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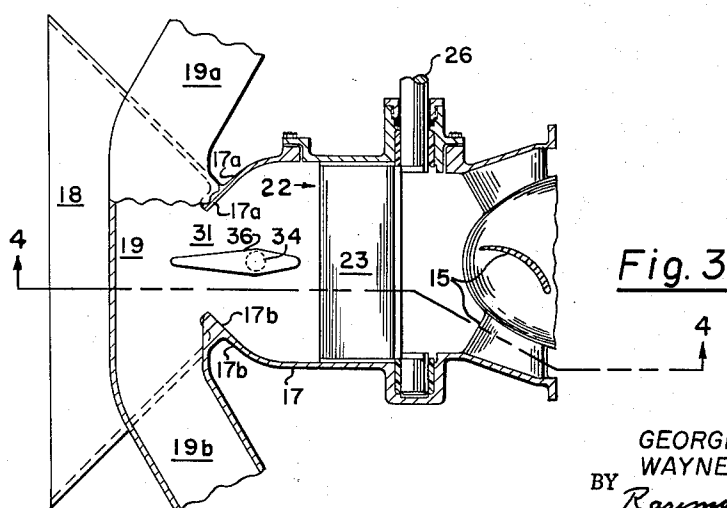
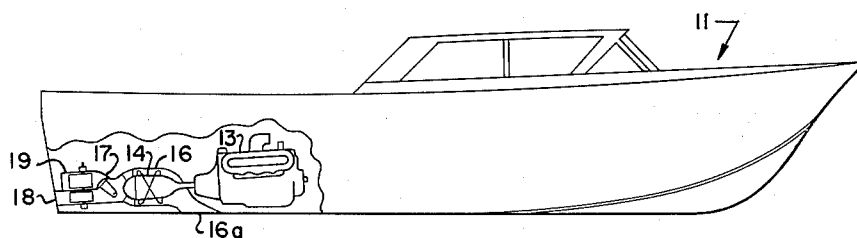
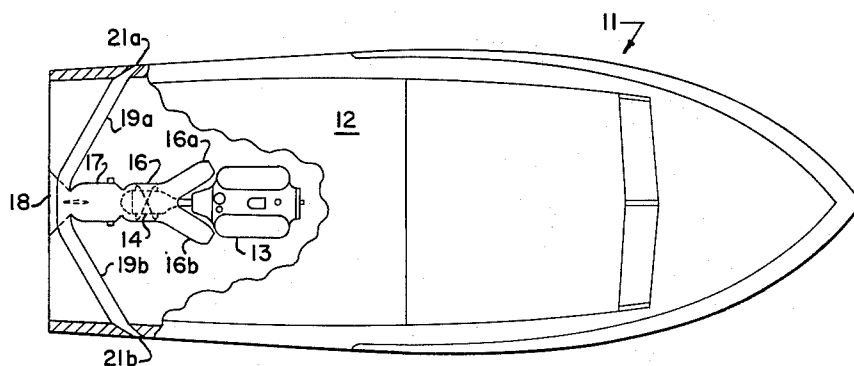
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3,102,389

