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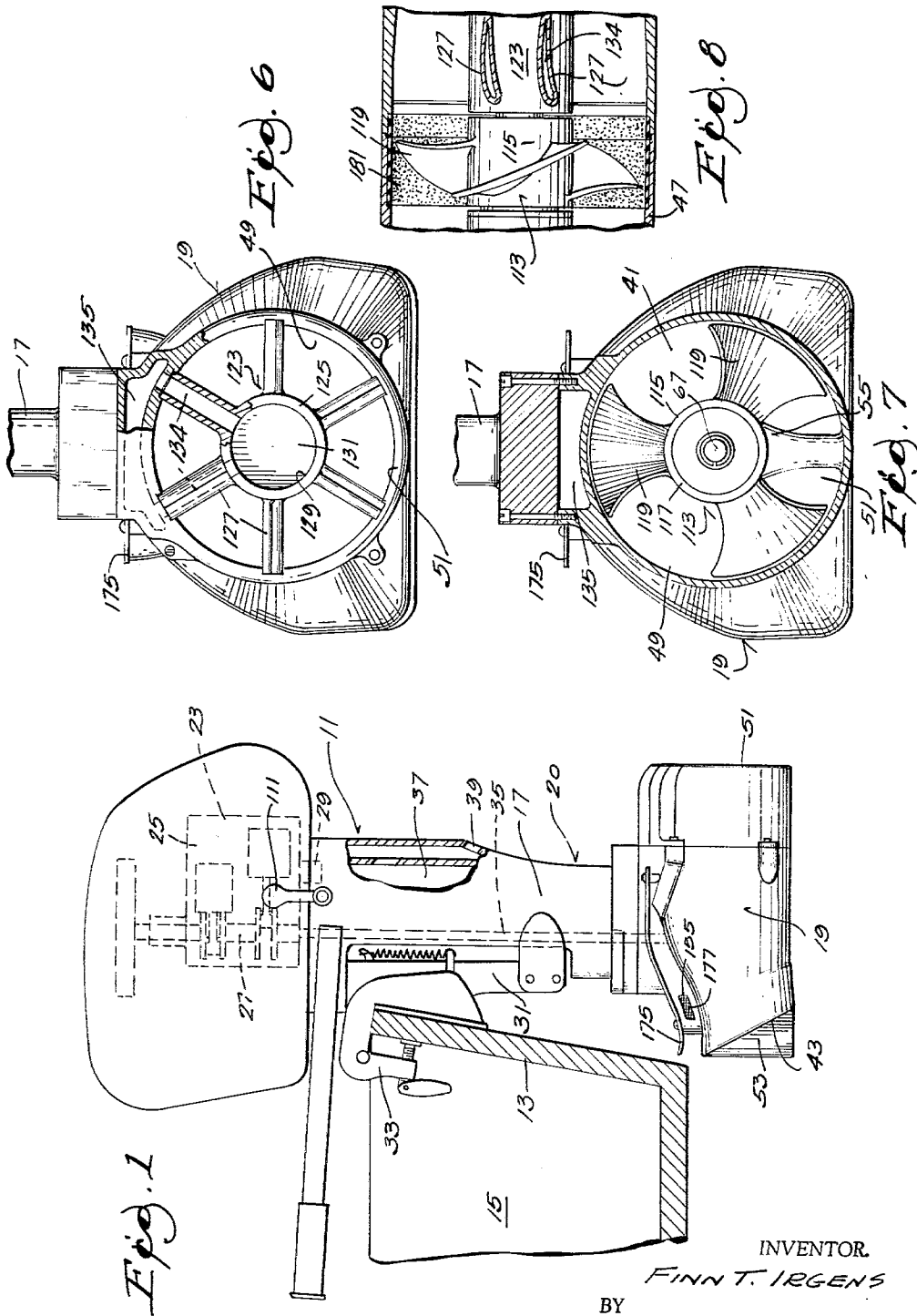
F. T. IRGENS

