June 30, 1970 A. W. WANZER 3,517,633

BOW THRUSTER

Filed Sept. 10, 1968 2 Sheets-Sheet 1

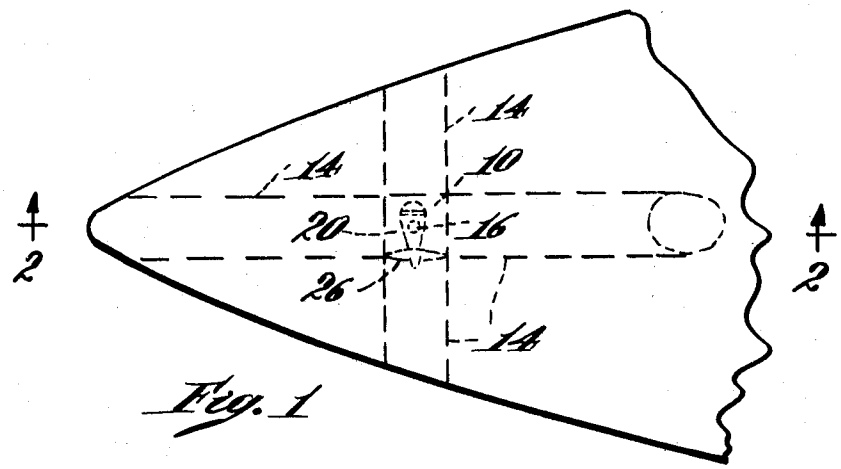


Fig. 1

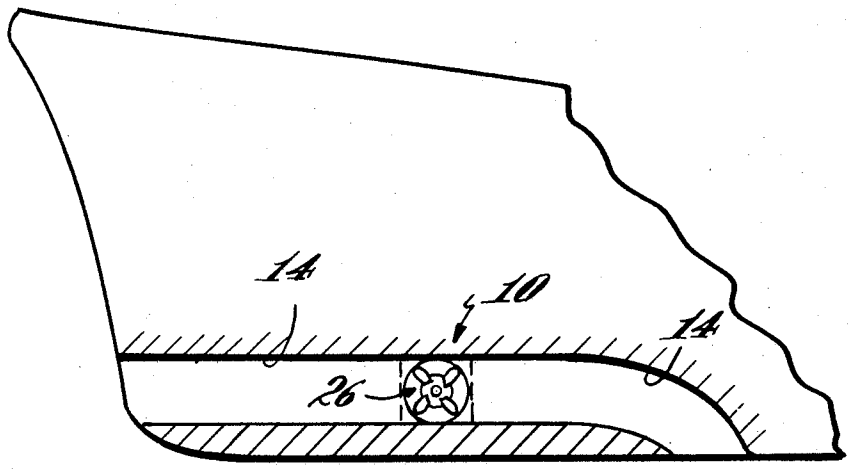


Fig. 2

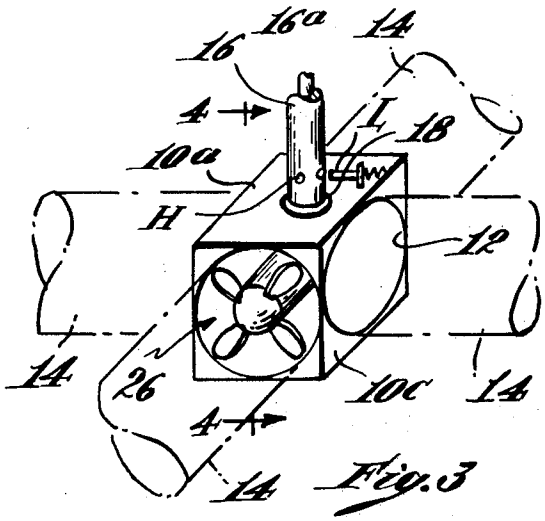


Fig. 3

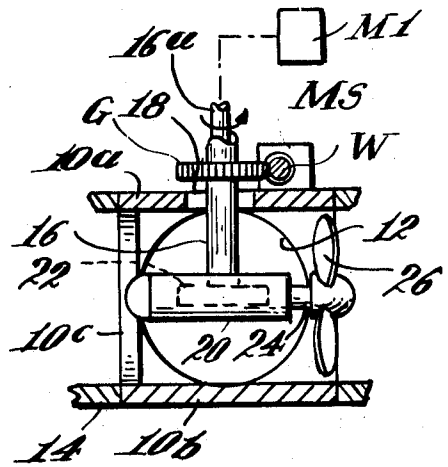


Fig. 4

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BOW THRUSTER

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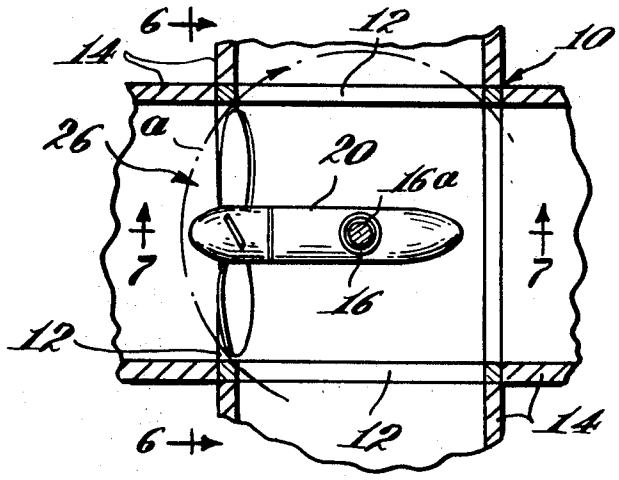


Fig. 5

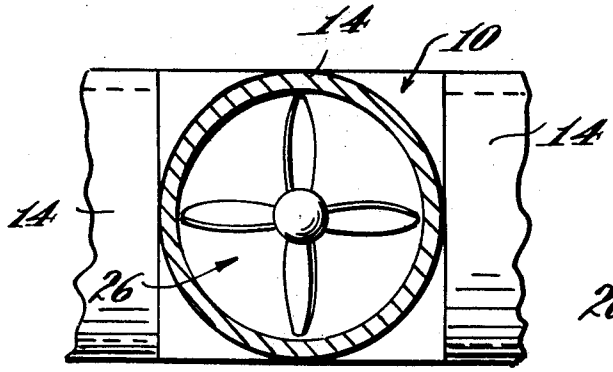


Fig. 6

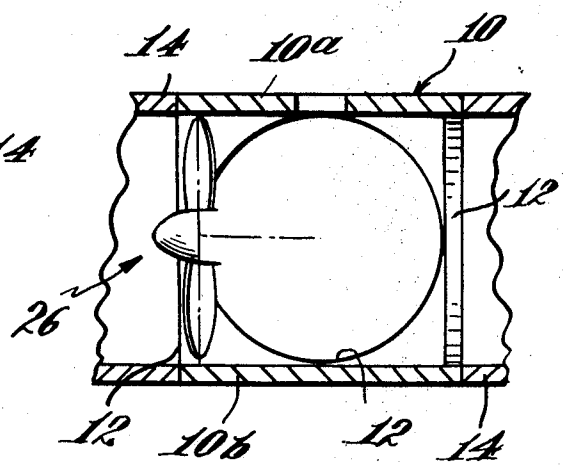


Fig. 7

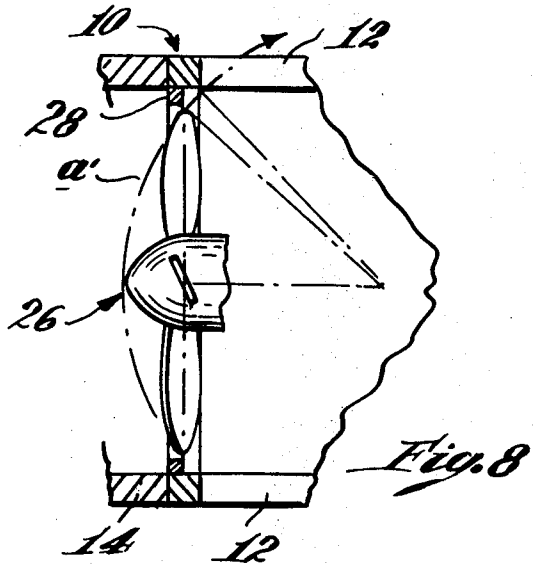


Fig. 8

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BOW THRUSTER

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ABSTRACT OF THE DISCLOSURE

Apparatus comprising, in combination with the hull of a ship, a chamber located in the hull below the water line, draft tubes extending from the sides of the chamber athwart ship and fore and aft, and a propeller mounted in the chamber for rotation about a horizontal axis and for movement about a vertical axis to enable disposing the rotating blade in confronting relation to any one of the draft tubes for directional thrust and obtaining flow to the propeller from the remaining three tubes.

