

April 2, 1963

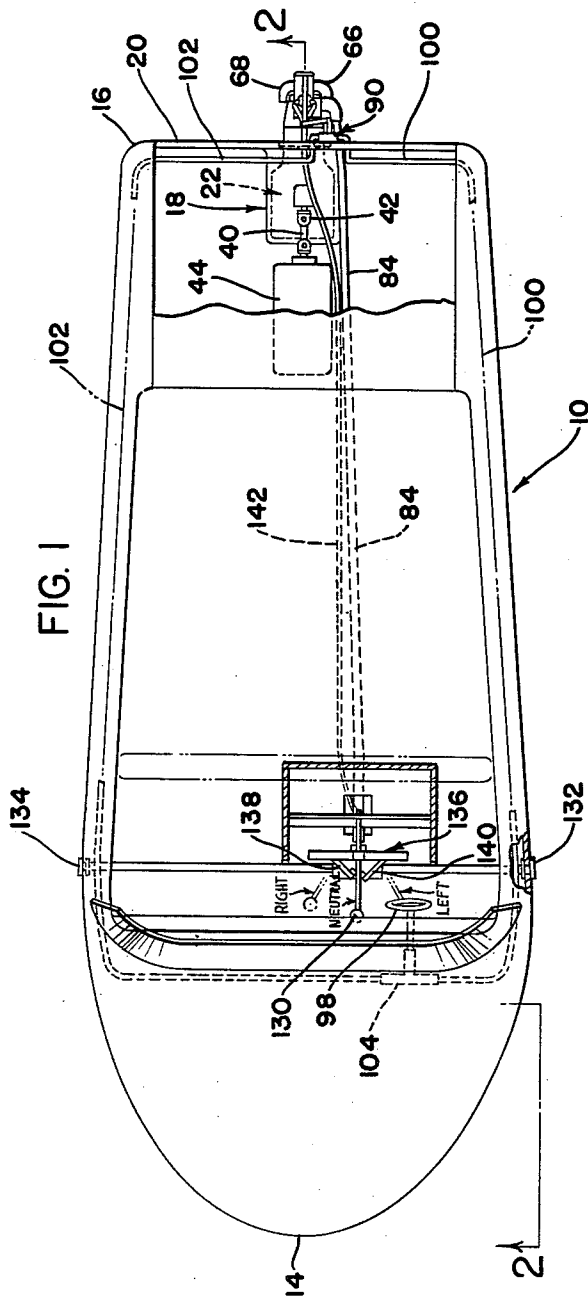
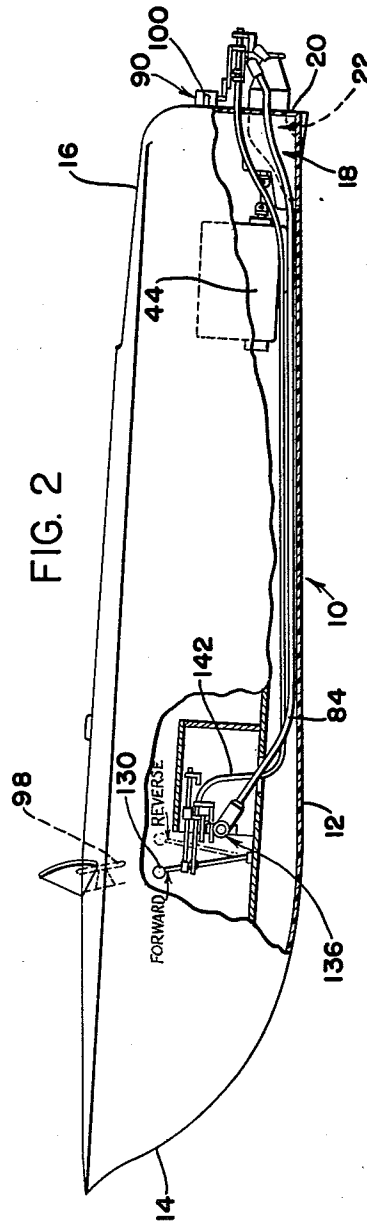
H. U. SPENCE

