

June 8, 1965

A. FOX

3,187,708

PROPULSION DEVICE

Filed June 7, 1961

3 Sheets-Sheet 1

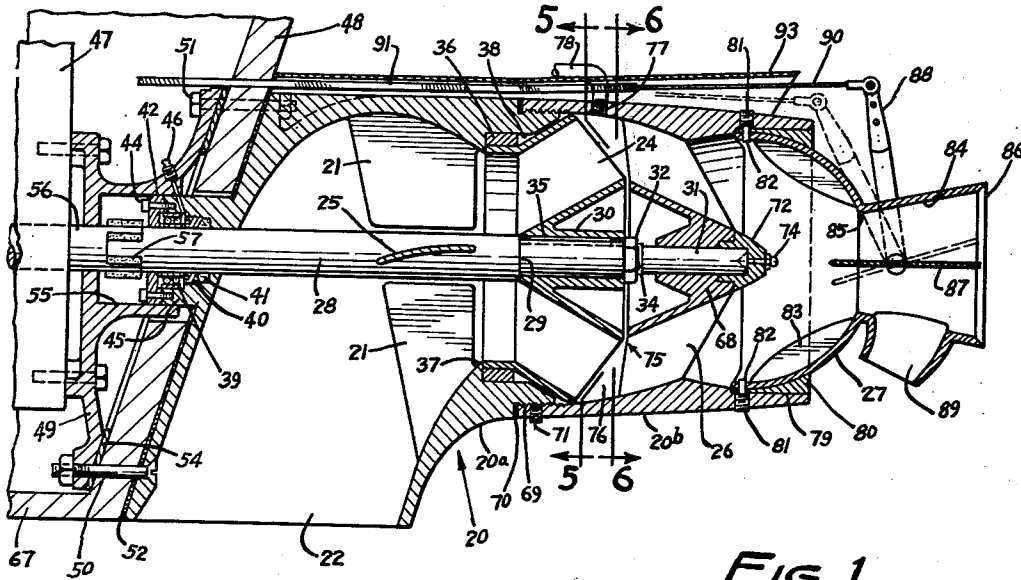


FIG. 1

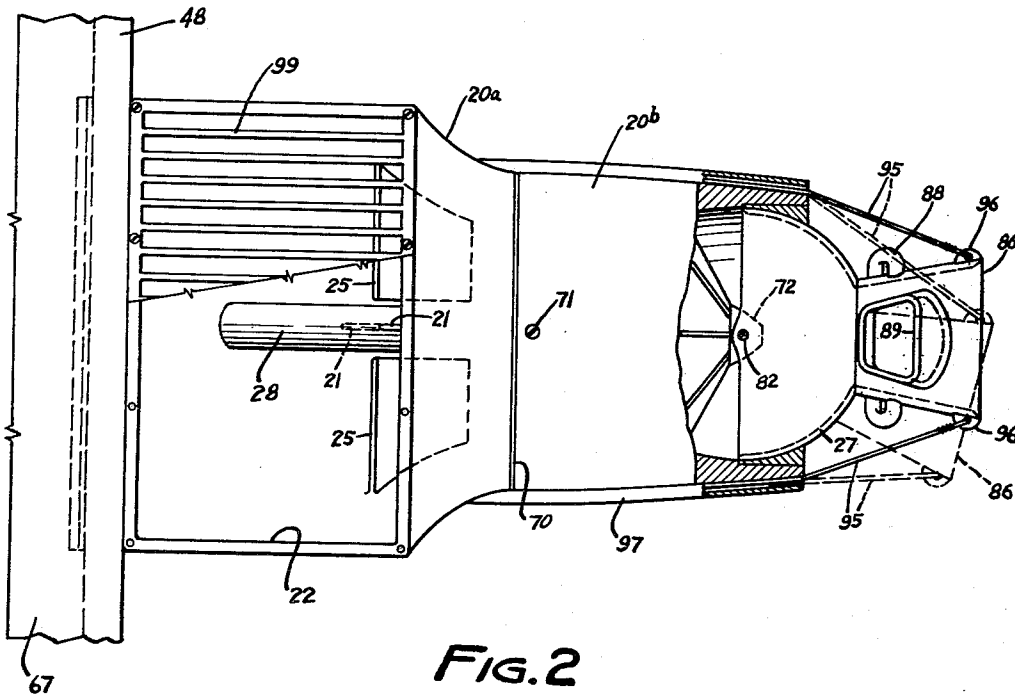


FIG. 2

INVENTOR.
ANTHONY FOX
BY
Moore, White & Durd
ATTORNEYS

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A. FOX

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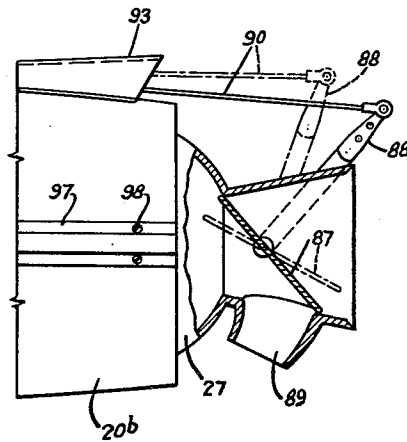