BACKGROUND OF THE INVENTION

Basically there are three types of mechanical assists available to facilitate maneuvering ships, the tunnel-type bow thruster commonly known as a "bow thruster"; the retractable thruster and the steerable thruster. The tunnel-type bow thruster comprises a tube mounted athwart ship, usually at the bow but also usable at the stern in which there is mounted one or more propellers which, when rotated, will develop a side thrust to assist in swinging the bow or stern or both around in a tight circle, or simply to develop side thrust to push or hold the vessel alongside a piling or pier, or even to hold it in a controlled position. The retractable thruster is a propeller and shaft housed within a well in the bow when not in use. It may be extended below the keel for use and retracted when not in use, or to make adjustments for the draft of the vessel. This type provides thrust to either port or starboard and gives added maneuverability in control of the ship for docking, slow-speed operations and changing heading. The steerable type, which may also be retractable, is installed below the bow and has a full 360° of rotation thus affording maximum maneuverability and control for precision station keeping, emergency propulsion power, etc.

The objects of this invention are to combine the desirable characteristics of the three basic bow thrusters and especially to embody in a tunnel-type thruster the greater ship maneuverability afforded by the retractable and steerable thrusters and additionally to provide for auxiliary bow steering and auxiliary propulsion to replace or supplement main propulsion and without altering or increasing the vessel's draft.

SUMMARY

As herein illustrated, the apparatus comprises, in combination with the hull of a ship, a chamber having a horizontal cross-section which is square, and side walls, each containing a circular opening which corresponds in diameter to the width of the wall which contains it. The chamber is located in the hull of the ship below the water line with its geometric center on or close to the longitudinal center line of the hull and near either end, and there are right-angularly disposed draft tubes connected to the four side walls over the openings, the axes of which intersect at said geometric center of the chamber. The draft tubes are disposed athwart ship and fore and aft, and there is

means supporting a propeller in the chamber for rotation about a horizontal axis and for movement about a vertical axis at said geometric center to position the plane of rotation of the propeller in any one of four positions confronting one of the walls and the opening therein. The propeller has tapered ends and is of such diameter that its ends will lie on the circle whose center is at the geometric center of the chamber and is tangent to the four corners thereof. In one form the diameter of the propeller corresponds to the diameter of the openings in the walls and is located at a position such that the tips of the propeller move in a path lying substantially in the plane of the inner side of the wall which the propeller confronts. Optionally, a propeller of smaller diameter may be employed, set further through the opening in the side wall with a ring surrounding it, provided, however, that the ends of the propeller and the circular portion of the ring closest to the path of movement of the ends of the propeller lie in the aforesaid circle of tangency.

The propeller is supported from the top of the chamber at the lower end of a hollow shaft journaled in a bearing at the top and there is means extending through the hollow shaft from an outside source of power for effecting rotation of the propeller shaft. In addition, there is means for effecting rotation of the hollow shaft to change the position of the propeller and means for holding the hollow shaft when the propeller is once positioned for operation.

The invention will now be described in greater detail with reference to the accompanying drawings wherein:

FIG. 1 is a plan view showing diagrammatically the location of the apparatus at the bow end of a ship;

FIG. 2 is an elevation of the position of the bow shown in FIG. 1, showing the location of the apparatus relative to the bottom line;

FIG. 3 is an isometric of the apparatus removed from the hull and drawn to somewhat larger scale;

FIG. 4 is a vertical section of the chamber and portions of the draft tubes plus driving means shown digrammatically;

FIG. 5 is a horizontal section of the chamber, to larger scale, showing the disposition of the propeller with respect to one of the side wall openings;

FIG. 6 is an elevation, partly in section, as seen from the left side of FIG. 5;

FIG. 7 is a vertical section taken on the line 7—7 of FIG. 6; and

FIG. 8 is a horizontal section similar to FIG. 5, showing the use of a ring mounted in one of the wall openings about a propeller of smaller diameter.

