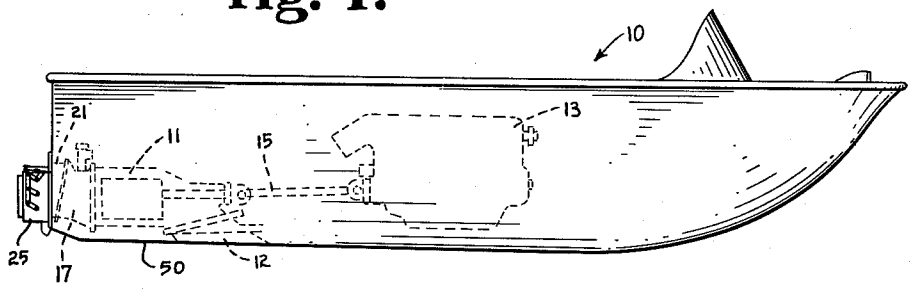
June 26, 1962 W. C. CHRISTENSEN ET AL 3,040,527

MULTIPLE DEFLECTOR CONTROL

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Fig. 1.



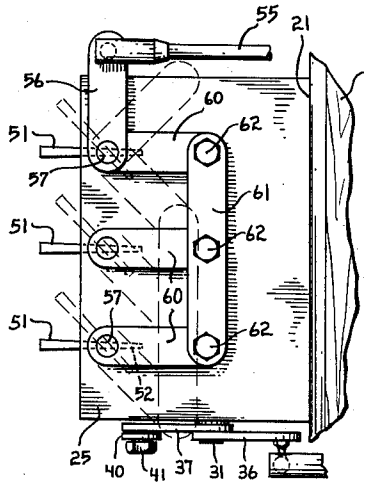


Fig. 3.

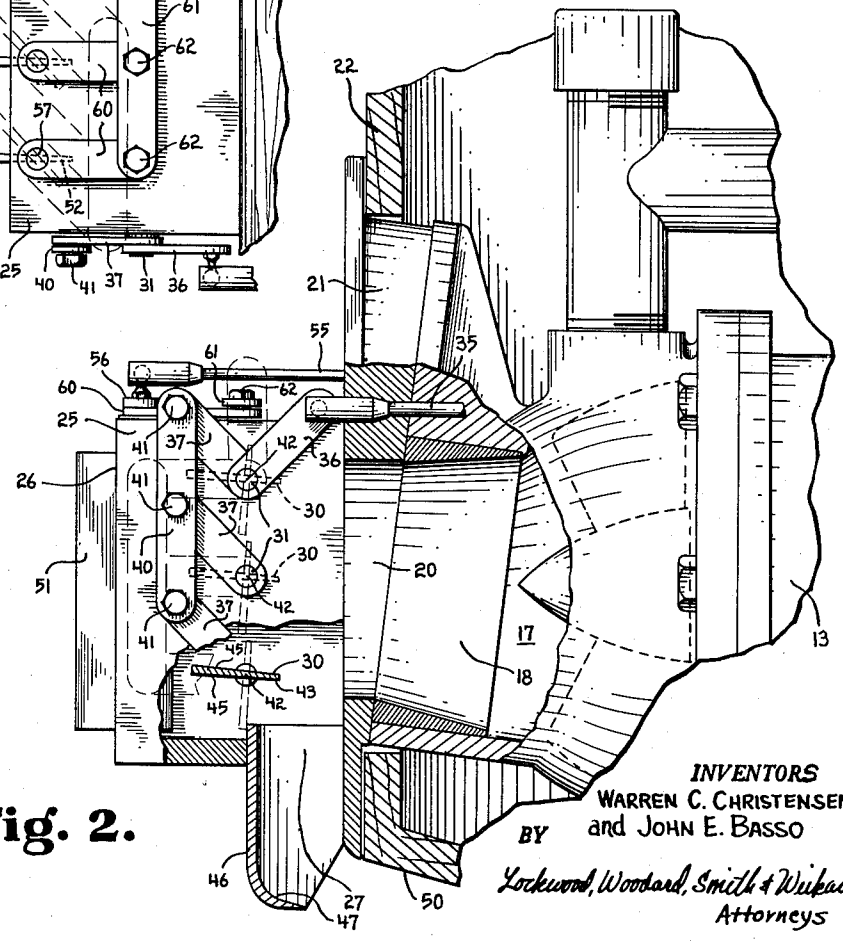


Fig. 2.