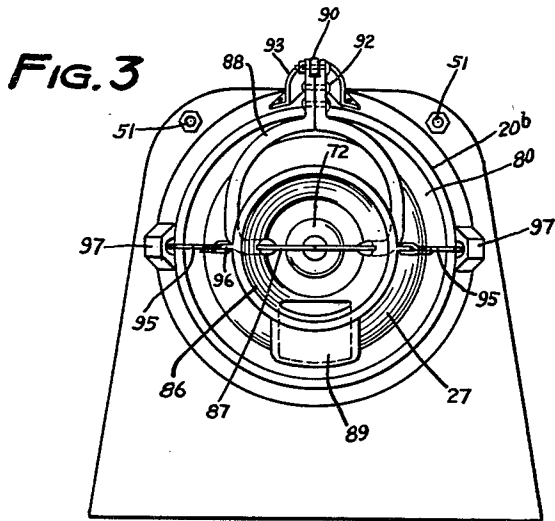


FIG. 4

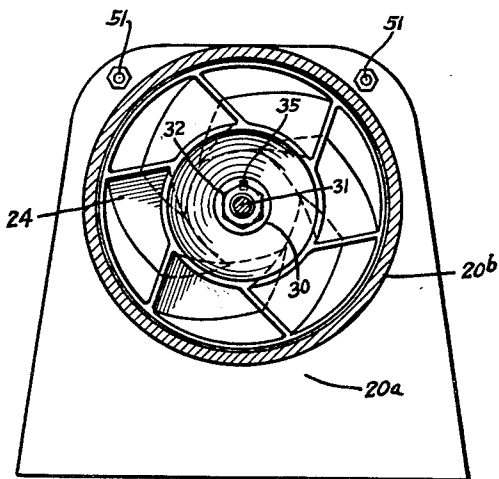


FIG. 5

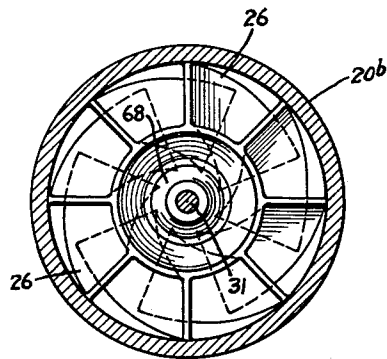


FIG. 6

INVENTOR.

ANTHONY FOX

BY *Moore, White & Durd*

ATTORNEYS

June 8, 1965

A. FOX

3,187,708

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FIG. 7

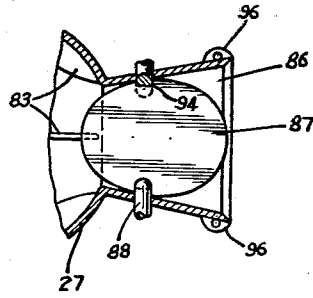
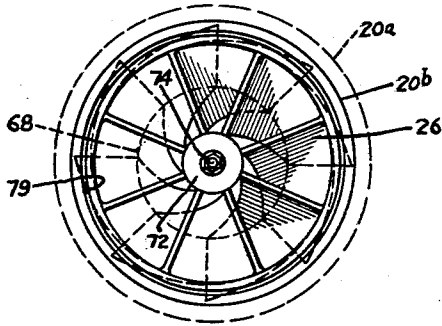


