United States Patent [19]
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[11] 3,776,173
[45] Dec. 4, 1973

[54] PROPULSION SYSTEM FOR A BOAT

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[22] Filed: Oct. 29, 1971

[21] Appl. No.: 193,761

[52] U.S. Cl. .... 115/12 R
[51] Int. Cl. B63h 11/00
[58] Field of Search .... 115/12 R, 12 A, 11, 115/14, 15, 16; 60/221, 232; 114/151; 239/127.1, 265.11, 265.35

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[57] **ABSTRACT**

The present invention relates to a propulsion system for a boat; and more particularly discloses a propulsion system that not only provides forward movement and directional control, but also provides means for controlling the attitude of the boat.

The disclosed system accomplishes this dual result by the use of a novel jet nozzle mounting structure that permits the nozzle to pivot in a horizontal direction and/or in a vertical direction. Pivoting in either direction is independent of the other, but may still be combined with the other one when so desired, so that any combination of boat heading and attitude may be provided.

6 Claims, 5 Drawing Figures

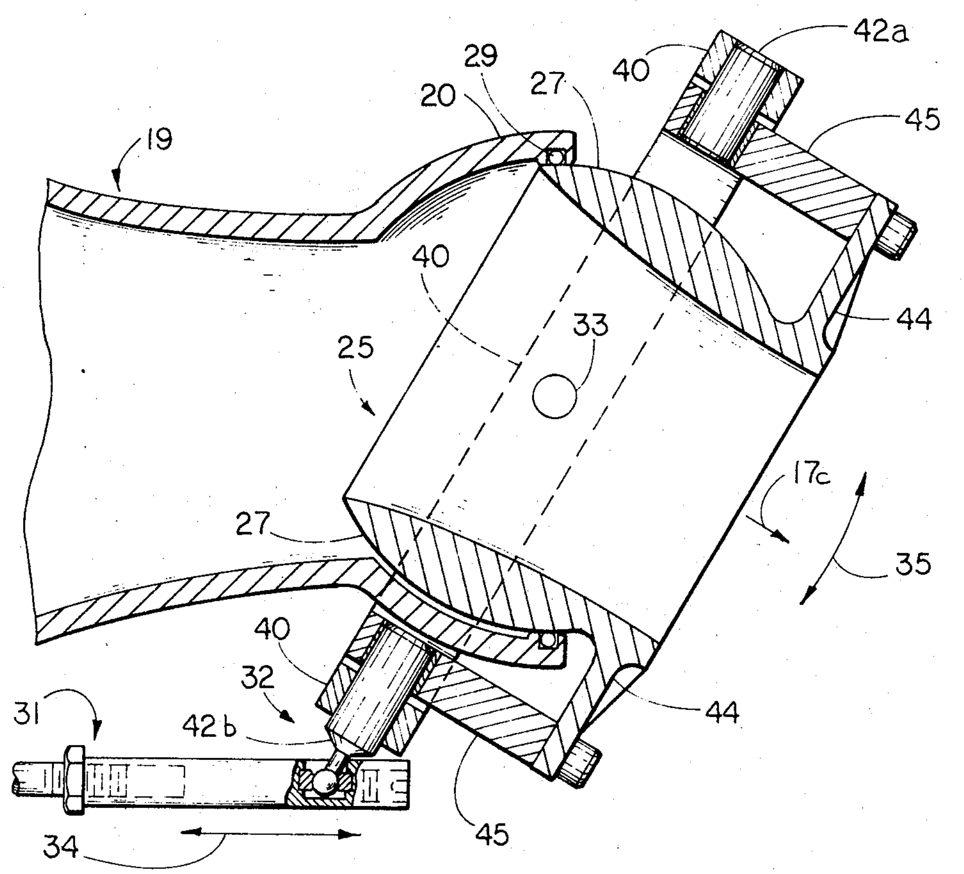


FIG-1

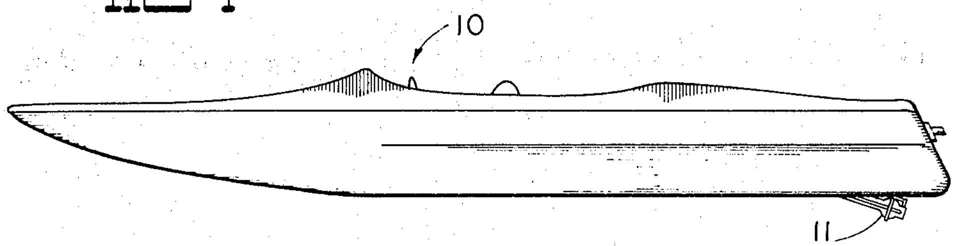


FIG-4

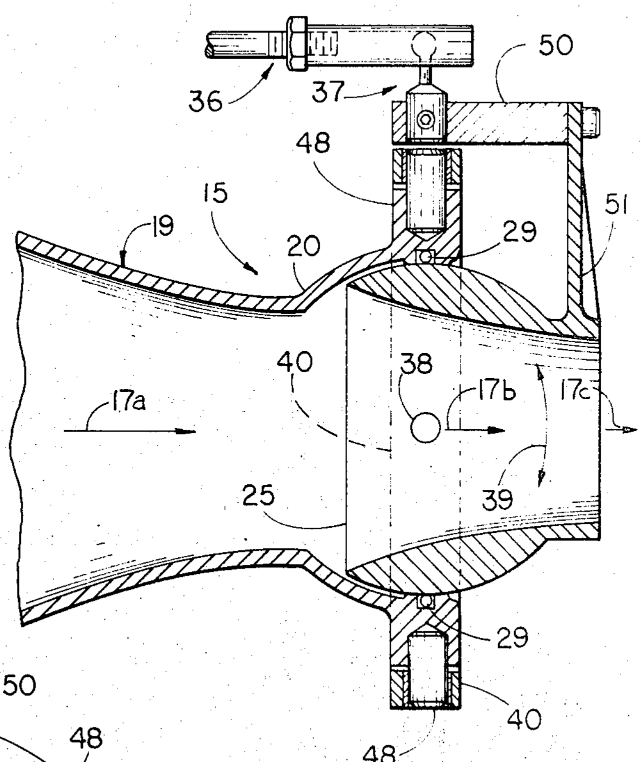
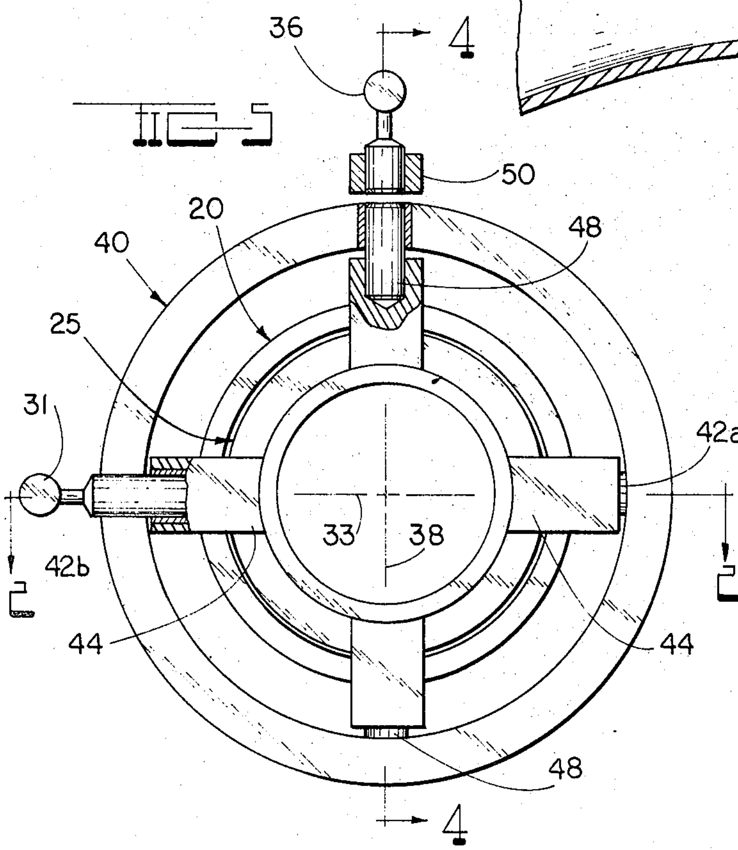


