United States Patent

[11] 3,611,972

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[21] Appl. No. **808,965**
[22] Filed **Mar. 20, 1969**
[45] Patented **Oct. 12, 1971**
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[32] Priority **Mar. 21, 1968**
[33] **France**
[31] **5,236**

[54] **SHIP WATER JET DIRECTIONAL CONTROL AND BRAKING MEANS**
8 Claims, 4 Drawing Figs.

[52] **U.S. Cl.** **114/151**
[51] **Int. Cl.** **B63h 25/46**
[50] **Field of Search** 114/151, 148

[56] **References Cited**

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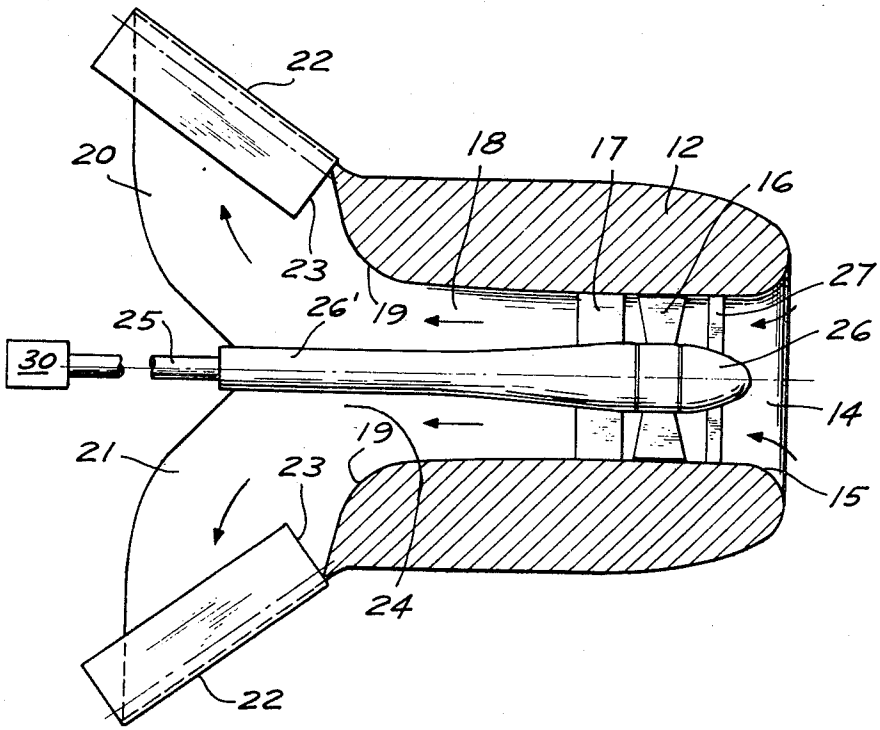
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ABSTRACT: Water jets are discharged from the front of the ship by a pump installed in a Y-shaped duct into which the water flows longitudinally, centrally of the ship and from which the flow discharges on the two opposite sides of the hull.