FIG. 8

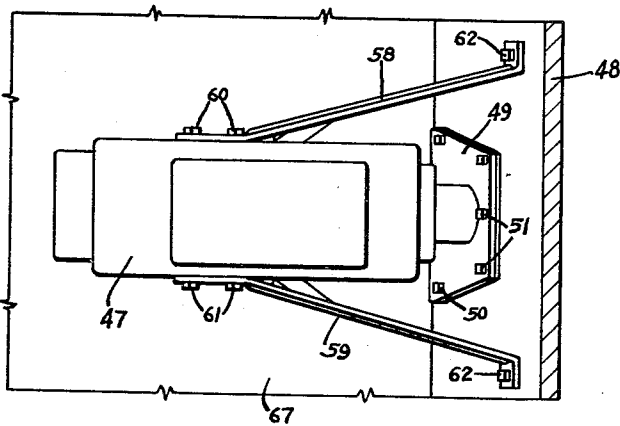


FIG. 10

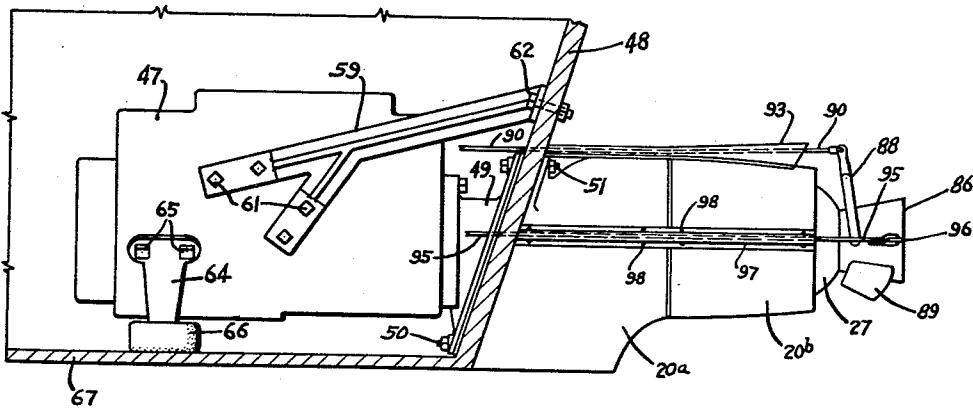


FIG. 9

INVENTOR.
ANTHONY FOX
BY
Moore, White & Pord
ATTORNEYS

1

3,187,708

PROPULSION DEVICE

Anthony Fox, Minneapolis, Minn., assignor to Propulsion Research, Inc., Minneapolis, Minn., a corporation of Minnesota

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6 Claims. (Cl. 115-12)

This invention is a propulsion unit for boats that supplants the gear box, propeller and rudder structure of a usual power boat arrangement. It is believed to be novel in the particular construction of the housing in which the impeller and water controlling vanes are arranged in that the outside shell of the unit is very smooth and has a minimum of projections thereon which might engage and snag on objects in the water. This streamlined construction is achieved in part by having portions of the housing that are normally secured together by flanges being secured by threads instead. The forward and reverse mechanism consists of a balanced deflector damper within the discharge nozzle which permits deflecting the water jet through forward or reverse ports. Yet another novel point of construction in this jet propulsion unit is the manner of mounting it and the engine which drives it in close-coupled arrangement on opposite sides of the transom of the boat so as to occupy a minimum of space both inside and outside and with the jet unit entirely outside of the boat hull. It is also believed novel in this type of unit to have the pivoting steering arrangement held in by a wear ring that establishes the position of the steering unit with threaded stub shafts serving both to hold the wear ring in the housing and provide the pivots for steering. Also novel is the flared discharge nozzle which minimizes friction between the nozzle and water being discharged.

Water jet propulsion units for boats are not novel in themselves, but many of the units that have been presented to the purchasing public are at least somewhat unsatisfactory in one or more of the following respects. They are frequently excessively long, heavy and expensive. They are often incapable of operating in a trouble free manner under conditions in which silt, sand and other small particles of hard materials are suspended in the water in which the craft is operating. The construction of some is such that they are difficult or impossible to steer when reversed. Most of these units heretofore offered occupy as much or more space inside the boat as a comparable propeller driving power plant would. Most also require cutting holes in the bottom of the hull, thus weakening the same, and increasing the likelihood of failure as the result of high speed engine operation and the interaction of the hull with water, especially rough water.