FIG-5



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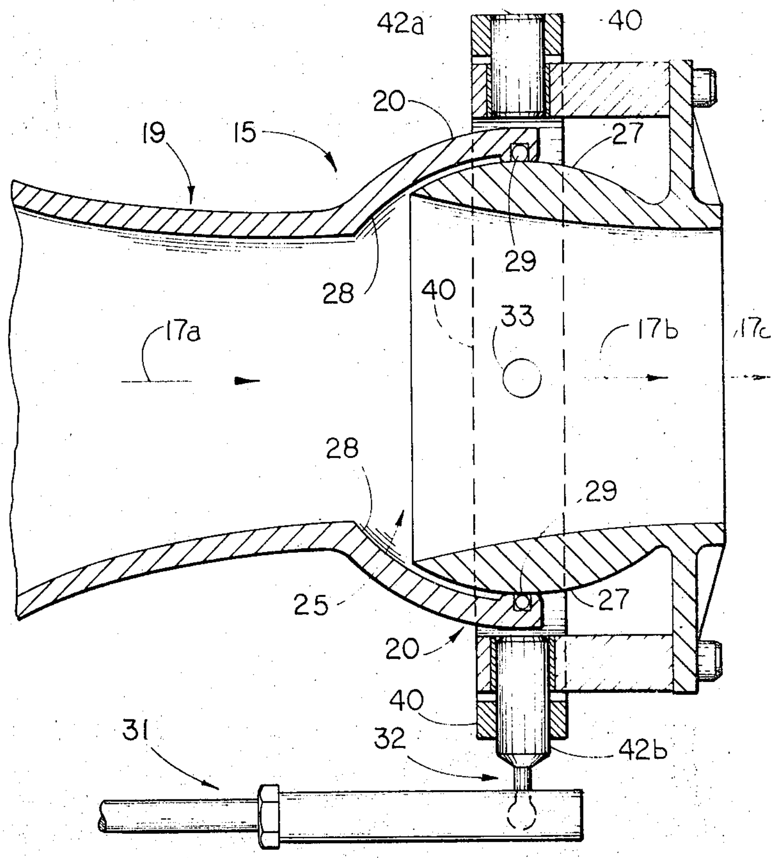

FIG. 2

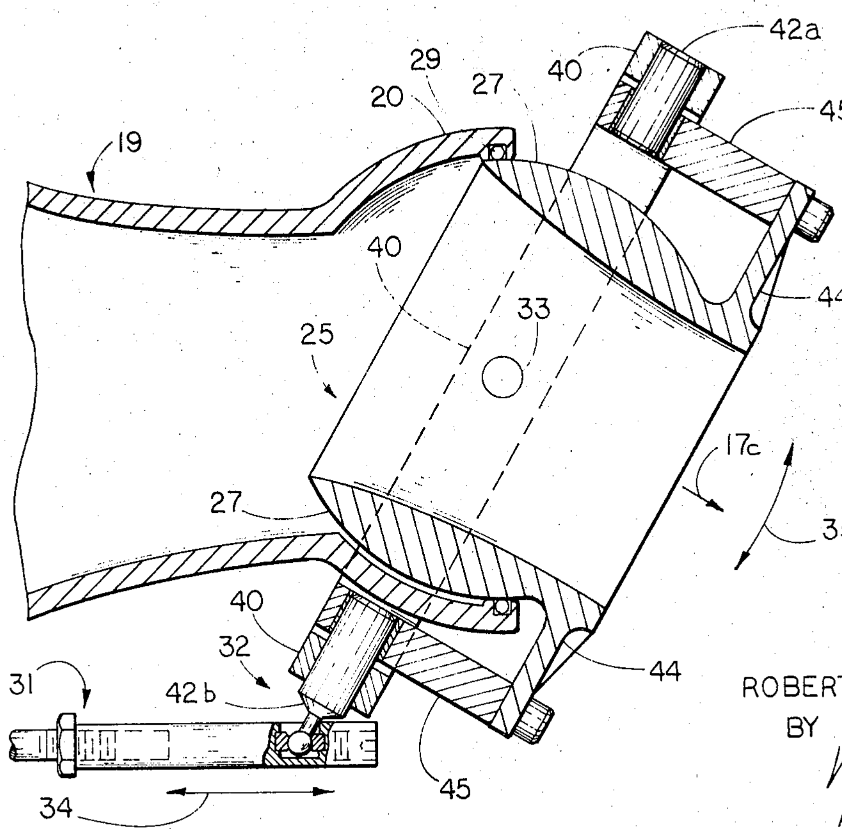

FIG. 3

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PROPULSION SYSTEM FOR A BOAT

BACKGROUND

In using and handling speedboats, there are many factors that enter into the pleasure obtained from these water craft and one of the most exhilarating factors is their high speeds. One way of obtaining even higher speeds is to use a more powerful engine, but there is a practicable limit to the engine size that is feasible for each boat. Therefore, as a practical matter, the power input cannot be continuously increased to too great an extent.

