Jan. 21, 1969 J. R. WYNNE ET AL 3,422,789

MARINE PROPULSION UNIT

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FIG. 1

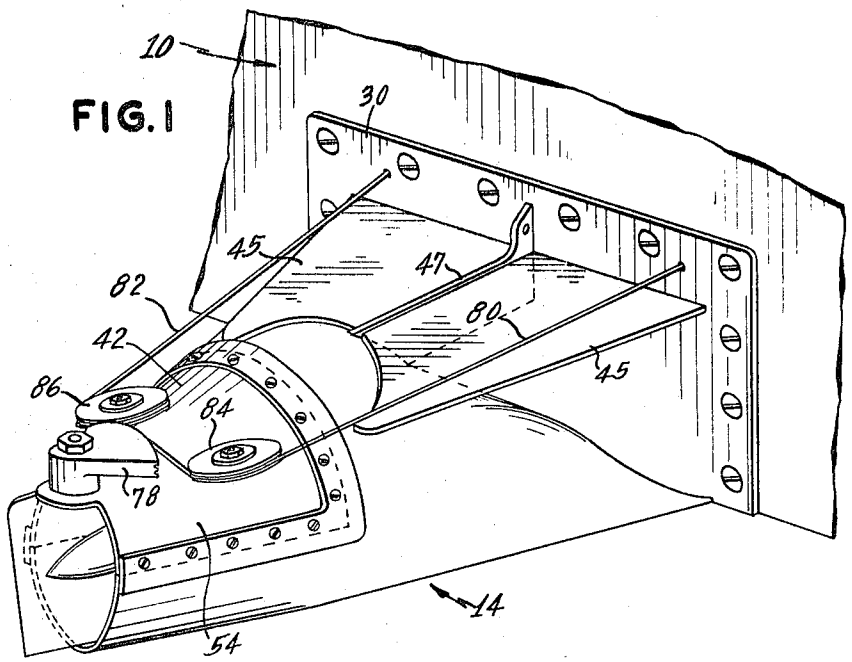
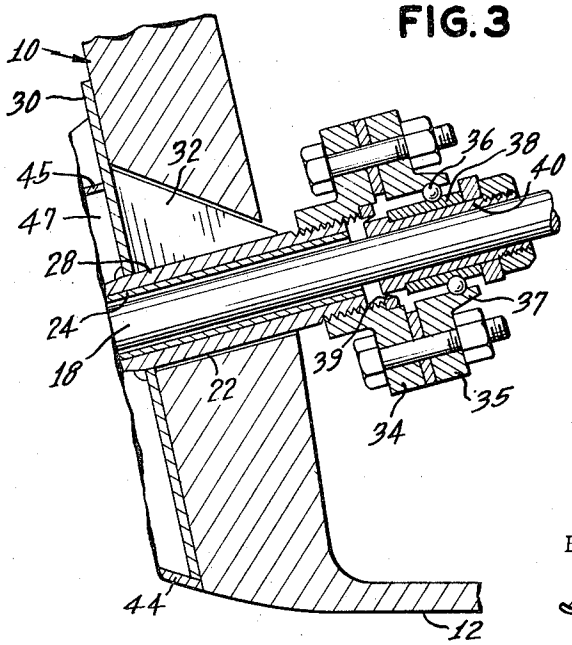


FIG. 3



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FIG. 2

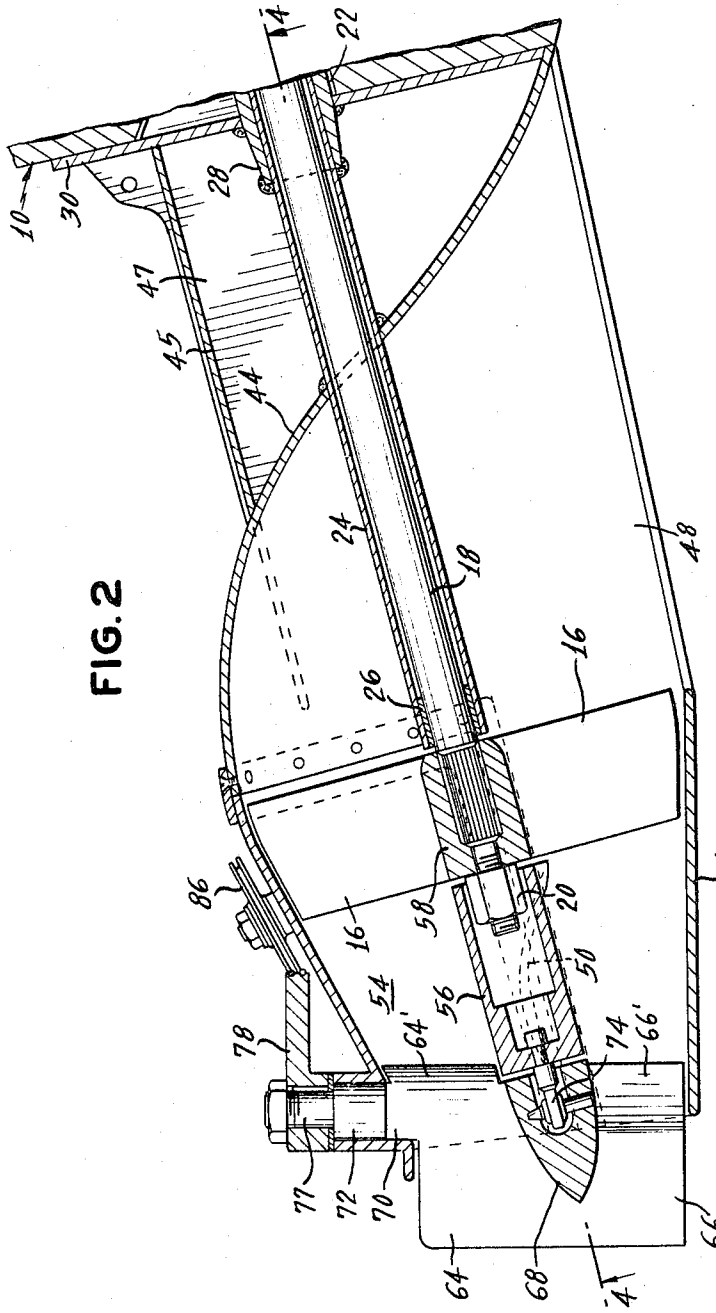


FIG. 7

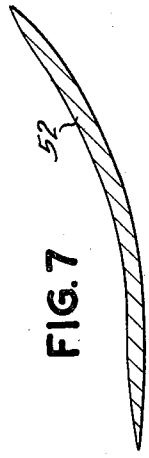
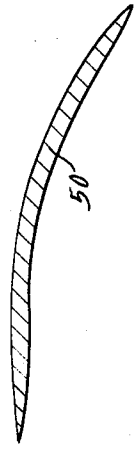


FIG. 6



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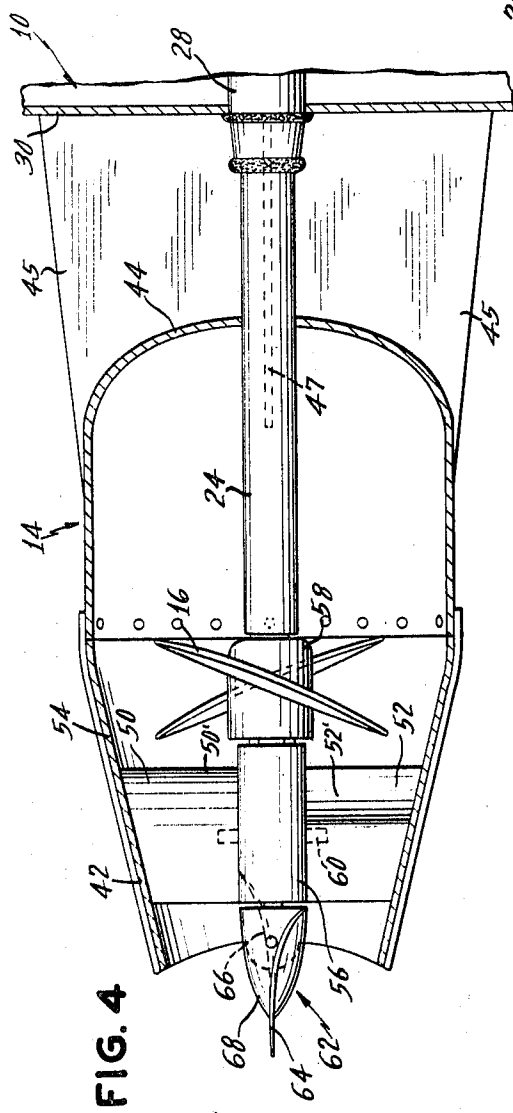