3,083,530

STEERING DEVICE FOR TURBINE POWERED WATERCRAFT

Filed Sept. 16, 1960

5 Sheets-Sheet 1



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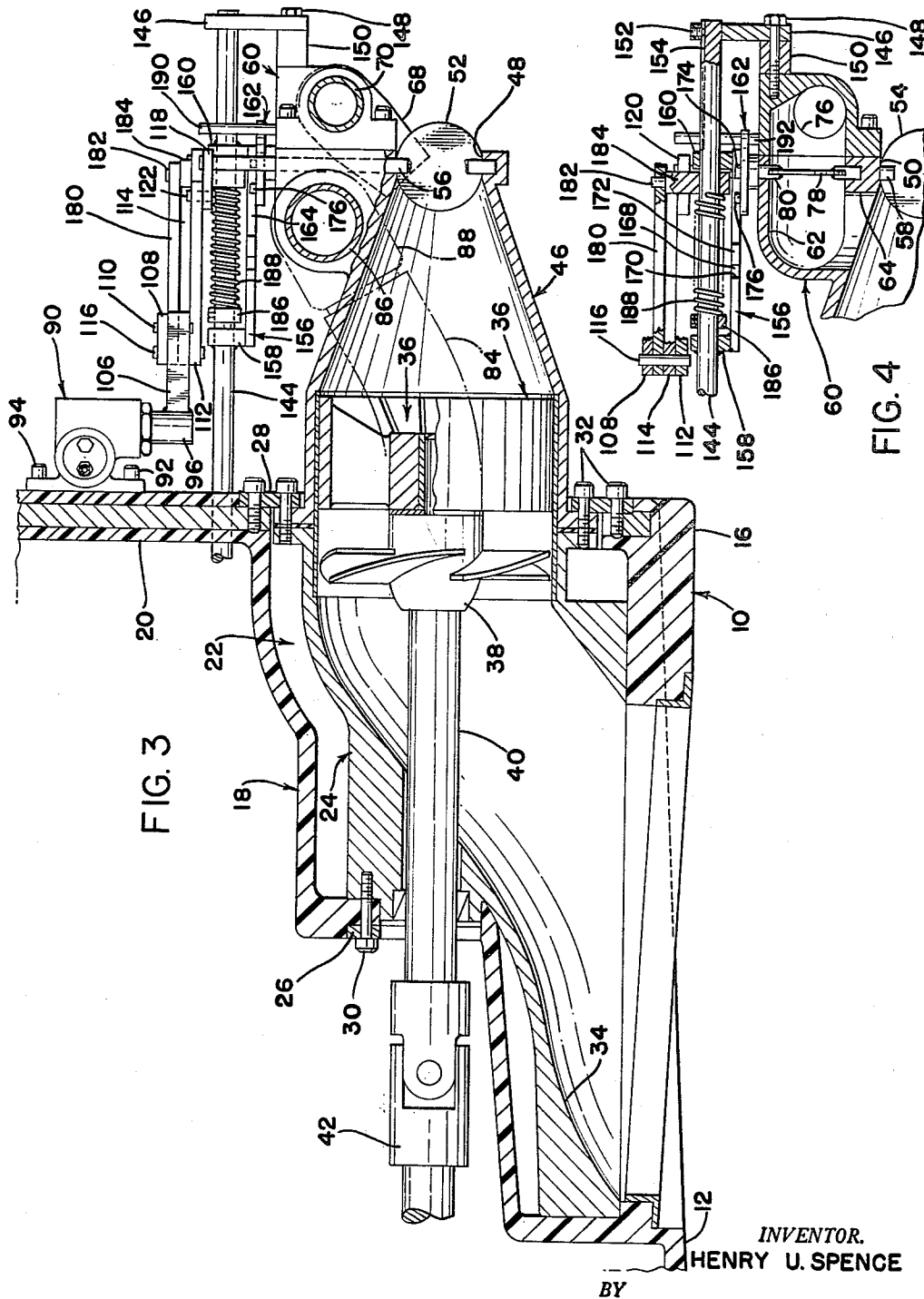
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STEERING DEVICE FOR TURBINE POWERED WATERCRAFT

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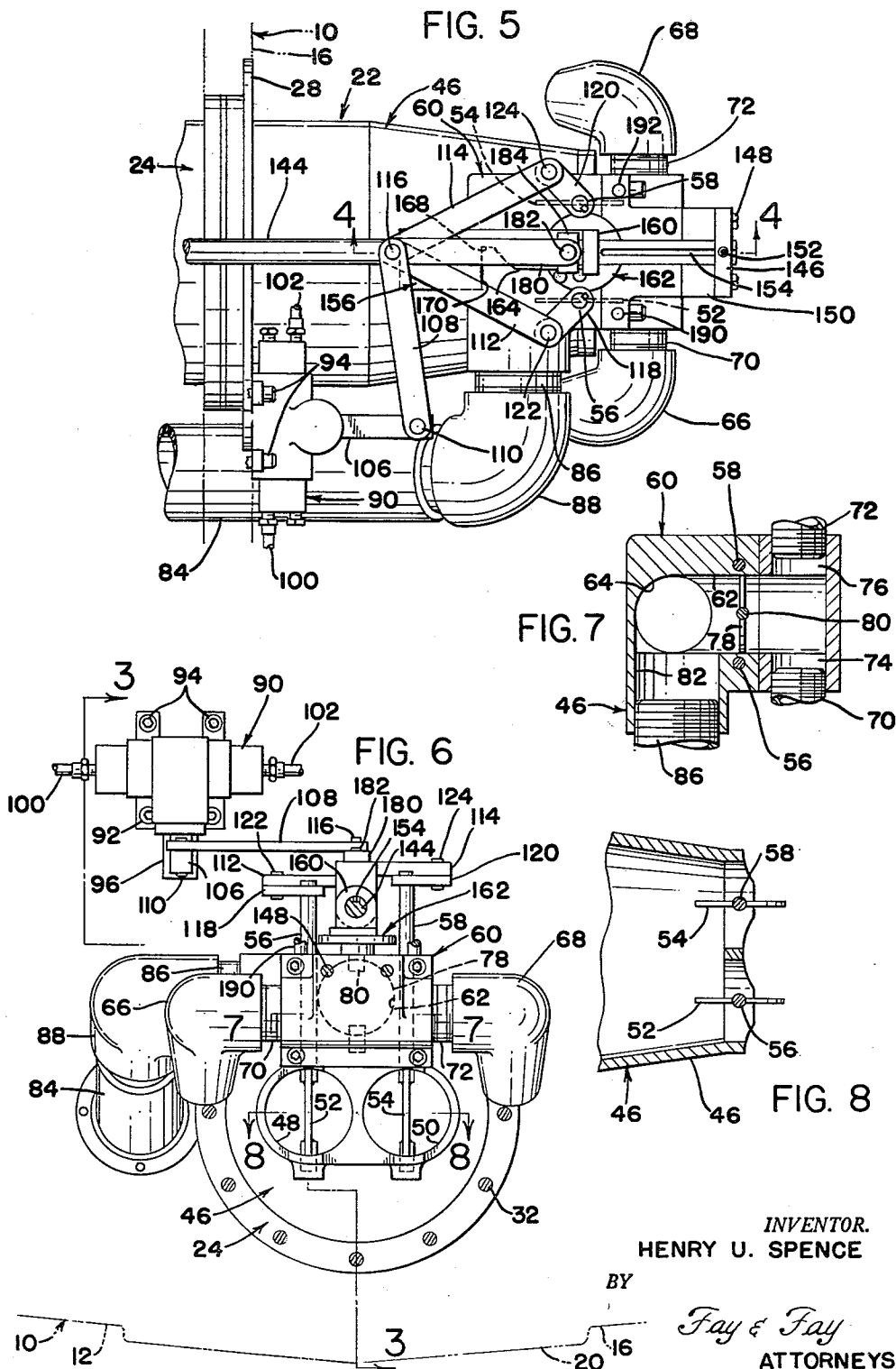
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5 Sheets-Sheet 3