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MARINE JET PROPULSION

Filed Dec. 16, 1963

3 Sheets-Sheet 1



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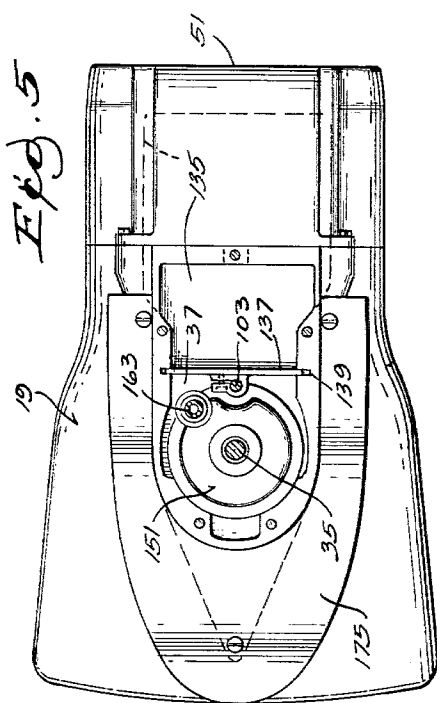
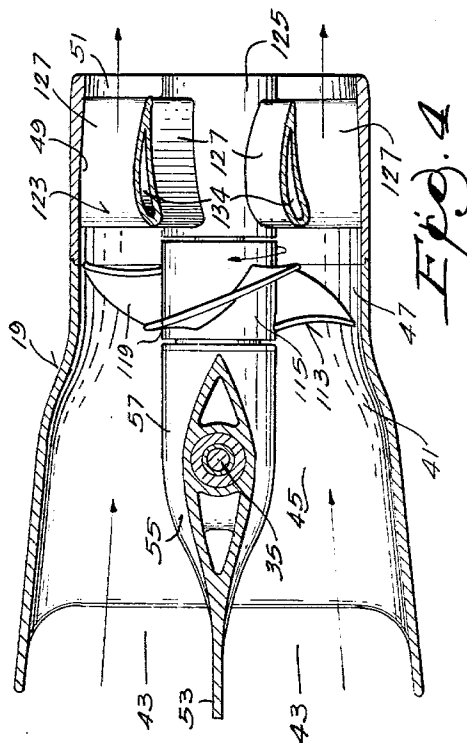
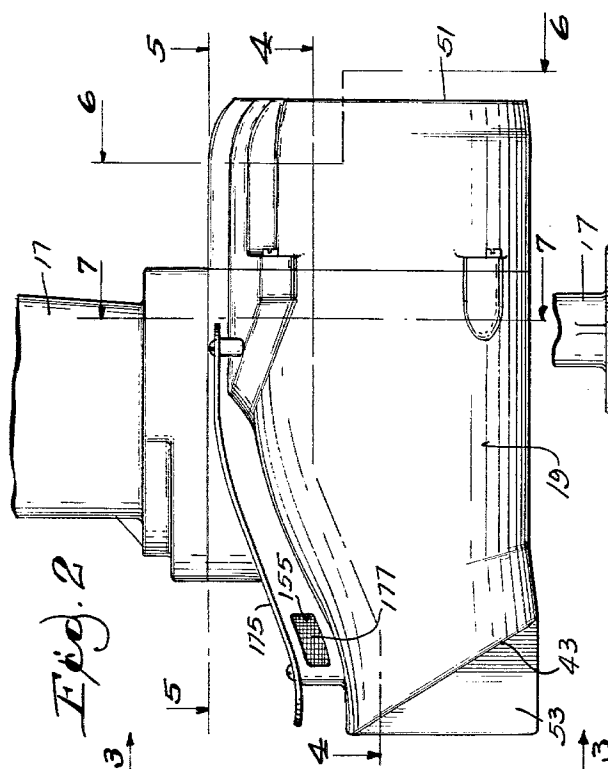
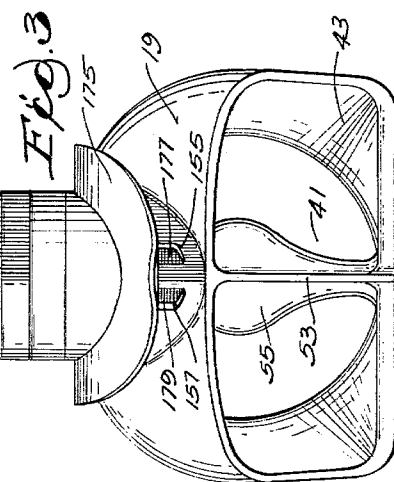
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3 Sheets-Sheet 2