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Fig. 4.

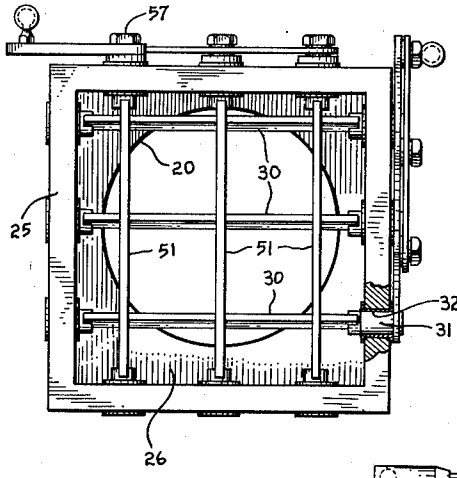
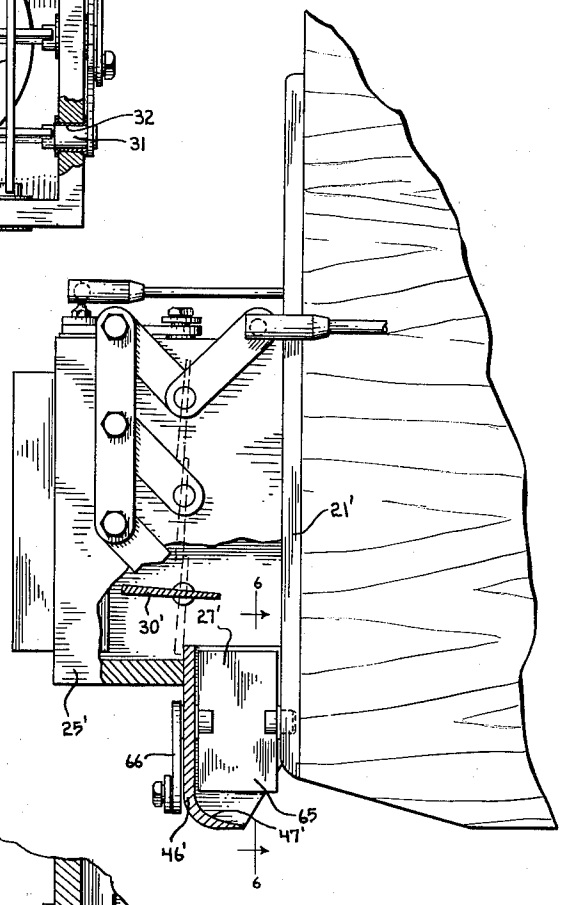


Fig. 5.



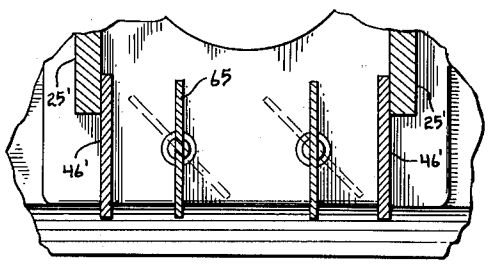


Fig. 6.

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MULTIPLE DEFLECTOR CONTROL

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4 Claims. (Cl. 60—35.55)

The present invention relates to propulsion apparatus and finds primary utility in watercraft as a device for propelling, steering and controlling the direction, stability and operation of such craft.

At least one form of water jet-propelled boat involves an engine arranged to drive a turbine which is located within a conduit passing through the boat. Water is drawn into the conduit through an intake opening at the bottom of the boat, is pumped through the conduit by the turbine and is exhausted in a stream from the rear of the boat, the stream leaving the boat above the water within which the boat is floating or is supported. The propulsion principle depends directly on a basic law of physics which provides that every action has an equal and opposite reaction. Thus, as water is ejected astern, the boat moves forward.