FIG. 4

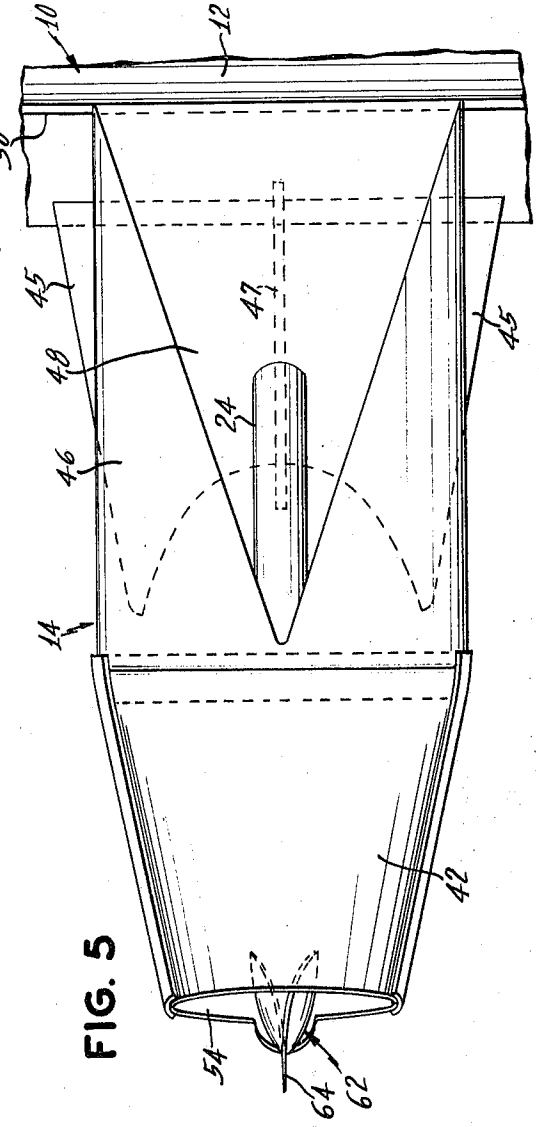


FIG. 5

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FIG. 8

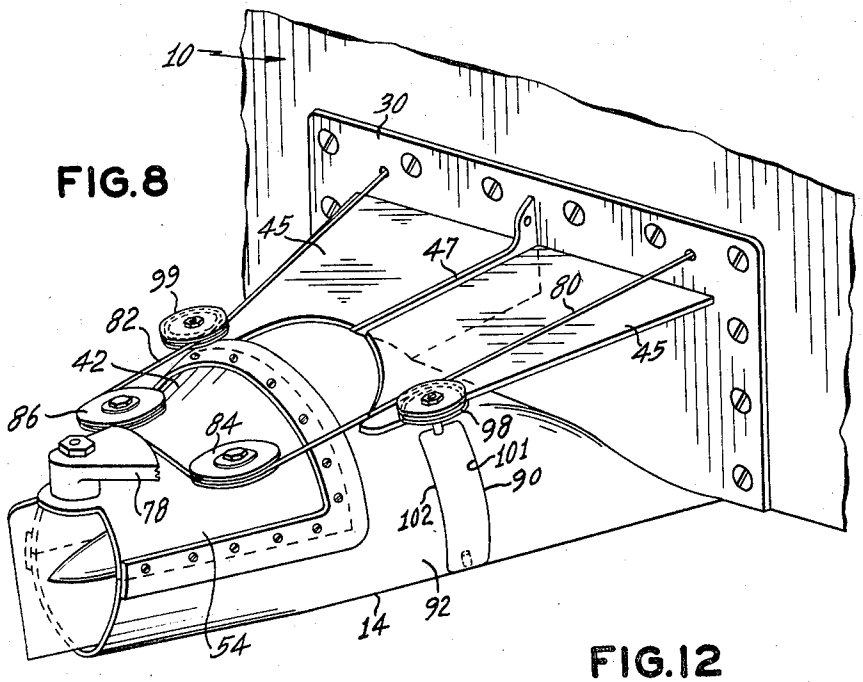


FIG. 12

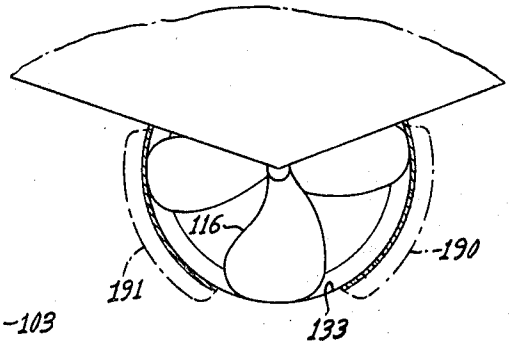
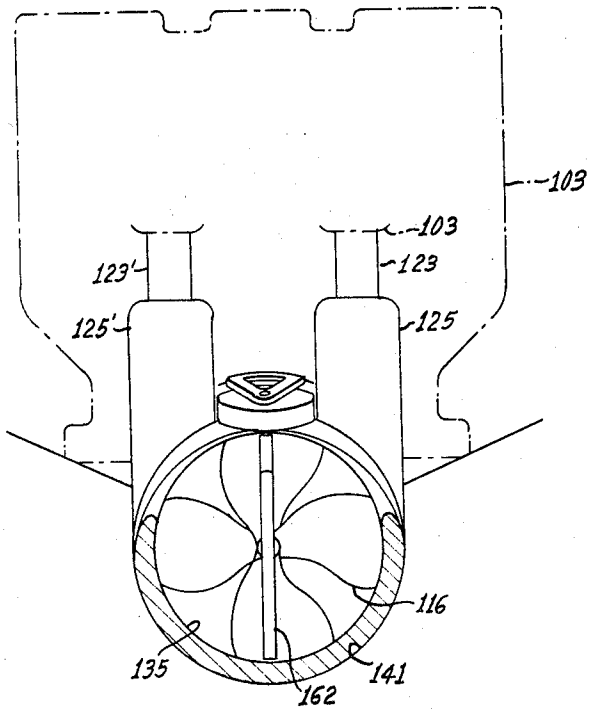


