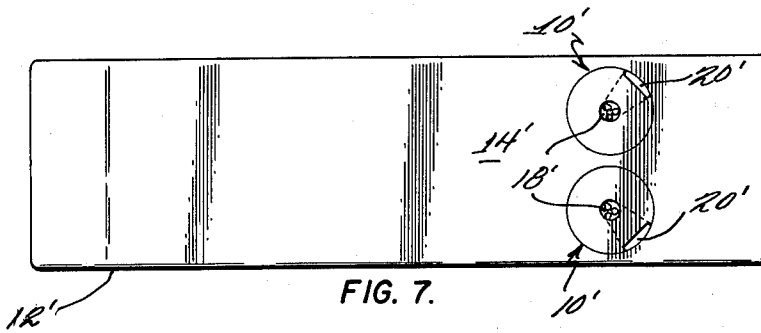


FIG. 7.

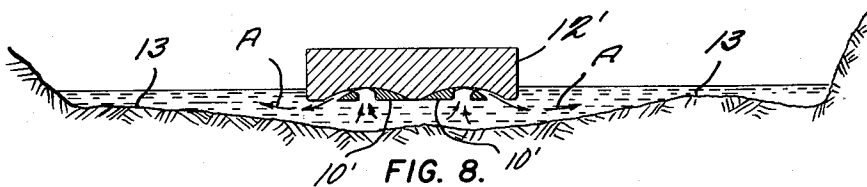


FIG. 8.

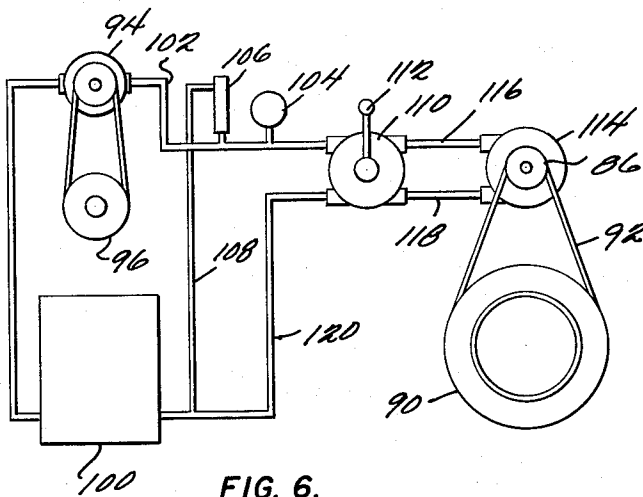


FIG. 6.

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## PROPULSION UNIT FOR SHALLOW DRAFT BOATS OR THE LIKE

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Filed Apr. 10, 1962, Ser. No. 186,422  
14 Claims. (Cl. 115-16)

The present invention relates to a propulsion unit for marine vessels, and, more particularly, to a steerable propulsion unit for use in shallow draft boats or the like wherein mass movement of water at an efficient rate to impart maximum thrust at a low rate of speed is obtained.

Heretofore efforts have been made to increase the thrust at low rates of speed for tow boats, landing craft and the like, especially where the marine vessel is operating in shallow channels or is used where it must be beached. One such prior system used in tow boats or the like having screw propellers is known as the "Kort Nozzle System" wherein the screw propeller operates in a cylindrical tube or nozzle. The "Kort" system decreases the tendency of the screw race to spread and provides increased towing efficiency, particularly at high slips. However, the heretofore propulsion units utilizing the "Kort" system have been the conventional type wherein the propeller rotates on a horizontal or substantially horizontal axis and, therefore, the minimum draft of the vessel was at least determined by the diameter of the propeller as the propeller had to be completely submerged in the water to operate efficiently. Another system considered for propelling shallow draft vessels is known as the "Voith-Schneider Propulsion System" which consists of a rotor mounted for rotation on a vertical axis and located under water at the stern of the vessel. The rotor was provided with a plurality of vertically extending impeller blades arranged around its periphery, the angle of attack of the impeller blades being controlled during rotation of the rotor in order to effect thrust in a desired direction. Such a system was effective for propulsion at slow speeds and steering but since the rotor and the impeller blades had to be exposed, it was necessary to arrange the same above the bottom of the hull but beneath the water line. Here again the minimum draft of the vessel was determined by the vertical length of the impeller blades mounted about the periphery of the rotor. Also, such a system had the danger of becoming fouled with debris or foreign material especially when the vessel was operating in extremely shallow water.