One problem present in the construction and operation of such water jet-propelled boats is that of maintaining the proper stability and particularly the proper trim of the boat. If the boat is heavily loaded at either the forward or rearward end, the hull will tend to rotate about a transverse axis in the water causing either the bow or the stern to ride low in the water. This effect, if unduly great, will be inconvenient to the occupants of the boat and will interfere with the proper operation and with the correct planing of the boat while in motion.

It is also highly desirable if not necessary that efficient means be provided for steering the boat when it is moving forwardly. Preferably, such steering means should be easy to operate and should not require the exertion of an undue amount of force for operation. Consequently, one object of the present inveniton is to provide improved means for steering and controlling the trim of a water jet propelled boat, said means being easy to operate and not requiring the exertion of great force.

A further object of the invention is the provision of improved propulsion apparatus.

Another object of the present invention is to provide improved marine propulsion apparatus capable of providing forward propulsion, no propulsion or rearward propulsion and capable of being shifted between forward propulsion, no propulsion or rearward propulsion with the exertion of a relatively small amount of force and with the propulsion apparatus operating at a relatively high velocity.

Still another object of the present invention is to provide improved propulsion apparatus which permits steering while the watercraft is moving in reverse.

A further object of the present invention is to provide improved marine propulsion apparatus which is compact and relatively flat in configuration whereby it may be mounted on a watercraft and will project only a relatively short distance rearwardly of the craft.

Related objects and advantages will become apparent as the description proceeds.

One specific embodiment of the watercraft propulsion apparatus of the present invention might comprise a conduit of square cross section fixed to said craft, means carried by said craft for propelling a stream of liquid through said conduit, a plurality of rectangular deflector vanes pivoted in said conduit about parallel horizontal axes transversely spaced from top to bottom of said conduit, said conduit having an opening through the sidewall

thereof located upstream of said deflector vanes, a deflector element fixed to said conduit and formed to guide liquid passing out of said opening in a direction forwardly of the craft, said deflector vanes being so formed and positioned that they may be pivoted to a position wherein flow through said conduit is blocked, a further plurality of deflector vanes pivoted in said conduit about parallel vertical axes transversely spaced across said conduit, said further plurality of vanes being positioned adjacent the exit of said conduit, and still a further plurality of deflector vanes pivotal upon said conduit and positioned to control the stream guided by said deflector element.

The full nature of the invention will be understood from the accompanying drawings and the following description and claims:

FIG. 1 is a side elevation of a jet boat embodying the present invention.

FIG. 2 is an enlarged side view similar to FIG. 1 and partially in section of the rear of the boat.

FIG. 3 is a top plan view of a portion of the structure illustrated in FIG. 2.

FIG. 4 is a rear elevation of a portion of the structure illustrated in FIG. 2.

FIG. 5 is a view similar to FIG. 2 of an alternative embodiment of the invention.

FIG. 6 is a vertical section taken along the line **6—6** of FIG. 5 in the direction of the arrows.

Referring now more particularly to the drawings, there is illustrated a jet boat indicated generally by the numeral **10** and having a turbine **11** mounted therein at the rear thereof. Water is conducted to the turbine through an intake **12** at the bottom of the boat and is acted upon by the turbine in such a manner as to be exhausted in a jet stream from the rear of the boat, the turbine being driven by a conventional marine engine **13** operatively connected to the turbine by means of a shaft **15**.

Secured to the rear of the turbine **11** is a discharge section or tailpipe **17** which has a nozzle **18** fixedly secured therein. When the apparatus is in the position of FIG. 2, the water is pumped into the discharge section **17** by means of the turbine and is formed into a cylindrical stream by means of the nozzle **18**, the stream moving directly rearwardly of the boat through a cylindrical aperture **20** in a mounting element **21** to which the tailpipe **17** is fixed. The mounting element **21** is, in turn, secured to the transom **22** of the boat and provides a mounting for a conduit **25** which has a generally square shaped cross-section as is suggested by the rear view of FIG. 4.