FIG. 13



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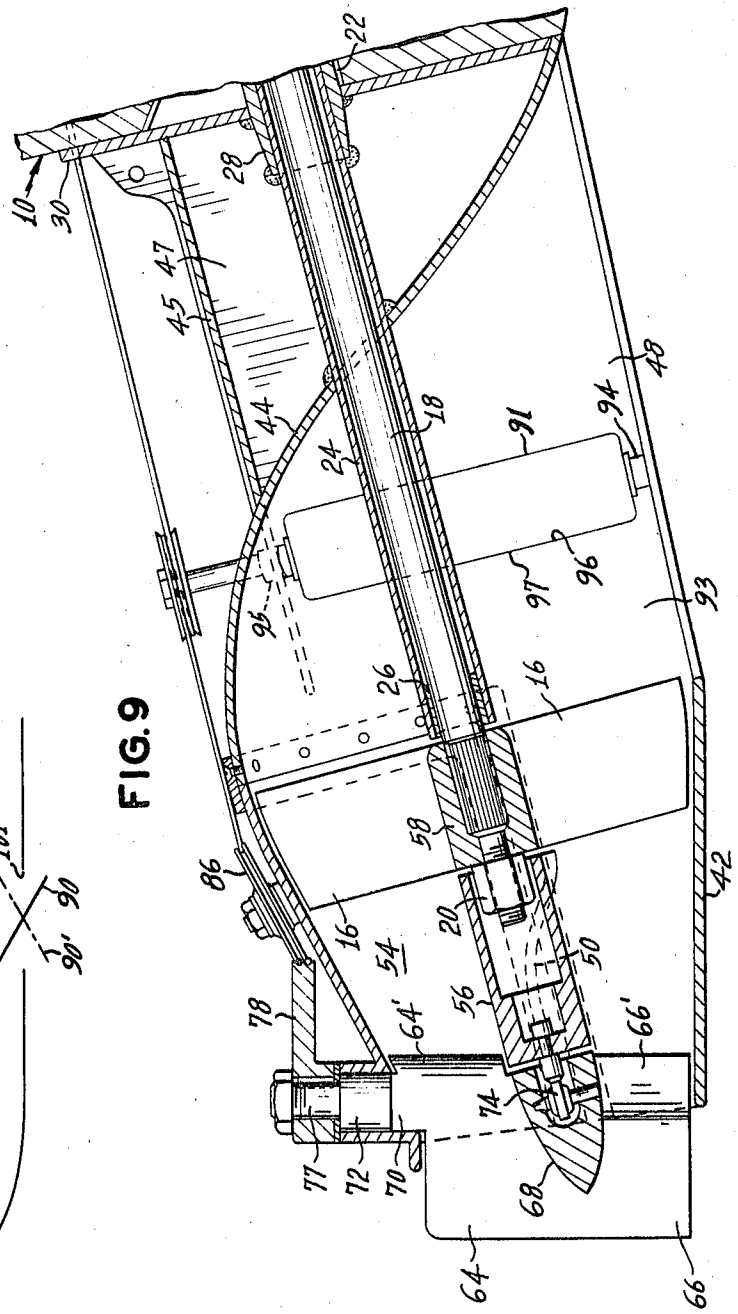


FIG. 9

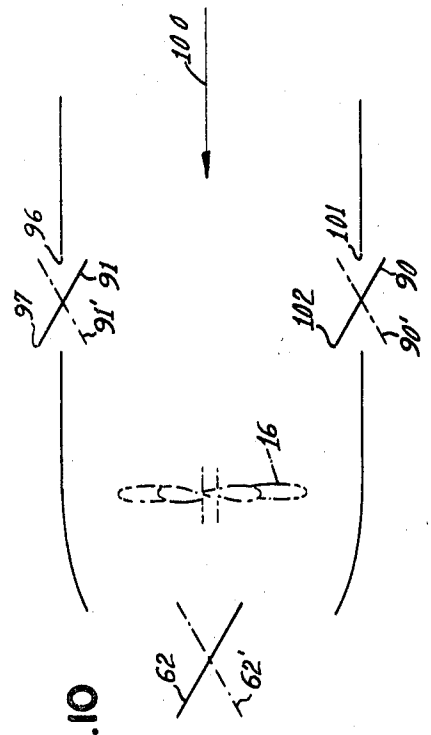


FIG. 10

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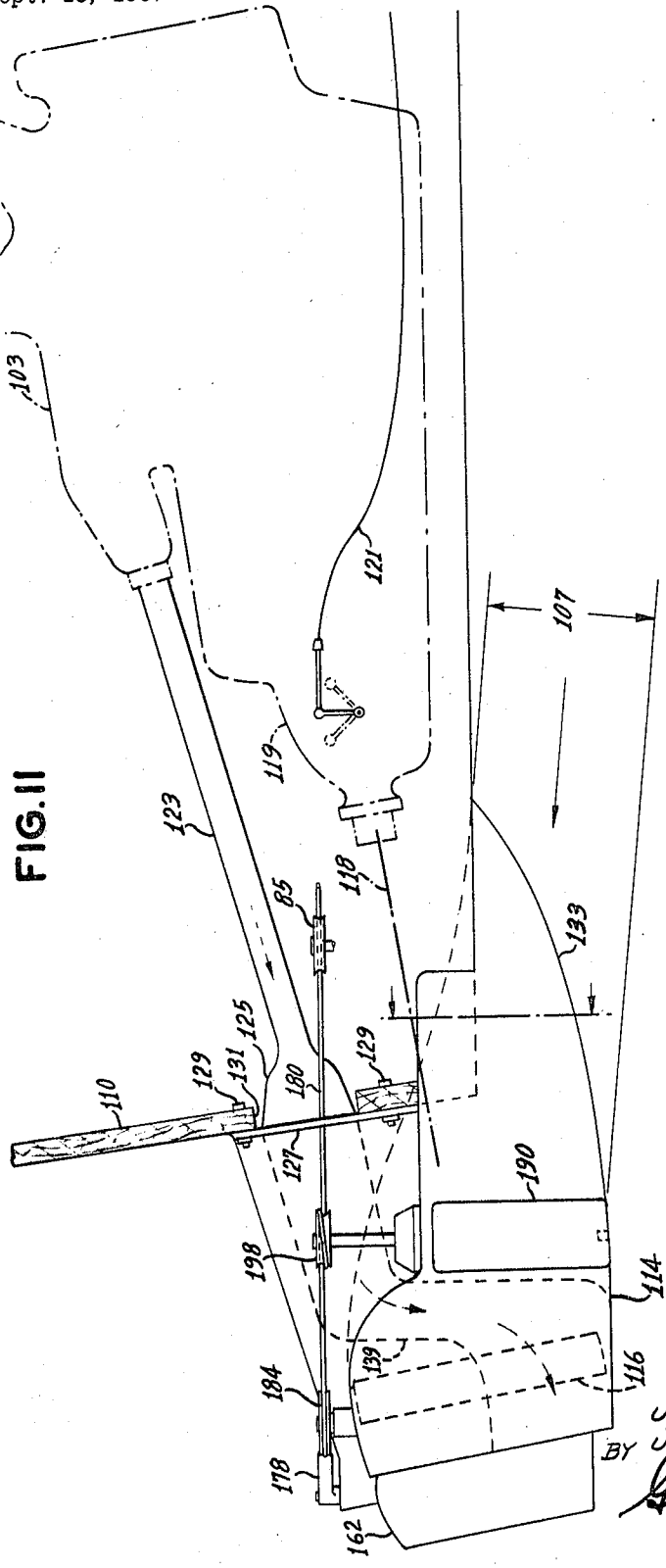


FIG. 11

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3,422,789

MARINE PROPULSION UNIT

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Continuation-in-part of application Ser. No. 455,171, May 12, 1965. This application Sept. 13, 1967, Ser. No. 671,914

U.S. Cl. 115—12 14 Claims

Int. Cl. B63h 21/24

ABSTRACT OF THE DISCLOSURE

A marine propulsion unit on a planing boat having a downwardly extending drive shaft through the transom opening with the propeller being substantially below the at rest water line, and a housing having an inlet below the planing surface, an outlet rearwardly thereof and a conical portion between inlet and outlet surrounding the propeller. Flow straightening means including a pair of horizontal vanes having oppositely curved portions facing and opposing the rotational components of the water from the propeller are disposed rearwardly of the propeller, and a rudder having oppositely curved vane portions is supported by the housing and a portion of the propeller hub adjacent the outlet. The housing is provided with side deflecting vanes forwardly of the propeller to deflect water laterally through side openings in the housing to provide steering while backing down.

Cross reference to related application

This application is a continuation-in-part of our copending application Ser. No. 455,171, filed May 12, 1965, entitled Marine Propulsion Unit, and now abandoned.

