Oct. 22, 1968 A. NUTKU 3,406,759

CONTROLLABLE PITCH PROPELLER

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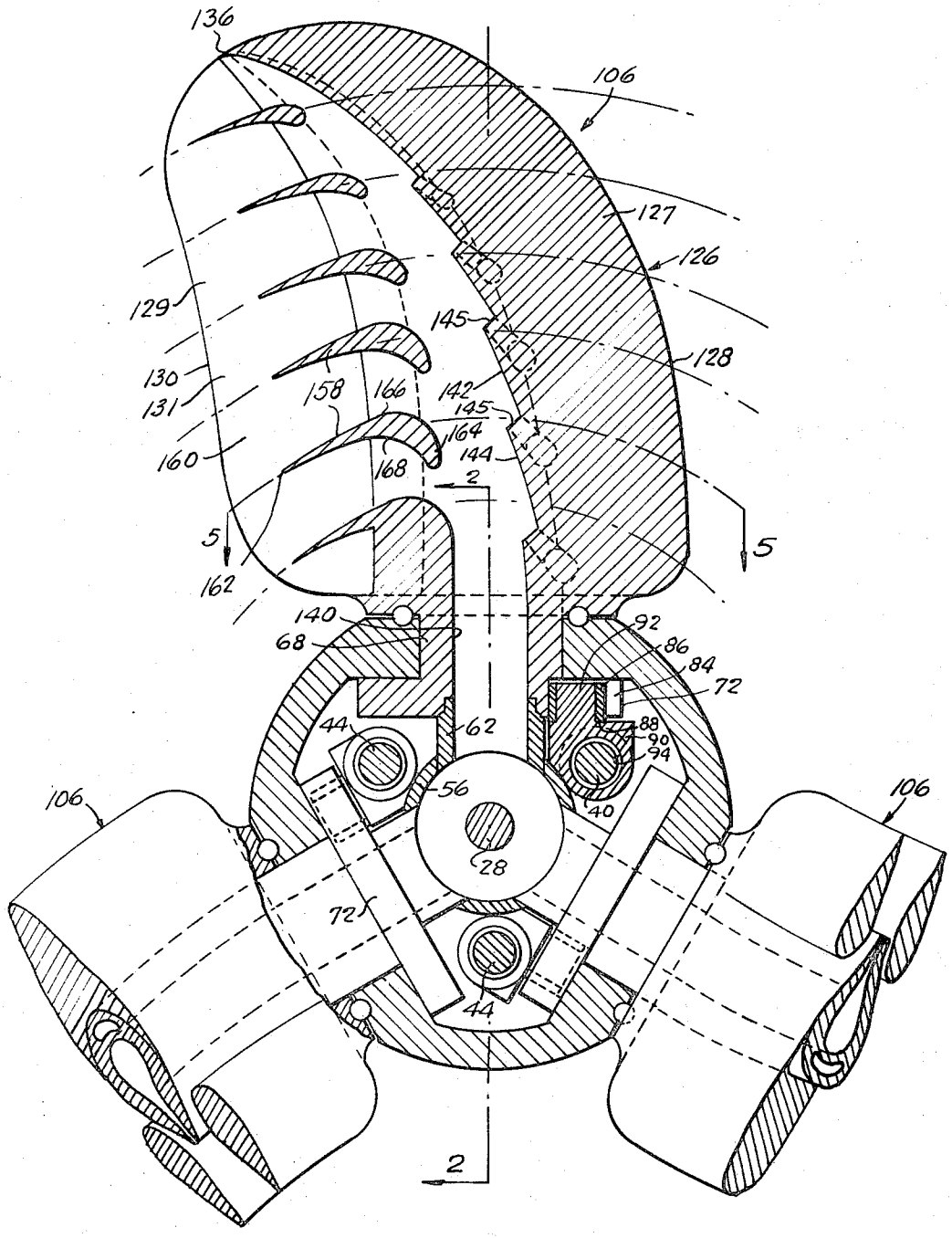


FIG. 1.

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FIG. 2.

