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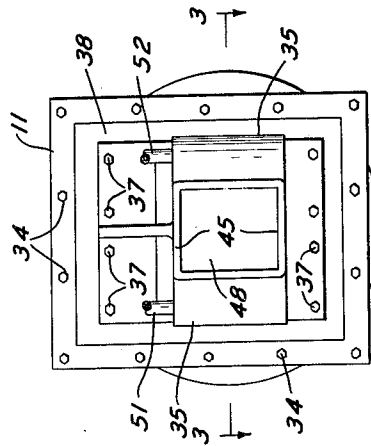
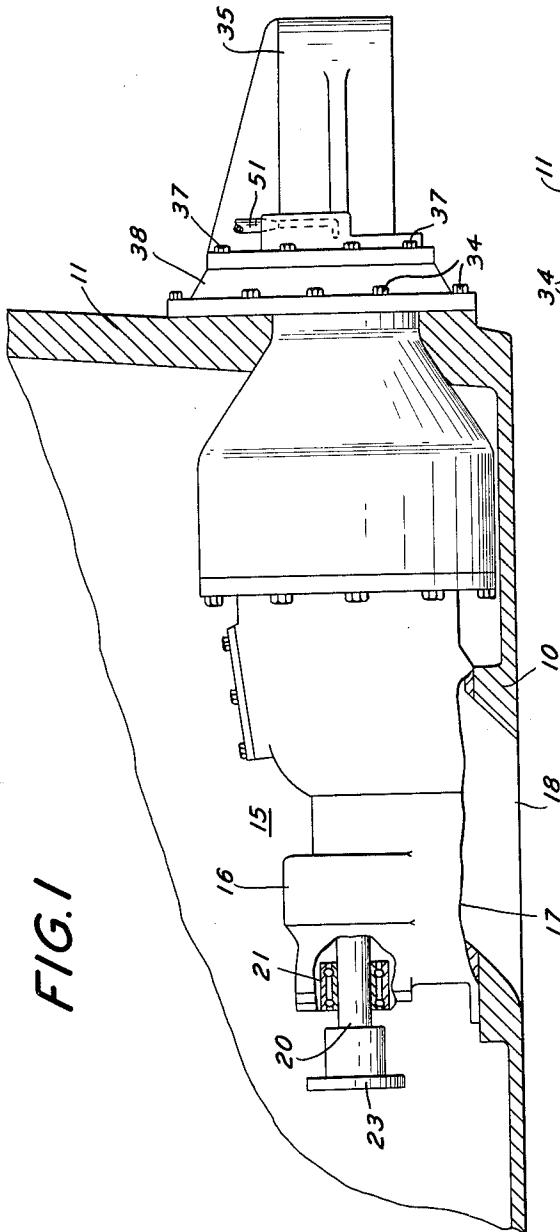
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3,206,928