However, as is well known, speedboats experience an appreciable amount of water drag, especially up to the speed at which the boat begins to "plane." It would therefore be advantageous to cause the boat to begin its planing operation at a lower speed. Unfortunately, the planing characteristic of a boat or its "trim angle" that controls the planing characteristic is inherent in a boat's design and construction, but if this trim angle were able to be changed, it would improve the boat's efficiency, increase the boat's speed, and improve the boat's stability for various different boating conditions.

OBJECTS AND DRAWINGS

It is therefore the principal object of the present invention to provide an improved speedboat.

It is another object of the present invention to provide an improved propulsion system for a speedboat.

It is still another object of the present invention to provide an improved jet propulsion system for a speedboat.

It is a further object of the present invention to provide an improved jet propulsion system that, in part, controls the boat's attitude.

It is a still further object of the present invention to provide an improved structure for a boat's propulsion system.

The attainment of these objects and others will be realized from a study of the following description, taken in conjunction with the drawings of which:

FIG. 1 shows a side view of a speedboat utilizing a jet propulsion system;

FIG. 2 shows a cutaway horizontal cross sectional view of the subject jet propulsion system in a dead-ahead driving orientation;

FIG. 3 shows a cutaway horizontal cross sectional view of the subject jet propulsion system in a turning orientation;

FIG. 4 shows a cutaway vertical cross sectional view of the subject jet propulsion system in a flat attitude; and

FIG. 5 shows a schematic rear view of the pivoting arrangement of subject jet propulsion system.

SYNOPSIS

The present invention discloses a dual purpose jet propulsion system for a speedboat; the jet nozzle being mounted in such a way that it may be pointed upwards, downwards, to the right, to the left, and in any desired intermediate combination of directions. This result is accomplished, in part, by forming part of the nozzle into a substantially spherically configurated bearing surface and by having this bearing surface coact with a suitable positioned O-ring. In this way, the O-ring provides a seal regardless of the direction in which the nozzle happens to be pointing.

A nozzle supporting ring is mounted on the propulsion system housing in such a way that the support ring can pivot only in a horizontal direction, thus causing the nozzle to also pivot in the horizontal direction so that independent direction control is thus obtained.

The nozzle is simultaneously mounted on the support ring in such a manner that the nozzle can pivot in a vertical direction; so that the independent attitude control is thus obtained.

In this way, the disclosed structure provides either pure directional control, pure attitude control, or any desired combination thereof.

Operation of a Jet Propulsion System

In the past, most speedboats used underwater propellers to propel the boat through the water and in response to the constant demand for greater speed the propellers were made larger, were made to rotate faster, were designed with different angles, etc. While these modifications tended to achieve their purpose, they also introduced new problems — such as cavitation of the propeller, undue breakage, undesirable slippage, wastage of power, etc. Thus, while these propeller modifications provided a limited increase in speed, they were not completely satisfactory.

The newer trend for speedboats is the use of a "jet propulsion" technique. This uses a water pump that forces a jet of high speed water rearward from the stern of the boat; this rearwardly directed water jet causing the boat to move in the opposite (forward) direction. As will be obvious, the jet propulsion technique — since it does not use propeller blades — does no have the problem associated with them; and the jet propulsion technique therefore offered many speedboat advantages.

As the speeds of the boats increased, their trim angle became much more important then previously, because this angle controlled the speed at which the boat began to plane, i.e., to rise from the surface of the water. This trim angle was usually conservatively designed for safety during average boating conditions, but if the boat was used under unusual boating conditions, this angle tended to be a disadvantage — in many cases causing the boat to "porpoise" or bounce on the water. This behaviour is, of course, not only undesirable, but may become dangerous at high speed.

The present application discloses means for controlling this trim angle without impairing the boat's efficiency.