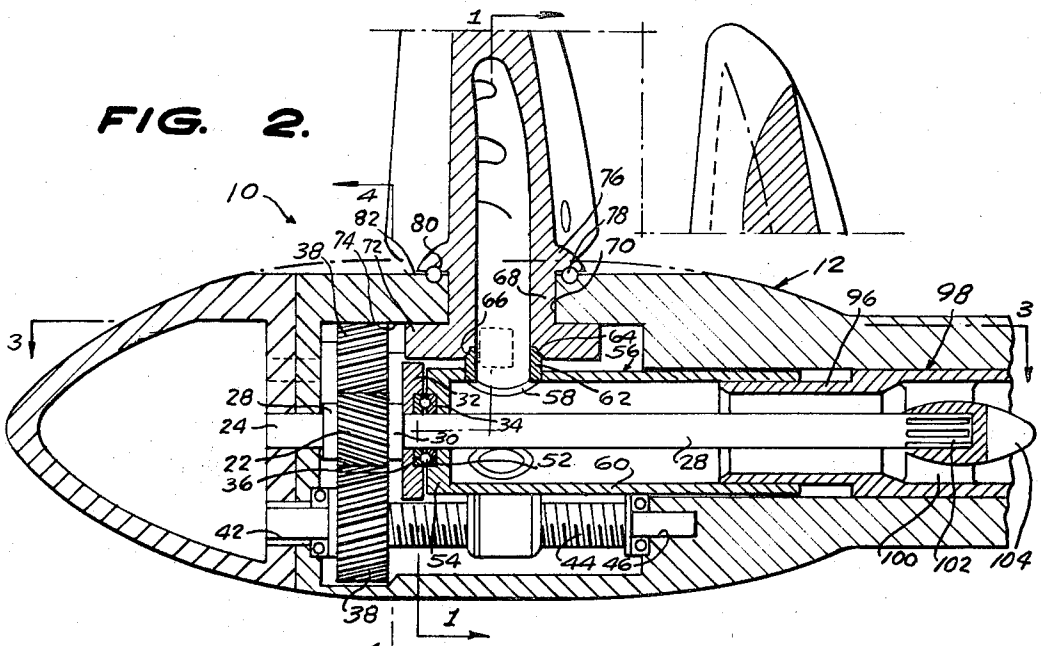
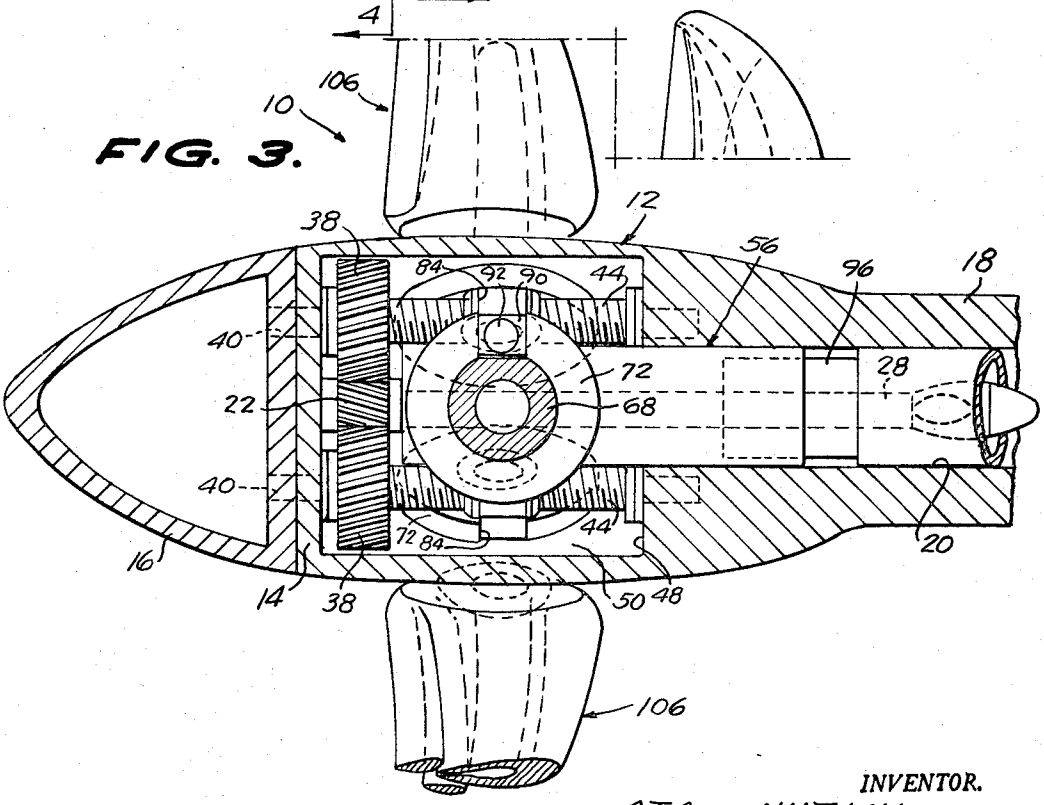


FIG. 3.



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FIG. 4.