HYDROJET PROPULSION CONTROL MEANS FOR BOATS

Filed March 31, 1961

3 Sheets-Sheet 1



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3 Sheets-Sheet 2

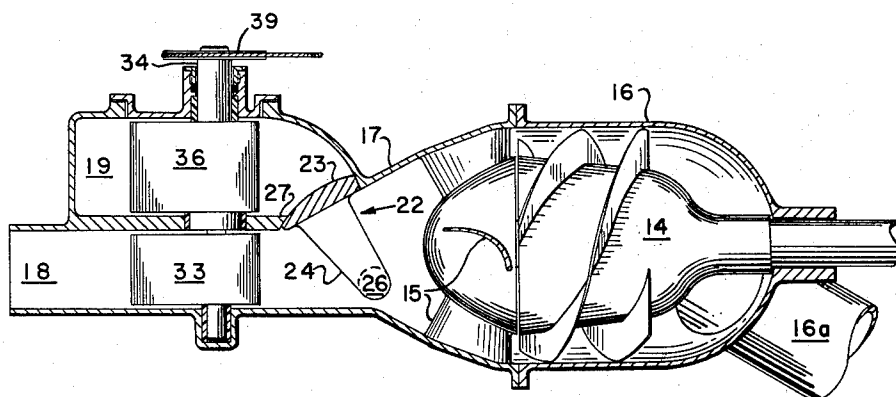


Fig. 4

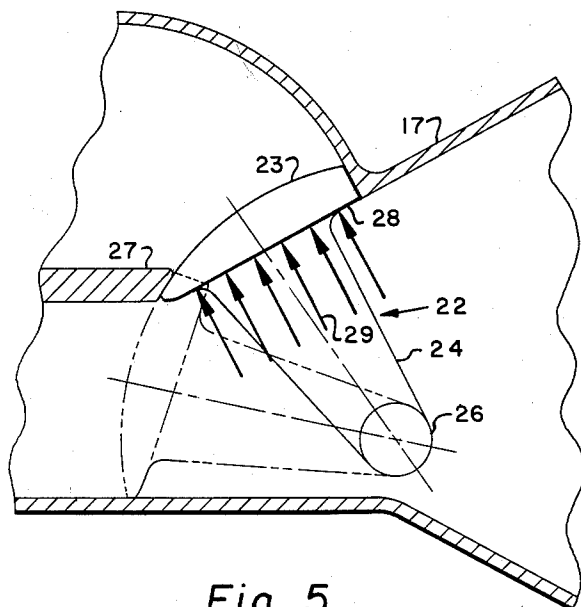


Fig. 5

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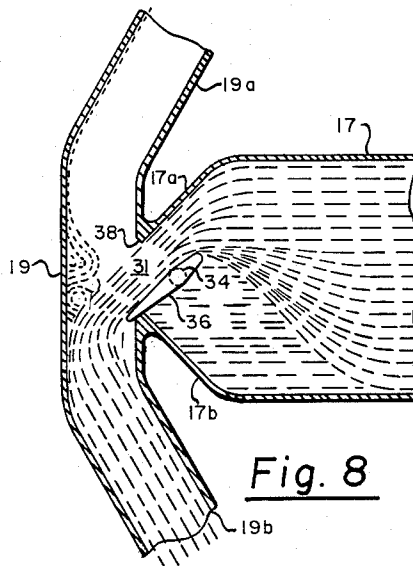
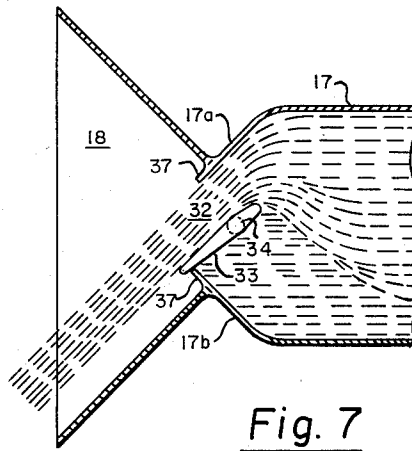
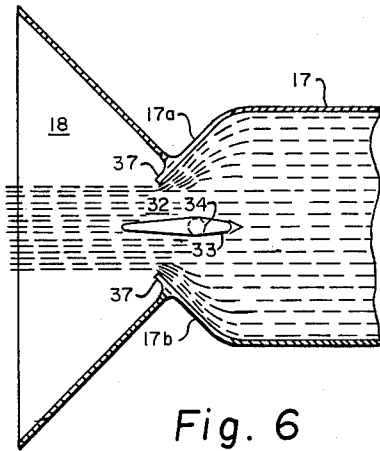
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3 Sheets-Sheet 3



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HYDROJET PROPULSION AND CONTROL MEANS FOR BOATS

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6 Claims. (Cl. 60—35.54)

This invention relates to systems for propelling and maneuvering boats, and more particularly to a mechanism for driving a boat forward, rearward, or turning it by means of the expulsion of reaction mass in the form of a water jet.