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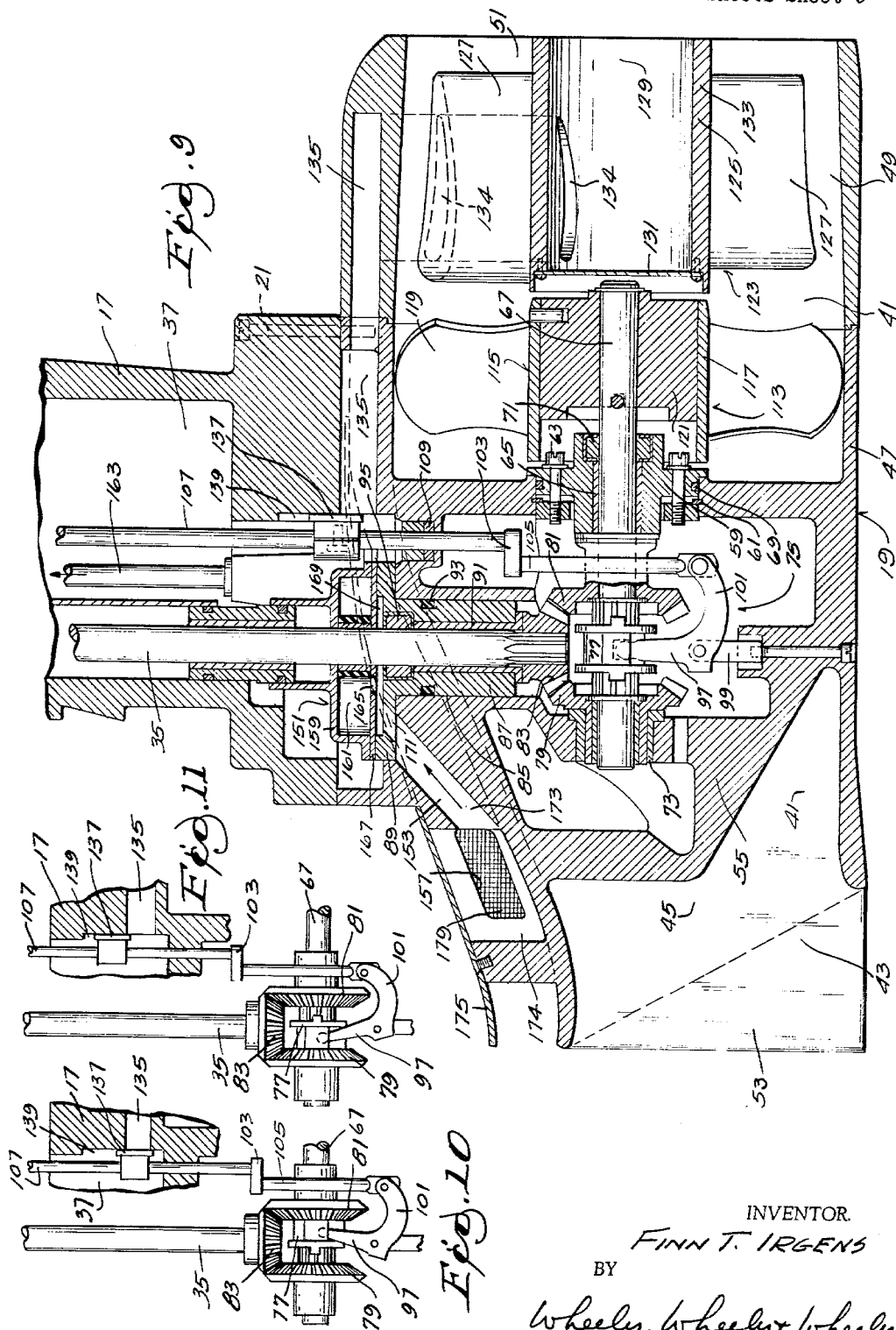
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3,249,083

MARINE JET PROPULSION

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16 Claims. (Cl. 115-12)

The invention relates generally to marine propulsion devices such as outboard motors and stern drive units. The invention also relates to such marine propulsion units which include reaction jet arrangements for developing thrust including a reaction jet shroud or housing having a fluid passage or duct with a cylindrical portion enclosing a rotor.

