July 17, 1962 C. W. F. HAMILTON 3,044,260

HYDRAULIC JET PROPULSION APPARATUS FOR WATER-BORNE CRAFT

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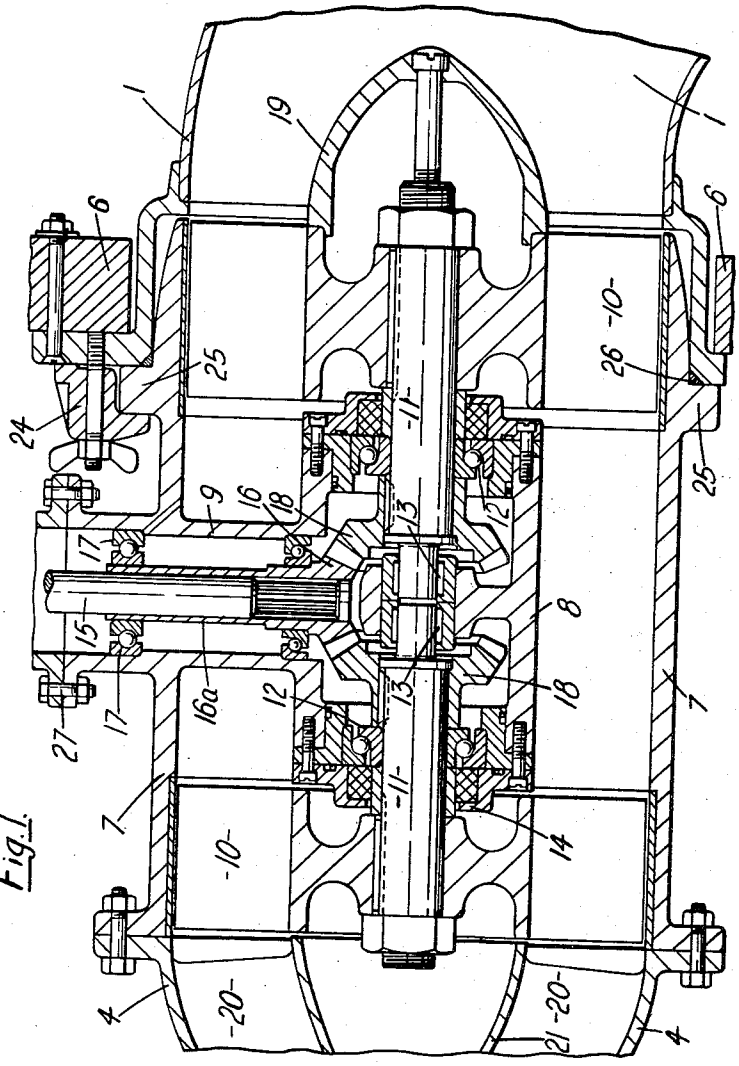


Fig. 1.

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Fig. 2.

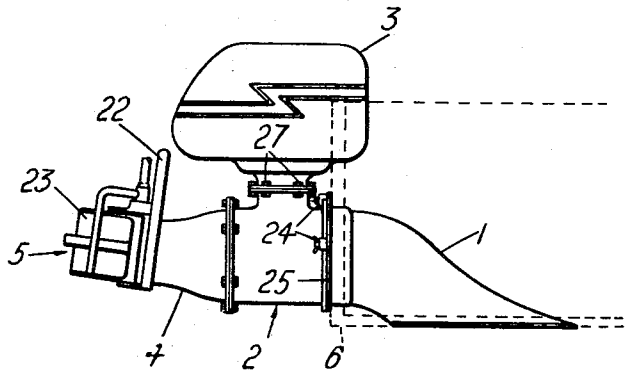


Fig. 3.