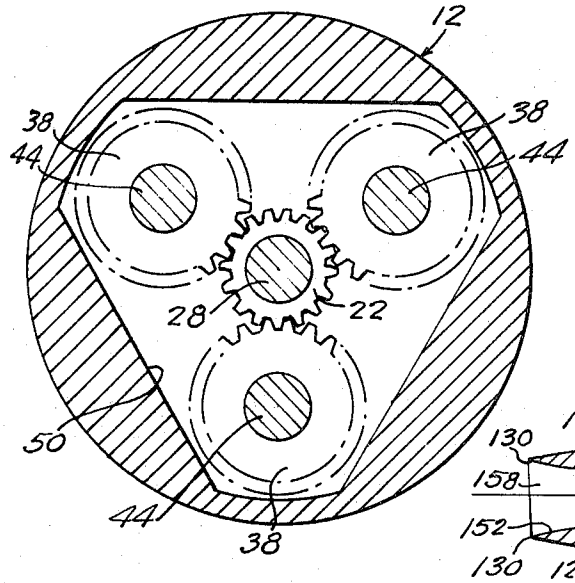


FIG. 5.

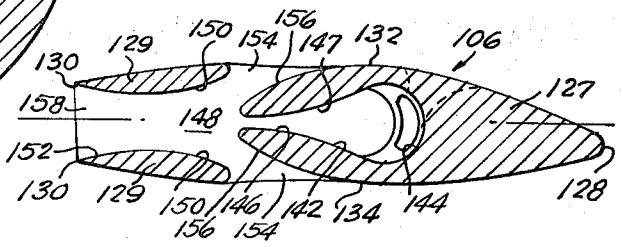


FIG. 7.

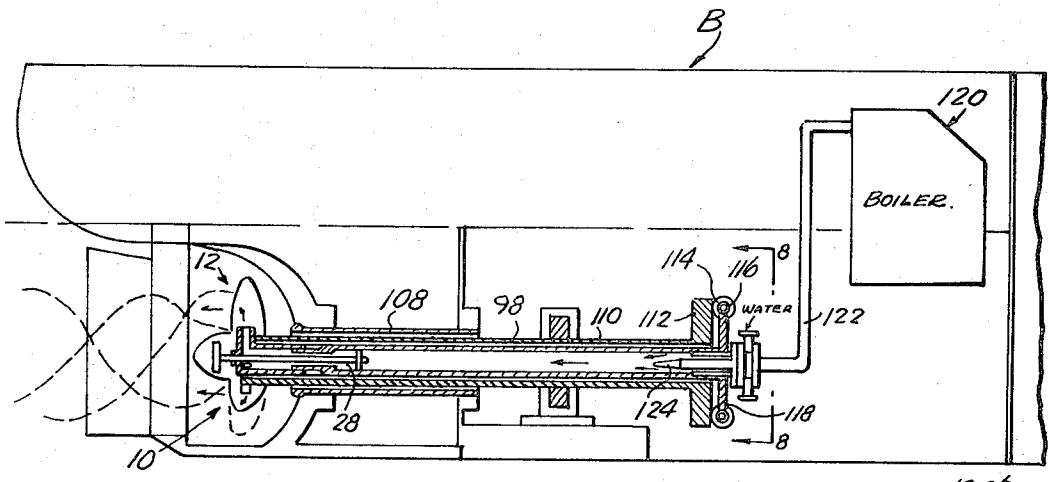
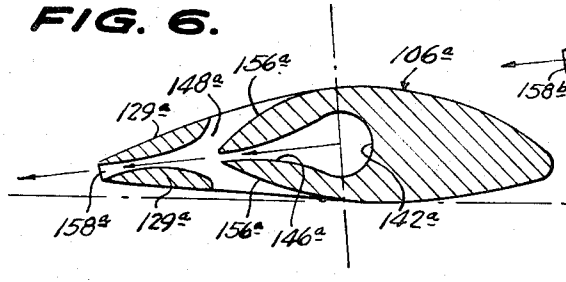


FIG. 6.



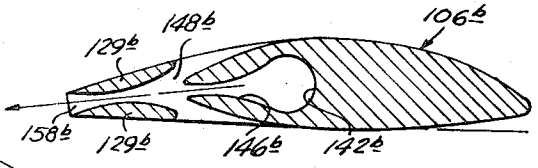


FIG. 6A.

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FIG. 8.