Accordingly, it is the principal object of this invention to provide an improved jet propulsion unit for watercraft.

Yet another object of this invention is to provide a jet propulsion unit for watercraft that can be mounted in close-coupled arrangement with an engine on opposite sides of the boat transom.

A further object of this invention is to provide a jet propulsion unit for boats that is substantially trouble free regardless of the conditions under which it is operated.

A still further object of this invention is to provide a jet propulsion unit for boats of simplified construction.

Yet another object of this invention is to provide a jet propulsion unit for boats having relatively high water capacity but small outside dimensions.

A still further object of this invention is to provide a jet propulsion and engine unit for a boat in which the

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mounting flanges of the propulsion unit and the engine cooperate to align the drive shaft of the engine with the impeller shaft of the propulsion unit.

It is another object of this invention to provide a jet propulsion unit for boats in which such materials as sand, grit, silt and the like will either be carried through the unit harmlessly or any elements which conceivably could be fouled by such materials may be quickly and easily cleared thereof.

Still another object of this invention is to provide a jet propulsion unit having a discharge nozzle which minimizes friction between water being discharged and the sides of the discharge nozzle.

Yet another object of this invention is to provide a mounting structure for both the engine and the propulsion unit whereby they are entirely supported by a single element of the boat hull.

Other and further objects of the invention are those inherent and apparent in the apparatus as described, pictured and claimed.

To the accomplishment of the foregoing and related ends, this invention then comprises the features hereinafter fully described and particularly pointed out in the claims, the following description setting forth in detail certain illustrative embodiments of the invention, these being indicative, however, of but a few of the various ways in which the principles of the invention may be employed.

The invention will be described with reference to the drawings in which corresponding numerals refer to the same parts and in which:

FIGURE 1 is a longitudinal sectional view through the entire unit with broken lines illustrating adjusted positions of parts as well as hidden parts;

FIGURE 2 is a bottom view of the device with portions thereof broken away to illustrate construction more fully; broken lines illustrate hidden and adjusted positions of parts;

FIGURE 3 is a rear elevation of the device in which broken lines illustrate hidden parts;

FIGURE 4 is a fragmentary side elevation of the device with portions broken away to illustrate the action of the deflection damper; broken lines illustrate hidden and adjusted positions of parts;

FIGURE 5 is a vertical section taken on the line 5-5 of FIGURE 1; broken lines illustrate hidden portions;

FIGURE 6 is a vertical section taken along the line 6-6 of FIGURE 1; broken lines illustrating hidden parts;

FIGURE 7 is a fragmentary rear elevation with the discharge nozzle removed;

FIGURE 8 is a horizontal section taken on the line 8-8 of FIGURE 1 with broken lines illustrating hidden parts;

FIGURE 9 is a reduced side elevation of the unit and its driving engine secured to the transom of a boat which is shown fragmentarily and in section; broken lines illustrate hidden parts; and

FIGURE 10 is a plan view of the engine shown in FIGURE 9 to illustrate the lateral disposition of the braces therefor.

Referring to the drawings and particularly to FIGURE 1, the jet unit is seen to have a housing 20 which is divided into two portions designated 20A and 20B.

Within housing 20 are rigid vertical water directing vanes 21 which direct water from intake 22 in a substantially straight path toward impeller 24. The horizontal vanes 25 are curved downward at their outer ends in order to divide water coming in through intake 22 approximately evenly between the upper and lower halves of the impeller entrance. At the rear of impeller 24 are the water directing vanes 26 which take the water impelled by im-

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PELLER 24 and straighten it for a substantially straight thrust in the direction of the discharge nozzle assembly 27.

Impeller 24 is rotatably supported within the housing 20 on an impeller shaft 28. This shaft is made of any suitable material such as stainless steel having great strength as well as resistance to corrosion by water. The impeller shaft has a shoulder 29 formed thereon against which central cone 30 of impeller 24 abuts to determine the forward position of impeller 24 on shaft 28. The rear end of shaft 28 is reduced as at 31 so that a nut 32 may be slid over it before the portion 20B of the housing is positioned and the nut tightened on the threads 34 to hold impeller 30 from rearward motion on shaft 28. Impeller 24 is secured against rotation will respect to the shaft 28 by suitable means such as the key 35.