More recently, propulsion units have been designed utilizing the principle of propelling by a jet thrust of the water drawn into centrifugal pumps and discharged through nozzles or the like extending beneath the bottom of the vessels. In such systems, the impellers for the pumps were located at a distance from the inlet and, therefore, the draft of the vessel had to be at least equal to the distance between the impeller for the pump and the inlet opening in order that the pump could be properly primed. Further, the arrangements heretofore designed provided either or both the inlets and outlets in vertical or angular planes and with the inlets and outlets arranged at different elevations. Thus, in extremely shallow water a seal of both inlet and outlet oftentimes could not be maintained and thus the pump could not maintain its suction.

An important object of the present invention is to provide a propulsion unit for shallow draft marine vessels which moves a large volume of water at a relatively low velocity, thus giving more thrust and efficiency for operation of the vessel at slow speeds.

Another important object of the present invention is to provide a propulsion unit for shallow draft vessels in which the inlet and outlet for the channel of water used

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to provide a propulsion jet lie in the same plane flush with the bottom of the vessel.

Still another object of the present invention is to provide a propulsion unit utilizing an axial flow propeller of large diameter rotatable on a vertical axis, the propeller rotating substantially in the plane of an inlet opening in the bottom of the vessel and the channel communicating with the inlet opening having an outlet opening also in the same plane as the inlet opening.

A still further object of the present invention is to provide a jet propulsion unit for a shallow draft boat having substantially a flat bottom, the jet propulsion unit being capable of swinging through a full 360° to thereby achieve maneuverability and, further, the jet propulsion unit having no portion extending below the bottom of the boat where it could be damaged by obstructions in the water or increase the drag on the boat.

A still further object of the present invention is to provide a jet propulsion unit for shallow draft boats which is made of a malleable steel rather than a cast material thereby decreasing the chances of damage due to explosive shock waves when the boat is used in military operations or damage from contact with obstructions in the water during normal use or military use.

Still another object of the present invention is to provide a shallow draft vessel capable of use as a military landing craft or as a tow boat in water where the bottom of the boat is likely to engage the beach or the bottom, the boat being provided with jet propulsion units which can be utilized for a dredging operation to clear a channel as the boat moves along or which can be utilized to facilitate the floating of the boat should it become grounded.

Another object of the present invention is to provide a jet propulsion unit for a shallow draft boat having means coacting with the propeller for providing a shearing action to any seaweeds or obstructions which tend to enter the intake thereof.

A further object of the present invention is to provide a propulsion unit which is at least partially buoyant.

These and other objects and advantages of the present invention will appear more fully in the following specification, claims and drawings in which:

FIGURE 1 is a vertical sectional view through the propulsion unit of the present invention, the propulsion unit being illustrated installed in the bottom of the boat;

FIGURE 2 is a longitudinal sectional view through a shallow draft boat and illustrating in elevation the propulsion unit installed in the boat;

FIGURE 3 is a plan view looking from above and showing the propulsion unit in the boat, portions of the propulsion unit being omitted for purposes of clarity;

FIGURE 4 is a bottom plan view of the propulsion unit of FIGURE 1;

FIGURE 5 is a sectional view of the second or inner housing taken substantially on the line 5-5 of FIGURE 1;

FIGURE 6 is a schematic diagram of the hydraulic steering control for the boat of the present invention;

FIGURE 7 is a bottom plan view of a modified form of boat and illustrating a pair of propulsion units mounted on opposite sides of the longitudinal axis of the boat; and

FIGURE 8 is a diagrammatic view of a cross-section of the boat of FIGURE 7 and illustrating the use of the propulsion units to perform a dredging operation.