The various elements **17**, **21** and **25** are secured together in such a manner that the passage leading from the turbine has no outlet with the exception of the rearward end **26** of the conduit **25** and the further exception of an opening **27** formed in the lower surface of the conduit **25**. Thus, it can be appreciated that the tailpipe **17** along with the nozzle **18** functions to form the water pumped by the turbine into a jet which normally will pass directly rearwardly through the conduit **25** so as to propel the boat forwardly.

A plurality of wedge-shaped deflectors **30** are pivotally mounted upon the sides of the conduit **25** by means of suitable pins **31** and bearing element **32**. These deflectors which are rectangular in shape, are pivoted by means of an actuating rod **35** which is pivotally connected to the uppermost deflector **30** by means of a link **36** fixed to the deflector at one end and pivoted to the actuating rod at its other end.

Each of the deflectors **30** is provided with a crank **37** fixed with relation thereto. Each of the cranks **37** has secured to its opposite end from its respective deflector, a connecting link **40** which is pivoted to each of the cranks **37** about respective axes **41**. It can be appreciated

that as the uppermost deflector 30 is pivoted by means of the actuating arm 35 and link 36, the pivoting of the uppermost deflector 30 will be reproduced in the other two deflectors 30 by means of the cranks 37 and link 40 and all of the deflectors will be positioned at the same angle at all times.

Each of the deflectors 30 are pivotal about an axis 42. It can be seen that a substantial portion 43 of the deflector projects forwardly of the axis 42. This forwardly projecting portion 43 functions to decrease the amount of force necessary to operate the actuating rod 35 and to pivot the deflectors 30. Because of the fact that the stream of water exhausted by the tailpipe 17 first engages the forwardly projecting portion 43, it produces a moment about the axis 42 which aids in maintaining the deflector in a position wherein it is deflecting the stream. In other words, as the actuating rod 35 is actuated to move the deflector, for example, to a position perhaps at 45 degrees to the horizontal, the stream acts on the portion 43 to aid in moving the deflector to this position.

One of the functions of the deflectors 30 is to maintain the trim of the boat. This is accomplished by positioning the deflectors 30 at a desired angle so as to cause the stream issuing from the tailpipe to be deflected either downwardly or upwardly. Assume, for example, that a heavy load is placed either in the front or rear of the boat. The boat will be caused to float with its bow or stern, respectively, in a downward position. This condition is inconvenient to the occupants of the boat and may affect the operation thereof, such as, for example, the correct planing of the boat. Assuming, for example, that the heavy load is located in the rear of the boat, the deflectors 30 would be pivoted so that the rearward end thereof is downward and causes the water to be deflected downwardly producing a moment which will tend to raise the stern of the boat and maintain it in a proper operating position. Alternatively, if a heavy load is located in the bow of the boat, the deflectors 30 can be used to deflect the stream of water upwardly to produce a moment tending to lower the rear of the boat.

It should be noted that the deflectors 30 have a taper or wedge-shape which is smallest at the forward portion 43 and enlarges from front to rear of the deflectors. This wedge-shape eliminates "dead spots" in the trim control. In other words, this tapering configuration causes the stream of water to maintain contact with the wedge-shaped deflectors all along their length even though the deflectors are aligned with the direction of flow. It has been found that if the opposite sides 45 of the deflector are in parallel relation, the stream of water will break away from those sides prior to reaching the rear of the deflector so that movement of the deflector when in this condition initially produces little or no effect upon the stream of water, resulting in a dead spot in the trim control. Thus, the tapering configuration of the deflectors 30 eliminates such dead spots.