In an ordinary propeller-driven boat, the propeller dissipates a good deal of its power in cavitation, in the creation of peripheral turbulence, and in the uncontrolled path of the water behind the propeller. The present invention overcomes these difficulties by the use of an inboard pump designed for the smooth transmission of water without cavitation or turbulence, and by the utilization of a flume, nozzle, and associated elements embodying hydrodynamic principles for the discharge of a water jet. There is also no protruding propeller to become fouled or damaged by floating or submerged objects, or to endanger swimmers who may be in the water nearby.

The present invention also has the advantage of allowing shallow draft where this is desirable, in that it is unnecessary to have anything extending below the bottom of the boat, as a propeller must often do in order to remain wholly submerged. Further, in small boats of the propeller type the shaft must extend somewhat downward at an angle to the waterline in order to keep the propeller submerged, whereby a portion of its thrust is expended in a lifting direction rather than wholly forward. In this invention, on the other hand, the reaction mass may be expelled rearwardly directly along the line of motion.

In addition, a change from forward direction to reverse may be made very rapidly in a boat employing this invention. When the propeller of a boat moving full speed ahead is reversed, it does not cut the water at the most suitable angle, being designed for efficiency in only one direction; further, cavitation is extremely pronounced, owing to the necessity for the propeller to thrust water against a rapid slipstream. Using the system of this invention, cavitation does not occur, and the thrust of the entire reaction mass may be instantly diverted by valve means to the opposite direction without reversing the pump, which turns in one direction only.

It is therefore an object of this invention to provide means for propelling boats by expelling reaction mass.

It is another object to provide means for maneuvering boats by controlling the direction of expulsion of reaction mass.

A further object of the present invention is to provide reaction-propelling means for boats in which the thrust is directly along the line of motion.

An additional object is the provision of reaction-propelling means in which the direction of thrust is instantly reversible.

Yet another object of the invention is to provide a reaction-propelling means of "fail-safe" nature for boats.

It is a still further object to provide hydrojet propelling means in which the direction of the water jet is controlled by hydrodynamic principles.

The foregoing objects and others ancillary thereto will be readily understood on reading the following specification in connection with the appended drawings, in which like numerals indicate like parts, and in which

FIGURE 1 is a plan view of a small boat, partially cut away, showing generally the installation of the mechanism of this invention;

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FIGURE 2 is an elevation of a small boat, partially cut away, showing another view of the installation;

FIGURE 3 is a plan view, partly in cross-section, of the forward and reverse nozzles;

FIGURE 4 is an elevation in section of the pump and the thrust nozzles, taken on line 4—4 of FIGURE 3;

FIGURE 5 is an enlarged sectional elevation of the forward-reverse valve, showing its geometry;

FIGURE 6 is a plan in cross-section of a portion of the forward nozzle and control vane, showing the water jet;

FIGURE 7 is a similar view showing the operation of the control vane; and

FIGURE 8 is a view of the reverse nozzle and its control vane, similar to FIGURE 7.

In FIGURE 1 there is shown a plan view of a small boat 11 having a portion of the after deck 12 cut away, with a plan view of the mechanism of the present invention. FIGURE 2 shows an elevation of the boat with a portion of the hull cut away, and the mechanism of the present invention outlined in centerline section elevation. Installed in the hull below the deck is a motor 13 of any suitable type, connected in driving relationship to a rotary pump 14 positioned directly astern of the motor. The pump is contained within a housing 16 which is prolonged forwardly and downwardly in bifurcated fashion to form water intake ducts 16a and 16b open to the water at the bottom of the hull. The use of double intakes and their positioning as shown is a matter of convenience, but any desired form of water intake for the pump may be used.