While the housing 20 is made from a strong lightweight alloy of aluminum and magnesium or other suitable material, a wear ring 36 is pressed into the housing at the point where the forward end of the impeller comes closest to it. Wear ring 36 may be of any suitable material and a suggested one that has been found practical is what is known as creamery metal, it being an alloy of nickel and brass which is reasonably hard and at the same time corrosion resistant. It will be seen that the shoulder of the housing portion 20A against which impeller 24 and wear ring 36 abut, as at 37, is such that the opening for water to pass into the interior of the impeller 24 is slightly smaller than the opening of the impeller itself. For this reason, any material being carried with the water will not get between the impeller and the wear ring 36 but instead will be carried with the flow of water through the impeller and out the rear of the unit. It will also be seen as at 38 that there is clearance between the impeller and the housing members 20A and 20B to allow any materials which do get into this area to be carried on rearward by the flow of water.

Shaft 28 is rotatably supported at the forward or transom end of housing portion 20A by means of suitable bearings 39 which are protected from water by means of a packing nut 40 bearing on and providing a tight seal with the packing gland 41. A ring, as shown at 42, suitably secured by cap screws 44, holds the bearing in the neck portion 45 of housing portion 20A. Grease for bearing port 39 is provided via a suitable grease fitting as seen at 46.

At 47 in FIGURE 1 is seen a fragmentary portion of the engine. It is secured to the transom 48 by means of a suitable mounting plate or flange 49 and bolts such as those disclosed at 50 and 51 extend through both the mounting flange 49 and appropriate flanges in portions of housing 20A as well as the transom 48 to pull both of the mounting flanges of the two portions of the entire structure tightly against transom 48. A sealing member or gasket such as that disclosed at 52 is provided between the mounting flange of housing 20A and transom 48. A similar seal or gasket is desirably positioned at 54 between mounting flange 49 of engine 47 and transom 48. Within mounting flange 49 is formed the ring 55 which fits snugly neck portion 45 of housing portion 20A. Neck portion 45 is fixedly located with respect to the shaft 28 and the drive shaft 56 is fixedly located with respect to collar portion 55. These fixed shaft, collar and neck relations correspond so that the entrance of neck portion 45, including the plate 42, into the collar 55, causes the shaft 28 to align with the shaft 56.

A yielding joint of the type in which cooperating portions on the two shafts interlace and are buffered with yielding, resilient material such as rubber or the like is seen at 57. While the two shafts are aligned by the interaction of the neck and collar structure, there may well be some movement of the engine with respect to the water jet unit particularly in rough water or under high output conditions. For this reason a yielding coupling is considered necessary at this point. Since the jet unit and the engine is close-coupled, however, it is not

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imperative to have a relatively complex universal joint at this juncture of the shafts.

Referring to FIGURES 9 and 10, the engine 47 will be seen also to be provided with the rigid braces 58 and 59 which extend from the engine block, and are secured thereto with suitable cap screws as at 60 and 61, to the transom 48 of the boat and secured in any suitable manner as by the bolts 62. Additional means for supporting the end of the engine spaced from the transom 48 may be employed in the form of a bracket 64 which is suitably secured as by the cap screws 65 to engine block 47 and resting on the air supports or shocks 66. These in turn rest on the inside bottom of hull 67. Either of these means for supporting the engine end spaced from the transom may be employed individually or jointly, depending on the nature of the hull with which the structure is used and various other factors. As seen in FIGURE 10 the engine is braced laterally as well as vertically by the supporting struts 58 and 59.

Referring again to FIGURE 1, shaft 28 at its rear portion 31 is rotatably supported by the central cone 68 of the vane units 26. Once the shaft 28 and impeller 24 are secured in the housing portion 20A, portion 20B may be fitted thereon by screwing together the threads shown at 69. A gasket, as at 70, will provide a seal for the two portions 20A-20B when the threads at 69 have been engaged sufficiently to hold the two units together, yet gasket 70 will yield enough to permit continued rotation of 20B until the assembly is properly arranged as to have the discharge and control arrangement of the unit properly oriented to housing portion 20A. When the two housing portions 20A-20B are correctly aligned, one or more set screws 71 are inserted and tightened to positively hold the two housing portions in proper alignment. A tail cone piece 72 is press-fitted into the cone portion 68 to both close off and protect the rear end of shaft 28 and also provide a means for applying a grease fitting 74 thereto by means of which grease is applied to the bearing surface within cone 68 that supports the rear end 31 of shaft 28.