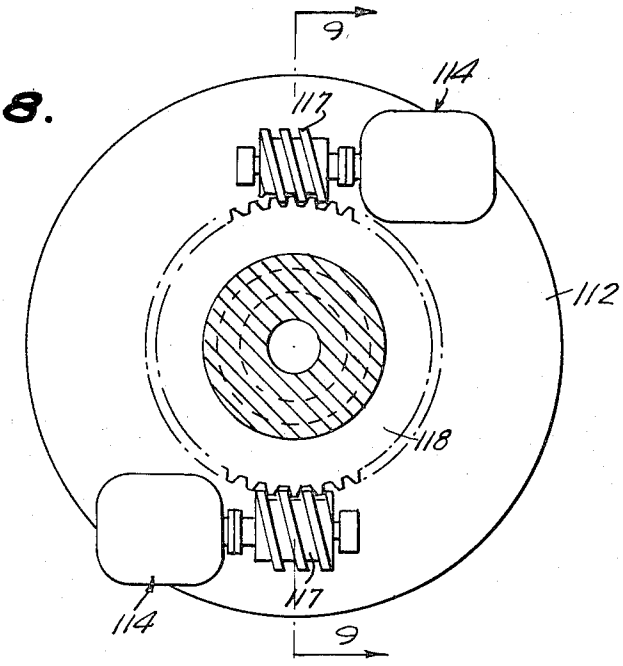
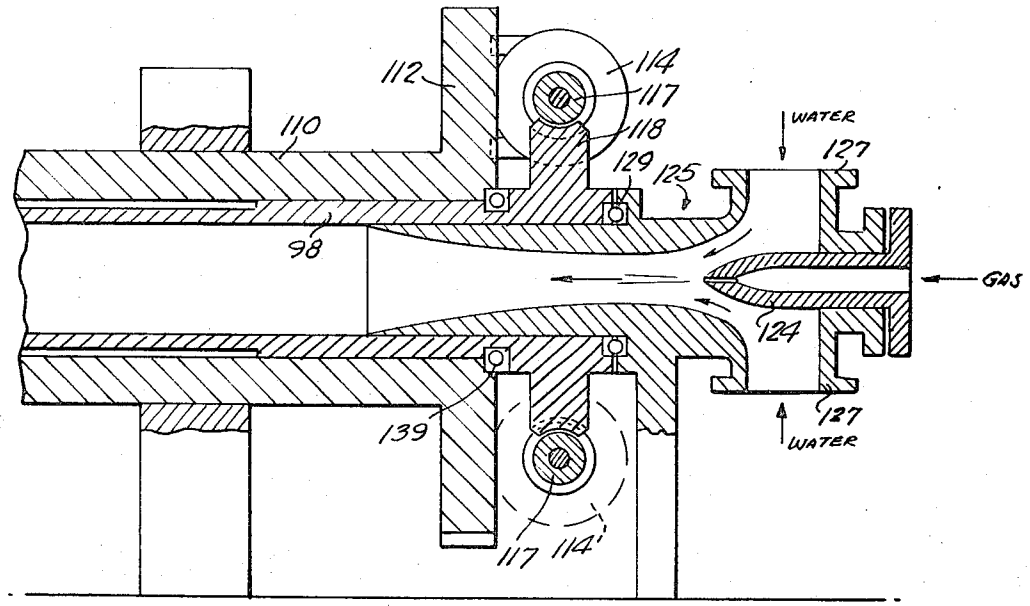


FIG. 9.



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3,406,759

CONTROLLABLE PITCH PROPELLER

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Filed Aug. 15, 1967, Ser. No. 660,796
14 Claims. (Cl. 170—135.4)

ABSTRACT OF THE DISCLOSURE

The invention provides a jet driven controllable pitch propeller comprising a hub having extending blade means, of split hydrofoil cross-section including a leading blade portion and laterally spaced tail vanes, said vanes defining discharge slot means on the trailing edge of the blade, a fluid duct extending lengthwise of the blade, located between the leading portion and said vanes, said vanes defining a discharge slot extending lengthwise of the blade in communication with said fluid duct, water inlet ports leading from the sides of the blade body into said duct, a venturi chamber located between said duct and said discharge slot, water inlet passages formed in opposite sides of the blade body and opening into the venturi chamber, fins extending across said discharge slot and spaced therealong, a tubular blade stock on the inner end of the blade journaled on said hub, said hub having a closed chamber, operating mechanism operatively connected to the blade stock, rotary actuating means for said mechanism extending lengthwise through the hub, operating means externally supported relative to the hub and connected to said actuating means, and means for supplying jet fluid under pressure to the hub chamber and into the blade fluid duct.

This invention relates to a gas-hydraulic jet driven controllable pitch propeller, adapted for marine propulsion, pumps, water turbines, and other hydrodynamic application.