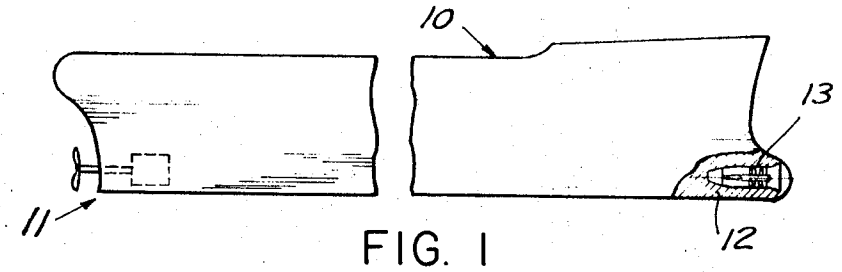


FIG. 1

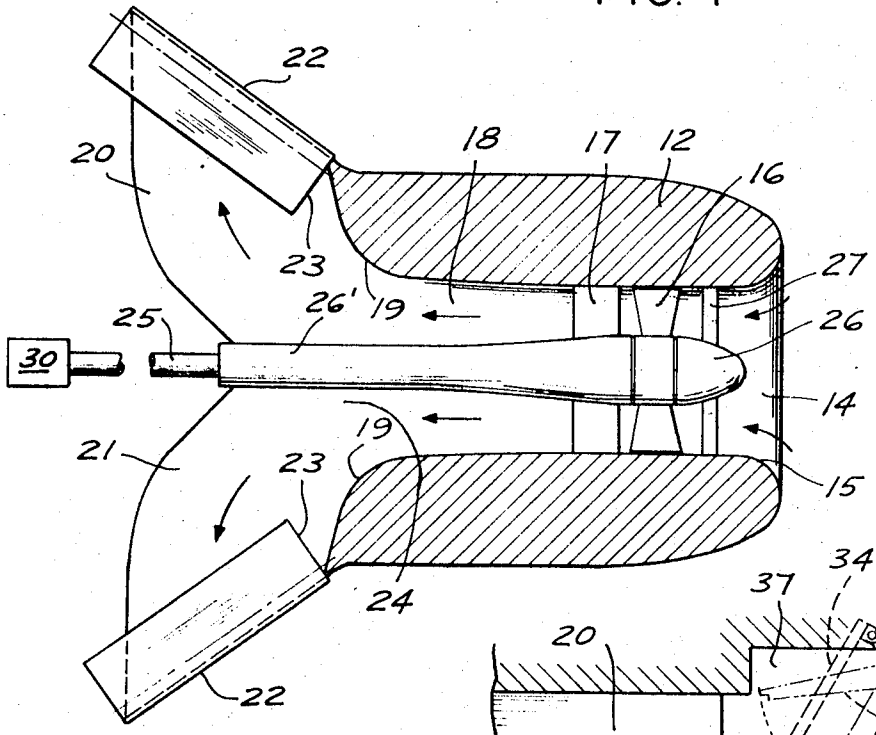


FIG. 2

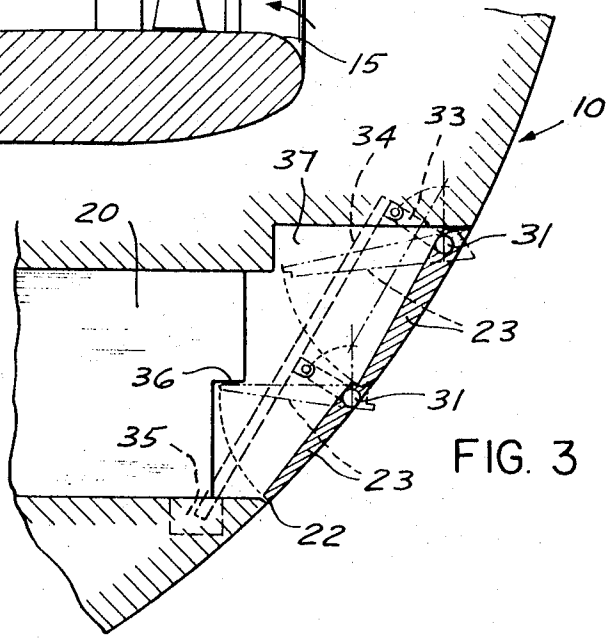


FIG. 3

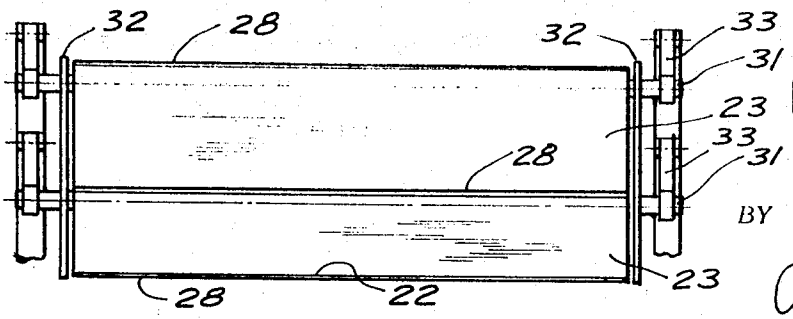


FIG. 4

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SHIP WATER JET DIRECTIONAL CONTROL AND BRAKING MEANS

THE INVENTION

This invention relates to means for controlling the direction of movement and the progress of a ship, and has for its primary purpose the provision of effective, reliable means for directionally controlling and/or braking a ship by water jets discharging from the front of the ship.