Overall Operation

FIG. 1 shows a boat **10** having a symbolically illustrated jet propulsion system **11** that produces a high speed jet of water that is forced out of the propulsion system **11** in a rearward direction. It is, of course, essential to be able to control the direction of the water jet and this horizontal direction control has been accomplished in a number of ways.

The disclosed apparatus achieves control of the water jet in an improved manner that may be understood from FIG. 2; which is a horizontal cross sectional view of the disclosed propulsion system **15**, as viewed from above. In FIG. 2, a water pump (not shown) produces a high volume flow of water that moves in the direction indicated by arrow **17**a; the water flow being contained by the walls of a housing **19**, housing **19** terminating in a substantially spherical portion **20**.

The Jet Nozzle

Housing portion **20** partially encloses a jet nozzle **25** having a constricting passageway that further accelerates the water flow, whose direction in the nozzle **25** is indicated by arrow **17***b;* the water jet emerging from nozzle **25** being indicated by the directional arrow **17***c.* Since the water jet is shown to emerge in an exact rearward direction in FIG. **2**, the boat to which the propulsion system **15** is attached will move forward in a "dead-ahead" manner.

It should be noted that nozzle **25** comprises a substantially spherically configurated bearing surface **27** that is partially enclosed by the flared housing portion **20.**

The Sealing Arrangement

Since the water in housing **19** and in nozzle **25** is under pressure, a seal is desirable between the exterior surface **27** of nozzle **25** and the interior surface **28** of housing portion **20.** For reasons that will become apparent from a later discussion, the disclosed structure uses a seal comprising an "O-ring" **29** that is fitted into a peripheral recess of the housing portion **20.** Thus, sealing O-ring **29** prevents the leakage of water and the loss of water pressure between the housing **19** and the nozzle **25.**

Horizontal Directional Control

In order to provide horizontal directional control for the boat, the emerging water jet — whose direction is indicated by aroow **17***c* — must be diverted from its exact rearward direction. This diversion is accomplished by means of a steering control rod **31** and a steering control linkage **32,** both of which will be more fully discussed later.

For the moment, attention is directed to the horizontal cross sectional view of the FIG. **3**. This illustration corresponds to FIG. **2** except that nozzle **25** has been pivoted and shows that the emerging jet now takes a new direction as indicated by arrow **17***c*.

This result has been achieved as follows. The steering control rod **31** has been moved leftward in the illustrating of FIG. **3,** causing the nozzle **25** to pivot around a vertically oriented "azimuth" pivot axis **33**; so that the water jet now emerges at an angle relative to the center line of the boat — thus causing the boat to turn from its original dead-ahead course.

Thus, the nozzle **25** may be pivoted horizontally to any desired extent and in either direction; the movement of the steering control rod **31** in either of the directions indicated by the double ended arrow **34** causing the nozzle **25** to pivot horizontally in a corresponding direction as indicated by the double ended curved arrow **35.**

It should be noted that during the above discussed horizontal pivoting of the nozzle **25,** the previously mentioned O-ring **29** continues to provide the desired sealing function. This is accomplished because O-ring **29** is always in arcuate peripheral contact with the spherical bearing surface **27** of the nozzle **25.** It should be noted in passing, that the sealing O-ring **29** establishes an "O-ring plane" whose significance will be discussed later.

In this way, the horizontal direction of the boat's movement is readily controlled by the jet propulsion system; without danger of losing water pressure at any particular angle, and without losing overall efficiency.

Boat Attitude

As indicated above, it is frequently desirable to control, and to change, the boat's attitude in order to prevent "boat squatting" or "boat plowing" and this attitude control is accomplished in a manner that is similar to that explained above in connection with the horizontal direction control. The attitude control will be better understood from FIG. **4,** which is a vertical cross sectional view, looking at the side of the subject propulsion system **15.**

As indicated previously, the arrows **17** indicate the direction of the water and jet flow, and it will be noted that the vertical cross section of FIG. **4** shows the emerging jet flow to be in a horizontal direction, as indicated by arrow **17***c*, so that the boat's attitude is substantially the angle built into the boat by its design and construction.

It should be noted that the previously discussed FIG. **2** illustrated a dead-ahead horizontal orientation of the nozzle **25,** and that the FIG. **4** illustration about to be discussed illustrates a flat-out vertical orientation of the nozzle.