At this point it is to be noted that the forward end of cone 68 is slightly smaller than the rear end of cone 30 of the impeller. As seen at 75 the forward cone of the impeller overhangs the cone of vanes 26 so that water is directed on the outside of cone 28 principally. Between the two cones is a slight space as at 76 in which there is always maintained a slight pressure. At this point in housing 20B is a port 77 into which an appropriate tube 78 shown in fragment connects and extends to the water jacket of the engine. Whenever the thermostat of the engine calls for cooling liquid, the pressure area 76 will cause water to flow through port 77 and tube 78 to cool the engine. Water which has been used for cooling is allowed to overflow into the water in which the boat is operating, in the usual manner. Other details of this structure are common in usage and therefore not shown in detail.

At the rear of housing 20B is formed a socket portion 79 into which the control discharge nozzle 27 is inserted. A tapered ring 80 provides a close fit to the ball portion of discharge nozzle 27. The ring 80 and ball 27 are simultaneously pushed into the housing 20B. They are a very tight slip fit. Once these units are properly positioned within the housing 20B, the pin units 81 are inserted which extend through both the ring and the nozzle 27. Stub shaft portions 82 serve as the pivot points for the discharge nozzle 27. Thus discharge nozzle 27 is pivoted about a vertical axis formed by the stub shafts 82 so that it can swing to the right or left as disclosed by the broken lines in FIGURE 2. Vanes 83 in nozzle 27 both stiffen the ball portion of nozzle 27 and aid in reducing turbulence of the water flowing through the unit.

The discharge nozzle is provided with a main discharge port 84 which enlarges from the smallest portion of the passageway for water as at 85 to the actual exhaust open-

ing 86 of the unit. Pivoted within this enlarging discharge portion of nozzle 27 is a deflection plate 87. Yoke structure 88 is journaled in the sides of the nozzle and supports the plate in any of the various positions to which it may be pivoted by means of the yoke 88. As shown in FIGURES 1 and 2, as well as in FIGURE 8, the ends of yoke 88 that embrace the deflection plate 87 are only slightly engaged with the plate itself so that the area between the two ends of the yoke that grip the deflection plate is nearly as great as the reduced opening 85 of the discharge nozzle. Because the discharge nozzle flares or enlarges from its most restricted point 85, to the actual point of discharge of the jet from the unit, the walls of the flaring portion 84 of the jet do not have any substantial contact with the water being expelled through discharge port 85.

At the bottom of the discharge portion 84 is the reverse port 89. Reverse port 89 not only serves to discharge water in a forwardly direction when the power of the unit is used to reverse the boat, it also acts as an air intake when the boat is thrusting forward as would be the case when the deflection plate 87 is positioned as shown in FIGURE 1. At this time the jet unit is largely raised out of the water as the boat planes on the bottom 67 of its hull. Air is therefore allowed to enter through port 89 and in doing so it mixes with the water being discharged through discharge port 86 and produces an aeration or bubbling action similar to bubbling or non-splashing faucets which are common. This bubbling action also serves to prevent any substantial skin friction or liquid-nozzle friction after the water passes the narrow point 85 of the discharge nozzle 27.

Yoke 88 may be moved forward and backward by any suitable means such as the heavy Bowden wire 90 having the usual casing 91. When the plate 87 is positioned as shown in FIGURE 1, all of the power of the jet is directed straight rearward for the greatest forward thrust. As the Bowden wire 90 extends forward to a suitable control adjacent to the operator of the vehicle, he can, by appropriately positioning his control lever, move plate 87 to the position shown in broken lines in FIGURE 1, in order to deflect at least some of the water being discharged upwardly. This deflection of the water being discharged through the jet tends to thrust the rear of the jet unit down and the nose of the boat up, which is of assistance in getting the boat up into a planing position on top of the water. As shown in FIGURE 4, this same control may be moved to the extreme rearward position as shown in solid lines in that figure, which deflects substantially all of the water being discharged through restricted area 85 out through the reverse port 89. In this position of plate 87, the entire thrust of the engine is being applied to move the boat backward through the water. The broken line position, shown in FIGURE 4, is one in which water being discharged straight rearwardly and through reverse port 89 is divided. By this dividing of the thrust from the jet, a neutral position may be located at which the rearward thrust and the forward thrust are substantially balanced and this produces no movement of the boat regardless of the power being exerted by the engine. The broken line position in FIGURE 4 is approximately a neutral position. It will be seen, therefore, that the deflection plate 87 may be used to direct all of the thrust of the engine selectively through the discharge port 86 or the reverse port 89 at will. Furthermore, the water being discharged through these ports may be divided proportionately in order to produce very controlled forward and backward motion as when maneuvering up to a dock or the like.