It should be noted that the deflectors 30 each have a rectangular configuration and are each spaced apart a suitable distance so that all of the deflectors can be pivoted into the dotted line position of FIG. 2 wherein the three deflectors block the passage of water through the rearward portion of the conduit 25 and cause the water to move downwardly through the opening 27. A deflector 46 is fixed to the conduit 25 and is arranged to guide the water passing downwardly through the opening 27 in such a manner that it is deflected by the curved surface 47 in a direction forwardly of the boat and so that the water passes beneath the bottom 50 of the boat. Thus, the boat is moved in a rearward direction in accord with the above mentioned law of physics.

A further plurality of deflector vanes 51 are pivotally mounted within and upon the conduit 25 adjacent the rearward end 26 thereof and in such a manner as to extend out of the conduit. The deflectors 51 are pivotal about equally spaced parallel vertical axes, each deflector having a leading or forwardly projecting portion 52 similar to the leading portion 43 of the trim vanes 30. This forwardly projecting portion 52 of each vane functions similarly to the forwardly projecting portion 43 to aid in the pivoting of the vane in the jet stream. It can be appreciated that the function of the vanes 51 is the steering of the boat which is accomplished by deflecting the jet stream either in a rightward or leftward horizontal direction.

It should be noted that each of the vanes 51 has a tapering configuration similar to the tapering configuration of the vanes 30. This taper or wedge shape produces a similar result to the taper of the vanes 30 in eliminating dead spots in the operation of the vanes 51. It can be appreciated that the elimination of dead spots in the steering of the boat is even more important than the elimination of dead spots in the trim control.

The deflectors 51 are operated by means of an actuating rod 55 which is pivoted to a link 56 which is fixed to a pin 57 providing a mounting for the leftward deflector 51 (as viewed in FIG. 4). Each of the deflectors 51 has a link 60 fixed to the pin 57 thereof, each of said links 60 having its extending end secured to a link 61 for pivoting about axes 62. It can be appreciated that the deflectors 51 will always be maintained at the same angle, as illustrated, for example, in dotted lines in FIG. 3, by means of the cranks 60 and link 61. Thus, operation of the actuating arm 55 will pivot all of the deflectors 51 similarly.

It should be noted that in the particular embodiment above disclosed, the deflector vanes 30 are so designed as to allow a certain amount of leakage therebetween when the vanes are in the fully closed position illustrated in dotted lines in FIG. 2. This leakage is allowed for the purpose of providing a certain small amount of water to pass over the steering vanes 51 in order that the boat may be steered while in reverse.

Referring to FIGS. 5 and 6, an alternative structure capable of being steered in reverse is illustrated and comprises a structure which is identical in most respects to the structure above described with the following exceptions. The deflectors 30' are so proportioned that when they are in the dotted line position illustrated in FIG. 5, the passageway through the conduit 25' will be completely blocked rather than only partially blocked. Since the only outlet for the stream of water is through the opening 27', the water will move downwardly therethrough and will be guided by the vane 46' and more particularly by the curved surface 47' thereof. The embodiment of FIGS. 5 and 6 is provided with deflector vanes 65 which are pivotally mounted upon the mounting element 21' and upon the deflector 46'. These deflectors 65 are operated by means of a suitable linkage 66 to deflect the water either rightwardly or leftwardly as viewed in FIG. 6 whereby steering in reverse is effected.

It should be noted that the trim vanes 30 and 30' of the above described two embodiments also have the function of stopping the boat or, alternatively of controlling the turbine so that it exerts no propelling force. This effect is accomplished by positioning the deflectors 30 or 30' at such an angle that the amount of water allowed to pass rearwardly through the conduit and out the end 26 thereof produces a forward propelling force which is balanced by the propelling force produced by the water deflected downwardly through the opening 27. Thus, the resultant propelling force is zero. By suitable operation of the trim control vanes, certain in between effects can be accomplished such as a slow forward movement of the boat or a slow rearward movement thereof.