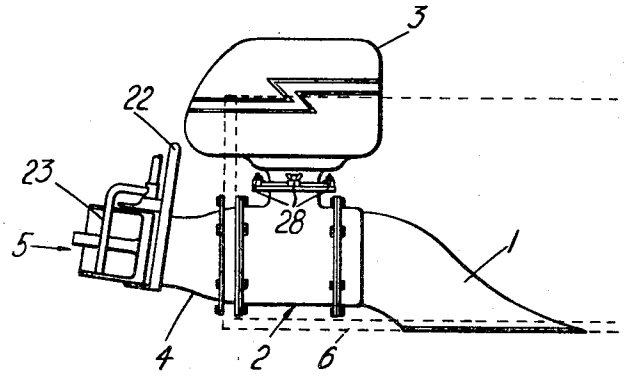


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Fig 4

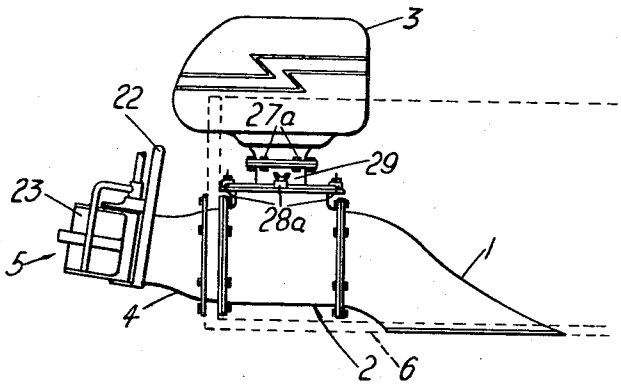
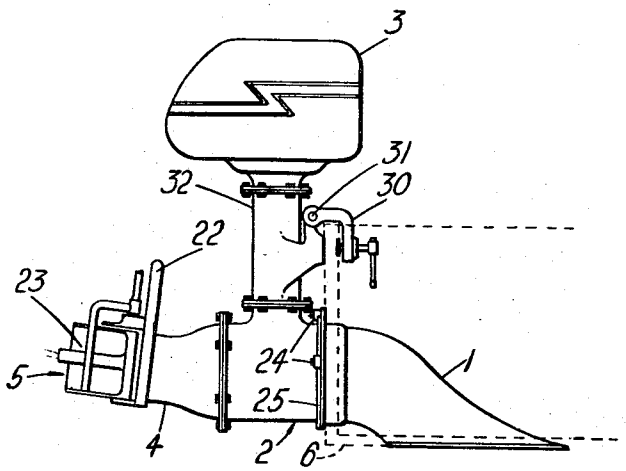



Fig 5

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# HYDRAULIC JET PROPULSION APPARATUS FOR WATER-BORNE CRAFT

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9 Claims. (Cl. 60—35.54)

The invention relates to hydraulic jet propulsion apparatus for water-borne craft, and has for its general object the provision of certain improvements and simplifications in the construction and in the manner of assembly and mounting of such apparatus.

A specific object of the invention is the provision of an improved form of such apparatus of which at least a part can be readily dismounted and detached from a craft to which it is fitted, for the purpose of storage, repair, or ease in handling the apparatus.

A further object of the invention, in at least one of its embodiments, is to provide a relatively simple and compact hydraulic jet propulsion apparatus for water-borne craft which combines the advantages of hydraulic jet propulsion (in particular, those of efficient operation in shallow water and high manoeuverability and safety of operation of the craft) with the advantages of an outboard marine motor (in particular, those of ease of mounting and dismounting of the motor and detachability of the mechanical parts), and which does this in a manner which provides for increased efficiency of operation by reduction of hydraulic losses at the water intake of the apparatus in comparison with certain known forms of outboard-mounted marine hydraulic jet propulsion apparatus.

Further objects and advantages of the invention will be apparent from the following description.

Hydraulic jet propulsion apparatus, when constructed in accordance with one aspect of the invention, consists of a hydraulic pump operable to discharge water as a propulsive jet, control means associated with the pump and adapted to control the direction of a jet of water so discharged, and a motor associated with the pump and operable to drive the pump; the pump, control means and motor being assembled as a unit which is adapted for readily removable mounting on a water-borne craft in association with an intake duct thereof, the pump being operable to draw water through the intake duct for discharge from the pump as a propulsive jet.

Hydraulic jet propulsion apparatus, when constructed in accordance with another aspect of the invention, consists of a hydraulic pump operable to draw water through the intake duct and to discharge the water from the pump as a propulsive jet, control means associated with the pump and adapted to control the direction of a jet of water so discharged, and a motor associated with the pump and operable to drive the pump; the pump, control means and motor being assembled as a unit which is adapted for readily removable mounting outboard of a water-borne craft, and the intake duct being adapted for fixed mounting within the said craft so as to provide a substantially watertight passage through which water from under the craft may be drawn by the pump for discharge therefrom, the said passage communicating with the pump through an aperture in a wall or transom of the craft.

Hydraulic jet propulsion apparatus, when constructed in accordance with a further aspect of the invention, consists of a hydraulic pump operable to discharge water as a propulsive jet, an intake duct associated with the pump and through which water can be drawn by the pump, a discharge section associated with the pump and through which water can be so discharged, and control means associated with the discharge section and adapted to control the direction of a jet of water so discharged; wherein the pump has a casing within which are a pair of co-axial impellers drivable from the motor through bevel gearing and through a drive shaft which is arranged with its axis perpendicular to that of the impellers.