The invention provides a marine propulsion device including a reaction jet housing which, forwardly of the rotor enclosing portion, includes an inlet portion which diverges laterally and which has a forwardly and downwardly inclined upper surface terminating at an inlet having a vertical dimension less than that of the rotor enclosing portion of the duct. As a consequence, during operation, water is lifted through the inlet portion to the rotor enclosing portion, thereby allowing a boat supporting such a housing to operate in shallower water than normally possible with conventional propeller drives.

The invention also provides for serial, coaxial location in the duct of a gear box supported by the housing, a rotor carried on a shaft extending from the gear box, and a stator supported by the housing. Also provided by the invention is an arrangement for discharging engine exhaust gas through the duct and an arrangement for selectively controlling such discharge to the duct in accordance with the direction of operation of the engine.

The invention further provides for use of a rotor having circular arc blades and for use of a resilient lining in the rotor enclosing portion of the duct to prevent rotor blade tip erosion because of sand or other grit-like material in the water. Still further, the invention provides a housing having a forwardly facing water pump inlet opening located above the inlet portion of the duct in position to receive water flowing rearwardly under the boat hull. Supported by the housing immediately above the water pump inlet opening is an anti-spray plate or deflector provided for assuring proper water flow to the water pump.

Other objects and advantages of the invention will become known by reference to the following description and accompanying drawings in which

FIGURE 1 is a partially broken away and sectioned view illustrating a boat mounted marine propulsion device in the form of an outboard motor embodying various of the features of the invention;

FIGURE 2 is an enlarged elevational view of a portion of the marine propulsion unit shown in FIGURE 1, including the reaction jet housing or shroud and a part of the supporting strut;

FIGURE 3 is a front elevational view taken along line 3-3 of FIGURE 2;

FIGURE 4 is a sectional view taken generally along line 4-4 of FIGURE 2;

FIGURE 5 is a sectional view taken along line 5-5 of FIGURE 2;

FIGURE 6 is a partially sectional view taken generally along line 6-6 of FIGURE 2;

FIGURE 7 is a sectional view taken along line 7-7 of FIGURE 2;

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FIGURE 8 is a fragmentary sectional view similar to a portion of FIGURE 4 illustrating a modified construction;

FIGURE 9 is an enlarged sectional view of a portion of the marine propulsion device shown in FIGURE 1 including the reaction jet housing or shroud and a part of the supporting strut;

FIGURE 10 is a fragmentary view, partially in section, illustrating the reverser and the exhaust gas discharge control means, these components being shown when the outboard motor is in forward driving condition; and

FIGURE 11 is a fragmentary view partially in section, similar to FIGURE 10, showing the reverser and the exhaust gas discharge control means when the outboard motor is in rearward driving condition.

In FIGURE 1, a marine propulsion device in the form of an outboard motor 11 is mounted on the transom 13 of a boat 15. However, various of the features of the invention are not limited to outboard motors and can also be readily incorporated in inboard-outboard stern drive units.

The outboard motor 11 shown in FIGURE 1 is generally of conventional construction, except for modification to the lower end of the strut 17 and for the incorporation of a reaction jet housing or shroud 19 which is supported by suitable means, such as bolts 21 (see FIGURE 9) at the lower end of the strut 17. In this last regard, the lower end of the strut is closed to eliminate the usual exhaust gas discharge outlet. In addition to the housing 19 and strut 17, which combine to form a lower unit 20, the outboard motor 11 also conventionally includes a power head 23 comprising an internal combustion engine 25 having a crankshaft 27 and an exhaust gas discharge port 29, together with a swivel bracket 31 to which the unitary assembly of the power head 23 and lower unit 20 are rigidly connected about a generally vertical axis. In addition, the swivel bracket 31 is supported by a transom bracket 33 for pivotal movement about a horizontal axis. As is conventional, the strut 17 journals a power shaft 35 which is connected to the engine crankshaft 27 and provides, in the interior thereof, an exhaust gas passage 37 which communicates with the exhaust gas discharge port 29 and includes a conventional exhaust relief arrangement in the form of an exhaust port 39 in the strut. A more complete disclosure of such a relief arrangement is provided in the Hulsebus United States Patent No. 3,045,423, issued July 24, 1962.