Referring now to the drawings and, in particular, to FIGURES 1 and 2, the propulsion unit of the present invention is generally designated by the numeral 10 and is illustratedly mounted in a shallow draft boat 12 having a substantially flat bottom 14. Generally the propulsion unit 10 comprises a duct 16 having a planar inlet 18 and

a planar outlet 20 both lying in the same horizontal plane and in the horizontal plane of the bottom 14 of boat 12. An axial flow propeller 22 is mounted for rotation on a vertical axis in the inlet opening 18 as will be explained in more detail later in the specification. The propulsion unit 10 is arranged to rotate 360° on an axis coincident with the axis of rotation of the propeller 22 so that the outlet opening 20 can direct the stream of jet water in any desired direction for steering the boat.

Water is drawn through the inlet 18 by the propeller 22 and is converted into thrust through the duct 16 and discharged through the opening 20. By having the outlet opening 20 of same area as the inlet opening 18 and further by having the cross-sectional area of the duct 16 at any point therethrough substantially equal to the area of the inlet opening 18 and the outlet opening 20, the propeller 22 rotating at a slow speed can transfer water through the duct 16 and convert it into energy so that a maximum thrust can be obtained. The inlet is made sufficiently large, for example, three feet in diameter, so that an extremely large propeller can be installed to move a large mass of water. By maintaining the large cross-sectional area throughout the duct and at the discharge opening with no restriction in the duct, there is no harmful nozzle or Venturi effect to increase velocity in the flow of water through the duct. A nozzling effect is harmful in towboats or the like as it increases the velocity of water and places a greater demand on the energy of input and, therefore, is inefficient except at high speeds.

The arrangement of the present invention shown in FIGURE 1 utilizes the "Kort" effect of propulsion in that by placing the axial flow propeller in the channel of duct 16 with the diameter of the propeller slightly less than the diameter of the duct 16 at its inlet, the tendency of the water being transferred through the propeller to spread is decreased to a minimum and, because the arrangement of the duct 16 is such that there is but one change of direction of the water flowing therethrough, there is very little loss of energy as compared to energy loss from a plurality of changes in direction.

In more detail, the propulsion unit 10 includes an inverted dish-shaped or concave outer housing 24 supported in an enlarged opening 26 provided in the flat bottom 14 of the boat 12. Bolts 30 extending through a flat peripheral flange rim 28 on the housing 24 and through the bottom 14 of the boat 12 detachably support a propulsion unit 10 in place. The outer housing 24 is provided with a vertically extending stem 32 which fixedly carries at its upper end the outer races 34 of a ball bearing 36.

A hollow, inner semi-spherical housing 38, complementary in shape to the concave portion of the outer housing 24 is supported within the outer housing for adjustable rotation 360° about a vertical axis. In more detail, the hollow housing 38 is provided with a stem 40 which telescopes through and out of the stem 32. Stem 40 fixedly carries an inner race 42 for the ball bearing 36 and thus the inner housing 38 is supported within the outer housing 24.

As best shown in FIGURES 1 and 4, the inner housing 38 carries the duct 16 which communicates with the circular planar inlet opening 18 at one end thereof and the elongated planar outlet opening 20 at the other end thereof. The housing 38, which is hollow, is provided with a flat bottom portion 44 and an inverted dish-shaped or concave portion 46. The space between the concave portion 46 and the flat bottom portion 44 other than where the duct 16 and stem 40 extend provides an air chamber 48 which effectively lightens the propulsion unit 10 and makes the same at least partially buoyant. Of course, the inner housing 38 could be made in other shapes to support the duct 16, but it is preferably hollow, as described above, so that it will assist in the buoyancy of the boat 12. The bottom portion 44 of the inner housing is made of a malleable steel in order that it can assume shocks from striking objects in the water or

concussion shocks from explosives. It is also desirable that the top portion 46, the duct 16, as well as the outer housing 24 be made of a malleable steel especially when the boat is intended for military uses.