In accordance with the invention, the control jets of water are produced on the two opposite sides of the hull at the front of the ship by a pump installed in the longitudinally disposed stem of a Y-shaped duct into which water is drawn from the ship's bow and passes along the longitudinal center of the ship to the arms of such duct from which the flow is discharged in the form of jets at the sides of the hull. Means are provided to control the discharge of the flows from the arms of the duct in steering or maneuvering and braking the ship.

A better understanding of the invention and the novel features thereof will be obtained from a consideration of the following description and the accompanying drawings, which show by way of example a layout embodying the invention and in which:

FIG. 1 is a schematic view showing the location of the apparatus of this invention in a ship's bow;

FIG. 2 is a horizontal longitudinal sectional view of the apparatus shown in FIG. 1;

FIG. 3 is an enlarged vertical sectional view of one of the discharge orifices shown in FIG. 2; and

FIG. 4 is an exterior elevational view of the control shutters provided in the discharge opening shown in FIG. 3.

In FIG. 1 of the drawings, the reference number 10 indicates generally the hull of a ship provided with a conventional type of propulsion unit which is indicated generally by the reference numeral 11. The front part of the ship shown is provided with a bulbous bow portion 12 in which is installed directional control and braking apparatus embodying the invention and indicated generally by the reference numeral 13. As is shown more clearly in FIG. 2 of the drawings, the apparatus of this invention which may be installed in the bow of the ship, or in a bulbous bow portion 12 thereof, as is indicated in FIGS. 1 and 2, comprises a Y-shaped horizontally disposed duct having a main stem 18 located in the longitudinal central portion of the ship and branching at its inner end 19 into two arms 20 and 21 which lead to discharge orifices 22 provided in the opposite sides of the ship's hull in the forward portion of the ship. A pump 16 is located in the main duct portion 18 adjacent to the outer end of the latter which forms a front-facing inlet or intake orifice 14 in the bow of the ship.

As is shown more clearly in FIG. 2 of the drawings, the outer part of the main duct 18 is formed to provide a wide-radius transition surface 15 to the outer hull surface of the ship. The surface 15 is designed to ensure a proper, practically uniform flow of the water to the pump under any operating condition It has been found that the ratio between the area of the orifice 14 and the pump cross-sectional area should be approximately between 1.3:1 and 2.5:1 so as to ensure sound and uniform flow conditions in the pump intake section at any ship's forward speed, or rate of sideslip, and to ensure the absence of separation and eddies in the flow past and around the hull at any pump operating condition, or when the pump is inoperative as is the case when the ship is proceeding under normal cruising conditions.

The pump 16 is supported in the duct 18 by fixed guide vanes 17 and at its intake end is provided with a fixed, faired nose cap 26 that is held in position at the end of the pump by a screen 27. The screen 27 also serves the purpose of protecting the pump from the ingress of foreign bodies. The pump has a faired tail section 26' that extends from the impeller blade hub thereof and through the longitudinal central portion of the Y-shaped duct so that the pump shaft 25 is enclosed throughout the extent of such duct. The pump is driven through its shaft 25 by a drive system indicated generally schematically by the box designated 30. The drive system 30 may be of any suitable known construction and includes a known type of friction clutch capable of allowing the pump impeller to rotate freely in windmill fashion, in which condition it will produce the lowest possible or minimum braking torque. The pump 16 is a single-stage propeller pump operating with a single direction of flow as indicated by the arrows in FIG. 2 of the drawings. The pump 16 illustrated is of the variable-speed type with fixed impeller blades. It is within the contemplation of this invention, however, that the pump 16 may have fixed or adjustable blades, fixed or adjustable stator vanes, and a constant or variable speed of rotation. The characteristic feature of the pump 16 is that it should have a high specific discharge, which may for example exceed 0.6 and in some applications be as high as, or even slightly greater than 1.0.