This invention relates to marine propulsion units and more particularly to novel and improved marine propulsion units particularly adapted for use with boats having stern mounted engines with the engine drive shaft extending rearwardly and outwardly through the transom of the boat.

There have been many prior arrangements for propelling a boat by means of an internal combustion engine located within the hull of the boat. Recently, considerable development has taken place in marine propulsion units of the type associated with boats in which the engine is located closely adjacent the stern transom of the boat. In some units of this type the engine is drivingly connected to a multi-stage pump generally of the axial flow type with water being drawn upwardly through an opening in the bottom of the boat and discharged rearwardly through an opening in the stern transom of the boat. In other devices associated with stern located engines, the engine is connected to an outboard propeller housing supported aft of the transom of the boat with means being provided for moving the housing to move the propeller generally vertically to facilitate placing the boat on or removing it from a trailer. In either of the types of propulsion units generally described above, there is considerable, and in some cases relatively complex, structure associated with the propulsion mechanism driven by the engine as well as the means for mounting this mechanism. Also, in the case of the engine-pump arrangement, the overall unit has a reduced overall efficiency inasmuch as the water drawn into the pump must be lifted a substantial vertical distance. Additionally, such engine-pump units usually produce a thrust which is substantially independent of the speed of the boat. This requires a large percentage of engine power to drive a planing boat over the characteristic hump in its drag curve

in order to get the boat up onto plane. Such units also often encounter difficulty when operating in choppy water inasmuch as air entering the inlet of the pump causes thrust to be lost and appreciable time is often required to clear the air, during which time the engine overspeeds. In addition, engine-pump units, when used in salt water, have a tendency for the internal parts thereof to foul with marine growth thus reducing the overall efficiency of the pumping unit.

Accordingly, it is an object of the present invention to provide in a boat having an engine mounted adjacent the stern transom thereof, a novel and improved propulsion unit disposed outboard of the transom and extending only a short distance below the planing surface of the boat.

It is a further object of the present invention to provide a novel and improved propulsion unit of the type described in which the thrust of the overall engine-propulsion unit combination will increase with speed to facilitate the obtaining of planing speed and reduce the power required to place the boat on plane.

It is a further object of the present invention to provide a novel and improved propulsion unit of the type described which will operate efficiently in choppy as well as calm water.

It is a further object of the present invention to provide a novel and improved marine propulsion unit of the type described which is relatively simple and economical in construction and which may readily be mounted on and disassembled from the transom of a boat.

It is yet another object of the invention to provide improved steering means for steering a duct type propulsion unit while backing down.

The novel features which are believed to be characteristic of this invention are set forth with particularity in the appended claims. The invention itself, however, both as to its organization and method of operation, together with further objects and advantages thereof, may best be understood by reference to the following description taken in connection with the accompanying drawings, in which:

FIG. 1 is an isometric view of a propulsion unit constructed in accordance with the present invention and mounted on the stern transom of a planing boat;

FIG. 2 is an enlarged, longitudinal cross-sectional view of the unit of FIG. 1;

FIG. 3 is an enlarged cross-sectional view of a portion of the installation of FIG. 1 illustrating the mounting of the unit on a boat and the connection of the same to an engine;

FIG. 4 is a cross-sectional view substantially along the line **4—4** of FIG. 2;

FIG. 5 is a bottom view of the unit of FIG. 2;

FIG. 6 is an enlarged cross-sectional view substantially along the line **6—6** of FIG. 4;

FIG. 7 is an enlarged cross-sectional view substantially along the line **7—7** of FIG. 4;

FIG. 8 is a perspective view of a propulsion unit of the type of FIGS. 1–7 modified by the provision of deflecting vanes for effective steering while backing down;

FIG. 9 is a vertical sectional view taken along the center line of the unit of FIG. 8;

FIG. 10 is a schematic representation, applicable to the units of FIGS. 8, 9, 11, 12 and 13, explanatory of the functions of the steering features thereof;

FIG. 11 is a side elevation of a further modified propulsion unit and the engine therefor, including advantageous means for disposing of engine exhaust gases;

FIG. 12 is a sectional view of the propulsion unit and a portion of the boat, taken along the line **12—12** of FIG. 11; and

FIG. 13 is a rear view of the unit of FIG. 11, with certain parts omitted for clarity, and including the engine

shown in broken lines to illustrate the position thereof relative to the unit.

With reference to the drawings, and particularly FIGS. 1–3, a preferred embodiment of a marine propulsion unit constructed in accordance with the present invention is shown mounted on the stern transom **10** of a boat of the type having a planing surface **12** on the underside of the bottom of the boat and extending forwardly from the lower edge of the transom **10**. The boat is of a conventional construction and has mounted within its hull an inboard engine (not shown). The propulsion unit comprises an outboard housing generally indicated at **14** and mounted on the outboard side of the transom **10** so as to extend rearwardly of the transom parallel to the centerline of the boat. As best shown in FIG. 2 the unit further comprises a propeller **16** mounted by a splined connection to the outer end of a propeller shaft **18**. The propeller is held on the shaft **18** by a retaining nut **20** threadably engaged over the outer end of the shaft **18**. The shaft **18** extends through an opening **22** in the transom. The opening **22** is disposed substantially below the upper edge of the transom and relatively close to the bottom of the transom. The shaft **18** is inclined at a substantial angle to the general plane of the planing surface **12**, and in the specific embodiment shown, the shaft angle is approximately **15** degrees. The shaft **18** is disposed within a sleeve **24** arranged telescopically and coaxially over the shaft. The sleeve **24** terminates at its outer end closely adjacent the propeller **16**. The outer end of the sleeve **24** is held in radially spaced relation to the shaft **18** by a self-lubricating bearing **26**. The sleeve **24** extends inwardly of the boat through the opening **22** in the transom and terminates a short distance inboard of the transom. Mounted on the forward portion of the sleeve **24** is an elongated collar or tube **28**. The collar **28** is disposed within the opening **22** in the transom and extends outwardly of the opening in opposite directions. The outer end of the tube **28** is fixed to the sleeve **24** in water sealed relation by suitable means such as a weld.

The tube **28** is further fixed relative to a mounting plate **30**, which as most clearly shown in FIG. 1, is adapted to be fixed, such as by bolts, to the outboard surface of the transom **10**, to support the sleeve **24** and collar **28** in fixed relation relative to the boat. The plate **30** extends entirely about and radially outwardly beyond the opening **22** in the transom and is preferrably fixed to the transom in water tight relation by suitable means such as bedding compound. The collar **28** is further supported relative to the mounting plate **30** by a stiffner or gusset **32** which is fixed to the mounting plate and collar and is disposed within the opening **22** in the transom. A flange **34** is mounted in fixed relation on the inner end of the collar **28** which is disposed forward of the transom and within the boat. The flange **34** is bolted to a second flange **35** which is on a collar **37** disposed co-axially over the shaft **18**. The collar **37** forms the outer race for a ball-bearing **36** for the shaft **18**. The inner race of the bearing **36** is provided by a sleeve **38** arranged co-axially over and about the shaft **18** and fixed to the shaft **18** by means of an intermediate sleeve **40**. The shaft **18** extends forwardly of the boat beyond the bearing **36** for connection by suitable means (not shown) to the drive shaft of the engine. Thus, the shaft **18** is rotatably supported intermediate its ends by the ball-bearing **36**, this bearing being located closely adjacent the inboard side of the transom and being supported on the mounting plate **30** which in turn is mounted on the transom. The inner or forward end of the propeller shaft is adapted to be rigidly connected to the crankshaft of the engine and extends in alignment with the engine crankshaft. A watertight shaft seal is provided between flange **34** and the shaft as shown at **39**.