In the case of mechanically driven propellers, expensive and difficult to maintain, engines or motors are the driving media, which by their thermal and mechanical losses limit their quasi-propulsive efficiency, cause loss of deadweight capacity in ships, due to the extra weight of their engines, and by their use of normal types of propellers, problems, such as limitation of diameter, r.p.m., cavitation, etc., efficiency is curtailed, and in the cases of existing controllable pitch propeller propulsion systems, push-pull rod mechanisms require costly and complicated hydraulic control systems working under very high pressures. In attempts to drive ships by direct jet propulsion, low efficiency, emanating from high ratio of ship speed and slip stream velocity of the jets makes their adaptation objectionable and impractical.

The primary object of the present invention is the provision of a gas-hydraulic jet driven controllable pitch propeller, working on the ejector principle, whose use eliminates the need for a driving engine or motor, the said jet propeller being instead, driven by fluids such as gas, steam, air, or water, or a combination thereof, which can be supplied by a generating source on the associated vessel, the said fluid or mixture being jetted from nozzles at the trailing edge of the propeller.

Another object of the invention is the provision of a propeller of split hydrofoil cross-section, having venturi fluid jet nozzles in a fluid discharge slot in the trailing edges of the blades of the propeller, with water intake ports leading into the slot, the said fluid nozzles, having at their sides, water passages which open to a common discharge for the fluid and for water drawn through water passages and ports, by the stream of jetted fluid, whereby

there is obtained the benefit of a combined jet fluid and water stream, which produces the thrust for rotation of the propeller, together with the contribution of torque forces produced due to the flow of stream in the curved fluid duct, and also by the lift forces of nozzles due to their hydrofoil configuration additionally contributing to torque for rotation.

A further object of the invention is the provision of a propeller, whether jet fluid driven or otherwise, wherein the blades of the propeller are together rotatable for changes in pitch, and for reversing, by simple mechanical means, rotationally driven by small and inexpensive electric or hydraulic motors, mounted on the shaft flange of a boat, which serves both to change the blade pitch to the desired angle and to hold the blades in such adjustments.

In the drawings:

FIGURE 1 is a fragmentary transverse section, taken on the line **1—1** of FIGURE 2, parts being broken away and in section;

FIGURE 2 is a vertical longitudinal section, taken on the line **2—2** of FIGURE 1;

FIGURE 3 is a longitudinal section, taken on the line **3—3** of FIGURE 2;

FIGURE 4 is an enlarged vertical transverse section, taken on the line **4—4** of FIGURE 2;

FIGURE 5 is a section taken on the line **5—5** of FIGURE 1;

FIGURE 6 is a view, like FIGURE 5, of an alternate form of propeller blade;

FIGURE 6*a* is a view, like FIGURES 5 and 6, showing another alternate form of propeller blade;

FIGURE 7 is an expanded schematic diagram, partly in vertical longitudinal section, illustrating drive and control means for the propeller, located in a ship;

FIGURE 8 is an enlarged vertical section, taken on the line **8—8** of FIGURE 7, showing the fluid jet nozzle and maneuvering gear, at the inner end of the screw shaft; and

FIGURE 9 is a fragmentary longitudinal section, taken on the line **9—9** of FIGURE 8.

Referring in detail to the drawings, and first to FIGURES 1 to 5 thereof, the illustrated propeller **10** comprises an elongated cylindrical cross section, hollow hub **12**, having a flat aft end wall **14**, a rearwardly extending cone **16**, the hub **12** merging, at its forward end, into a reduced diameter axial tubular extension **18**, having a smooth axial bore **20**.

Each of the propeller blades **106** comprises a preferably solid blade body **126** having a generally split hydrofoil cross-section, with one leading portion **127**, and a pair of laterally spaced tail vanes **129**, defining a discharge slot **131** and **158**, as illustrated in FIGURES 5 and 6, which provides a tapered and rounded leading edge **128**, and two trailing edges **130**. The blade body **126** is hydrodynamically centered relative to and preferably integral with the root end of the related blade stock **68**. Given the above-described cross-section, the blade body **126** has a cambered back **132** and a face **134**, the major portion of which may be straight or cambered, and is preferably formed into a streamlined configuration.

As shown in FIGURE 1, the leading edge **128** of the blade body **126** curves radially outwardly so that its tip **136** is located behind its blade stock **68**. The trailing edges **130** of the blade body **126** may be straight or concavely curved.