From the above description, it can be appreciated that the present invention provides an improved propulsion apparatus incorporating means for steering and controlling the trim of a water jet propelled boat, said means being easy to operate and not requiring the exertion of a great amount of force. It can also be appreciated that the

present invention provides an improved marine propulsion apparatus which is capable of easy shifting between forward propulsion, no propulsion or rearward propulsion. It should be pointed out that such shifting may be accomplished even though the turbine of the boat is operating at a relatively high speed because of the forwardly projecting portion **43** on the deflector vanes **30**. Thus, as a great amount of water moves past these vanes at a high speed, the forwardly projecting portion **43** provides an even greater moment aiding in turning or pivoting these vanes.

While the invention has been illustrated and described in detail in the drawings and foregoing description, the same is to be considered as illustrative and not restrictive in character, it being understood that only the preferred embodiment has been shown and described and that all changes and modifications that come within the spirit of the invention and the scope of the claims are also desired to be protected.

The invention claimed is:

1. Propulsion apparatus comprising means for propelling a stream of liquid, a conduit having an exit and receiving said stream, a deflector vane mounted within said conduit and pivotal about a vertical axis, and a deflector vane mounted within said conduit and pivotal about a horizontal axis, said deflectors each having a wedge shape tapering from a forward upstream portion upstream of their respective axes to a relatively thicker downstream portion, said deflectors being located in proximity to the conduit exit whereby they can vary the direction of the effluent stream of liquid.

2. Propulsion apparatus for watercraft comprising a conduit of rectangular cross section fixed to said craft, said conduit having an exit means carried by said craft for propelling a stream of liquid through said conduit and out said exit, a plurality of rectangular deflector vanes pivoted in said conduit about parallel horizontal axes transversely spaced from top to bottom of said conduit, said deflector vanes each having a wedge shape tapering from a forward upstream portion upstream of said axes to a relatively thicker downstream portion, said conduit having an opening through the sidewall thereof located upstream of said deflector vanes, a deflector element fixed to said conduit and formed to guide liquid passing out of said opening in a direction forwardly of the craft, said deflector vanes being so formed and positioned that they may be pivoted to a position wherein flow through said conduit is blocked, and a further plurality of deflector vanes pivoted in said conduit about parallel vertical axes transversely spaced across said conduit, said further plurality of vanes being positioned adjacent the exit of said conduit and each having a wedge shape tapering from a forward upstream portion upstream of said vertical axes to a relatively thicker downstream portion, said horizontally pivoted deflectors being located in proximity to said conduit exit whereby they vary the direction of the effluent stream of liquid.

3. Propulsion apparatus for watercraft comprising a conduit of square cross section fixed to said craft, means carried by said craft for propelling a stream of liquid through said conduit, a plurality of rectangular deflector vanes pivoted in said conduit about parallel horizontal axes transversely spaced from top to bottom of said conduit, said conduit having an opening through the sidewall thereof located upstream of said deflector vanes, a deflector element fixed to said conduit and formed to guide liquid passing out of said opening in a direction forwardly of the craft, said deflector vanes being so formed and positioned that they may be pivoted to a position wherein flow through said conduit is blocked, a further plurality of deflector vanes pivoted in said conduit about parallel vertical axes transversely spaced across said conduit, said further plurality of vanes being positioned adjacent the exit of said conduit, and still a further plurality of deflector vanes pivotal upon said conduit and positioned to control the stream guided by said deflector element.

4. Propulsion apparatus for watercraft comprising a conduit of rectangular cross section fixed to said craft, means carried by said craft for propelling a stream of liquid through said conduit, a plurality of deflector vanes pivoted in said conduit about parallel horizontal axes transversely spaced from top to bottom of said conduit, said conduit having an opening through the lower wall thereof located upstream of said deflector vanes, a deflector element fixed to said conduit and formed to guide liquid passing downwardly out of said opening in a direction forward of the craft, said deflector vanes being so formed and positioned that they may be pivoted to a position wherein flow through said conduit is blocked, and a further deflector vane pivotal upon said conduit about a horizontal axis longitudinal of the boat, said last mentioned deflector vanes being positioned below said opening in the path of liquid passing through said opening for providing a sideward horizontal component of velocity thereto.

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