With reference to FIGS. 1, 2 and 4 the outboard housing **14** is fabricated from sheet metal and comprises a generally conical portion **42** which surrounds the propeller **16** and has an axis lying coincident with the axis of the shaft **18**. The greater diameter end of the conical housing portion **42** is approximately in registry with the forward end of the propeller **16** and the conical portion **42** tapers rearwardly to terminate a substantial distance behind the propeller. The housing **14** forward of the conical portion **42** is faired into a generally flat wall **44** which is inclined forwardly and downwardly from adjacent the upper forward portion of the conical portion **42** and terminates at the base of the mounting plate **30** where it is fixed thereto by suitable means such as welding. The wall **44** is provided with an opening through which the tube **24** extends in water sealed relation. The sides of the outboard housing **14** forward of the conical portion **42** are curved downwardly terminating in a bottom wall **46** which, as shown in FIGS. 2 and 5 is provided with an inlet opening **48** which is generally triangular in shape having its base extending along the base of the mounting plate **30** and its apex disposed closely adjacent the large diameter end of the conical portion **42** of the outboard housing. A generally flat stiffener plate **45** extends from adjacent the upper end of the wall **44** over the shaft sleeve **24** and to adjacent the top of the mounting plate **30**. A vertical stiffener **47** extends from the underside of the plate **45** to the sleeve **24** for support of the portion of the sleeve between the mounting plate **30** and the wall **44**.

In accordance with one aspect of the invention, the general plane of the inlet opening **48** is inclined relative to the general plane of the planing surface **12** of the boat at a substantial angle. In the specific embodiment shown, the general plane of the opening **48** is inclined downwardly and rearwardly from the mounting plate **30** at an angle of approximately **15** degrees to the general plane of the planing surface **12** of the boat, or in other words extends generally parallel to the axis of the shaft **18**. Accordingly, as the boat is moved through the water and particularly at speeds below but approaching the planing speed of the boat, the boat will be inclined with its bow up so that the general plane of the opening **48** will be inclined at a very substantial degree corresponding to the inclination of the opening relative to the planing surface of the boat plus the inclination of the boat itself relative to the line of the movement of the boat. In this manner, water will be forced into the opening **48** with a very substantial ram effect so as to completely fill the duct formed by the interior of the outboard housing. Even after the boat is at planing speed, and its bow angle has reduced, the general plane of the opening **48** will still be inclined a substantial amount relative to the direction of movement of the boat through the water, and the faster the boat goes the greater will be the ram effect, thus providing an increase in the flow rate of water and a resultant improvement in propeller efficiency. The greater inclination of the general plane of the opening **48** at lower speeds approaching planing speed of the boat assures that a substantial ram effect will occur in this speed range to assist in placing the boat on plane much easier than if the inlet opening **48** were not inclined substantially relative to the direction of movement of the boat.

The outer diameter of the propeller **16** passes closely adjacent the inner wall of the conical portion **42**. In this connection, the tips of the propeller blade are generally rectangular in planform but slightly tapered in order to correspond to the conical cross-section of the surrounding portion of the outboard housing. With reference to FIGS. 4, 6 and 7, disposed aft of the propeller **16** and closely adjacent thereto are a pair of horizontally extending flow straightening vanes **50**, **52**. The vanes **50**, **52** are mounted at their outer ends on a removable portion **54** of the outboard housing **42**. As most clearly shown in FIG. 1 the removable housing portion **54** is generally semi-conical in configuration and generally forms the top half of the conical portion **42** of the outboard hosuing. The removable portion **54** is adapted to be mounted on the remainder of

the outboard housing by a plurality of screws disposed about the sides and forward end of the removable portion **54**. By removing the portion **54** of the outboard housing, access may be readily had to the propeller **16** for repair or replacement thereof and further the removable portion **54** facilitates clearing of the inside of the outboard housing as well as painting of the same with antifouling paint.

The inner ends of the vanes **50, 52** are supported on a hub **56** which is generally conical in shape and tapers toward the after end of the housing **14**. The forward end of the hub **56** is of the same outer diameter as the after end of the propeller hub **58** which is generally tapered forwardly toward the mounting plate **30**. The hubs **56, 58** thus provide a streamlined contour. In accordance with another aspect of the invention, the vanes **50** and **52** may be mounted on the removable portion **54** of the outboard housing and on the hub **56** by means of pivots, as at **60**, with the axis of the pivots being aligned and extending at right angles through the longitudinal axis of the conical portion **42** of the outboard housing. The vanes **50, 52** may thus be adjusted for best efficiency about the axis of the pivots **60**. Suitable means (not shown) associated with the pivots **60** are provided to lock the vanes in angularly adjusted position about their pivotal axis. The general planes of the vanes **50, 52** extend generally laterally across the conical portion **42** of the outboard housing and as shown in FIGS. 6 and 7, the vanes **50, 52** have a cross-section which is such that the vanes will tend to straighten the flow of water passing from the after end of the propeller **16** so as to tend to remove the rotational component of the water about the axis of the shaft **18** and tend to direct the water axially of the conical portion of the outboard housing.

Disposed aft of the vanes **50, 52** and relatively closely adjacent thereto is a rudder generally indicated at **62**. The rudder **62** comprises a pair of vertically extending vane portions **64, 66** fixed at their inner ends on a hub **68** the outer contour of which forms a continuation of the faired streamlined contour of the hub **56** for the fixed vanes **50, 52**. The vertical vane portions **64, 66** of the rudder are curved as shown in FIG. 4 so that the rudder also acts as a flow straightener to remove the rotational components of the water and direct the water axially outwardly of the exhaust opening at the after end of the outboard housing. The upper rudder vane portion **64** has an upwardly extending projection **70** which is rotatively received within a generally vertically extending boss **72** on the removable housing portion **54**. With reference to FIG. 2, the hub of the rudder is pivotally supported in a spherical bearing **74** received within an opening extending inwardly from the forward end of the hub **68**. The outer race of the bearing **74** is supported on the hub **56**, the after end surface of which is dished or concaved to permit pivotal movement of the hub **68** relative to the hub **56** without interference between the two. The outer tips of the rudder vanes are tapered inwardly and rearwardly of the outboard housing so as to permit their reception within the outer end portion of the generally conical housing portion **42** which is preferably slightly out of round by being flattened top and bottom to permit movement of the blade about their pivotal axis a sufficient amount without interference with the housing **14**. It will also be observed that the rudder extends a substantial distance rearwardly beyond the after end of the outboard housing.

Straightening the flow, the forward portions **64'** and **66'** of the rudder vane portions, and the forward portions **50'** and **52'** of the flow straightening vanes provide forward thrust on the boat.

With reference to FIG. 2, the projection **70** on the upper rudder vane portion **64** terminates in a post which is externally threaded. A quadrant **78** is mounted on the post **77** for rotation therewith and is maintained in assembly with the post by means of a nut threaded over the outer end of the post. The quadrant **78** is preferably keyed or splined to the post **77**. With reference to FIG. 1, the rudder may be moved by means of cables **80, 82** which extend from within the boat through openings in the transom and mounting plate **30** and rearwardly generally along the top of the outboard housing **14**. The cable **80** which is on the starboard or right side of the housing extends around a sheave **84** rotatably carried by the removable housing portion **54** and disposed on top of the removable portion **54**. The cable **80** then extends about the arcuate surface of the quadrant **78** and is anchored to the quadrant adjacent the leftward end of the cable supporting surface of the quadrant as viewed in FIG. 1. The cable **82** extends rearwardly of the housing **14** and around the sheave **86**, also mounted on top of the housing portion **54**. The cable **82** then extends along the arcuate cable supporting surface of the quadrant **78** in an opposite direction to the cable **80**. The cable **82** is anchored on the rightward end of the quadrant as viewed in FIG. 1. Accordingly, it will be apparent that movement of the cable **80** in a direction inwardly of the boat will effect a clockwise movement of the quadrant, as viewed in FIG. 1, to provide a corresponding movement of the rudder to effect turning of the boat to the left. The opposite result will be achieved when the cable **82** is moved inwardly of the boat.