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STEERING DEVICE FOR TURBINE POWERED WATERCRAFT

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FIG. 9

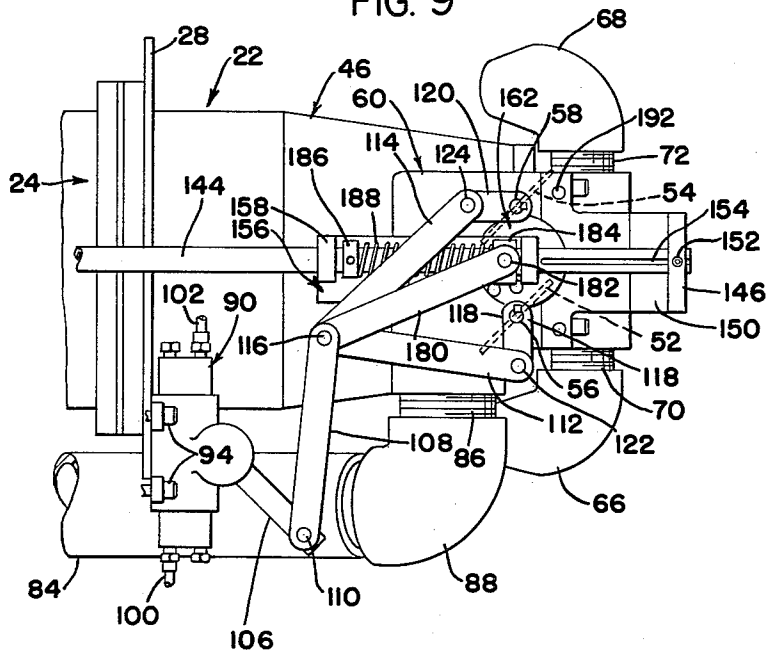
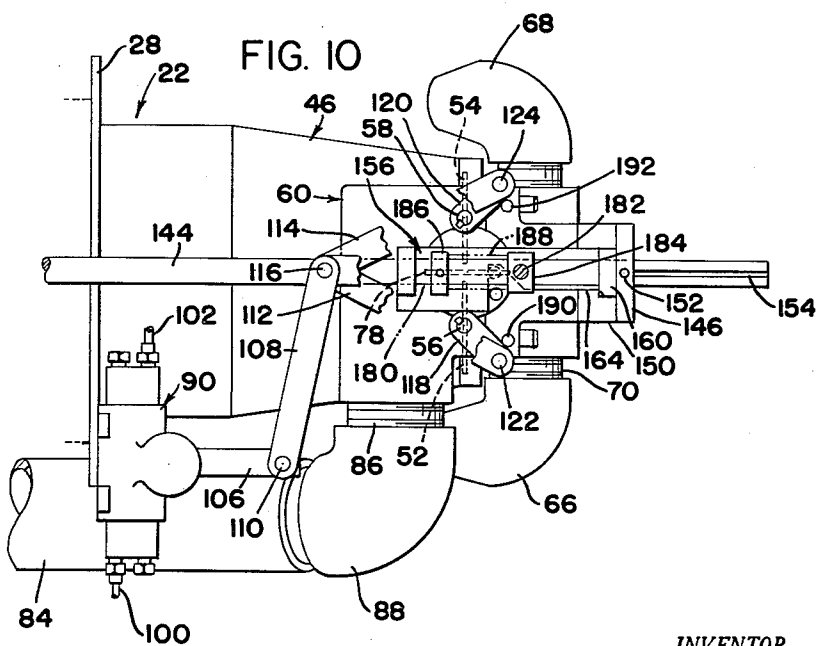