Referring again to FIG. **4,** an attitude control rod **36** and an attitude control linkage **37** provide for vertically pivoting the nozzle **25** around a horizontally oriented "elevation" pivot axis **38,** as indicated by the curved double ended arrow **39.**

The vertical pivoting action is similar to the horizontal pivoting action previously described, except that a total of only about twenty degrees of vertical movement is needed to provide the desired change of attitude angle.

It is readily apparent that as nozzle **25** is vertically pivoted around this elevation axis **38,** the water jet will be directed either upwards or downwards. Thus, by controlling the vertical angle of the water jet, the effective attitude of the boat may be quickly and easily adjusted for changing boating conditions; without adversely affecting the boat's forward direction, the boat's speeds, or the boat's efficiency during the vertical pivoting action.

It will be noted, as indicated above, that the sealing O-ring **29** establishes an O-ring plane and that during the vertical pivoting, the O-ring **29** continues to seal the housing **19** and the nozzle **25** in the same manner as for the horizontal pivoting of the nozzle. Thus, a relatively simple O-ring and a substantially spherically configurated bearing surface provide a simple solution to the sealing problem.

The Horizontal Pivoting Mechanism

In order to provide coordinated horizontal and vertical pivoting, it has been found desirable to use a ring and pivot arrangement that will be best understood by referring back to FIG. **2.** This shows a support ring **40** that is positioned to peripherally encircle the end portion **20** of housing **19** and — in a manner and for reasons to be discussed later — supporting ring **40** is affixed to housing portion **20** in such a way that the supporting ring **40** cannot rotate, it can only pivot around the vertically oriented "azimuth" axis **33.** The support ring **40** therefore pivots in a first, horizontal mode.

The peripheral support ring **40** is shown to have diametrically oppositely positioned ring sockets for accepting pivot pins **42***a* and **42***b* that are fixed in respective ring sockets in any suitable manner; e.g., pins, threaded arrangements, adhesives, etc. Thus, the pivot pins **42***a* and **42***b* are affixed in supporting ring **40** at diametrically opposite locations and these pivot pin locations always remain in the same horizontal plane as the support ring **40** pivots around the vertically oriented azimuth axis **33.**

FIG. **3** indicates that support ring **40** has been pivoted horizontally around the vertically oriented azimuth axis **33.** The nozzle **25** has pair of diametrically oppositely positioned horizontally oriented "radials" **44** that carry longitudinal nozzle arms **45** having bearing recesses for receiving respective pivot pins **42***a* and **42** respectively. A suitable bearing material, such as a sleeve of Teflon or Nylon, may be inserted between the pivot pins **42** and their recesses.

The Horizontal Pivoting Action

The resultant horizontal pivoting action may be understood by briefly referring back to FIG. **2,** which shows the nozzle **25** in its dead-ahead horizontal orientation. The horizontal pivoting shown in FIG. **3** has been accomplished by moving the steering control rod **31** leftward; the horizontal linkage **32** pulling though the pivot-pin **426** on its attached portion of ring **40,** which — acting through, the nozzle arms **45,** and the radials **44** — causes support ring **40** and the nozzle **25** to pivot horizontally around the vertically oriented azimuth axis **33** to the horizontal orientation indicated in FIG. **3.** Thus, the amount and direction of horizontal pivoting is controlled by the steering control rod **31.**

Since nozzle **25** is exposed to appreciable water flow and water pressure, the steering control rod **31** is preferably provided with suitable holding or clamping means (not shown).

The Horizontal Linkage

it will be noted from FIG. **3** that the lower shown pivot pin **42***b* extends outside of the support ring **40,** and is indicated to terminate in a ball. FIG. **3** further shows that the end portion of the steering control rod **31** contains a cutout that is adapted to receive the ball; a set screw causing a pair of pressure pads to contact the ball, and to hold it in place. Of course, many such type of ball joints are commercially available.