The blade stock **68** has an axial bore **140**, which is registered with the inner end of a jet fluid duct **142**, which extends along the skew curve of the blade body, at the after-end of the leading blade portion **127**, and has

a leading wall **144** which is curved along the skew curve, with dents or steps **145** for water inlet ports leading from back of the blade into the duct **142**. As shown in FIGURE 5, the duct **142** is pear-shaped in cross-section, with its larger cross-section bounded by the wall **144**. The duct **142** is tapered in cross section toward the blade tip **136**.

The open smaller trailing end portion **147** of the duct **142** opens to a relatively narrow jet orifice **146**, which provide for venturi discharge of jet fluid from the duct **142**, into a substantially larger cross section water venturi chamber **148**, which opens to the discharge slot **131** or **158**, between the vanes **129**, at the trailing edge of the blade body. The venturi chamber **148** has convex to straight side walls **150**, which provide between them, at the after ends thereof, a V-shaped flaring discharge nozzle aperture **152**, and at their forward ends, V-shaped water inlet passages **154**. Further, the leading part of the blade body **126** containing the duct **142** terminates, at its trailing end, in converging walls **156**, which are spaced from water passage walls **150**, so as to provide water intake ports which are spaced along the major portion of the length of the leading blade portion of the blade body **126**.

Extending between the vane wall portions **150** and **152**, and spaced along the length of the chamber **148** are transverse fins **158**, between which are defined combined water and jet fluid nozzles **160**. The fins **158** have streamlined trailing edges **162** which are located on circles concentric with the axis of the hub **12** of the propeller, and rounded larger cross section leading edges **164**. The backs **166** of the fins are convexly curved ,and their inner faces **168** are concavely curved, so that the fins have curved hydrofoil cross sections, with the leading edges of adjacent fins spaced closer together than their trailing edges.

In the case of the propeller blade **106***a*, shown in FIGURE 6, an alternate form of blade body cross section of the blade body **126***a*, is embodied, the dimensions and proportions of the water passages and discharge chamber **148***a* being reduced and changed for increased venturi discharge of combined water and jet fluid, according to the nature of the jet fluid used.

FIGURE 6*a* shows another form of propeller blade **106***b*, involving further reductions in related cross sections.

In the hub **12** of the propeller, a center axial gearwheel **22** has a stub shaft **24** journalled, as indicated at **26**, through the hub aft wall **14** and the cone **16**, and a shaft **28** extending rearwardly from the gearwheel **22**, is axially and spacedly in the bore **20** of the extension **18**. The center gearwheel **22** is stabilized in place by a rear shoulder **28**, bearing against the hub rear aft wall **14** and a forward shoulder **30**, bearing against the transverse strut **32**, extending across the interior of the hub **12**. An anti-friction bearing **34** is inset, as indicated at **36**, in the front side of the strut and is traversed by the shaft **28**.

The center gearwheel **22** is in mesh with, in this case, three equally circumferentially spaced outer or planetary gearwheels **38**, having rear stub shafts **40** journalled, as indicated at **42**, through the hub aft wall **14** and the cone **16**. Threaded maneuvering shafts **44** extend forwardly from the outer gearwheels **38**, and, at their forward ends, are supportably journalled, as indicated at **46**, in the front wall **48** of a hub chamber **50**, containing the gearwheels **22** and **38** and their shafts.

The bearing **34** is also inset, as indicated at **52**, in the rear end wall **54** of a jet fluid pressure tube **56**, which fits in the rear part of the bore **20** of the hub extension **18**. Jet fluid ports **58** are provided, at equally spaced intervals around the side wall **60** of the tube **5**, in which are suitably secured, radial tubular collars **62**, having reduced outer ends **64**. The outer ends **64** are sealingly seated in tapered seats **66**, in the inner ends of tubular propeller blade stocks **68**.

The propeller blade stocks **68** are cylindrical in cross section, and are journalled through accommodating openings **70** in the sides of the hub **12**. The stocks **68** have inner bearing collars **72**, at their inner ends, which bear against flat sides of the hub chamber **50**, and external bearing collars **76**, which are rotatably supported, relative to the hub **12**, by means of bearings **78**, engaged in recesses **80** and **82**, provided in the collars **76** and the exterior of the hub.

As shown in FIGURES 1, 2 and 3, each of the inner bearing collars **72** are provided, at the forward sides of the blade stocks **68**, with radial slots **84**, in which are engaged tubular bearings **86**, which have inner ends **88**, extending inwardly from the collars **72**. Follower blocks **90** are engaged with the inner ends **88**, have stubs **92** journalled in the bearings **86**, and at right angles to the stubs **92**, the blocks are formed with threaded bores **94**, in which the threaded maneuvering shafts **44** are threaded.