FIG. 10



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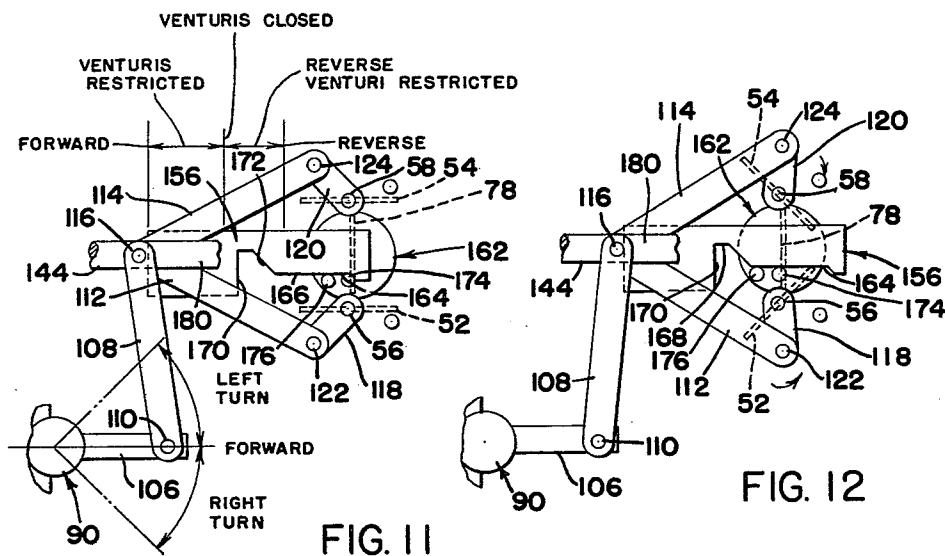
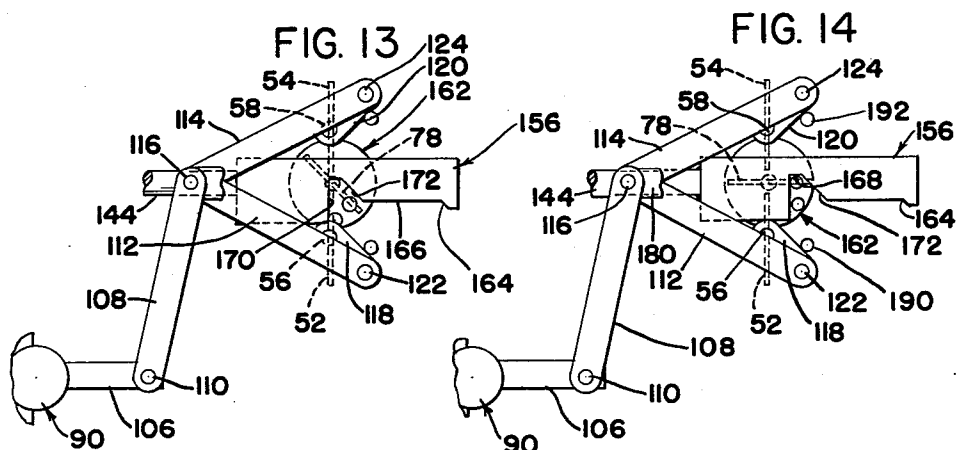
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STEERING DEVICE FOR TURBINE POWERED WATERCRAFT

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5 Sheets-Sheet 5



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3,083,530

STEERING DEVICE FOR TURBINE POWERED WATERCRAFT

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Filed Sept. 16, 1960, Ser. No. 56,510
9 Claims. (Cl. 60—35.55)

This invention relates to a steering device for watercraft of the type employing a turbine to project a high velocity jet of water from the stern of the craft for propulsion purposes.

In the past, steering devices of various descriptions have been proposed for use in connection with craft of the type described. For one reason or another, however, these proposed devices have not proved entirely satisfactory. One particularly pronounced disadvantage of steering devices constructed in accordance with prior proposals lies in the fact that they are complicated and awkward. As a result, production costs are high, and maintenance is an ever present problem.

The instant invention proposes a solution to the various problems which have heretofore faced the industry, and, generally speaking, includes a turbine housing provided with a venturi section which acts as a nozzle through which hydraulic jet streams are directed for propulsion purposes. Suitable propulsion control valving and deflection means are employed in association with the venturi section for the purpose of directing the jets either to port or starboard to impart to the craft a turning moment. These valving and deflector means may also be employed to deactivate forward propulsion jets, whereby to route flow through a manifold to forwardly directed nozzles for the purpose of activating reverse propulsion jets. Suitable valving means is employed to prevent flow through the reverse jet nozzles when the valving and deflector means in association with the venturi section are so positioned as to activate the forward propulsion jets. Novel linkage arrangements are employed for co-ordinating the operation of the valving and deflector means and the reverse propulsion control valving means in response to the operation of the various controls of the craft.

It is a general object of the invention to provide a steering device for use in connection with watercraft employing high velocity jet streams as propulsion means.

It is a more particular object of the invention to provide a steering device of the type described which is relatively simple in construction and positive in operation in order thereby to reduce both costs of production and of maintenance.

It is a further object of the invention to provide a steering device for use in connection with watercraft employing hydraulic jet propulsion systems, which device utilizes means for directing the jet stream produced by the system to port or to starboard in order to impart to the craft a turning moment.