Just aft of the pump and communicating therewith is a housing 17 containing the forward-reverse valve and serving as a water duct and header between the pump and the nozzles for forward or sternward motion. In FIGURE 2 the forward-reverse valve is shown in position for forward motion, blocking the upper, reverse nozzle and allowing a water jet to be ejected sternward under pressure and parallel to the water surface on which the boat floats, through drive nozzle 18. Reverse nozzle 19 is bifurcated, the bifurcations being prolonged forwardly and downwardly in ducts 19a and 19b to the port and starboard sides of the boat, respectively, and adapted to discharge water jets through ports 21a and 21b in a forward direction parallel to the surface of the water, and somewhat angularly outward from the centerline of the boat. Both drive nozzle 18 and reverse ports 21a and 21b are located as near the bottom of the boat as possible, and below the waterline.

FIGURE 3 is a plan view, largely in cross-section, of the reverse nozzle superposed on the drive nozzle and sharing a common transverse separating wall therewith, the control vane in the reverse nozzle, and the forward-reverse valve and its mounting. FIGURE 4 is a cross-section, taken on line 4—4 of FIGURE 3, showing an elevation of the drive nozzle, reverse nozzle, header containing the forward-reverse valve and stator blades, the pump, and a portion of one of the intake ducts.

The pump 14 may be a rotary pump of conventional helical form as shown, or other suitable pump. It draws water in through intake ducts 16a and 16b, passes it through stator blades 15 to straighten the flow, and delivers it under pressure to the header section 17; with the forward-reverse valve 22 in its uppermost position as shown, blocking the entrance to the reverse nozzle, the water will be delivered to the lower, forward-drive nozzle.

Forward-reverse valve 22 is a stirrup-shaped element comprising a valve plate 23 of rectangular outline having a pair of mounting arms 24 extending from the upstream side thereof, one arm at each end. The extending ends of the arms are fastened by any conventional means to a rotatable shaft 26 journaled in, and horizontally positioned by, the side walls of housing 17, the shaft being provided with appropriate bearings and sealing means to

prevent escape of water. Preferably, the shaft will comprise integral extensions of the arms 24, as shown, not extending across the flume, and thereby avoiding any occlusion of the water flow. The stirrup-shaped valve is thus positioned with the plate downstream from the shaft, extending across the channel, and adapted to swing up and down in an arcuate path upon partial rotation of the shaft, thereby fully opening one nozzle and closing the other at each end of its travel, or partially opening both nozzles when the plate is in an intermediate position.

The downstream face of the valve plate is convexly curved along the arc of travel, seating in part against the congruently curved edge of intermediate wall 27 between the drive nozzle and the reverse nozzle, and seating one edge or the other of the plate, according to its position, against the inner surface of housing 17. The valve plate need not have a precision fit against its seats, and there may be some leakage past its ends, but this is of no significance in the manipulation of the boat. To adjust the valve to any desired position, shaft 26 may be turned manually by means of a lever, crank, handwheel, linkage, or other conventional means, or it may be controlled by any suitable power actuation, such as gears, hydraulic cylinder, etc.

Since the forward speed of a boat incorporating the present invention is great, it would be extremely inconvenient and possibly dangerous to the passengers if the valve should accidentally shift from forward to reverse. FIGURE 5 shows a "fail-safe" feature of the mechanism, whereby if the valve control means should not be locked in place, manually held, or otherwise positively positioned, the valve will automatically assume the forward drive position.