The duct 16, as previously mentioned, has the same cross-sectional area throughout its length although its configuration changes from a circular configuration at the inlet opening 18 to an elongated flattened shape at the outlet opening 20, the elongated flattened outlet opening having a major axis extending radially of the bottom 44 of housing 38. It is only necessary to provide the duct 16 with a short vertical portion 50 and then gently curve the same and extend it radially and at an acute angle to the planar outlet opening 20. By such an arrangement the flow of water caused by rotation of the propeller 22 does not lose too much energy when changing from the vertical to the radial direction. By making the portion 52 of the duct extend at an acute angle to the outlet opening 20, the outlet opening may be arranged horizontally in the bottom 38 as the water flowing through the duct 16 is given a proper vector for distributing the thrust developed by the movement of the water by the propeller 22.

The stem 32 of the outer housing 24 is provided with a fitting 54 through which a waterproof grease 56 is pumped into the annulus provided between the concentric stems 32 and 40. The waterproof grease 56 provides a lubricant between the rotatably adjustable inner housing 38 and the stationary outer housing 24 as well as a means for preventing water from passing upwardly between the two housing past the bearing 36.

The propeller 22 is supported on the lower end of a vertical drive shaft 60 which extends through the stem 40 and duct 16. A spider 62 provided within stem 40 carries a water-lubricated bearing 64 which supports the lower end of the shaft 60. The upper end of the stem 40 is provided with a water-tight top or cover plate 66 having a waterproof stuffing box 68 therein and through which drive shaft 60 extends.

A frame structure 70 comprising arcuate shaped angle members 72, vertical members 74 and cross members 76 is fixedly secured to the upper side of the stationary outer housing 24. Frame structure 70 is adapted to support a gear box 78 having bevel gears therein respectively carried on the upper end of the drive shaft 60 and on an end of jack shaft 80. Also supported on the frame structure 70 is a reduction gear unit 82 having a shaft 84 extending vertically downwardly therefrom. The shaft 84 is provided with a sprocket 86 at its lower end just above a bearing 88 suitably supported in the frame structure 70. An enlarged sprocket 90 fixedly supported on the portion of the stem 40 above the uppermost end of the stem 32 has an endless chain 92 extending therearound as well as around the sprocket 86. It will now be apparent that rotation of the vertical shaft 84 will cause the entire inner housing 38 to rotate on a vertical axis, the axis being coincident with the axis of rotation of the drive shaft 60 for propeller 22.

While it is possible to rotate the shaft 84 by a hand wheel or the like, it is preferably desirable to provide a hydraulic steering system for rotating the shaft 84 in one direction or the other a predetermined amount. Referring now to FIGURE 6, the hydraulic steering system for controlling the position of the housing 38 includes a pump 94 belted to a power take-off 96 from a prime mover 98 for the propeller 22, the prime mover 98 may be a Diesel engine or the like. The hydraulic pump forces fluid from an accumulator 100 into a pressure line 102 having the usual pressure gauge 104. A by-pass valve 106 is provided in the pressure line so that unused fluid can be returned through a relief line 108 to the accumulator 100. A four-way valve 110 operated by a hand lever 112 can direct fluid to either side of a hydraulic motor 114 by directing the pressure fluid in line 102 through either of the lines 116 or 118. It will now be understood that when the valve 110 is actuated, it will

drive the motor 114 in one direction or the other a desired distance as determined by how long the lever 112 is held in one position or another. The hydraulic fluid discharged from the hydraulic motor 114 is returned to the accumulator through a return line 120. As best shown in FIGURE 2, the four-way valve 110 and its control 112 are mounted on a pedestal 122 at a convenient place on the boat 12.

The propeller 22 is also driven by the prime mover 98 off of its power take-off 96. In more detail, belting 124 respectively passing about a pulley 126 on the shaft of the power take-off 96 and a pulley 128 on the end of the jack shaft 80 drives the jack shaft. The jack shaft 80 in turn through the beveled gears in the gear box 78 rotates the drive shaft 60 for the propeller 22.