It is a still further object of the invention to provide in a device of the type described suitable reverse propulsion jets for imparting rearward motion to a turbine-powered watercraft.

It is still another object of the invention to provide in a device of the type described novel control linkage means for co-ordinating the operation of the forward propulsion control valve means and the rearward propulsion control valve means.

It is an even further object of the invention in a device of the type described to provide dual purpose means which may be employed to deflect the forward propulsion jet streams either to starboard or port thereby to impart to the craft a turning moment, and which may further be employed to deactivate the forward propulsion jets without at the same time deflecting the same in such a

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manner as to impart a turning moment to the craft. Other and further objects of the invention will be apparent from the detailed description to follow.

In the drawings:

FIG. 1 is a schematic plan view with parts broken away of a watercraft embodying the invention;

FIG. 2 is a schematic section taken approximately on line 2—2 of FIG. 1;

FIG. 3 is an enlarged fragmentary section taken on line 3—3 of FIG. 6;

FIG. 4 is a fragmentary section taken on line 4—4 of FIG. 5;

FIG. 5 is a fragmentary plan view of FIG. 3;

FIG. 6 is a fragmentary rear elevation of FIGS. 3 and 5;

FIG. 7 is a section taken approximately on line 7—7 of FIG. 6;

FIG. 8 is a section taken approximately on line 8—8 of FIG. 6;

FIG. 9 is a view similar to FIG. 5, showing the various components in an alternate position;

FIG. 10 is a view similar to FIG. 9 but showing the components in a still further alternate position;

FIG. 11 is a schematic diagram showing the position of the various components when the steering device is oriented for straight forward propulsion;

FIG. 12 is a schematic diagram showing the position of the various components when the forward propulsion jets are deactivated;

FIG. 16 is a schematic diagram showing the position of the various components with the forward propulsion jets deactivated and with the reverse propulsion jets in the first stage of activation; and

FIG. 14 is a schematic diagram showing the position of the various components with the forward propulsion jets deactivated and with the reverse propulsion jets completely activated.

Referring now more particularly to the drawings, I have illustrated in FIGS. 1 and 2 a watercraft embodying the invention, and indicated generally at 10. The craft includes a hull 12 having a bow 14 and a stern 16. The hull 12 is provided along its central axis with a turbine receiving tunnel 18 which opens rearwardly to the transom 20 at one end and downwardly to the keel area at the other. Mounted within the tunnel is a turbine indicated generally at 22.

The turbine 22 includes a housing 24 mounted within the tunnel 18 by means of suitable retainer plates 26 and 28 and bolts 30 and 32. The intake 34 of the turbine is directed downwardly through the keel area of the hull 12.

Mounted within the housing 24 is a stator 36. An impeller 38 is mounted for rotation adjacent the stator 36 on the intake side thereof. A suitable drive shaft 40 provided with a universal joint 42 is employed for drivingly connecting an engine 44 to the impeller 38.

It will be observed that the housing 24 includes a rearwardly projecting portion extending through the transom 20 of the craft and provided with a venturi section 46 for increasing the velocity of hydraulic flow subsequent to its passing through the stator 36. The free end of the venturi section 46 is so constructed as to provide a pair of substantially circular orifices 48 and 50 arranged in horizontal side by side relationship and through which the jet stream generated by the turbine is projected.

Forward propulsion control valves 52 and 54 of the butterfly type are mounted in the orifices 48 and 50 for rotation about vertical axes. As will be observed, the forward propulsion control valves 52 and 54 are provided with elongated vertical operating stems 56 and 58 for actuation by a control linkage to be hereinafter described.

The upper portion of the venturi section 46 is pro-

vided with a manifold 60. The manifold 60 is provided with a generally cylindrical rearwardly directed fluid passageway 62 which communicates with the interior of the venturi section 46 by means of a generally vertical take-off passageway 64. A pair of downwardly and forwardly directed elbows 66 and 68 communicate with the passageway 62 in the manifold by means of nipples 70 and 72 and branch passageways 74 and 76 which enter the passageway 62 at substantially right angles thereto. The elbows 66 and 68 act as nozzles for directing a pair of jet streams toward the transom when it is desired to impart rearward motion to the craft.

Arranged intermediate the ends of the passageway 62 is a suitable reverse propulsion control valve 78 illustrated as being of the butterfly variety. The reverse propulsion control valve 78 is mounted within the passageway 62 for rotation about a vertical axis, and is provided with an elongated vertical operating stem 80 which extends upwardly beyond the manifold 60. As will be observed, the operating stems 56 and 58 for the valves 52 and 54 also extend upwardly beyond the manifold.

For purposes to be described hereinafter, a branch passageway 82 is provided which intersects the passageway 62 upstream from the valve 78. Conduit 84 is attached in fluid conducting relationship with the branch passageway 82 by means of nipple 86 and elbow 88.