It will be noted in FIG. 2 of the drawings that the pump delivery section of the main duct 18 is a slightly divergent straight section that is coaxial with respect to the pump. The pump delivery section is followed by a Y-branch 19 from which extend two arm or branch ducts 20 and 21 that each lead to a discharge orifice 22. Each arm duct is convergent, the extent of this convergence being such that the ratio between the cross-sectional area at the entrance 24 to the Y-branch 19 and the cross-sectional area at the end of each arm i.e., the discharge orifice 22, is between 1.3:1 and 2:1, Since the ratio between the cross-sectional areas at the upstream and downstream ends of each duct is of the stated order, the total combined cross-sectional area of the two discharge orifices 22 is greater than, or at least equal to, the cross-sectional area at the Y-branch entry 24. It will thus be seen that with only one orifice open, the flow through the duct becomes convergent or contracted, while when both orifices are simultaneously open or operating together, the flow will be divergent, or enlarged, or at least have a uniform velocity distribution if the cross-sectional area rotor is 2:1. The hydraulic design features of the Y-shaped duct, and especially its rounded transition contours, are such that when only one orifice 22 is open, such orifice discharges full-bore without separation and with a substantially uniform flow distribution across the jet. With both orifices discharging at the same time, the flow, as has been indicated, will be divergent, or at least of uniform velocity.

The discharge orifices 22, as is shown more clearly in FIG. 4 of the drawings, are each of an elongated shape, for example rectangular, as shown, and have a length approximately three or four times their height. As indicated in FIGS. 3 and 4, the elongated orifices 22 extend lengthwise of the ship and are located along the ship's waterlines so that the jets are discharged therefrom directly into the surrounding waters. With such an arrangement, it has been found that the interaction of the flow past and around the ship's hull with the jets is so limited that most of the effectiveness of the transverse thrust produced by the jet when the ship is under way is preserved. On the other hand, it has also been found that such an arrangement helps to dissipate the jet's energy so as to limit possible damage by the jets to the shore, or banks, or to any obstacles the ship may encounter.

Each of the discharge orifices 22 is controlled by two elongated shutters 23,23 which when fully closed, as shown in solid lines in FIGS. 3 and 4 of the drawings, complete the continuity of the hull plating and thereby prevent parasitic drag. The shutters 23,23 are horizontally hinged on bars 31,31 for retraction inwardly as shown in dotted outline in FIG. 3 of the drawings, and so that their joint lines 28 run parallel to the ship's longitudinal centerline in the closed positions thereof. As is also shown in FIG. 3, the shutters 23 are so hingedly mounted and configured that in their closed positions the outer surfaces thereof are flush with the exterior surfaces of the ship's hull plating and the joint lines 28 are substantially closed. The opening and closing of the shutters 23,23 for each orifice 22 are separately controlled in any suitable manner. Thus, as indicated in FIGS. 3 and 4 of the drawings, the control shutters may be pivotally supported on sideplates 32, and operated by arms 33 secured to the shutter bars 31 and

pivotally connected to rods 34 actuated by a remotely controlled motor 35 in a manner known to the art. The end portion of each arm duct 20,21 may be constructed to provide side shoulders 36 against which the ends of the lower or free edge of the lower shutter abuts in its opened position, and a pocket 37 into which the upper shutter is retracted. The arms 33 and rods 34 are constructed and arranged so that in the retracted positions of the shutters, the bottom shutter is slightly inclined upwardly from its pivotal axis, and the top shutter is inclined downwardly from its pivotal axis so that it forms a continuation of the discharge end of the upper wall of the arm duct.