Referring now to FIGURES 1 and 4, it will be noted that a grid 130 is provided on the bottom portion 44 of the inner housing 38 and covers the inlet opening 18. The grid 130 includes a plurality of parallel bars 132 extending transverse of a second plurality of parallel bars 134, the bars 132 and 134 being suitably attached to the bottom portion 44. Since the propeller 22 is positioned in the opening 18 with its leading edges of its blades lying substantially in the plane of the inlet opening 18, the leading edges are in close proximity to the bars 132 and 134 of grid 130 and provide a shearing action therewith for any seaweed or other obstructions passing into the inlet opening 18.

Referring now to FIGURES 7 and 8, a modification of the present invention is disclosed wherein a shallow draft boat 12' is provided with a pair of propulsion units 10' positioned in side-by-side relationships transverse of the boat and on opposite sides of the longitudinal axis of the bottom 14'. The propulsion units 10' are identical in construction to the propulsion unit 10 heretofore described and therefore a detailed description of the same is not believed necessary. Propulsion units 10' are independently steerable in that their inner housings may be rotated on vertical axes independently of each other to direct the outlet openings 20' in any desired direction. As shown in FIGURES 7 and 8, the outlet openings 20' may be arranged to be fanned out at an equal angle from the center line of the boat so that the boat may move forward but have its jets being discharged through the outlets and directed rearwardly toward the outside. When running in extremely shallow water, as shown in FIGURE 8, the suction from the inlets 18' picks up silt or sand directly beneath the boat and deposits it to the sides of the boat, as shown at 13. The arrows A in FIGURE 8 illustrate the direction of the flow of water with the silt and sand carried therewith through the propulsion units 10'. The channel beneath the boat 12' is thus kept clear by the dredging action of the pair of propulsion units.

In summation of the above, the boat 10 of the present invention provides a propulsion unit utilizing an axial flow propeller rotatable in a horizontal plane about a vertical axis, the propeller being positioned in a duct having a planar inlet opening and a planar outlet opening lying in the same plane. By having the leading edges of the propeller blades rotatable substantially in the plane of the inlet opening, it will now be apparent that water can be transferred into thrust even though the boat is theoretically in only a quarter of an inch of water as the water will seal both the inlet and outlet openings and suction can be maintained by the propeller. By having the axial flow propeller rotating in a horizontal plane, the propeller can be made of extremely large diameters, for example, three feet or more, and since the duct through which the water passes has the same cross-sectional area throughout with no restrictions therein, a minimum of energy loss is obtained with a maximum amount of thrust at low speeds.

It is thus seen that the objects and advantages of the present invention have been fully and effectively accomplished by the boat described and illustrated in the drawings. However, the present invention is susceptible to

some modifications without departing from the spirit and principle thereof.

Therefore, the terminology used in this specification and the illustrations in the drawings are for the purpose of description and not limitation, the scope of the invention being defined in the appended claims.

What is claimed is:

1. In a shallow draft boat having a substantially flat bottom with an opening therein, an improvement in a propulsion unit therefor comprising: a housing attached to the bottom of the boat and closing the opening thereof, a second housing mounted within said first housing and rotatably adjustable on a vertical axis with respect to the first housing, said second housing having a planar bottom portion lying substantially in the plane of the flat bottom of the boat, said second housing having an inlet opening in its planar bottom portion coaxial with the vertical axis of rotation of the same and an outlet opening in its planar bottom portion spaced radially outwardly from the inlet opening, said inlet opening being circular in cross-section and said outlet opening being elongated and having a cross-sectional area substantially equal to the cross-sectional area of said inlet opening, a duct in said second housing having a portion extending vertically upwardly from the inlet opening and then another portion extending in a radial plane to the vertical axis of the vertical portion and downwardly to the outlet opening for providing a channel for water having one change of direction therein, the downwardly extending portion of said duct communicating with the outlet opening at an acute angle to the plane of the same, said duct having a cross-sectional area throughout its length substantially equal to the cross-sectional area of the inlet opening and the outlet opening, an axial flow propeller supported in the vertical portion of said duct and rotatable on the vertical axis of the same for drawing water through said inlet opening and discharging the same through said outlet opening, said propeller having blades with leading edges lying in the same plane as the plane of said inlet opening and having a maximum diameter slightly less than the diameter of the vertical portion of said duct so the tips of the blade lie in close proximity to the walls of the vertical portion of the duct, and means for rotating said propeller.