Referring to the drawings, FIGS. 1 and 2 show diagrammatically the bow portion of a ship in which the bow thruster is mounted, it being understood, however, that it may be mounted at the stern end of the ship side or at both the bow and stern ends. As shown, the bow thruster comprises a chamber **10** located with its geometric center on the longitudinal median line of the ship near the bow below the water line and has rectangularly arranged top and bottom walls **10***a*, **10***b* and four side walls **10***c*. Each of the four side walls **10***c* of the chamber contains a circular opening **12** over which is welded one end of a draft tube **14** of corresponding inside diameter. The draft tubes **14** at the opposite sides of the chamber extend therefrom athwart ship through the opposite sides of the hull and the draft tubes at the fore and aft sides of the chamber extend along the center line forwardly through the bow and rearwardly through the bottom. As shown in FIGS. 5, 6 and 7, the chamber **10** is square in horizontal and vertical section and the opening **12** in each side wall corresponds in diameter to the width of the wall containing it.

A hollow shaft **16** is mounted above the chamber in a vertical position with its lower end extending through a suitable bearing **18** in the top wall **10***a* for rotation about its vertical axis. At the lower end of the hollow shaft there is mounted a housing **20** containing driving means **22** from which extends a horizontal propeller shaft **24** for rotation by said driving means about a horizontal axis at right angles to the axis of the hollow shaft **16**. A propeller **26** is fixed to the shaft **24** for rotation about the horizontal axis of the shaft **24**. The driving means **22** may be a motor in the housing **20** connected by electric or hydraulic means to a source of power at some other part of the ship, for example, through the hollow shaft **16**, or it may be gearing connected to a drive shaft **16***a* extending through the hollow shaft **16** to a motor M1 (FIG. 4). The hollow shaft **16** is rotatable through 360° to enable positioning the propeller **26** in any one of four positions in confronting relation with the four side walls of the chamber and hence the draft tubes **14**. Rotation of the hollow shaft **16** may be provided by whatever means is considered most expedient and is shown diagrammatically herein as a gear G on the shaft **16**, a meshing worm W and a servo-motor MS.

As illustrated in FIGS. 5, 6 and 7 the propeller **26** corresponds substantially in diameter to the diameters of the openings in the side walls and is located at a distance from axis of the shaft **16** (FIG. 5) corresponding to its radius, so that when disposed in confronting relation to a side wall the tips of the blades which are tapered (substantially parabolic) lie substantially in the plane of the inner side of the wall containing the opening. Due to the taper at the ends of the blades these ends will clear the interior wall structure at the corners of the chamber, moving along a circle indicated by the dot and dash lines *a*, which is tangent to the four interior corners of the chamber and has its center at the geometric center of the chamber. It is thus possible to maintain a very close tolerance between the propeller blades and the wall structure with high efficiency in operation.

FIG. 8 shows a modification in which the diameter of the propeller is made shorter and a ring **28** is set into each opening in each side wall in the path of movement of the tip ends of the propeller blades. As related above, the tip ends of the propeller blades must be tapered, substantially parabolic, and lie on the circle of tangency marked *a'* whose center is at the geometric center of the chamber and in addition the circular portion of the ring **28** closest to the path of movement of the tip ends of the blade must also lie on said circle of tangency with, of course, sufficient clearance to permit free rotation of the propeller.

The supporting shaft **16** enables changing the position of the propeller in the chamber **10** to obtain a change in direction of thrust, heading correction or steering without reversing the drive of the propeller shaft **24**. Ordinarily the friction in the gearing will hold the propeller in operative position. If a hydraulic motor is employed locking the fluid in the motor will prevent displacement of the hollow shaft **16**. If an electric motor is employed a brake may be used to lock the hollow shaft **16** to prevent its displacement. For the purpose of illustration only, the means for holding the propeller in each of its four positions when rotated to a given position is shown as a spring-pressed latch bolt L (FIG. 3) which may be withdrawn momentarily to permit the hollow shaft **16** to be rotated and then allowed to drop into a hole H in the hollow shaft when the propeller has been rotated to the desired position.