Thus, it will be seen that there has been provided a novel and improved means for propelling a boat wherein a conventional marine inboard engine may be used to drive directly the propeller shaft without any intervening right angle drives or the like. The propeller shaft is connected either directly to the inclined engine or to the output shaft of a conventional gear reduction carried by the engine. The entire propulsion unit of the outboard housing and propeller and other associated elements carried by the housing are mounted as a unit on the transom simply by extending the propeller shaft through the stern opening in the transom and then bolting the mounting plate **30** to the transom. This eliminates the need for a shaft log, shaft stunt etc. necessary to the usual inboard engine installation. The outboard housing projects downwardly and rearwardly of the boat an amount sufficient to achieve the desired ram effect of water entering the inlet **48** of the housing, while at the same time the unit does not project sufficiently below the bottom of the boat to interfere with operation in shoal waters and eliminates the need for the provision of mechanisms for vertically moving the outboard housing upwardly to permit launching and recovery from and on a boat trailer. In this latter connection, the outboard housing is disposed below the general plane of the planing surface **12** of the boat an amount corresponding to a location of the propeller such that the general plane of the planing surface of the boat passes through the propeller shaft axis closely adjacent the center of rotation of the propeller. Thus, the outboard housing projects below the planing surface a distance approximately equal to the radius of the propeller.

The propulsion unit of this invention also has the advantage of being adapted for use with a boat in which the engine is located relatively closely adjacent the stern transom, thus achieving maximum efficiency for planing hulls, and at the same time assuring that the engine occupies only a minimum of usable space within the boat. The generally swept back shape of the intake duct tends to encourage the shedding of weeds and other debris quite effectively. However, if desired the inlet opening **48** may be protected with a grill or a screen. Inasmuch as the general plane of the planing surface **12**, or after bottom portion of the boat, intercepts the propeller axis at or cosely adjacent the center rotation of the propeller, it will be apparent that when the boat is at rest the duct or passage through the outboard housing will be for the most part filled with water. At least over one-half of the propeller will be submerged. In other words the water line of the boat when the boat is at rest is at least at a level with, if not above, the center of the propeller. Thus, even at slow speeds the housing will tend to be completely filled

with water thus reducing, if not eliminating, pumping losses present in installations in which the water must be lifted a substantial distance by a pump before water reaches the pump itself. As noted above when the boat is moving through the water at speeds approaching but below planing speeds, and when the boat is at planing speed, water will be rammed into the inlet of the outboard housing to assure that the housing will be completely full. When the boat is operating in choppy water, if any air enters the inlet of the outboard unit it will be removed substantially immediately by the ram effect as soon as the inlet **48** is again submerged. Thus, no loss of thrust will be encountered when operating in choppy water, and there will be little if any tendency for the propeller to cavitate. Also, the location of the inlet **48** aft of the transom assures that the opening **48** will remain submerged a substantially greater portion of the time when the boat is operating in choppy water than would be the case if the inlet were located in the hull of the boat substantially forward of the transom. Inasmuch as water is flowing through the outboard housing at all times that the boat is in forward motion, steering control may be maintained even if engine stops. It will also be observed that the housing **14** extends parallel to the centerline of the boat so that the portion of the housing in the water provides directional stability at high speeds by acting as a skeg or keel.

In accordance with the invention, the outboard housing should be inclined relative to the planing surface of the boat an amount sufficient to assure that the opening **48** will be inclined relative to the direction movement of the boat sufficiently to achieve the ram effect which is desired. The effective area of the inlet opening **48** is, of course, sufficient to permit a flow of water adequate to fill the duct at normal operating speeds. At the same time a compromise has been achieved between allowable installation angle of the engine, clearance between the engine and bottom of the boat, propeller size and overhang of the outboard housing aft of the stern so that water entering the inlet **48** is not redirected an appreciable amount before it encounters the propeller **16**. The placing of the propeller relative to the inlet opening **48** such that when the boat is at planing speed water entering the inlet **48** flows generally directly and in a straight line to the propeller **16** to a large part eliminates losses due to turning of the water as would occur in installations where the water is directed first vertically upwardly within the boat and then at right angles through a pump or the like. The propeller is located at or just aft of the juncture of the larger diameter end of the conical housing portion **42** and the upper end of the inclined forward surface **44** of the housing which in cooperation with the conical portion provides a bend in the passage through the housing on the order of about 30 degrees. The placing of the propeller in or just aft of this bend in the duct will result in the propeller blades tending to guide the flow of water around the bend, and thus the propeller blade acts as guide vanes to prevent a turbulent mixing of axial and radial flow of the water as it is turned to flow through the conical portion of the duct.

The water passing from the propeller will, of course, have both axial and rotational movement. The rotational component of movement of the water is in part removed by the horizontal stator vanes **50**, **52** and in part by the rudder vanes **64**, **66**. Thus, it will be seen that generally speaking a four bladed stator is provided with the vanes of the stator extending at right angles to each other. Two of the stator blades or vanes **50**, **52** may, as noted above may be pivotably mounted so as to serve as means for adjusting the trim of the boat. The other two flow straightening vanes also serve as the rudder for the vessel. The use of the rudder as straightening vanes reduces the number of components in the flow path of the water and thus minimizes losses due to skin friction and also reduces the length of the duct with an attendant economy of material and component parts.

When it is desired to repair or replace the propeller the removable housing portion **50**, **54** is removed. Inasmuch as the rudder and fixed vanes **50**, **52** are mounted on the removable portion **52**, they will be removed at the same time, thus permitting free access to the propeller. At the same time the entire interior of the outboard housing will be readily accessible for cleaning or the applying of antifouling paint.

Referring now to FIGS. 8 and 9, there is shown a marine propulsion unit of the jet type as described in connection with FIGS. 1 through 7, but to which reverse steering means are added. The reverse steering means comprise a pair of deflecting vanes, of which vane **90** is seen in FIG. 8 and vane **91** in FIG. 9, and which are so disposed as, preferably, to substantially close respective openings in the respective side walls **92** and **93** of the duct **14** through which the water is impelled by the propeller or impeller **16**. In order for the jet unit to drive the boat in reverse, the shaft **18** is arranged to be operable selectively in forward and reverse directions of rotation (such as by an engine with forward, neutral and reverse transmission as shown in FIG. 11). The deflecting vanes **90** and **91** are so pivotally mounted to the shell by means of pivots **94** and **95**, as seen in FIG. 9, that each is swingable from a position in alignment with the respective side wall, and preferably closing the side wall opening, such as opening **96**, into a reverse steering position in which the rearward edge, such as edge **97** of deflecting vane **91**, is swung inwardly of the duct and in which the vane, accordingly, deflects water laterally outwardly from the duct through the respective side wall opening.

Each vane is arranged to be swung for steering from a convenient remote location, such as from the usual pilot's control station within the boat, and the steering means shown comprises a respective sheave fixedly connected to each vane. The sheaves **98** and **99** are thus connected to vanes **90** and **91**, respectively, and steering cable **80**, **82** is drivingly entrained on each pulley. As the cable is pulled in one direction the rear edge of each deflecting vane and the rear edge of the rudder are unitarily swung in the same direction. Thus if the port cable is pulled, the rear edge **97** of vane **91** swings to starboard and inwardly of the duct, while the rear edges of the rudder **62** and of vane **90** also swing to starboard.

FIG. 10 illustrates schematically, in top view, the steering action. Arrow **100** represents the flow of water in duct **14** during forward drive of propeller or impeller **16**. The rudder **62** is shown in full lines in a position to steer the boat to port. Deflecting vanes **90** and **91** have some steering effect during forward driving of the boat, vane **91** deflecting water laterally outwardly to port through the opening **96** and vane **90** tending to deflect water inwardly into the duct through the respective opening **101**. To steer to starboard, the rudder and deflecting vanes would, of course, be swung into the broken line positions **62'**, **90'**, and **91'**, respectively.