The control linkage for the forward propulsion control valves 52 and 54 includes a rack and pinion assembly 90, which is mounted upon the transom 20 of the craft as by means of bolts 92 and 94. Mounted upon the pinion (not shown) for rotation therewith is a vertically oriented shaft 96. In the illustrated embodiment, the rack and pinion assembly is of the hydraulically operated type and is connected by means of hydraulic lines 100 and 102 to a piston assembly 104 which is, in turn, connected to the steering wheel 98 of the craft. Rotation of the wheel 98 causes movement of the pistons (not shown) in the assembly 104 to force hydraulic fluid through the lines 100 and 102 thereby to impart horizontal movement to the rack component (not shown) of the rack and pinion assembly 90. Movement of the rack causes rotation of the pinion component (not shown) of the assembly and the shaft 96.

In order to transfer movements of the shaft 96 to the forward propulsion control valves 52 and 54, an arm 106 is provided which is fixedly mounted upon the shaft 96 for movement through a horizontal arc.

A second link 108 is pivotally mounted at 110 to the free end of the arm 106. As will be observed, the link 108 extends from the pivot 110 transversely of the arm 106 and terminates at a position substantially over the central axis of the craft and of the venturi section 46. A pair of links 112 and 114 are pivotally mounted at 116 to the end of the link 108 remote from the pivot 110. The links 112 and 114 converge in the direction toward the bow of the craft and are connected to the forward propulsion control valves 52 and 54 by means of relatively short links 118 and 120. The link 118 is keyed or otherwise fixedly mounted at one end to the elongated operating stem 56, and at the other end is pivotally mounted as at 122 to the link 112. The link 120 is pivotally mounted at one end as at 124 to the link 114 and at the other end is fixedly attached to the elongated operating stem 58. As will be seen from the drawings, the links 118 and 120 converge in the direction away from the bow of the craft.

From the description thus far, it will be evident that movement of the steering wheel 98 will suffice, through the operation of the turn control linkages, to cause rotation of the forward propulsion control valves 52 and 54 about vertical axes. If, for example, the steering wheel 98 is rotated in a clockwise direction, the piston assembly 104, hydraulic lines 100 and 102, and the rack and pinion assembly 90 will act to cause clockwise rotation of the arm 106, as seen in FIG. 9. This, in turn, will cause the

link 108 to translate toward the port side of the craft. Translation of the link 108 exerts a pulling force on the link 114 and a pushing force on the link 112. These forces are transferred to the links 118 and 120 causing them and the operating stems 56 and 58 to rotate in a counterclockwise direction. The rotation of the operating stems 56 and 58 pivots the forward propulsion control valves 52 and 54 to the position shown in dotted lines in FIG. 9. These valves rotate together and during the turning operation maintain a generally parallel disposition relative to one another.

The angular disposition attained by the forward propulsion control valves 52 and 54 as a result of the rotation of the steering wheel causes the jet stream, when passing through the orifices 48 and 50, to be deflected at an angle to the central axis of the craft. This, of course, imparts to the craft a turning moment. Counter-rotation of the steering wheel causes the control linkages to assume once again the position shown in FIG. 5, thereby causing the orientation of the valves 52 and 54 along the axes of the orifices 48 and 50. When the valves are so oriented, the jet stream is not deflected and a turning moment is no longer imparted to the craft.

Mounted in the cockpit of the craft is a control lever 130 which may be moved forwardly and rearwardly as well as from side to side. When moved from side to side, i.e., from starboard to port and vice versa, the control lever 130 is operative to energize novel bow steering apparatus constructed in accordance with the teachings of my co-pending United States patent application Serial No. 56,582 entitled "Bow Steering for Hydraulic Jet Driven Boats" filed September 16, 1960. Generally speaking, the bow steering apparatus includes laterally directed nozzles 132 and 134 which are connected in fluid conducting relationship with the manifold 60 by means of the branch passageway 82 and the conduit 84. A diverter valve 136 is actuated by the control lever 130 acting in conjunction with links 138 and 140.

When moved forwardly and rearwardly, the control lever is operative to cause direction of the jet stream generated by the turbine either to the orifices 48 and 50, or to the reverse jet nozzles 66 and 68. To the accomplishment of this end, a cable 142 of the push-pull variety is attached at one end to the control lever 130 in a well-known manner so that forward and rearward movements of the control lever impart similar movements to the push-pull cable.

At the other end, the cable is attached to a horizontal control rod 144 positioned above the venturi section 46 of the turbine housing and below the turn control linkages for the forward propulsion control valves 52 and 54. As will be observed, the control rod 144 lies generally along the central axis of the craft.

The free end of the control rod 144 is mounted for reciprocation in a support 146 mounted rigidly to the manifold 60 by means of bolts 148 or the like, and spacer 150. To prevent undesirable rotation of the control rod 144, a screw 152 is threaded into the support 146 for slidable movement within a longitudinal groove 154 provided in the rod.

A horizontally disposed cam plate 156 is fixedly mounted to the control rod 144 above the manifold by means of cam plate supports 158 and 160. Obviously, rearward and forward movements of the control lever 130 are transferred to the cam plate through the operation of the cable 142 and the control rod.

A flat, generally circular operating disk 162 is non-rotatably mounted upon the end of the operating stem 80 of the reverse propulsion control valve 52. The operating disk is positioned above the manifold 60 and lies below the cam plate 156 in a plane generally parallel thereto.

The cam plate 156 is provided with a relatively shallow notch 164 which presents a flat elongated dwell 166 generally parallel to the longitudinal axis of the cam plate.