In FIGURE 5 the valve 22 is shown in its uppermost, forward drive position, closing the reverse nozzle, and is shown in phantom outline in its lower, reverse position. It will be observed that the flat upstream face 28 of the valve plate is not normal to a centerline through the axis of the shaft and the plate itself, but the plane of face 28 is canted with its upper edge forward, in any position possible to the valve. Static pressure, however, acts normal to face 28, as shown by arrows 29, so that the net force of static pressure has always an upward component sufficient to lift the valve to its uppermost position. It is mechanically desirable to confine the divergence between the centerline and the direction of static pressure to as small an angle as possible, and in the hardware of the present embodiment this angle is approximately $7\frac{1}{2}^\circ$. However, it is not intended to limit the invention to any particular angle, since the minimum angle required will depend on the weight of the valve, its area, and the pressure encountered in header 17. Should it be desired to control the valve manually by a lever, it is possible, of course, to position the lever so that the moment of its dead weight adds to the lifting effect.

FIGURES 6, 7, and 8, respectively, show in semi-diagrammatic form the jet flow in forward drive, the steering means in forward drive, and the steering means in reverse. The sternward portions 17a and 17b of the side walls of header 17 are angularly constricted to form upper throat 31 just upstream of the reverse nozzle, and congruent lower throat 32 just upstream of the drive nozzle, the two throats being separated by the horizontal partition 27 which also separates the nozzles. The side walls are parallel to the centerline in the upstream part of the header, then converge inwardly in the downstream direction at a suitable angle to form the throats. In the present embodiment it has been found convenient to make this angle 45° , but it may be greater or lesser, depending on the maximum angle at which it is desired to discharge the water jet.

A control vane or blade 33 for the drive nozzle throat is pivotally positioned within the header on the centerline and extending downstream through throat 32. In cross-sectional plan view the vane has the shape of two

narrow isosceles triangles placed base to base, the apexes being rounded off and the angles formed by the juxtaposition of the bases being faired into the sides by smooth curves. The upstream one of two such hypothetical triangles is preferably of less height than the other, being in the present embodiment approximately one-half the height of the downstream triangle.

The vane is mounted on a rotatable shaft or pintle 34 vertically disposed with its axis passing through the centerline of the header and through the thickest part of the vane, that is, bisecting the two bases of the hypothetical triangles. The shaft is also positioned somewhat upstream from the narrowest constriction of the throat, and the dimensions and proportions of the vane so chosen that when the vane is turned to its fullest extent (such as the full right rudder shown in FIGURE 7) the face of the downstream triangle forming the jet boundary will be parallel to the facing side wall.

When control vane 33 is oriented in the straight fore-and-aft position shown in FIGURE 6 the water jet will issue in a straight line sternward. In this position the actual throat 32 is directly between lips 37 which are extensions of 17a and 17b and which project somewhat into the flared nozzle 18. Owing to the sharp edges of lips 37 the water will not follow around the flare of the nozzle, and a substantially rectangular jet issues with its lateral boundaries parallel or very nearly so, its top and bottom boundaries being also parallel and shaped by the top and bottom plates of the nozzle.

When the vane is turned, as in FIGURE 7, the throat moves upstream a short distance, its most upstream position being directly between the thickest part of the vane and the edge of the adjacent lip, this being the narrowest part of the gap, and occurring only at full rudder. Full rudder completely occludes one side of the header constriction, as shown, and the water immediately upstream from the occluded lip is more or less dead or in slight turbulence. The jet issues on the other side of the vane with substantially parallel boundaries shaped by the side wall of the throat and the flat side of the vane downstream from the turning axis.

It is not necessary to employ full rudder to obtain turning action, since the jet will always issue generally parallel to the centerline of the control vane, whatever its position, the water tending to follow the downstream flat sides of the vane. Moreover, owing to the proportioning of the vane upstream and downstream from its turning axis, the vane will remain in whatever position it may be placed from straight ahead to full rudder, the pressures on the fore and aft portions of the vane being equal.

As shown in FIGURE 8, the reverse throat and nozzle are provided with a control vane 36 identical in design and proportions to forward control vane 33, except that the two vanes may be of different heights, as shown in FIGURE 4. Reverse control vane 36 is positioned in the reverse throat and nozzle above and congruent with vane 33. Both vanes turn on the same axis, and should preferably be mounted on, or integral with, the same vertical shaft 34, which is journaled in the bottom and top walls of the header, and passes through partition 27, and is provided with appropriate bearings and sealing means to prevent escape of water.