A threaded rod and a lock nut are used to provide length adjustment of the steering control rod **31.**

Vertical Pivoting

It was pointed out above in connection with FIG. **2** and **3,** that support ring **40** was pivoted horizontally around an azimuth axis **33,** but could not rotate. Therefore, the pivot pins **42** mounted on support ring **40** are always in and always remains in the same horizontal plane regardless of the instantaneous position of the support ring **40.**

As a result of this always horizontal orientation of the pivot pins **42,** nozzle **25** — which is mounted on pivot pins **42,** — is adapted to pivot vertically around the always horizontal pivot pins **42.** Therefore, these pivot pins **42** define the above mentioned elevation axis **38** around which the nozzle **25** pivots vertically and the pivot pins **42** will therefore be designated as the "elevation pivot pins **42.**"

The vertical pivoting action may be better understood by referring back to the vertical cross sectional view of FIG. **4.** From this illustration, it will be recalled that the vertical pivoting action of nozzle **25** takes place around a horizontally oriented elevation axis **38.** The operation of this horizontally oriented elevation axis **38** will be understood by referring back to FIGS. **2** and **3** and visualizing the vertically oriented elevation axis **38** as being defined by the elevation pivot pins **42.**

Since the elevation axis **38** and the elevation pins **42** are always in the same horizontal plane, the vertical pivoting of nozzle **25** will therefore cause the nozzle to point upward, point downward, or point horizontally as indicated in FIG. **4,** regardless of the instantaneous direction of the nozzle **25**/support ring **40** combination.

FIG. **4** also shows a pair of diametrically oppositedly positioned pivot pins **48** that are affixed to housing portion **20** and are seated in bearing recesses of the support ring **40** — suitable bearing sleeves being used as previously discussed. These pivot pins **48** define the ends of the vertically oriented azimuth axis **33,** and will therefore be referred to as "azimuth pivot pins **48.**" Thus, the azimuth pivot pins **48** attach the support ring **40** to housing portion **20**; preventing support ring **40** from rotating, and limiting the support ring **40** to a horizontal pivoting movement.

The Vertical Linkage

FIG. **4** shows a vertical linkage **37** that is quite similar to the horizontal linkage **32** previously discussed in connection with FIG. **3.** The vertical, or attitude control linkage **37,** comprises an attitude control rod **36** that accepts a ball which is affixed to a longitudinal arm **50** attached to a nozzle radial **51.**

However, it should be noted that, unlike the previously discussed horizontal linkage, the vertical linkage **36** has its ball/rod connection separated from the support ring **40.** Thus, as the attitude control rod **36** is moved forward or backward, it does not affect the support ring **40,** rather it causes the nozzle **25** to pivot vertically around its elevation axis **38** — which is carried on support ring **40.**

The principal difference between the horizontal linkage and the vertical linkage is as follows. The horizontal linkage is attached to the support ring **40,** and provides a horizontal pivoting around the azimuth axis **33;** whereas the vertical linkage is attached to the nozzle **25** and provides vertical pivoting around elevation axis **38.**

Attention is now directed to FIG. **5,** which is partially cutaway rear view that schematically illustrates the overall structure and the pivoting support. FIG. **5** shows support ring **40** to be supported on housing **20** by means of the pair of vertically oriented oppositely positioned azimuth pivot pins **48** that are affixed in a vertical plane on housing portion **20.** Due to the fact that the pair of azimuth pivot pins **48** are located in a vertical plane, and are fixedly positioned with respect to the housing portion **20,** support ring **40** cannot rotate peripherally; but, rather, is restricted to a horizontal pivoting motion around the vertically oriented azimuth axis **38.** Thus, as indicated previously, support ring **40** pivots horizontally as indicated in FIG. **2** and **3** — to produce horizontal direction control.

FIG. **5** also shows that nozzle **25** is supported on support ring **40** by means of a pair of oppositely positioned elevation pivot pins **42** that are always located in a horizontal plane on ring **40.** Due to the fact that the pair of elevation pivot pins **42** are located in a horizontal plane, and are fixedly positioned with respect to the ring, nozzle **25** cannot rotate peripherally, but, rather, is restricted to a vertical pivotal motion around the horizontally oriented elevation axis **33** to provide vertical attitude control.

The steering control rod **31,** and the attitude control rod **36** are indicated to be at the near side and the top side respectively of the overall structure, but these locations may be varied as desired.

It can now be understood that nozzle **25** may assume a dead-ahead horizontal direction as illustrated in FIG.

2, and that entire nozzle 25 may be horizontally pivoted around its vertically oriented azimuth axis 38 defined azimuth pivot pins 42. As a result of this horizontal pivoting, the nozzle 25 may be pivoted rightward or leftward, depending upon the movement of the steering control rod 31. In this way, directional control is achieved.