BOAT STEERING APPARATUS

Filed May 16, 1962

2 Sheets-Sheet 1



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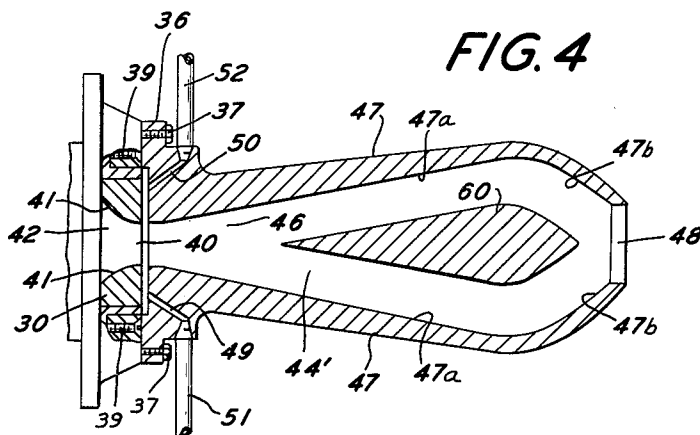
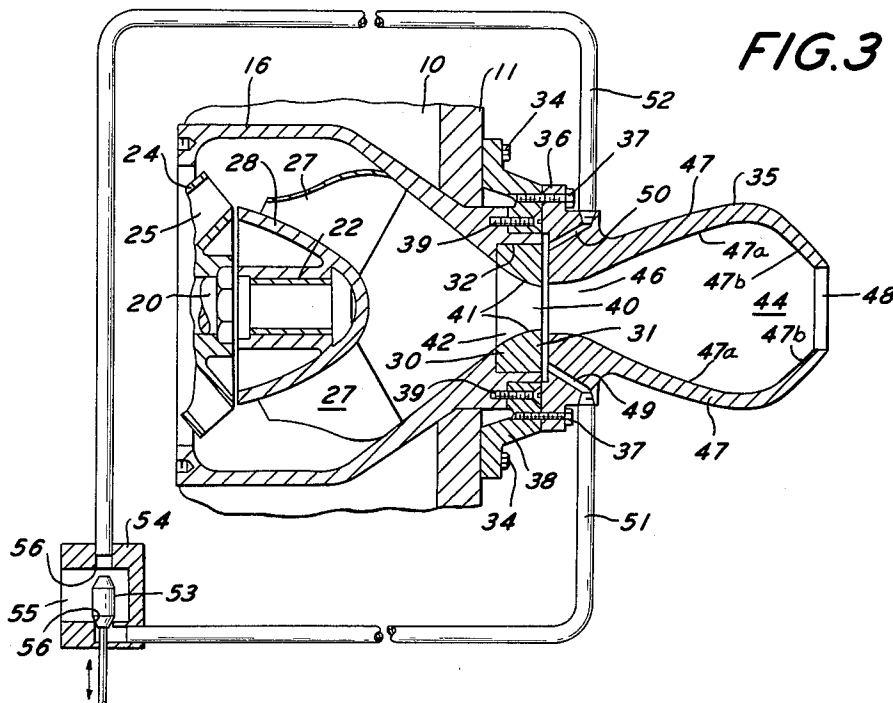
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BOAT STEERING APPARATUS

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20 Claims. (Cl. 60—35.54)

This invention relates to boat steering apparatus and more particularly apparatus for controlling the positioning of a fluid jet delivered from the boat for propulsion or for steering.

It is the present practice to employ a fluid jet discharge from the rear of a boat for propelling the boat. Movable baffles or vanes or other mechanical moving parts have been employed to deflect the jet for purposes of steering the boat, but such mechanical steering systems have relatively moving parts which deteriorate from corrosion, erosion and fouling with solid contaminants of the fluid environment, and also require lubrication for proper operation.

It has been shown that the direction of a jet may also be controlled through the interaction of other fluid streams without the use of any movable deflecting vanes. These latter control systems are called fluid interaction controlled systems.

The principal object of the present invention is to provide improved fluid interaction jet controlled apparatus which is particularly useful for steering jet propelled boats but is not limited to such use.

It is a further object of the present invention to control the direction of the jet by the admission of atmospheric air under the control of a valve of simple construction.

It is a further object of the present invention to control the direction of a jet smoothly and continuously.

It is a further object of the present invention to provide a steering means which will not detract from the efficiency of the jet in the straight-a-way condition.

It is a further object of the present invention to provide boat steering apparatus which is relatively short in the direction of the jet.

It is a further object of the present invention to provide boat steering apparatus which has no moving parts in contact with the jet.

It is a further object of the present invention to provide boat steering apparatus which proportionately reduces the steering effect at high speeds or under choppy and hazardous water conditions.

It is a further object of the present invention to provide boat steering apparatus which inherently includes power steering capabilities without requiring any additional moving parts.

Other objects and advantageous features of the invention will be apparent from the description and claims.

The nature and characteristic features of the invention will be more readily understood from the following description, taken in connection with the accompanying drawings forming part thereof, in which:

FIGURE 1 is a side elevational view of boat steering apparatus in accordance with the invention;

FIG. 2 is a rear elevational view of the apparatus shown in FIG. 1;

FIG. 3 is a horizontal sectional view taken approximately on the line 3—3 of FIG. 2, fluid connections and a control valve therefor being shown diagrammatically; and

FIG. 4 is a horizontal sectional view of a modified form of interaction chamber.

It should, of course, be understood that the description and drawings herein are illustrative merely, and that various modifications and changes can be made in the

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structure disclosed without departing from the spirit of the invention.

Like numerals refer to like parts throughout the several views.