It will be understood that when reverse control vane 36 is positioned in a straight fore-and-aft position water will flow equally on both sides thereof between lips 38 and be diverted by nozzle 19 into ducts 19a and 19b for eventual ejection through ports 21a and 21b for rearward motion. When vane 36 is turned to full rudder as shown in the drawing, the jet will issue parallel to the downstream flat face of the vane. Since nozzle 19 is closed at the rear, the jet will be diverted principally toward one or the other of ducts 19a or 19b, according to which way the vane is turned, but with a small proportion splashing against the rear wall and being diverted into the other duct. Hence, the turning action which

may be exerted in reverse is not so great as when going forward.

Both forward control vane 33 and reverse control vane 36 being operated by the same shaft, it may be provided with turning means such as a pulley 39 and a line to the ship's wheel, or it may have the wheel mounted directly on its upper end, or have any other convenient means of control.

It will be apparent that the forward-reverse valve 22 need not be positioned in either full forward or full reverse, but may be placed in an intermediate position to hold the boat motionless without reducing motor speed and pump flow. It may also be adjusted to partial forward or partial reverse to give any desired percentage of headway or sternward. Since both control vanes turn together, the turning motion will be in the desired direction even with both nozzles in partial operation.

The various elements of this invention are formed of corrosion-resistant metal, of which corrosion-resistant cast iron is preferred because of its low cost. However, other corrosion-resistant metals such as bronze or stainless steel will function equally well. The elements may be made of plate, bar, and round stock and fashioned by machining, welding, and other conventional techniques, but are preferably cast, with only such machining as may be necessary for fitting.

Although this invention has been described above in a preferred embodiment, it will be understood by those skilled in the art that various changes and modifications may be made without departing from the scope of the invention. It is intended to cover all such modifications in the appended claims.

What is claimed is:

1. Boat propelling means comprising in combination a water pump, a motor connected to said pump in driving relationship thereto, a header communicating with said pump and disposed downstream therefrom, a drive nozzle communicating with said header and disposed downstream therefrom and adapted to discharge a water jet sternward, a reverse nozzle communicating with said header and disposed downstream therefrom and adapted to discharge a water jet forward, and a valve disposed within said header and adapted to selectively channel water from said pump to said drive nozzle and said reverse nozzle, said valve being responsive to water flow through said header to urge said valve in a direction closing said reverse nozzle.

2. Boat propelling means comprising in combination a water pump, water intake means for said pump communicating therewith and disposed upstream therefrom, a motor connected to said pump in driving relationship thereto, a header communicating with said pump and disposed downstream therefrom, a drive nozzle communicating with said header and disposed downstream therefrom and adapted to discharge a water drive jet sternward, first control vane means pivotally disposed midstream within said header and extending into said drive nozzle and adapted to control the steering angle of discharge of said drive jet, a reverse thrust means comprising a reverse nozzle communicating with said header and disposed downstream therefrom and discharging into a thrust conduit which terminates in at least one thrust nozzle adapted to discharge a water reverse jet in a forward direction, second control vane means pivotally disposed midstream within said header and extending into said reverse nozzle and adapted to control the steering angle of said reverse jet, and a valve disposed within said header and adapted to selectively channel water from said pump to said drive nozzle and said reverse nozzle, said valve being responsive to water flow through said header to urge said valve in a direction closing said reverse nozzle.