As shown in FIGURES 1, 4 and 8, the deflection plate 87 is entirely contained within nozzle portion 84. For this reason, regardless of the direction in which water is being deflected, it is always being employed usefully and not merely spraying out into the air in a useless or even

annoying manner as to throw water on the occupants of the craft being powered by the jet unit.

As shown in FIGURE 3, yoke 88 is divided into two portions and suitably clamped together as by the bolt assembly units 92. For this reason, the yoke may be disassembled and removed from the portion 84 of the discharge nozzle 27 in order to remove the deflection plate 87 for service or repair. As shown in FIGURE 8, the deflection plate is provided with the notches 94 and the ends of the yoke portions are bifurcated so as to embrace the top and bottom of the plate. Thus the bifurcated ends of the yoke portions retain the plate on its top and bottom while the engagement of the yoke portion with the notches 94 causes the plate to be retained in a forward and backward direction with the yoke. This structure has been found extremely trouble free, and if trouble should develop, the disassembly of the yoke by removing the bolts 92 makes it possible to repair any difficulty quickly and easily. Any suitable superstructure housing, as shown at 93, is used to both protect and lend an attractive appearance to the Bowden cable structure 90-91. This housing may be any suitable casting, stamping or extrusion that is secured to the outside of the housings 20A and 20B.

As shown in FIGURE 2, steering is controlled by suitable means such as the cables 95 which are secured to the pierced ears 96 that are at the outer end of the discharge nozzle 27. For this reason cables 95 have excellent leverage in pulling the discharge nozzle either to the right or left. When one cable is pulled, the other is automatically released in the commonly understood manner by having them secured to a steering wheel drum or other similar mechanism. When one of the cables is tightened and the other loosened, discharge nozzle 27 pivots about the points 82. Suitable housings such as extrusions 97 are used to encase the cables 95 on the exterior of housings 20A and 20B. As shown in FIGURE 9, these extrusions are suitably secured to the housings by suitable means such as cap screws 98 and serve in addition to set screws 71 to hold the portions 20A and 20B of housing 20 in proper alignment with the axis of pivoting of discharge nozzle 27 in a vertical plane. Cables 95 may be provided at the transom of the boat with any suitable sort of water seal and one suggested form is an accordion pleated rubber sleeve arrangement that can be tightly secured to both the transom and the cable and yet yield sufficiently to provide steering. In this manner, water is prevented from gaining access to the interior of the boat, yet the housings 97 are left open at their rear ends in order to achieve drainage whenever water does enter these housings.

In FIGURE 2 also is shown the grille 99, the purpose of which is to limit the size objects entering intake 22. When a grille such as that shown at 99 is used over intake 22, any object that is small enough to enter the intake 22 is small enough to be pumped directly through the jet and exhausted through exhaust port 86. As seen in FIGURE 3, housing 93 has sufficient flare at its rear end to permit the Bowden cable 90 to yield laterally in either direction as discharge nozzle 27 is turned.

Referring to FIGURE 5, impeller 24 will be seen to have vanes in it that are slanted after the manner of a propeller blade as well as being angled radially from a position near the shaft 28 at the entrance to the impeller to an exit portion more widely spaced from the shaft. For this reason impeller 24 not only exerts axial thrust after the manner of a water screw, but also throws the water out its discharge port with considerable force as a centrifugal pump. As shown in FIGURE 5, the impeller 24 rotates counter-clockwise. This dual radial and axial thrust imparted to the water being thrown by impeller 24 produces an extremely high volume as well as substantial force pump. By comparing FIGURES 6 and 7, vanes 26 will be seen to slant at their ends nearest to impeller 24 in the opposite direction to the direction of slant of the impeller blade. In this manner the

water that is given some rotating or torque action, as the result of the rotary action of the impeller, tends to have its rotary motion counteracted and straightened out. FIGURE 7, which is a view looking at the vanes 26 from the discharge nozzle end thereof, shows that they have rear portions which extend in a straight line with respect to the length of the unit thereby discharging the water in an almost straight stream toward the discharge nozzle 27. As a result of the interaction of the impeller and vanes 26, very little of the torque action of the unit is felt in the operation of the boat itself.