Referring now more particularly to the drawings in which a preferred embodiment of the invention is illustrated, a portion of the bottom wall of a boat is shown at 10 with a stern 11 extending upwardly therefrom in a conventional manner.

The bottom 10 of the boat preferably has mounted thereon and secured thereto a fluid jet device 15 which may be of any preferred type for providing a jet of water for propulsion. For this purpose, a housing 16 can be provided having an inlet opening 17 aligned with an opening 18 in the bottom 10 of the boat for water intake. The housing 16 has mounted therein a horizontal shaft 20 which can be supported in a front thrust bearing 21 and in a rear bearing 22. The shaft 20 can be rotated in any desired manner, such as by an engine (not shown) connected thereto by a flexible shaft coupling 23.

In the interior of the housing 16, the shaft 20 has an impeller 24 mounted thereon with vanes 25 for delivering fluid from the inlet opening 17 through fixed vanes 27 which support the bearing housing 28 for the rear bearing 22 and which are shaped to straighten out the flow of water from the impeller vanes 25 and deliver the same to the orifice 30 where it issues in the form of a jet. The jet is preferably delivered rearwardly of the boat.

The structure just referred to has heretofore been proposed and employed to provide a jet for boat propulsion.

In accordance with the present invention, a jet shaping orifice 30 is provided and has a rim 31 extending into a complemental socket opening 32 in the housing 16. A control housing 35 is provided and has a flange 36 which is secured by bolts 37 to a mounting frame 38. The mounting frame 38 can also be secured to the housing 16 by screws 39. The mounting frame 38 is fastened to the stern 11 of the boat in any desired manner, such as by bolts 34.

The jet shaping orifice 30 has a discharge opening 40 of rectangular shape with converging side boundary faces 41 and top and bottom boundary walls 42 formed as part of the orifice 30.

The control housing 35, rearwardly of the orifice 30, has an interiorly disposed interaction chamber 44 bounded at the top and bottom by flat plates 45 formed as part of the control housing 35. The interaction chamber 44 has an inlet section 46 axially aligned with the discharge opening 40 with the sides thereof spaced further apart than the width of the discharge opening 40.

The interaction chamber 44, rearwardly of the inlet section 46, has opposite side walls 47. The side walls 47 have portions 47a shaped so that the power jet can be locked thereon by boundary layer effect and portions 47b which direct the jet in offset or angular relation to the straight discharge, the portions 47a and 47b preferably being formed as continuous arcuate surfaces.

The interaction chamber 44 has a discharge opening 48 at the rear end thereof preferably of suitable size, as hereinafter explained, to set up a pressure in chamber 44 which may be different from the ambient discharge pressure.

The shaping of the side walls 47 is determined by the maximum velocity of the jet and the desired steering angle, a steering angle or maximum deflection of the jet of the order of 30° to either side being satisfactory.

The divergent portions 47a of the side walls 47 may separate as sharply as possible consistent with obtaining good lockon action of the jet, thereby decreasing the overall length of the interaction chamber 44.

The angle of the converging portions 47b of the side walls 47 must be sufficient to provide the desired maximum jet deflection.

At the entrance of the chamber 44 pipe connections 49 and 50 are provided to each side, these connections 49 and 50 being connected respectively by pipes 51 and 52 to ports 56 in a valve 53 in a valve housing 54 for determining the flow of fluid through the connections 49 and 50 in either direction to or from the connection 55. The valve 53 can be manually operated by a steering wheel (not shown).

In FIG. 4 a modified form of interaction chamber 44' is shown in which a fluid divider 60 is provided coaxially disposed with respect to the jet shaping orifice 30.

The mode of operation will now be pointed out.

Assuming that the shaft 20 is rotated to drive the impeller 24, water is drawn in through the opening 18 and the opening 17 to the vanes 25 of the impeller 24. Water delivered by the vanes 25 is straightened by the fixed vanes 27 and delivered through the outlet 40 in jet form.

In the form of the invention shown in FIG. 3, the jet of liquid, with the valve 53 in its neutral or intermediate position, will move in a straight path to and through the interaction chamber 44 and through the discharge opening 48 to drive the boat in a straight path.

If, now, it is desired to change the direction of movement of the boat the valve 53 is moved in the appropriate direction from its central or neutral position.