The intake duct, in apparatus according to any of the foregoing aspects of the invention, has one or more intake openings through which water can be drawn into the duct, the (or each) intake opening being fitted with an intake screen which is arranged across the opening and through which water drawn into the duct passes. The intake duct is faired smoothly into the intake opening or openings, the arrangement being such that no part of the apparatus projects below the plane or planes formed by the bottom of the craft, or a continuation thereof in a rearward direction.

In apparatus according to the last of the above-mentioned aspects of the invention, the intake duct may either be built into the lower part of the hull of a craft to which the apparatus is to be fitted, or it may be attached to the rest of the apparatus as a normal part thereof.

The discharge section referred to above will normally consist of a converging acceleration chamber containing a fixed centre fairing and a set of radial guide vanes, in accordance with known practice, the chamber terminating at its smaller end in a circular nozzle through which water is discharged as a propulsive jet when the apparatus is in operation.

The control means are mounted immediately behind the discharge section, in apparatus according to the last-mentioned aspect of the invention, and preferably include a sliding gate for shutting off and reversing the jet, and steering gear comprising a pair of coupled deflectors whereby the jet is deflected to one side or the other for steering purposes.

The impellers of the pump may be fixedly mounted one on each of a pair of axially aligned impeller shafts and may be contra-rotating when the pump is in operation, or they may be fixedly mounted on a common impeller shaft so as to be rotatable in the same direction, the bevel gearing being modified to provide the desired drive. In the latter arrangement a set of stator vanes will normally be provided between the impellers to straighten the flow of water from the forward to the rear impeller.

Various exemplifications of propulsion apparatus constructed in accordance with the invention will now be described in more detail by way of example of how the invention can be carried into effect, and with reference to the accompanying drawings, in which:

FIGURE 1 is a longitudinal vertical section of a portion of apparatus according to one exemplification of the invention;

FIGURE 2 is an elevation of apparatus according to the exemplification shown in part in FIGURE 1, showing the apparatus mounted on a boat;

FIGURE 3 is an elevation, similar to FIGURE 2, of apparatus according to another exemplification of the invention;

FIGURE 4 is an elevation, similar to FIGURE 2, of apparatus according to a third exemplification of the invention; and

FIGURE 5 is an elevation, similar to FIGURE 2, of apparatus according to a fourth exemplification of the invention.

In the drawings, similar parts are indicated by the same reference numerals throughout.

The apparatus of all the exemplifications shown in the drawings has as its principal parts an intake duct 1, a hydraulic pump 2, a motor 3, a discharge section 4, and

control means which are indicated generally at **5** in FIGURES 2, 3, 4 and 5.

The intake duct **1** is fitted within the hull of a boat **6** on which the apparatus is mounted, the position of the intake duct in the hull being determined by the manner in which the apparatus is to be mounted, as will be seen from FIGURES 2 to 5 of the drawings. Particularly in the arrangement shown in FIGURE 2, the intake duct may be built into the hull of the boat as virtually an integral part of the hull. An intake opening is formed in the bottom of the boat, and the lower end portion of the intake duct is faired smoothly into the intake opening, which is fitted with a grille through which water is drawn into the intake duct **1** and into the pump **2** when the apparatus is in operation.

The pump **2** is driven by the motor **3**, and its internal construction (which is common to all of the illustrated exemplifications of the invention) is shown in FIGURE 1 of the drawings. As will be seen from that figure, the mechanism of the pump is mounted in what is basically an annular casing consisting of a substantially cylindrical outer shell **7** and a cylindrical inner hub **8** which is supported concentrically within the outer shell **7** by means of a radial strut **9** of streamlined hydrofoil cross section.

Within the outer shell **7**, and at opposite ends of the hub **8**, are a pair of impellers **10** which are keyed one on each of a pair of axially aligned impeller shafts **11** rotatably supported in bearings **12** within the hub **8**. The adjacent end portions of the shafts **11** are journalled within needle-roller bearings **13** supported in a central bearing block of the hub **8**, so that the shafts **11** can rotate independently of each other. The bearings **12** are combined journal and thrust bearings, and entry of water into the bearings is prevented by water seals **14** which are secured to the opposite ends of the hub **8**, and which also bear on the outer rings of the bearings **12** so as to retain the bearings in position within the hub.