It will be understood from the foregoing description that in the use of the apparatus to steer or maneuver the ship, the discharge orifice 22 on the ship's side opposite to the direction in which it is intended to direct the ship is opened, and the discharge orifice 22 on the other side of the ship is closed. The openings of such discharge orifices are also controlled through their associated shutters to add an additional braking force to the braking forces being produced as a result of the ship's drag and by the appropriate operation of the ship's screws or main propulsion unit 11. This braking force exercised by the resulting jets discharging directly into the surrounding water in directions transverse to the direction of movement of the ship will be proportional to both the rates of flow through the arm duct, or ducts and the ship's forward speed. In order to provide the greatest possible braking force by the apparatus of this invention, both discharge orifices must be simultaneously and fully open in order to reduce the hydraulic load dissipated by the jets to a minimum, and the pump 16 must be operated at its highest possible speed. The pump 16 and the driving system are so constructed and arranged that the manner in which the pump operates at its highest speed is made dependent on a certain critical speed of the ship. It will be understood that the water intake for the apparatus of this invention is dependent on the hydraulic head created by the ship's forward speed. As the ship's speed increases the pump has to produce that much less head, and, therefore, the power absorbed by the pump is also reduced. The critical forward speed of the ship is taken as that ship's speed at which the pump shaft horsepower becomes zero with both discharge orifices fully open. When the ship's speed is below that critical speed, the pump is run at the highest speed the motor allows, while when the ship's speed is above such critical value, the pump is allowed to rotate freely in windmill fashion in order that it may reach its highest possible rotational speed and thereby enable the rate of flow through the apparatus to reach its maximum value. In accordance with the invention, the apparatus, and especially the pump impeller and shaft assembly, are designed so that the maximum rotational speed of the pump will be attained when the ship is traveling at full speed.

It will also be understood that by proper selective manipulation of the shutters, one may impart to the vessel at the same time, a turning movement and a braking movement. This may be accomplished for example, by opening both discharge orifices 22 simultaneously, but selectively controlling the shutters 23 thereof so that one orifice 22 is opened to a greater degree than the other.

What is claimed is:

1. Apparatus for effecting directional control and/or braking of a ship by means of water jets discharging from the front of the ship, comprising a Y-shaped duct having a main section to be located in the longitudinal central portion of the ship with its outer forward end forming a front-facing centralized inlet orifice in the bow of the forward-moving ship, and having two branch sections extending from a Y-branch entry at the inner end of said main section to the opposite sides of the hull and terminating in discharge orifices at such hull sides, whereby an inflow of water takes place in the longitudinal central portion of the forward end of the ship and such flow may be discharged on the two opposite sides of the hull, said two branch sections and their discharge orifices being constructed and arranged to cause the energy of the two jets discharged thereby to be dissipated perpendicularly to the direction of movement of the ship, means controlling the flow discharge through said orifice, and pump means for affecting the rate of flow through said Y-shaped duct and comprising a single-stage propeller pump located in said main duct section and having a specific discharge higher than 0.6, said controlling means being operable to discharge the jets from both of said orifices at the same time during forward movement of the ship so that the energy created in such jets by the flow which enters the inlet orifice at the bow due to the forward movement of the ship and the additional action of said pump means on said flow is simultaneously dissipated on both sides of the hull perpendicularly to the forward movement of the ship to exert a braking action on such forward movement of the ship.

2. Apparatus for effecting directional control and/or braking of a ship by means of water jets discharging from the front of the ship, comprising a Y-shaped duct having a main section to be located in the longitudinal central portion of the ship with its outer forward end forming a front-facing centralized inlet orifice joined by a wide-radius transition surface to the outer hull surface of the ship, and having two branch sections extending from the inner end of said main section to the opposite sides of the hull and terminating in discharge orifices at such hull sides, whereby an inflow of water takes place in the longitudinal central portion of the forward end of the ship and such flow may be discharged on the two opposite sides of the hull, said discharge orifices being arranged lengthwise of the ship and discharging such inflow in the form of jets directly into the surrounding water in directions transverse to the direction of movement of the ship, means controlling the flow discharge through said orifices, and pump means for affecting the rate of flow through said Y-shaped duct and comprising a pump located in said main duct section adjacent to such transition surface, a faired nose cap provided on the inlet end of said pump, and a faired tail section extending from the impeller blade hub of said pump and through the longitudinal central portion of said Y-shaped duct.