At its inner end, the jet fluid tube **56** is slidably sleeved, in a slip joint, over a reduced diameter rear end portion **96** of a rotatable pitch control tubular shaft **98**, which is suitably journalled in the hub extension **18**, and has adjacent to the rear end portion **96**, a diametrical web **100**, in which the forward end of the center shaft **28** is splined, as indicated at **102**. The forward end of the shaft **28** is capped by a tear drop streamliner **104**. With this arrangement, rotation of the tube **98**, in either direction, by suitable means hereinafter exemplified, produces rotation of the threaded maneuvering shafts **44**, and thereby rotation of the propeller blade stocks **68**, for effecting and maintaining pitch adjustments, and astern orientation of propeller blade bodies **106**, of which the stocks **68** are component parts.

FIGURE 7 shows an illustrative installation of a propeller **10** for propelling a ship B, wherein the stern of the ship has installed therethrough a cylindrical outer casing **108**, through which extends a tubular stationary shaft **110**, which reaches rearwardly beyond the stern, and has, on its forward end, an annular flange **112**, upon which are mounted small electric or hydraulic motors **114**. The motors **114** have driving pinion worm gears **117**, which are in mesh with the worm wheel **118**, which is fixed on the rear end of the tubular control shaft **98**. Rotation of control shaft **98**, for changing pitch of the blades **106**, of the propeller **10**, in either direction, is obtained by operating the motors **114**.

For supplying jet fluid under pressure to the interior of the tubular control shaft **98**, whether steam or some other gaseous fluid, the same is supplied from a source, such as a boiler **120**, installed in the ship B, the fluid being ejected from an axial jet nozzle **124**, through the tubular shaft **98**, the nozzle **124** being incorporated in an ejector venturi nozzle which has water inlets **127** for a mixed jet of gas-water under pressure. Anti-friction bearings **129** and **139**, between the jet nozzle body and the worm wheel **118**, and between the hollow shaft **110**, and the tubular control shaft **98**, are arranged, as shown in FIGURE 9.

While the invention has been described with respect to gas hydraulic jet driven controllable pitch propellers, it will be obvious that the same described structure may be used with minor or no changes when driven by a jet or jet plasma however derived and propelled.

What is claimed is:

1. A gas-hydraulic jet driven controllable pitch propeller comprising a hub having blade means extending therefrom, said blade means comprising a blade body of a split hydrofoil cross section comprising a leading blade portion and laterally spaced tail vanes, said vanes defining discharge slot means on the trailing edge of the blade body, fluid duct means extending lengthwise of the blade body, said duct means being located between the leading blade portion and said vanes, said vanes defining therebetween said discharge slot means extending lengthwise thereof, said fluid duct means being in communication with said discharge slot means, said duct means comprising water inlet ports leading from the sides of the blade body into the said duct, a venturi chamber located between said

duct means and said discharge slot, water inlet passages formed in the opposite sides of the blade body and opening into said venturi chamber, jet means comprising fins extending across said discharge slot means and spaced therealong, said blade body having a tubular blade stock on its inner end journalled on said hub, said hub being formed with a closed chamber, operating mechanism operatively connected to the blade stock, rotary actuating means for said mechanism extending lengthwise through the hub, operating means externally supported relative to the hub and connected to said actuating means, and means for supplying jet fluid under pressure to the hub chamber and into the propeller blade body fluid duct.

2. A propeller of the character described comprising a hub having a propeller blade body extending therefrom, said blade body being of split hydrofoil cross section and having a solid leading blade portion and spaced trailing vanes, a lengthwise extending jet fluid duct located between the leading body portion and said vanes, said body being formed with water passage means located between the leading body portion and the vanes, said vanes defining venturi discharge jet nozzle means therebetween, said water passage means and said jet fluid duct opening to said nozzle means, said blade body having a tubular stock having a bore opening to said jet fluid duct, and means for supplying jet fluid under pressure into the bore of the blade stock.

3. A propeller according to claim 2, wherein said blade means are formed, on their faces and backs thereof, adjacent to the trailing edge of the leading portion of the blade means, with water intake passage means communicating with venturi discharge nozzle means, said discharge nozzle means comprising a lengthwise extending venturi discharge chamber formed between the cambered inner faces of the tail vanes, opening full length to the trailing edges of the blade means, and formed between lengthwise spaced fins of hydrofoil cross section extending across said chamber, beginning with the opening of the fluid jet nozzle of the fluid duct at the trailing edge of the leading blade portion, said fluid duct leading from blade stock to blade tip with a skew having venturi jet nozzles at its trailing edge and a dented leading wall.