Steering can be effected in several different ways, dependent upon the shaping of the parts and the variation of certain dimensions.

It has been found that when the jet issues from the jet shaping orifice 30 it expands slightly as it passes through the interaction chamber 44.

If the opening 48 is much larger than the size of the jet where it emerges from the chamber 44 there will be negligible pressure change in the chamber 44. As the size of the opening 48 is decreased an aspirating effect is obtained causing a negative pressure in the chamber 44 which is at a maximum when the opening 48 is approximately equal to the size of the jet. If the opening 48 is decreased below jet size the aspirating effect disappears.

If the opening 48 is smaller than the size of the jet where it emerges from the chamber 44 then a positive pressure effect is obtained in the chamber 44.

The jet divides the interior of the chamber 44 into two regions with which the pipes 49 and 50 are in communication.

The jet may be deflected toward either side wall portion 47a if the pressure on one side thereof is higher than that along the other side thereof, and the jet will follow along the diverging portion 47a of the wall and then be returned by the converging portion 47b.

The controlling pressures along the wall portions 47a may be varied by admitting or removing fluid through the fluid connections 49 and 50. The valve 53 can have the connection 55 connected to a source or sink whose pressure is higher or lower than the pressure along the wall portions 47a when the valve 53 is at its midposition.

If the source connected to the connection 55 is at a higher pressure, moving the valve 53 in a direction to open one of the ports 56 will increase the pressure along the wall portion 47a to which it is connected and will cause the jet to deflect toward the opposite wall portion 47a and move therealong.

It has been found advantageous to size the opening 48 so that the average pressure in the chamber 44 is below atmospheric. Thus, the atmosphere provides a source at 55 higher than the average pressure in the chamber 44 so that when either of the valve ports 56 is open, atmospheric air is drawn through that port 56 to increase the pressure in the corresponding side of the chamber 44.

This arrangement requires no additional source of pressure fluid and is thus particularly advantageous for boat steering.

The valve 53 is such that in the midposition both ports 56 are open and displacement of the valve stem gradually causes one port to close while the other is opened. The

steering effect on the jet is also gradual provided the opening of the ports 56 in the midposition is not smaller than about one-eighth of the cross section of the jet. If the total opening of the ports 56 is too small there may be a snap action with a sudden change from a locked on condition of the jet along one wall portion 47a to a locked on position along the opposite wall portion 47a.

The areas of the connecting tubes 51 and 52 and the passageways 49 and 50 must each be greater than the midposition area of ports 56 to avoid loss of steering sensitivity near the midposition of the valve 53.

The use of a baffle 60 as shown in FIG. 4 makes the sizing of the ports 56 and of the opening 48 less critical. The introduction of the baffle 60 slightly reduces the efficiency of the jet for propulsion in the straight and undeflected condition.

It has also been found feasible to size the opening 48 to produce a pressure above atmosphere in the chamber 44 and if connection 55 is connected to the atmosphere whichever of the ports 56 is open can be used for exhausting fluid to the atmosphere causing a reduction in the pressure on the corresponding side of the chamber 44. The connection 55 may then be connected to a sump (not shown). The steering just referred to operates reversely, insofar as control by the valve 53 is concerned from that previously described, and avoids entraining air in the jet.

For a given configuration having the desired performance characteristics the length of the interaction chamber 44 is proportional to the width of the jet. The power of the jet is a function of its cross section. Accordingly, by providing a greater height of the jet the power can be increased without increasing the width, and the linear dimension of the chamber 44 can be kept smaller for a given power output.

In order to seal the jet along the top and bottom of the chamber 44 a rectangular shape of jet is preferred, the nozzle 40 being shaped accordingly.

When the boat is moving at high speeds or under choppy conditions there is a tendency for air to be admitted with water through the inlet opening 18. Such air has the effect of changing the condition of the jet from a solid liquid condition. The jet is not then deflected to the same extent for the same movement of the valve 53. This has been found advantageous in that it prevents excessively sharp turning of the boat under hazardous conditions.

The energy of the jet itself is utilized in a manner such that no auxiliary sources of power are necessary. The valve 53 can be moved with relatively small effort.