2. The shallow draft boat as claimed in claim 1 wherein said second housing includes a sealed chamber surrounding said duct and providing buoyancy for the propulsion unit.

3. The shallow draft boat as claimed in claim 1 wherein said second housing has at least the bottom portion thereof made from a malleable steel.

4. The shallow draft boat as claimed in claim 1 wherein the bottom portion of said second housing includes a grid extending across the inlet opening, the leading edges of the blades of said propeller coacting in close proximity to the grid for shearing any foreign material passing through the inlet opening.

5. The shallow draft boat as claimed in claim 1 including a second opening therein and a propulsion unit therefor identical with said first-mentioned propulsion unit, said first and second openings and their respective propulsion units being arranged transversely on each side of a longitudinal axis of the bottom of the boat.

6. In a shallow draft boat having a flat bottom with an opening therein, an improvement in a propulsion unit therefor comprising: a concave housing attached to the bottom of the boat and closing the opening thereof, a hollow second housing semi-spherical in shape and complementary to the concave first housing, said second housing being mounted within said first housing and rotatably adjustable on a vertical axis with respect to the first housing, said second housing having a horizontally extending planar bottom portion lying in the same plane as the plane of the boat bottom, said horizontally extending planar bottom portion having a circular inlet opening

coaxial with the vertical axis of the second housing and an outlet opening spaced radially outwardly from the inlet opening, said inlet opening and said outlet opening having substantially the same cross-sectional area, an elongated duct extending from said inlet opening to said outlet opening and providing a channel for water, an axial flow propeller supported for rotation on a vertical axis in said duct, said propeller having blades with leading edges lying in substantially the same horizontal plane as the plane of said inlet and outlet openings, and means for rotating said propeller.

7. The shallow draft boat as claimed in claim 6 wherein the planar bottom portion of said second housing is made from a malleable steel.

8. A shallow draft boat as claimed in claim 6 wherein said second hollow housing includes a sealed chamber in the semispherical portion of the same except where said duct extends through the same.

9. A shallow draft boat as claimed in claim 6 including a grid carried by the bottom portion of said second housing and covering said inlet opening, said grid coacting with the leading edges of the blades of said propeller to provide a searing action on any foreign material entering the intake opening.

10. The shallow draft boat as claimed in claim 6 including a tubular stem extending upwardly from said second housing and coaxial with the vertical axis of rotation of the same, a tubular stem extending upwardly from said first housing and concentrically surrounding and spaced from the stem of said second housing, a bearing posi-

tioned between said stems, and means for supplying a waterproof grease to an annulus area between the tubular stems beneath said bearing.

11. The shallow draft boat of claim 10 wherein said means for rotating said propeller include a drive shaft extending vertically through said duct and the tubular stem of said second housing, said tubular stem being provided with a spider for supporting said shaft.

12. The shallow draft boat as claimed in claim 11 wherein the tubular stem of said second housing is provided with a cover plate at its upper end and a stuffing box in said cover plate through which said shaft passes.

13. The shallow draft boat as claimed in claim 12 including a water lubricated bearing positioned between said shaft and said spider.

14. The shallow draft boat as claimed in claim 6 wherein said duct has a cross-sectional area substantially equal to the cross-sectional area of said inlet and outlet openings and wherein said outlet opening is elongated and having a major axis transverse to a radius of the planar bottom portion of said second housing.

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