By providing the structure just described it is possible to combine the advantages of the three types of bow thrusters now commercially available in one installation, to wit, the tunnel-type, retractable and steerable thrusters and to obtain the adavntages of these basic type thrusters in a single structure. This is achieved in the present structure, first, because it embodies the conventional athwart

ship tunnel-type draft tube in which there is a propeller turnable therein to produce lateral thrust in either direction for added maneuverability and control for docking; second, because it provides for propulsion or an aid to propulsion typical of the retractable steerable thruster so that in the event of main power failure the vessel may be propelled to the extent of moving into a suitable harbor for repair without any increase in draft of the vessel; and third, because it provides to a considerable extent the capabilities of a steerable thruster and hence facilitates control for precision station keeping.

Additionally by dimensioning the propeller so that it rotates substantially in the plane of the inner side of the wall it confronts at any given time, or within the side wall opening when a surrounding ring is employed, it is possible to provide for minimum internal turbulence, cavitation and sluggishness in response to commands given in maneuvering the ship.

It should be understood that the present disclosure is for the purpose of illustration only and that this invention includes all modifications and equivalents falling within the scope of the appended claims.

I claim:

1. Apparatus to facilitate maneuvering ships comprising, in combination with the hull, a chamber having an internal, horizontal section which is square, said chamber being located in the hull below the water line with its geometric center on the longitudinal center line of the hull adjacent an end, said chamber having four walls, each containing an opening corresponding in diameter to the width of the wall in which it is contained, right-angularly disposed draft tubes, the axes of which intersect at said geometric center with one disposed athwart ship and the other fore and aft, said draft tubes being connected to the four side walls of the chamber over the openings therein, and means supporting a propeller in the chamber for rotation about a horizontal axis passing through the geometric center and for movement about a vertical axis passing through said geometric center to position the plane of rotation of the propeller in any one of four positions confronting one of the openings.

2. Apparatus according to claim **1**, wherein the propeller corresponds substantially in diameter to the inside diameters of the openings in the walls and has tapering ends, the extremities of which in each place of confrontation travel in a plane coinciding with the inner side of the wall which the propeller confronts.

3. Apparatus according to claim **1**, wherein the propeller corresponds substantially in diameter to the inside diameters of the openings in the walls and has substantially parabolic ends, the extremities of which in each place of confrontation travel in a plane coinciding with the inner side of the wall which the propeller confronts.

4. Apparatus according to claim **1**, wherein the propeller is situated at a radial distance from the vertical axis about which it is turned, to position it in confronting relation to the openings in the walls, which corresponds in radius to the radius of the openings in the walls.

5. Apparatus according to claim **1**, wherein a shaft entering the top of the chamber supports the propeller for turning about said vertical axis.

6. Apparatus according to claim **1**, wherein there is means for positioning and holding the propeller in each of its positions confronting an opening in one of the side walls.

7. A bow thruster assembly comprising a hollow chamber of square horizontal section, said chamber having a top, bottom and four side walls, each side wall containing a circular opening through it corresponding in diameter to the inside width of the wall containing the opening, a draft tube secured to each wall of the chamber over the opening therein, said draft tube corresponding in diameter to the diameter of the opening and being disposed with its axis at right angles to the wall, a pro-

peller, means mounting the propeller in the chamber so that it may be turned to face any one of the four openings, and means operably connected to the propeller to effect rotation in any one of said four positions about an axis coinciding with the axes of the draft tube extending therefrom.

8. A bow thruster according to claim 7, wherein the ends of the propeller are substantially parabolic and in any position confronting an opening in a wall of the chamber the ends lie on a circle whose radius corresponds substantially in length to the length of the diagonal from the geometric center of the chamber to an inside corner of the chamber.

9. A bow thruster according to claim 7, wherein the diameter of the propeller is smaller than said wall openings, and a ring is mounted in each opening concentric with the axis of rotation of the propeller with the circular portion thereof most closely adjacent the tip ends of the propeller lying on the circle of tangency passing through

the inside corners of the chamber which has its center at the geometric center of the chamber.

10. Apparatus according to claim 7, wherein the means mounting the propeller comprises a hollow shaft rotatably journaled in the top wall of the chamber with a portion extending into the chamber, with its axis passing through the geometrical center of the chamber, a propeller shaft rotatably mounted at the lower end of the hollow shaft at a right angle to the axis of the hollow shaft with its axis passing through the geometrical center of the chamber, and means for supplying power to said propeller shaft to effect its rotation, said means extending from an outside source of power through said hollow shaft.

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ANDREW H. FARRELL, Primary Examiner