The reaction jet housing 19 includes, as seen best in FIGURE 9, means defining a water conduit or duct 41 including, in series, an inlet 43; an inlet portion 45; a cylindrically shaped central portion 47, an outlet portion 49; and an outlet 51. The inlet duct portion 45 extends forwardly of the central duct portion 47 in laterally divergent and vertically convergent relation thereto, terminating in the inlet 43. In order to locate the inlet 43 in the water while affording discharge of a water jet at a higher elevation, at least partially above the water level, the inlet portion 45 extends downwardly to locate the inlet 43 in a rearwardly and downwardly inclined disposition, the inlet 43 being open both vertically and horizontally and having a center below the axis of the cylindrical portion 47.

Projecting forwardly of the inlet 43 and between the top and bottom thereof is a longitudinally extending, centrally disposed web 53 which extends into the inlet duct portion 45 and, intermediate of the top and bottom of the

inlet portion, flares laterally to provide a hollow gear box or case 55 (see FIGURE 4) having a main portion 57 of generally cylindrical outline.

The rearward end of the gear box 55 includes an axial opening normally closed by a closure or plug 59 (see FIGURE 9) which is tightened against a snap ring 61 by several bolts 63. The plug 59 supports a bearing 65 which, in turn, rotatably supports the rearward end of a rotor shaft 67. Entry of water into the gear case 55 through the bore containing the plug 59 and around the rotor shaft 67 is respectively prevented by a gasket 69 and by a suitable packing 71.

At its forward end, the rotor shaft 67 is supported by a bearing 73 fixed in the gear case 55. Intermediate the ends of the rotor shaft 67 is a conventional reverser 75 including a dog or collar 77 which is non-rotatably shiftable axially of the rotor shaft 67 for selective driving engagement with a pair of bevel gears 79 and 81 journaled coaxially on the rotor shaft. In turn, both the bevel gears 79 and 81 are enmeshed with a bevel gear 83 on the lower end of the power shaft 35 which extends into the gear case 55 through a bore 85. The bore is normally closed by an apertured plug 87 which includes a flange 89 and supports a bearing 91 for the lower end of the power shaft 35. Entry of water is excluded from the gear case 55 by a suitable O-ring 93 between the plug 87 and the bore 85 and by packing 95 between the power shaft 35 and the plug 87.

The dog or collar 77 is shiftable axially of the rotor shaft 67 by a yoke 97 which is pivotally mounted on a post 99 within the gear box 55. The yoke includes an arm 101 pivotally connected to a shift rod 103, including an offset portion 105 disposed laterally with respect to the rotor shaft 67, and an upper, relatively elongated portion 107 extending from the offset portion 105 through a packing 109 carried by the housing 19 and upwardly into the strut 17 for connection with a conventional actuating device, such as the lever 111 (see FIGURE 1). As a consequence, vertical movement of the shift rod 103 is selectively capable of disconnecting the rotor shaft 67 from the power shaft 35 and of connecting the rotor shaft 67 to the power shaft for rotation of the latter in either direction.

Carried on the rotor shaft 67 in the central duct portion 47 rearwardly of the gear case 55 is a rotor 113 which includes a hub 115 comprising a sleeve 117 from which there extends a series of blades 119. Although the type and number of blades can be varied, the disclosed construction utilizes three blades 119 of the circular-arc type. Use of circular-arc type blades assures a relatively constant pressure distribution, reduces sensitivity to cavitation, and facilitates manufacture. Non-rotatably telescopically received in the sleeve 117 is a bushing 121 which is non-rotatably coupled to the rotor shaft 67. The diameter of the hub 115 is substantially equal to the diameter of the main portion 57 of the gear box 55 to provide for streamline flow through the duct 41.

The outlet portion 49 of the duct 41 is designed to provide a rearwardly decreasing cross-sectional area. Various arrangements can be employed. In the disclosed construction, the outlet portion 49 is of truncated conical shape with a slightly rearwardly converging taper which terminates in the outlet 51. Fixedly supported in the outlet duct rearwardly of the rotor 113 is a stator 123 which converts the rotational kinetic energy of the fluid as it leaves the rotor 113 to axially directed kinetic energy. The stator 123 comprises a cylindrical hub 125 and a series of vanes 127 which extend from the hub and are fixed to the wall of the outlet duct portion 49. The diameter of the hub 125 corresponds to that of the hub 115 of the rotor 113 and is coaxial therewith to provide for smooth fluid flow. Although various types and numbers of vanes can be used, in the disclosed construction, there are six vanes of air foil configuration. In each

case, the air foil configuration extends uniformly from adjacent the hub 125 to the wall of the duct 41.