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A deeper notch 168 extends across a portion of the cam plate 156 in communication with the relatively shallow notch 164. The notch 168 is provided, remote from the dwell 166, with a side wall 170 generally perpendicular to the dwell. The other side wall 172 of the notch joins the dwell 166 on an obtuse angle.

The operating disk 162 is provided with a pair of spaced follower lugs 174 and 176. Both such follower lugs are mounted upon the operating disk 162 in off-center relationship, and are so arranged on the disk that a line drawn through their centers forms substantially a right angle with the plane of the reverse propulsion control valve 78.

An examination of FIGS. 11 and 12 reveals that when the cam plate 156 is at the forward extent of its reciprocal travel, as a result of the forward placement of the control lever 130, both follower lugs 174 and 176 engage the dwell 166. As seen in FIG. 4, when the follower lugs are in this position, the rearward propulsion control valve 78 is arranged generally perpendicular to the axis of the fluid passageway 62 and the valve being so oriented, prevents flow through the reverse jet nozzles 66 and 68.

As the control lever 130 is moved rearwardly, the cam plate 156 moves rearwardly also under the influence of the push-pull cable 142 and the control rod 144. The rearward propulsion control valve 78 remains closed until such time as the leading follower lug 176 strikes the side wall 170 of the notch 168. The proportioning of the notch 178 with respect to the size and spacing of the follower lugs 174 and 176 is such that the trailing lug 174 clears the dwell 166 simultaneously with the striking of the leading lug 176 by the side wall 170. Continued rearward movement of the cam plate 156 causes counterclockwise rotation of the operating disk 162, as seen in FIG. 13, until such time as both follower lugs lie against the side wall 170, as seen in FIG. 14, further rotation being thereby prevented. When the follower lugs both lie along the side wall 170, the reverse propulsion control valve 78 is full open to allow fluids to pass through the reverse jet nozzles 66 and 68 to cause reverse propulsion of the craft. When it is desired to deactivate the reverse propulsion jets, the control lever 130 is again moved forwardly, and the resulting forward translation of the cam plate 156 imparts to the control disk 162 a clockwise rotation thereby to close the reverse propulsion control valve 78.

Obviously, if the reverse propulsion jets are to be effective, it is necessary that the forward propulsion jets be deactivated when the reverse propulsion jets are activated. This, in turn, requires a co-ordination between the operation of the forward propulsion control valves 52 and 54 and the reverse propulsion control valve 78. To provide for this co-ordination, an elongated link 180 is employed. The link 180 is mounted at one end upon the pivot 116 which, as previously noted, also serves as the pivot for the links 112 and 114. The other end of the link 180 is pivoted at 182 upon a link support 184, which is slidably mounted upon control rod 144. A collar 186 is fixed upon the control rod 144 between the cam plate support 158 and the link support 184. Received around the rod 144 and bearing at one end upon the collar 186 and at the other end upon the link support 184 is a relatively stiff compression spring 188.

The operation of the co-ordinating linkage for the forward propulsion control valves 52 and 54 and the reverse propulsion control valve 78 will be more easily understood from reference to the schematic representations in FIGS. 11-14. FIG. 11 shows the orientation of the valves and the various control linkages therefor when the craft is moving straight ahead. It will be seen that the forward propulsion control valves 52 and 54 are full open and the reverse propulsion control valve 78 is full closed.

Upon rearward movement of the control lever 130, the

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cam plate 156 is moved rearwardly away from the transom 20. At the same time, the stiff spring 188 is compressed between the collar 186 and the link support 184 thereby exerting a force against the link support which, in turn, imparts a rearward movement to the link 180. As the link 180 moves rearwardly, it pulls against the pivot 116 and forces the links 112 and 114 to spread with respect to one another thereby imparting, through the links 118 and 120 clockwise rotation to the starboard forward propulsion control valve 54, and counterclockwise rotation to the port forward propulsion control valve 52. Progressive stages of the movement of the valves 52 and 54 may be observed in FIG. 13 and either FIG. 10 or 14. Obviously, the movement of the link 180 also influences the link 108, but the latter merely swings about the pivot 110 without at the same time causing rotation of the arm 106.

The hydraulic jet stream issuing forth from each of the venturi section orifices 48 and 50 is, of course, deflected by the movement of the valves 52 and 54. No turning moment is imparted to the craft, however, since the jets cancel one another out.

It is important that the stiffness of the spring 188 and the length of the dwell 166 be so chosen as to allow the forward propulsion control valves 52 and 54 to close fully prior to the time the leading follower lug 176 strikes the side wall 170 of the notch 168 and the reverse propulsion control valve 78 begins to open. Otherwise, the effectiveness of the reverse propulsion jets would be to some degree reduced by the at least momentary lack of complete deactivation of the forward propulsion control valves. For this same reason, suitable stops 190 and 192 are provided to prevent over travel of the forward propulsion control valves 52 and 54 as they close.

When it is desired once again to deactivate the reverse propulsion jets and activate the forward propulsion jets, the control lever is moved from reverse position to forward position to reciprocate the cam plate 156. The follower lugs 174 and 176 ride out of the notch 168 and into the dwell 166, thereby rotating the operating disks 162 to close the reverse propulsion control valve 78. The forward propulsion control valves 52 and 54 remain closed until, the follower lugs continue to slide along the dwell 166, the cam plate support 160 engages the link support 184 and forces the link 180 forwardly towards the transom 20 which, in turn, acts upon the links 112, 114, 118 and 120 to open the forward propulsion control valves.