3. Apparatus for effecting directional control and/or braking of a ship by means of water jets discharging from the front of the ship, comprising a Y-shaped duct having a main section to be located in the longitudinal central portion of the ship with its outer forward end forming a front-facing centralized inlet orifice, and having two branch sections extending from a Y-branch entry at the inner end of said main section to the opposite sides of the hull and terminating in discharge orifices at such hull sides, whereby an inflow of water takes place in the longitudinal central portion of the forward end of the ship and such flow may be discharged on the two opposite sides of the hull, the ratio between the cross-sectional area of the Y-branch entry at the inner end of said main duct section and the cross-sectional area of each duct section at its discharge orifice is approximately between 1.3:1 and 2:1, and the total combined cross-sectional area of the two discharge orifices is greater than or at least equal to the cross-sectional area at the Y-branch entry at such inner end of said main section, said discharge orifices discharging such inflow in the form of jets directly into the surrounding water in directions transverse to the direction of movement of the ship, means controlling the flow discharge through said orifices, and pump means for affecting the rate of flow through said Y-shaped duct and comprising a single-stage propeller pump located in said main duct section and having a specific discharge higher than 0.6.

4. Apparatus as defined in claim 3, in which said main duct section inwardly from the pump propeller to the entrance of the Y-branch of the duct, is a slightly divergent straight section.

5. Apparatus as defined in claim 3, in which said branch duct sections are hydraulically designed to have rounded transition contours such that with only one discharge orifice open, the open discharge orifice will discharge full bore without separation and with a substantially uniform flow distribution across the jet.

6. Apparatus for effecting directional control and/or braking of a ship by means of water jets discharging from the front of the ship, comprising a Y-shaped duct having a main section to be located in the longitudinal central portion of the ship with its outer forward end forming a front-facing centralized inlet orifice, and having two branch sections extending from the inner end of said main section to the opposite sides of the hull and terminating in discharge orifices at such hull sides, whereby an inflow of water takes place in the longitudinal central portion of the forward end of the ship and such flow may be discharged on the two opposite sides of the hull, said discharge orifices being arranged lengthwise of the ship and discharging such inflow in the form of jets directly into the surrounding water in directions transverse to the direction of movement of the ship, means for controlling the flow discharge through said orifices comprising shutters constructed and arranged to provide a continuation of the exterior surfaces of the hull in the fully closed condition thereof, and to be retracted inwardly into said branch duct sections from such fully closed condition, and pump means for affecting the rate of flow through said Y-shaped duct.

7. Apparatus as defined in claim 3, in which said flow discharge control means includes adjustable closure means at the terminal ends of said branch duct sections for each discharge orifice, and means operable to selectively control said closure means.

8. Apparatus for effecting directional control and/or braking of a ship by means of water jets discharging from the front of the ship, comprising a Y-shaped duct having a main section to be located in the longitudinal central portion of the ship with its outer forward end forming a front-facing centralized inlet orifice, and having two branch sections extending from the inner end of said main section to the opposite sides of the hull and terminating in discharge orifices at such hull sides, whereby an inflow of water takes place in the longitudinal central portion of the forward end of the ship and such flow may be discharged on the two opposite sides of the hull, said discharge orifices being arranged lengthwise of the ship and discharging such inflow in the form of jets directly into the surrounding water in directions transverse to the direction of movement of the ship, means for controlling the flow discharge through said orifices including a plurality of shutters covering each of said discharge orifices and having joint lines disposed generally parallel to the ship's longitudinal centerline, the shutters at each orifice being constructed and arranged to provide a continuation of the exterior surfaces of the hull in the closed condition thereof, and to be retracted inwardly into its associated branch duct section from such fully closed condition, and means for actuating such shutters, and pump means for affecting the rate of flow through said Y-shaped duct.