The impeller shafts **11**, and consequently the impellers **10**, are driven from the motor **3** through a drive shaft **15** which is arranged perpendicularly to the axis of the impeller shafts **11**, and which enters the casing of the pump through the strut **9**. Transmission of power from the drive shaft **15** to the impeller shafts **11** is effected through bevel gearing comprising a bevel pinion **16** having a vertical socket **16***a* which is splined on the lower end portion of the drive shaft **15**, the pinion **16** meshing with a pair of bevel crown wheels **18** which are keyed one on each of the impeller shafts **11**, adjacent to their journalled end portions. The socket **16***a* is suitably supported within the strut **9** by bearings **17**, as shown in FIGURE 1. As will be apparent, variation in the ratio of the rotational speeds of the drive shaft **15** and impeller shafts **11** can be achieved by variation in the number of teeth on the pinion **16** and crown wheels **18**.

Rotation of the drive shaft **15** by the motor **3** causes the impeller shafts **11** and impellers **10** to rotate in opposite directions, the assembly thus constituting a two-stage axial-flow pump with contra-rotating impellers. This arrangement ensures the imposition of the desired pressure head on the passing water, and also ensures substantially parallel water flow from the second impeller without the use of intermediate guide vanes. The axial length of the pump is kept to a minimum and the pump is relatively light, simple, and compact.

To minimise frictional resistance to the flow of water through the pump, a fairing **19** is fitted to the front impeller to rotate therewith, as will be seen from FIGURE 1.

The motor **3**, preferably a vertical shaft engine, is mounted directly above the pump **2**, and is removably secured thereto in one or other of the ways described below and shown in FIGURES 2 to 5 of the drawings.

The discharge section **4**, a part of which is shown in longitudinal section in FIGURE 1, consists of a tapered casting through which passes a bore of progressively reducing circular cross-section, forming an acceleration chamber within which is mounted a set of fixed straightening vanes **20** radiating from a fixed central fairing **21**, all in accordance with known practice.



When the motor **3** is water-cooled, the supply of cooling water may be obtained through a tapping into the outer shell **7** of the discharge section **4**, at a point where a suitably high pressure of water exists.

The control means **5** consist of a sliding gate **22** which is operable to shut off or reverse the thrust of the jet of water issuing from the discharge section **4**, and steering gear comprising a pair of coupled deflectors **23** mounted immediately behind the gate **22**, and operable to deflect the jet to one side or the other as it issues from the discharge section **4**, so as to produce a corresponding alteration in the direction of travel of the boat **6**.

In the exemplification of the invention which is shown in FIGURES 1 and 2 of the drawings, the intake duct **1** is mounted inboard of the boat **6**, its rear end opening through an aperture in the transom of the boat. The remainder of the apparatus is mounted outboard of the boat by means of quick-release clamps **24** which are secured to the transom and are releasably engageable with a flange **25** at the forward end portion of the outer shell **7** of the pump casing, so as to bring the pump into endwise contact and alignment with the rear end of the intake duct **1**. Watertight contact between the pump **2** and the intake duct **1** is achieved by means of an O-ring or other suitable seal **26** which is readily parted when the pump is removed, but which ensures a watertight connection when the pump is mounted on the intake duct. The motor **3** is removably secured to the pump **2** by bolts **27** engaging mating flanges of the casings of the pump and motor.

In the two exemplifications of the invention which are shown in FIGURES 3 and 4, both the intake duct **1** and the pump **2** are mounted inboard of the boat **6**, only the discharge section **4** and the control means **5** being disposed rearwardly of the boat. In the arrangement shown in FIGURE 3 the motor **3** is removably secured to the pump **2** by quick-release clamps **28** which replace the bolts **27** shown in FIGURE 2, the drive shaft **15** of the motor being designed to part from the sleeve **16***a* of the bevel pinion **16**.

In the exemplification shown in FIGURE 4, the construction of the pump casing is modified by the provision of a flanged connecting collar **29** between the motor **3** and the pump **2**, the motor being secured to the collar **29** by bolts **27***a*, and the collar being secured to the pump casing by quick-release clamps **28***a* so as to permit of the quick detachment and removal of the whole, or substantially the whole, of the mechanism of the pump, including the impellers, along with the motor **3**, following the release of the quick-release clamps **28***a*. A cover plate (not shown in the drawings) may be provided to seal the opening in the pump casing through which the mechanism of the pump is removed so as to enable the boat to remain seaworthy in adverse marine conditions when the motor and pump are so removed. The remainder of the apparatus, comprising the intake duct **1**, the non-removable part of the pump **2**, the discharge section **4**, and the control means **5**, may be more or less permanently attached one to the other and built into the boat as a substantially integral part thereof.