I claim:

1. Jet direction control apparatus comprising a source of fluid under pressure, a nozzle to which said source is connected for providing a fluid jet, wall portions defining a jet direction control chamber into which said nozzle is directed, said control chamber having a single discharge opening, said discharge opening being aligned with said nozzle, and having between said nozzle and said discharge opening opposite diverging wall portions followed by opposite converging wall portions, fluid connections to opposite sides of said chamber between said nozzle and said diverging wall portions for influencing the direction of said jet, a source of pressure fluid, and means for controlling the flow from said source through said connections to said opposite sides of said chamber.

2. Jet direction control apparatus as defined in claim 1 in which said last means is valve means.

3. Jet direction control apparatus as defined in claim 1 in which said source of pressure fluid is the atmosphere and said last means is valve means.

4. Jet direction control apparatus as defined in claim 1 in which said source of pressure fluid is the atmosphere and said last means includes a valve member for simultaneously reducing flow through one of said connections while increasing the flow through the other of said connections.

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5. Jet direction control apparatus as defined in claim 1 in which said last means is valve means, and said valve means has control ports connected to said fluid connections and a movable member for controlling said ports, and said movable member has portions for closing one of said ports while opening the other of said ports.

6. Jet control apparatus as defined in claim 1 in which said last means is a movable valve member for controlling fluid flow through said connections, and said diverging wall portions at the jet entrance are more widely spaced than the opening of said nozzle to proportion the deflection of the jet to the movement of said valve member.

7. Jet direction control apparatus comprising a source of fluid under pressure, a nozzle to which said source is connected for providing a fluid jet, wall portions defining a jet direction control chamber into which said nozzle is directed, said control chamber having a single discharge opening, said discharge opening being aligned with said nozzle, and having between said nozzle and said discharge opening opposite diverging wall portions followed by opposite converging wall portions, fluid connections to opposite sides of said chamber between said nozzle and said diverging wall portions for influencing the direction of said jet, a source of fluid connected to said fluid connections, and means for controlling the pressure of said source through said connections to values different from those of the pressures at said opposite sides of said chamber.

8. Jet direction control apparatus as defined in claim 7 in which said diverging and converging wall portions on each side have continuous arcuate surfaces.

9. Jet control apparatus as defined in claim 7 in which the discharge opening is of a size related to the jet to produce an aspirating effect which reduces the pressure in said chamber.

10. Jet control apparatus as defined in claim 7 in which the discharge opening is of a size related to the jet to produce a back pressure in said chamber higher than that at the discharge opening.

11. Jet control apparatus as defined in claim 7 in which said diverging wall portions bound with the jet opposite regions at which the pressure decreases when approached by the jet and for influencing the direction of the jet.

12. Jet control apparatus as defined in claim 7 in which said nozzle is rectangular in cross section.

13. Jet control apparatus as defined in claim 7 in which the height of the nozzle is in excess of its width.

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14. Jet direction control apparatus as defined in claim 7 in which said chamber between said nozzle and said discharge opening has a free and unobstructed path for said jet.

15. Jet direction control apparatus as defined in claim 7 in which said chamber has a fluid divider therein interposed between said nozzle and said discharge opening for continuously dividing said jet in accordance with fluid delivery through said fluid connections.

16. Boat steering apparatus comprising a boat, a source of fluid under pressure mounted in said boat, a nozzle to which said source is connected for providing an impelling fluid jet, a control housing mounted in said boat and having wall portions defining a jet direction control chamber into which said nozzle is directed, said control chamber having a single discharge opening, said discharge opening being aligned with said nozzle, and having between said nozzle and said discharge opening opposite diverging wall portions followed by opposite converging wall portions, fluid connections to opposite sides of said chamber between said nozzle and said diverging wall portions for influencing the direction of said jet, a source of pressure fluid connected to said fluid connections, and means in said fluid connections for controlling flow through said fluid connections.

17. Boat steering apparatus as defined in claim 16 in which said last means is valve means.

18. Boat steering apparatus as defined in claim 16 in which said source is the atmosphere and said last means is valve means.

19. Boat steering apparatus as defined in claim 16 in which said source is the atmosphere, and said last means includes a manually operable valve member for selectively reducing flow through one of said connections while increasing the flow through the other of said connections.

20. Boat steering apparatus as defined in claim 16 in which said diverging and converging wall portions on each side have continuous arcuate surfaces.

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