It is apparent that many modifications and variations of this invention as hereinbefore set forth may be made without departing from the spirit and scope thereof. The specific embodiments described are given by way of example only and the invention is limited only by the terms of the appended claims.

What is claimed is:

1. A water jet propulsion unit comprising a housing, an impeller rotatably mounted in said housing, a socket portion in said housing to the rear of said impeller, a discharge nozzle pivotally mounted on a vertical axis in said socket, a discharge port in the rear of said discharge nozzle, a reverse port near said discharge port, and a deflection damper pivotally mounted on a horizontal axis within said discharge nozzle port area whereby water being discharged through said discharge nozzle may be deflected through said discharge and reverse ports selectively and proportionately at will, said deflection damper including a plate notched at its sides and a split yoke journalled in said discharge nozzle and having bifurcated ends engaging the notches in said deflection damper plate.

2. The combination of claim 1 in which the narrowest part of said discharge nozzle is in front of said split yoke and the ends of the split yoke when engaged with said plate are spaced a distance equal to the inside diameter of the smallest part of said discharge nozzle.

3. In combination with a boat transom, an engine having a crank shaft, a mounting flange on said engine, a water jet propulsion unit having an impeller shaft, mounting means cooperating with the mounting flange of said engine and being adapted to support said water jet propulsion unit entirely outside said transom, said water jet propulsion unit comprising a housing, and an impeller secured to said impeller shaft within said housing, a plurality of water directing vanes inside said housing both in front of and behind said impeller, a socket portion in said housing behind the vanes to the rear of said impeller, a discharge nozzle pivotally mounted on a vertical axis in said socket, said discharge nozzle having a forward converging portion and a rearward diverging portion, a discharge port at the rear of said diverging portion, a reverse port near said discharge port, and a deflection damper pivotally mounted on a horizontal axis entirely within said diverging portion of said discharge nozzle whereby water discharged through said discharge nozzle may be deflected through said discharge and reverse ports selectively and

proportionately at will, means for pivoting said discharge nozzle independently of the action of said deflection damper, and means in addition to said mounting flange for supporting the portion of said engine spaced from said transom.

4. The combination of claim 3 in which the mounting flange of said engine has a collar formed therein and said mounting means includes a neck formed thereon that slidably sits snugly within said collar of said mounting flange of said engine.

5. A water jet propulsion unit adapted to be mounted outside a boat transom comprising a housing, an impeller rotatably mounted in said housing, a plurality of fixed water directing vanes inside said housing and both in front of and behind said impeller, a socket portion in said housing behind the vanes to the rear of said impeller, a discharge nozzle pivotally mounted on a vertical axis in said socket, said discharge nozzle having a forward converging section and a rearward diverging section, a discharge port at the rear of said discharge nozzle, a reverse port formed in said discharge nozzle near said discharge port, and a deflection damper pivotally mounted on a horizontal axis entirely within the diverging section of said discharge nozzle whereby water being discharged through said discharge nozzle may be deflected proportionately and exclusively through said discharge and reverse ports, and means for pivoting said discharge nozzle independently of the action of said deflection damper.

6. A water jet propulsion unit being adapted to be mounted entirely on the outside of a boat transom comprising a housing, an impeller rotatably mounted in said housing, a discharge nozzle secured to said housing and including a forward converging section and a rearward diverging section, a discharge port at the rear of said diverging section, a reverse port formed in said discharge nozzle near said discharge port, and a deflection damper pivotally mounted intermediate its ends on a horizontal axis entirely within said diverging section of said discharge nozzle whereby water being discharged through said discharge nozzle is deflected proportionately, selectively and exclusively through said discharge and reverse ports.

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MILTON BUCHLER, *Primary Examiner.*

ANDREW H. FARRELL, *Examiner.*