In the exemplification of the invention which is shown in FIGURE 5, the unit comprising the pump **2**, motor **3**, discharge section **4** and control means **5** is mounted outboard of the boat **6**, as in the exemplification shown in FIGURE 2, and is supported by means of a clamp **30** which is securable in a conventional manner, as illustrated, to the transom of the boat. The said unit is hingedly attached to the clamp **30** through the medium of a hinged connection **31**, so that it can be turned around the connection **30** to lift the lower part of the unit out of the water and move the pump **2** away from the rear end of the intake duct **1**. In this way, access is provided to

the interior of the pump intake duct **1** and pump **2** so that, in particular, any accumulations of weed or other debris can be removed from those parts. The intake duct **1** is mounted either permanently or removably inboard of the boat **6**, and, as in the exemplification shown in FIGURES 1 and 2, its rear end communicates with the pump **2** through an aperture in the transom of the boat. Watertight contact between the adjacent ends of the intake duct **1** and pump **2** is obtained in the same manner and by the same means as in the exemplification shown in FIGURES 1 and 2 and hereinbefore described with reference to those figures.

In the exemplification shown in FIGURE 5, also, an elongated flanged connecting collar **32** is provided between the pump **2** and the motor **3** for the purpose of providing the necessary vertical separation between the pump and the motor so as to allow for movement of the said unit around the connection **31** without fouling the clamp **30**, the drive shaft **15** being of correspondingly greater length than in the exemplification shown in FIGURES 1 and 2 of the drawings.

I claim:

1. In a hydraulic jet propulsion apparatus for water craft, means defining a water conveying duct having an inlet end beneath the water craft and an outlet end leading to the exterior of the water craft, means fixed mounting the duct within the water craft, a unit assembly including hydraulic pump means, a discharge section communicating with the pump means from which water can be discharged as a propulsive jet, motor means operably coupled to said pump means to drive the same and control means operably associated with the discharge section for controlling the direction of the water jet discharged therefrom, means removably mounting said unit assembly outboard of the water craft, and means providing a fluid tight connection between said unit assembly and the outlet end of said duct so that when said pump means is driven by the motor means water is drawn by the pump means through the inlet end of the duct and discharged through said discharge section as a propulsive jet.

2. A hydraulic jet propulsion apparatus as claimed in claim 1 including a casing in which said pump means is located, said pump means including a pair of co-axial impellers, a drive shaft from said motor means arranged perpendicular to said impellers and bevelled gear means between said drive shaft and said impellers.

3. A hydraulic jet propulsion apparatus as claimed in claim 1 in which said means removably mounting said unit assembly comprises clamp means attached to said water craft and means hingedly attaching said clamp means to said unit assembly for swinging movement toward and away from the outlet end of said duct.



4. A hydraulic jet propulsion apparatus as claimed in claim 1 in which said discharge section is attached to the pump means aft of the pump means with said control means being mounted on and immediately aft of said discharged section.

5. A hydraulic jet propulsion apparatus as claimed in claim 4 wherein said control means include a sliding gate operable to shut off and reverse the water jet discharged from said discharge section and steering means including a pair of interconnected deflecting means operable to deflect the jet to one side or the other for steering the water craft.

6. A hydraulic jet propulsion apparatus as claimed in claim 1 including a grill arranged across said inlet end for preventing the entry of foreign matter into the duct and said inlet end and at least said unit assembly being so located as to project above a plane defined by the bottom of the water craft.

7. A hydraulic jet propulsion apparatus as claimed in claim 1 wherein said discharge section includes a converging acceleration chamber, a fixed center fairing and a set of radial guide vanes, a circular nozzle at the smaller end of said converging acceleration chamber through which the water is discharged as a propulsive jet.

8. A hydraulic jet propulsion apparatus as claimed in claim 1 including a casing in which said pump means is located, said pump means including a pair of axially aligned shafts, at least one impeller on each shaft, a drive shaft extending from said motor means arranged perpendicular to said pair of shafts and bevelled gearing means between said drive shaft and pair of shafts for rotating said shafts in opposite direction.

9. A hydraulic jet propulsion apparatus as claimed in claim 1 including a casing in which said pump means is mounted, said pump means including a pair of co-axial impellers, a common shaft on which said impellers are mounted, a drive shaft extending from said motor means arranged perpendicular to said common shaft, gear means between the drive shaft and common shaft for rotating said common shaft, and a set of stator vanes between the impellers serving to straighten the water flow from the forward to the rearward impeller during operation of the pump means.

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