It may also be understood that nozzle 25 may assume a level vertical orientation as indicated in FIG. 4; and that the nozzle 25 may be pivoted vertically about its horizontally oriented elevation axis 33 defined by elevation pivot pins 42. As a result of the vertical pivoting, the nozzle 25 may be pivoted upward or downwad depending upon the movement of attitude control rod 36. In this way, attitude control is achieved.

Thus, the disclosed boat propulsion system controls boat direction and the boat's attitude.

It should be noted that the disclosed support ring pivoting arrangement gives the same mechanical effect as though the nozzle were rotating on its peripheral sealing O-ring, but has the additional advantage that the much stronger ring structure is adapted to take all of the necessary stresses, while still assuring a desired spherical relationship between the nozzle and the housing. In this way, the O-ring has the sole function of providing a sealing effect; being completely relieved from the mechanical loading effects produced by the boat's driving jet propulsion system.

SUMMARY

The subject invention has many advantages over prior art propulsion systems. First of all, it controls both the horizontal direction and the vertical attitude. Second, the structure is quite simple. Third, the sealing system is extremely efficient. Fourth, there is no feedback between the horizontal control system and the vertical control system; each is substantially independent of the other, and yet their actions may be combined to any extent desired. Fifth, on a given boat the planing speed was reduced from 25 miles per hour to 17 miles per hour; thus providing improved overall efficiency. Sixth, the boat's top speed was increased by 7 miles per hour. Seventh, boat's attitude may be adjusted instantaneously, as soon as a different boating condition makes such a change desirable. And finally, these improved results are achieved without increasing the size of the engine.

What is claimed is:

1. A jet propulsion system for a boat, comprising:
a jet producing nozzle;
said nozzle comprising a substantially spherically configurated bearing surface;
direction control means for pivoting said nozzle horizontally around a vertically oriented azimuth pivot axis, for controlling the direction of said boat;
trim angle control means for pivoting said nozzle vertically around a horizontally oriented elevation pivot axis, for controlling the attitude of said boat;
a housing having a flared housing portion adapted to partially enclose said bearing surface of said nozzle;
a support ring positioned to peripherally encircle said housing portion;
means for pivotally attaching said support ring on said housing portion for causing said support ring to pivot in only a first manner;
means for attaching said nozzle to said support ring for causing said nozzle to pivot in said first manner.

2. The combination of claim 1 including;
means for attaching said nozzle to said support ring for causing said nozzle to pivot in a second manner.

3. The combination of claim 2 including means comprising a directional control rod and a directional control linkage interlinking said directional control rod and said support ring, for causing said nozzle to pivot in said first manner.

4. The combination of claim 2 including means, comprising a trim angle control rod and a trim angle control linkage interlinking said trim angle control rod and said nozzle, for causing said nozzle to pivot in said second manner.

5. The combination of claim 2 wherein said first pivotal manner is horizontal, and said second pivotal manner is vertical.

6. A jet propulsion system for a boat, comprising;
a jet producing nozzle having a substantially spherically configurated bearing surface;
a housing having a flared housing portion adapted to partially enclose said bearing surface of sai nozzle;
means, comprising a sealing O-ring positioned in the interior surface of said housing portion for providing a seal between the interior surface of said housing portion and said bearing surface of said nozzle;
direction control means for pivoting said nozzle horizontally around a vertically oriented azimuth axis, for controlling the horizontal direction of said jet from said nozzle;
said direction control means comprising a support ring positioned to peripherally encircle said housing portion;
said direction control means further comprising pivot means, including a pivot pin arrangement between said support ring and said housing portion, for causing said support ring to be limited to a pivotal movement in only a horizontal direction;
said direction control means further comprising means for attaching said nozzle to said support ring, for causing said nozzle to pivot in said horizontal direction;
means, comprising a direction control rod and a direction control linkage interlinking said direction control rod and said support ring, for actuating said direction control means;
trim angle control means for pivoting said nozzle vertically around a horizontally oriented elevation axis, for controlling the vertical direction of said jet from said nozzle;
said trim angle control means comprising pivot means, including a pivot pin arrangement between said support ring and said nozzle, for causing said nozzle to pivot in a vertical direction;
means, comprising a trim angle rod and a trim angle linkage interlinking said trim angle rod and said nozzle, for actuating said trim angle control means.

* * * * *