3. Boat propelling means comprising in combination a water pump, water intake means for said pump and communicating therewith and disposed upstream there-

from, a motor connected to said pump in driving relationship thereto, a header having vertical side walls and communicating with said pump and disposed downstream therefrom, a drive nozzle communicating with said header and disposed downstream therefrom and adapted to discharge a water drive jet sternward, a reverse thrust means comprising a reverse nozzle superposed on said drive nozzle and communicating with said header and disposed downstream therefrom and discharging into a reverse thrust conduit which terminates in at least one thrust nozzle adapted to discharge a water reverse jet in a forward direction, the side walls of said header converging angularly inward in the downstream direction to form a throat for said drive nozzle and a throat for said reverse nozzle, first control vane means pivotally mounted within said header and extending through said drive nozzle throat and adapted to control the angle of discharge of said drive jet, second control vane means pivotally mounted within said header above said first means and extending through said reverse nozzle throat and adapted to control the angle of discharge of said reverse jet, and valve means disposed within said header and adapted to selectively channel water from said pump to said drive nozzle and said reverse nozzle.

4. Boat propelling means comprising in combination a water pump, water intake means for said pump communicating therewith and disposed upstream therefrom, a motor connected to said pump in driving relationship thereto, a header having top and bottom walls and vertical side walls and communicating with said pump and disposed downstream therefrom, a drive nozzle communicating with said header and disposed downstream therefrom and adapted to discharge a water drive jet sternward, a reverse thrust means comprising a reverse nozzle superposed on said drive nozzle and communicating with said header and disposed downstream therefrom and discharging into a reverse thrust conduit which terminates in at least one thrust nozzle adapted to discharge a water reverse jet in a forward direction, a horizontal partition separating said nozzles and having its forward edge extending into said header and forming with said bottom wall a drive nozzle entrance and with said top wall a reverse nozzle entrance, the side walls of said header converging angularly inward in the downstream direction to form a throat for said drive nozzle and a congruent throat for said reverse nozzle, first control vane means pivotally mounted within said header below said partition and extending through said drive nozzle throat and adapted to control the angle of discharge of said drive jet, second control vane means pivotally mounted within said header above said partition and extending through said reverse nozzle throat and adapted to control the angle of discharge of said reverse jet, and valve means disposed within said header and adapted to selectively occlude said drive nozzle entrance and said reverse nozzle entrance.

5. In a boat having a hull with side and bottom walls and a transom, the combination with said boat of propelling means disposed within said hull and comprising a water pump, a motor connected to said pump in driving relationship thereto, water intake means for said pump communicating therewith and having an intake aperture upstream therefrom and below the waterline of said boat, a header communicating with said pump and disposed downstream therefrom, a drive nozzle communicating with said header and disposed downstream therefrom and adapted to discharge a water jet sternward below the waterline of said boat, a reverse nozzle communicating with said header and disposed downstream therefrom and adapted to discharge a water jet forward below the waterline of said boat, and a valve disposed within said header and adapted to selectively channel water from said pump to said drive nozzle and said reverse nozzle, said valve being responsive to water flow through said

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header to urge said valve in a direction closing said reverse nozzle.

6. In a boat having a hull with side and bottom walls and a transom, the combination with said boat of propelling means disposed within said hull and comprising a water pump, a motor connected to said pump in driving relationship thereto, water intake means for said pump communicating therewith and having an intake aperture upstream therefrom and below the waterline of said boat, a header communicating with said pump and disposed downstream therefrom, a drive nozzle communicating with said header and disposed downstream therefrom and adapted to discharge a water drive jet through said transom and below the waterline of said boat, first control vane means disposed midstream within said header and extending into said drive nozzle and adapted to control the angle of discharge of said drive jet, a reverse nozzle communicating with said header and disposed down-

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stream therefrom, a left port and a right port disposed in the side walls of said boat below the waterline thereof and communicating with said reverse nozzle and adapted to discharge water therefrom in a forward direction, second control vane means disposed midstream within said header and extending into said reverse nozzle and adapted to control the direction of water flow therein, and valve means disposed within said header and adapted to channel water from said pump to said drive nozzle and said reverse nozzle.

References Cited in the file of this patent

UNITED STATES PATENTS

386,041	Thornycroft	July 10, 1888
2,024,274	Campini	Dec. 17, 1935
2,797,659	Haase et al.	July 2, 1957