While I have illustrated the invention as being included in but a single embodiment, it will be immediately apparent to those skilled in the art that a number of modifications could be made to the illustrated embodiment without at the same time departing from the true spirit of the invention. It is, therefore, my desire to be limited only by the scope of the appended claims.

I claim:

1. A steering device for watercraft including at least two forward propulsion jet means, butterfly valve means in association with each of said forward propulsion jet means and rotatable about substantially vertical axes, means to rotate the valves in substantial parallelism to deflect the forward propulsion means for turning purposes, means to rotate the valves in opposite directions for deactivating the forward propulsion jet means and reverse valve means operatively associated with said means to rotate said butterfly valve means, said reverse valve means becoming activated upon movement of the means to rotate said butterfly valves past the closed position of said butterfly valves whereby the last mentioned valves will remain closed and the reverse valve means will open.

2. In a watercraft employing turbine means to produce a high velocity hydraulic jet stream, and a venturi section through which the stream is projected for propulsion purposes, the improvement comprising: at least two orifices, at the free end of the venturi section and arranged adja-

cent one another for directing propulsion jets from the stern of the craft, forward propulsion control butterfly valve means in each orifice rotatable about generally vertical axes, reverse jet nozzle means directed downwardly and forwardly of the craft, takeoff means establishing fluid conducting communication between the turbine means and the reverse jet nozzle means, reverse propulsion control valve means in the takeoff means and apart from the forward propulsion control butterfly valve means for regulating flow through the reverse jet nozzle means, co-ordinating means interconnecting the forward propulsion control butterfly valve means with the reverse propulsion control valve means for causing opening of the reverse propulsion control valve means immediately after closing of the forward propulsion control butterfly valve means, and vice versa.

3. Structure as defined in claim 2, and further including means for rotating the forward propulsion control butterfly valve means in opposite directions as they close.

4. Structure as defined in claim 2 characterized by the provision of means for rotating the forward propulsion control butterfly valve means from side to side in substantial parallelism to deflect, for turning purposes, the propulsion jets issuing from the orifices in the venturi section.

5. In a watercraft employing means to produce a high velocity hydraulic jet stream, and a venturi through which the stream is projected for propulsion purposes, the improvement comprising forward propulsion jet producing means connected to the venturi, reverse propulsion jet producing means in fluid conducting communication with the venturi, valve means in association with the forward propulsion jet producing means for activating and deactivating the same, valve means apart from said first named valve means and in association with the reverse propulsion jet producing means for activating and deactivating the same, and co-ordinating means interconnecting both valve means for opening one immediately after the closing of the other, and vice versa, said coordinating means comprising first link means connected to each of said first mentioned valve means, second link means operatively connected to said first link means and further connected to each other and to the third link means, so that the valves will move in parallelism in the open position, and means independent of said third link means for rotating said valves in opposite directions to deactivate the propulsion jet producing means without imparting a turning moment to said watercraft.

6. In a steering device for a watercraft including a manual steering member, a pair of orifices arranged in horizontal side by side disposition, and through which high velocity jet streams are projected for forward propulsion purposes, the improvement comprising: a butterfly valve mounted in each orifice and rotatable about a generally vertical axis, a vertically extending operating stem fixed on each valve for imparting rotation thereto, a first pair of links, one link of the first pair being fixedly

mounted at one end to one of the operating stems, the other being fixedly mounted at one end to the other operating stem, a second pair of links, one link of the second pair being pivotally mounted at one end to the other end of one of the links of the first pair, the other link of the second pair being pivotally mounted at one end to the other end of the other link of the first pair, the links of the second pair being pivotally mounted together at their other ends, a third link pivotally mounted to said other ends of both links making up the second pair and extending transversely thereof, and means for causing lateral and axial translation of the third link in response to movements of the manual steering member, thereby to rotate the butterfly valves in the same direction and deflect the high velocity jet streams for turning purposes.

7. Structure as defined in claim 6 further including means for rotating the butterfly valves in opposite directions to deactivate the high velocity jet streams without at the same time imparting a turning moment to the craft, and a discrete reversing valve means operatively associated with said link means to be actuated after said butterfly valve means are rotated oppositely to each other to the closed position.

8. In a water craft, forward propulsion jet producing means, reverse propulsion jet producing means, forward propulsion control valve and deflector means for activating and deactivating regulating flow to the forward propulsion jet producing means and for deflecting the forward propulsion jet means produced thereby, reverse propulsion control valve means apart from said first mentioned valve means for regulating flow to the reverse propulsion control valve means, an operating stem for each of the valve means, first linkage means for activating the operating stems of the forward propulsion control valves to deflect the forward propulsion jet means, second linkage means for activating the operating stem of the rearward propulsion control valve means, and third linkage means interconnecting the first and second linkage means for causing coordinated closing of the forward propulsion control valve and opening of the reverse propulsion control valve means and vice-versa.

9. Structure as defined in claim 8 in which the second link means include cam follower means provided on the operating stem for the reverse propulsion control valve means, and cam means in engagement therewith.

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