For reverse operation, to back down the boat, the impeller rotation is reversed to cause water flow in the direction opposite to arrow **100**. To back down to port, the rudder and vanes would be swung into their full lines position, with the rearward edge **102** of vane **90** disposed inward of the duct, whereby water is deflected to flow laterally in a starboard direction through opening **101**. The flow past rudder **62** tends to urge the boat stern to port, while there is a tendency for water to flow forwardly and generally to starboard along vane **91** and to enter through opening **96** into the duct, thereby tending further to urge the stern to port. It will be apparent that during backing down the vane having its rear edge disposed inwardly of the duct, such as is edge **102** of vane **90** in the full line position in FIG. 10, this vane being upstream of the impeller, intercepts a strong, positive flow of water which the vane then forces out through the corresponding opening **101**. Water enters opening **96** because rear vane edge **97** is outwardly of the duct, but under these conditions, the water so entering opening **96**

is the result of induced rather than positive flow and, accordingly, the steering effect of vane **91** while backing down to port is somewhat less than the effect of vane **90**. During forward propulsion, since the deflecting vanes are forward of the impeller, all of the flow through openings **96** and **101** would be induced flow rather than positive flow, while the flow through opening **101** (the vanes and rudder being in their full line positions of FIG. 10) would be somewhat greater than the flow through opening **96**. The steering effect of rudder **62** during forward operation will be normally greater than the effect of the deflecting vanes **90** and **91**, unless the rudder is made smaller than desired size or its quadrant is too large in proportion to the diameters of sheaves **98** and **99**.

While it is preferable that the vanes **90** and **91** be disposed and proportioned to substantially completely close their respective openings during straight operation of the boat for optimum duct efficiency, it will be apparent that steering can be accomplished even if the openings are not so closable. Thus even if the openings are not closed when the vanes and rudder are aligned with the duct walls and parallel to the boat axis, the vanes and rudder would have no course changing effect.

The positions of vanes **90** and **91** and of rudder **62** for straight steering are omitted from the diagram of FIG. 10, but it will be apparent that for straight steering each would be parallel to the arrow **100**, with vanes **90** and **91** closing openings **101** and **96**, respectively.

FIGS. 11, 12, and 13 show a further modified propulsion unit so arranged that the deflecting vanes for reverse steering are lower in the water, and providing for an engine exhaust as a part of the outboard drive unit housing.

The propulsion engine **103** is mounted within the boat forwardly of transom **110** and comprises a drive shaft **118** extending through the transom and operated in forward and reverse directions through a forward-neutral-reverse transmission **119** controlled through cable **121** from the pilot's station. Exhaust pipes **123** and **123'** lead from the engine to a respective jacket or housing, such as jacket **125** and thence through a plate **127** attached to the transom by bolts **129** and through a transom opening **131**. Plate **127** closes opening **131** and also supplies support to outboard housing **114** to attach it to the boat.

The housing **114** is generally similar to housing **14** previously described and has a forward intake opening **133**, a rearward jet opening **135**, an impeller **116** and a rudder **162**. Straightening vanes may be provided within the duct or housing **114** as described hereinabove in connection with FIGS. 1–7, and rudder **162** may be shaped as described in connection with rudder **62**.

The housing or shell **114** is disposed for the most part below the planing water line of the hull, and the intake area of the forward opening **133** may be generally projected as at **107**.

Deflecting vanes **190** and **191** are pivotally mounted to the side walls **192** and **193** of the housing, in the manner previously described for vanes **90** and **91**, and swingable in the same manner by means of sheaves or pulleys, such as sheave **198** and vane **190**, engaged by steering cable **180**. Cable **180** extends from a pilot station in the boat along idler sheaves, such as idler sheaves **85** and **184**, to a connection with steering quadrant **178** for rudder **162**. The vanes **190** and **191** swing with rudder **162** as described in connection with FIG. 10, and FIGS. 8 and 9. It will be understood that elements **110, 114, 116, 118, 162, 178, 180, 184, 190, 191** and **198** correspond to, and except to the extent specifically otherwise described may be substantially identical in construction and function to elements **10, 14, 16, 18, 62, 78, 80, 84, 90, 91** and **98** as previously described.

Shell or housing **114**, however, is further provided with side exhaust gas passageways indicated in broken lines at **139** in FIG. 11. The jacket **125** opens into passageway **139**, as does the exhaust pipe **123** at a point somewhat aft of transom **110**. The jacket **125** may, if desired, be supplied at its forward portion forward of the transom with water for cooling the exhaust in a well known manner, and the water and exhaust gases then mix within passageway **139** aft of the transom. Alternatively, the exhaust pipe may connect directly into jacket **125** with no water supplied, and the jacket may be no more than an enlarged and generally flattened or narrower continuation of the exhaust gas passage.

While only one passage **139** is shown on the starboard side of housing **114**, it will be understood that a similar passage is arranged on the port side for jacket **125'** and pipe **123'**. The passages preferably meet generally below impeller **116** and the exhaust gases, or the gas and water mixture if the jackets are supplied with water, issue from a generally submerged narrow arcuate exhaust opening **141** rimming the lower portion of the housing **114** at its rear outlet **135**.

What is claimed as new and what it is desired to secure by Letters Patent of the United States is:

1. In a marine propulsion unit mounted on a planing boat having a stern transom and a planing surface, a propeller shaft extending rearwardly through an opening in said transom and parallel to the centerline of the boat, the axis of said shaft being inclined downwardly and rearwardly of said planing surface, a propeller mounted on said shaft rearwardly of said transom with at least a substantial portion of the propeller being below the at rest water line of the boat and being partially below the general plane of said planing surface, a propeller housing mounted on and fixed to said transom and extending rearwardly thereof parallel to the longitudinal centerline of said boat, said housing including a generally conical portion disposed co-axially over said shaft and closely surrounding said propeller, said conical portion tapering rearwardly of the propeller and being provided at its rearward end with an outlet opening, and means providing a water inlet opening in said housing forward of said propeller and disposed below said planing surface, the general plane of said inlet opening being inclined substantially downwardly and rearwardly of said transom and inclined downwardly to the general plane of said planing surface, flow straightening means disposed within said conical portion of the housing rearwardly of said propeller and including a pair of horizontal vanes supported by said conical portion of said housing, a central propeller hub portion extending in alignment with said shaft and stationary with respect to said shaft and propeller, said central hub portion being connected to said pair of horizontal vanes, said flow straightening means further comprising a rudder supported by said housing on a generally vertical axis and partially extending into said rearward end of said housing conical portion, an end propeller hub portion mounted to said rudder for pivotal movement therewith, said end hub portion being disposed in general alignment with said central hub portion and being at least partially within said rearward end of said housing conical portion, joint means between said end hub portion and central hub portion for maintaining said central hub portion in its position aligned with said shaft during pivoting of said end hub portion with said rudder while steering the boat.

2. In a marine propulsion unit mounted on a planing boat having a stern transom and a planing surface, a propeller shaft extending rearwardly through an opening in said transom, a propeller mounted on said shaft, at least a substantial portion of the propeller being below the at rest water line of the boat, a housing mounted on and fixed to the transom and extending rearwardly thereof, said housing including a portion closely surrounding said propeller and extending rearwardly thereof to provide a water outlet for the housing, means providing a water inlet opening in said housing forward of said propeller and below said planing surface, and flow straightening means disposed rearwardly of said propeller and

including a plurality of curved vanes mounted in selected positions within said housing and extending generally radially of and spaced angularly about the axis of said shaft with the curves thereof facing and opposing the rotational component of the flowing water from said propeller, said plurality of curved vanes including a pair of generally horizontally extending oppositely curved vanes, and means mounting said vanes for selective adjustable positions with respect to said housing about a generally horizontal axis.