4. A propeller according to claim 2, wherein said blade means are formed, on the faces and backs thereof, adjacent to the trailing edge of the leading portion of the blade means and the noses of the tail vanes, with water intake passage means communicating with venturi discharge nozzle means, said discharge nozzle means comprising a lengthwise extending venturi discharge chamber formed between the cambered inner faces of the tail vanes, opening full length to the trailing edges of the blade means, and formed between lengthwise spaced fins of hydrofoil cross section extending across said chamber, beginning with the opening of the fluid jet nozzle of the fluid duct, at the trailing edge of the leading blade portion, said fluid duct leading from blade stock to blade tip with a skew, having venturi jet nozzles at its trailing edge and a dented leading wall, said fluid duct leading wall accommodating at its dents, water intake ports leading from water intake slits opened at the back of the blade means.

5. A gas-hydraulic jet driven controllable pitch propeller according to claim 1, wherein said blade means comprises at least two circumferentially spaced blade bodies, a center gearwheel journalled in said chamber and connected to said actuating means, planetary gearwheels journalled in said chamber and meshed with the center gearwheel and individually associated with the blade bodies, said planetary gearwheels having threaded shafts, said blade stocks having lateral collars formed with radial slots, follower blocks slidable in said slots, said follower blocks being threaded to run on the threaded shafts.

6. A gas-hydraulic jet driven controllable pitch propeller according to claim 1, wherein said blade means comprises at least two circumferentially spaced blade bodies, a center gearwheel journalled in said chamber and connected to said actuating means, planetary gearwheels having threaded maneuvering shafts, said blade stocks having lateral collars formed with radial slots, follower blocks being threaded to run on the threaded maneuvering shafts, said follower blocks having stubs journalled in said slots.

7. A gas-hydraulic jet driven controllable pitch propeller according to claim 1, wherein said blade means comprises at least two circumferentially spaced blade bodies, a center gearwheel journalled in said chamber and connected to said actuating means, planetary gearwheels having threaded maneuvering shafts, said blade stock having lateral collars formed with radial slots, the follower blocks being threaded to run on the threaded maneuvering shafts, said follower blocks having stubs journalled in said slots, said actuating means comprising a tubular control shaft running inside the screw shaft of the ship, said tubular control shaft serving also as jet fluid pipe, and having on its ship-side end a worm wheel which is actuated by worm gears arranged on the shafts of the maneuvering motors mounted on the flange of said screw shaft.

8. A propulsion system comprising a propeller having a hub, means supporting the hub for rotation, said hub having a tubular extension extending axially therefrom, at least one propeller blade mounted on and extending from said hub, said blade having a body and a tubular stock journaled on the hub, said stock being formed with a bore communicating with the interior of said tubular extension, control means having mechanism within said hub and operatively connected to the blade stock for rotating the blade and changing the pitch of the blade in opposite directions, said control means comprising a rotary member extending through said tubular extension, rotating means operatively connected to said member, said blade body comprising a leading portion and laterally spaced trailing vanes, the spacing of the vanes defining a jet fluid discharge slot extending lengthwise of the blade body, said blade body being formed with duct means extending lengthwise of the body and communicating at its inner end with the bore of the blade stock, said duct being located between the leading portion of the blade body and said vanes, said duct being formed to provide a venturi slot spaced from and directed to discharge jet fluid to said discharge slot, water passage means spaced lengthwise of the blade body and opening to the opposite sides of the blade body, said water passage means leading into said discharge slot at opposite sides of said venturi slot, and means for supplying jet fluid under pressure through the hub to the bore of the propeller blade stock.

9. A propulsion system according to claim 8, wherein said fins extend across said discharge slot between said vanes, said fins being spaced from each other lengthwise of the discharge slot and defining jet therebetween.

10. A propulsion system according to claim 8, wherein said blade duct is curved relative to the axis of the blade stock radially outwardly and toward said discharge slot, said duct being tapered in cross-section radially outwardly from the blade stock.

11. A propulsion system according to claim 10, wherein said fins have convex outer surfaces and concave inner surfaces.

12. A propulsion system according to claim 8, wherein the facing surfaces of said vanes are convex to provide venturi passage of jet fluid through the discharge slot.

13. A propulsion system according to claim 8, wherein said water passage means are angled inwardly from the sides of the blade body toward said discharge slot.

14. A propulsion system according to claim 13, wherein said venturi slot and the cross-section of the blade body between said water passage means being narrower than said discharge slot.

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