3. In the marine propulsion unit as defined in claim 2 wherein said housing includes a removable portion extending from adjacent the forward end of said propeller toward the rearward end of said housing, said flow straightening means being carried by said removable housing portion, said removable portion extending circumferentially about said propeller sufficiently to permit removal thereof from said housing after removal of said removable portion.

4. In the marine propulsion unit as defined in claim 3 wherein said plurality of curved vanes comprises a pair of oppositely curved vane portions defining a rudder carried by said removable portion and pivotally mounted on a generally vertical axis on the same with the curved vane portions being each disposed at least in part within the rearward end of said housing.

5. In a marine propulsion unit mounted on a planing boat having a stern transom and a planing surface, a propeller shaft extending rearwardly through an opening in said transom, a propeller mounted on said shaft, at least a substantial portion of the propeller being below the at rest water line of the boat, a housing mounted on and fixed to the transom and extending rearwardly thereof, said housing including a portion closely surrounding said propeller and extending rearwardly thereof to provide a water outlet for the housing, means providing a water inlet opening in said housing forward of said propeller and below said planing surface, and flow straightening means disposed rearwardly of said propeller and including a plurality of curved vanes mounted in selected positions within said housing and extending generally radially of and spaced angularly about the axis of said shaft with the curves thereof facing and opposing the rotational component of the flowing water from said propeller, said plurality of curved vanes including a pair of oppositely curved vane portions defining a rudder pivotally supported by said housing on a generally vertical axis with the curved vane portions being disposed at least partially within the rearward end of said housing.

6. In a marine propulsion unit mounted on a planing boat having a stern transom and a planing surface, a propeller shaft extending rearwardly through an opening in said transom and parallel to the centerline of the boat, the axis of said shaft being inclined downwardly and rearwardly of said planing surface, a propeller mounted on said shaft rearwardly of said transom with at least a substantial portion of the propeller being below the at rest water line of the boat and being partially below the general plane of said planing surface, a propeller housing mounted on and fixed to said transom and extending rearwardly thereof parallel to the longitudinal centerline of said boat, said housing including a generally conical portion disposed co-axially over said shaft and closely surrounding said propeller, said conical portion tapering rearwardly of the propeller and being provided at its rearward end with an outlet opening, and means providing a water inlet opening in said housing forward of said propeller and disposed below said planing surface, the general plane of said inlet opening being inclined substantially downwardly and rearwardly of said transom and inclined downwardly to the general plane of said planing surface said flow straightening means including a pair of oppositely curved vane portions defining a rudder supported by said housing on a generally vertical axis and at least partially disposed within the smaller diameter end of said conical portion of said housing, one of said curved vane portions being disposed generaly above the axis of said shaft and the other of said vane portions being disposed generally below the axis of said shaft.

7. In a marine propulsion unit mounted on a planing boat having a stern transom and a planing surface, a propeller shaft extending rearwardly through an opening in said transom, means in said boat for driving said propeller shaft selectively in forward and reverse direction, a propeller mounted on said shaft, at least a substantial portion of the propeller being below the at rest water line of the boat, a housing mounted on and fixed to the transom and extending rearwardly thereof, said housing including a portion closely surrounding said propeller and extending rearwardly thereof to provide a water outlet for the housing, means providing a water inlet opening in said housing spaced forward of said propeller and below said planing surface, and flow straightening means disposed rearwardly of said propeller and including a plurality of curved vanes mounted in selected positions within said housing and extending generally radially of and spaced angularly about the axis of said shaft with the curves thereof facing and opposing the rotational component of the flowing water from said propeller, said plurality of curved vanes including a pair of generally horizontally extending oppositely curved vanes, and means mounting said vanes for selective adjustable positions with respect to said housing about a generally horizontal axis, a pair of deflecting vanes constituting in a first position portions of the respective side walls of said housing forwardly of said propeller, means mounting each said vane for swinging on a respective upright axis, each vane having a rearward edge disposed rearwardly of its said upright swinging axis, and selective means for swinging said vanes to swing one and the other said vane from its said first positions aligned in its said side wall into a reverse steering position wth its respectve rearward edge disposed inwardly of said housing thereby selectively to steer the boat when in reverse to port and starboard in response to corresponding lateral deflection of water from said housing by the selectively inwardly swung vane.

8. In a marine propulsion unit mounted on a planing boat havig a stern transom and a planing surface, a propeller, a propeller shaft extending rearwardly through an opening in said transom and mounting said propeller, means including said shaft for driving said propeller selectively in forward and reverse directions, at least a substantial portion of the propeller being below the at-rest water line of the boat, a housing mounted on and fixed to the transom and extending rearwardly thereof, said housing including a portion closely surrounding said propeller and extending rearwardly thereof to provide a water outlet for the housing, means providing a water inlet opening in said housing forward of said propeller and below said planing surface, flow straightening means disposed rearwardly of said propeller and including a plurality of curved vanes mounted in selected positions within said housing and extending generally radially of and spaced angularly about the axis of said shaft with the curves thereof facing and opposing the rotational component of the flowing water from said propeller, said plurality of curved vanes including a pair of oppositely curved vane portions defining a rudder pivotally supported by said housing on a generally vertical axis with said oppositely curved vane portions being disposed at least partially within the rearward end of said housing, said housing comprising an opening on each respective side thereof forwardly of said propeller, two steering vanes having rearward edges, each said vane being pivotally mounted on a respective upright axis which is forward of the rear edge of the respective vane to said housing in a respective said opening and each vane selectively swingable on such axis from a position closing its

respective said opening to a postion in which its rearward edge is disposed inwardly of said housing to thereby direct a portion of the water flowing forwardly in said housing from said propeller rotating in reverse direction laterally outwardly from the respective side of the housing, and steering means for swinging said rudder and steering vanes.

9. The combination according to claim **8** wherein said steering means comprises means interconnecting said steering vanes and said rubber for swinging of both of said steering vanes and said rudder in unison in the same directions.

10. The combination according to claim **8** wherein said housing is provided with a narrow gas passageway defining the outer wall of the housing under the propeller and opening rearwardly below the water outlet of said housing, said passageway having upwardly and forwardly extending branches along the sides of said housing, said branches having upward forward ends adapted and arranged to receive engine exhaust gases to be conducted by said branches and passageway for underwater disposition from said opening.

11. In a marine propulsion unit mounted on a planing boat and comprising an elongated shell having side walls and open forward and rearward ends, said shell defining a duct for the passage of water between said ends, a rotatable impeller in said duct spaced from said forward end thereof, means for driving said impeller selectively in a forward direction of rotation to impel water through said duct from said forward to said rearward end and in a reverse direction to impel water from said rearward to said forward end, reverse steering means comprising means defining a side opening in each said side wall between said impeller and said forward end, two deflecting vanes having rear edges, said vanes being pivotally mounted to said shell at said respective openings for swinging on upright axes forward of the rear edge of the respective vane and said vanes being arranged to swing from a first position aligned with its respective side wall into a reverse steering position in which its said rear edge is disposed inwardly of said duct and forwardly of said impeller to deflect water during reverse operation of said impeller laterally through its respective said opening, and means to swing each said vane selectively between its said first and second positions.

12. The combination according to claim **11** wherein said shell is provided with a rudder swingably mounted on an upright axis adjacent said rearward end in the stream of water from said impeller when said impeller is rotated in said forward direction, and wherein said vane swinging means interconnects said rudder and said vanes operative to swing said vanes and rudder together in one and the other direction.

13. The combination according to claim **11** wherein said shell is provided with an external passageway having an upper forward portion adapted to receive engine exhaust gases and extending from said portion generally downwardly and rearwardly outwardly around a side of said shell passing rearwardly of said opening in said side and terminating rearwardly in an outlet opening along a lower portion of the shell at its said rearward end.

14. The combination according to claim **11** wherein said shell is provided with a rudder swingably mounted on an upright axis adjacent said rearward end in the stream of water from said impeller when said impeller is rotated in said forward direction, and wherein steering means are provided for swinging said rudder on its said axis.

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