In order to muffle the engine 25, the outboard motor 11 includes an arrangement for discharging the exhaust gases into and through the duct 41 in the jet housing 19. This arrangement includes means defining a rearwardly opening cavity 129 in the hub 125 of the stator 123, together with exhaust gas passage means communicating through the lower unit 20 between the hub 125 and the exhaust port 29 of the engine 25. In the disclosed construction, the cavity is defined by a disk 131 which is bolted or otherwise secured to the forward end of a hollow cylindrical member 133 which forms the hub.

Such exhaust gas passage means includes conduits or passages 134 communicating with the cavity 129 and extending in one or more of the vanes 127, together with a gas conduit 135 in the housing 19 connected with the gas passages 134 in the vanes 127 and with the conventional exhaust gas passage 37 which is located in the strut 17 and which, in turn, communicates with the engine exhaust gas discharge port 29. As shown in FIGURE 6 of the drawings, exhaust gas passages 134 are provided in two of the vanes 127 and the gas conduit 135 extends forwardly in the upper wall of the housing 19 from the gas passages 133 in the vanes to an area adjacent to the power shaft 35 (see FIGURE 5) for communication with the gas passage 37 in the strut 17.

When the rotor 113 is operating in reverse, it is desirable to avoid discharging the exhaust gas into the fluid in the duct 41 upstream from the rotor. Accordingly, control means are provided for precluding exhaust gas discharge through the stator hub 125 when the drive is in reverse condition, while permitting free discharge of such gases during forward operation. In the preferred embodiment, such control means is operably connected with the shift rod 103 for operation concurrently with shifting of the drive.

More particularly, the shift rod 103 passes through the gas conduit 135 in the housing 19 and has mounted thereon for vertical movement therewith, a valve plate 137 which is movable relative to a socket or recess 139 above the gas conduit 135. The valve plate 137 moves with the shift rod 103 so as to be wholly located in the recess 139 when the drive is in forward condition, thereby allowing unhindered exhaust gas flow to the stator hub 125 for discharge into the jet housing duct 41. When the engine drive is shifted to neutral by downward vertical movement of the shift rod 103, the valve plate 137 moves into a position partially closing the gas conduit 135. In response to such further downward movement of the shift rod 103 which is effective to shift the drive into reverse, the valve plate 137 is lowered to completely close the gas conduit 135, thereby preventing exhaust gas discharge through the stator hub. Under such circumstances, the exhaust gas from the engine 25 is vented through the relief port 39 in the strut 17.

Coolant water for the internal combustion engine 25 is provided by a pump 151 which communicates through a flow passage 153 with a pair of forwardly facing inlet ports 155 and 157 located in the housing 19 above the upper wall of the inlet portion 45 of the duct 41. More particularly, the pump 151 includes a casing 159 which surrounds a part of the power shaft 35 and which is located on top of the plug 87. Carried by the power shaft 35 within the casing 159 is an impeller 161 which discharges coolant from the casing 159 through a line 163 to the engine jacket.

Coolant water is admitted to the casing 159 through the flow passage 153 which includes an aperture 165 in the bottom plate 167 of the pump casing 159 in communication with a recess 169 in the upper face of the flange 89 of the plug 87. Extending through the flange 89 is a bore 171 which communicates with the recess 169 and with a passageway 173 in the housing 19 lead-

ing to a void or chamber 174 which is open at the top. The void 174 communicates with the inlet ports 155 and 157 extending through the side walls of the housing 19 and is closed at the top by an anti-spray plate 175 which assists in assuring continued flow to the water pump by preventing upward escape of water from the area of the water pump inlet ports 155 and 157. Thus the pressure condition in the water adjacent the inlet ports is maintained by preventing upward spraying of water. The anti-spray plate 175 is secured to the top of the forward part of the housing 19 and extends laterally and rearwardly around the housing neck which is connected to the strut 17. Suitable means are provided for supporting screen 177 and 179 across the respective inlet ports 155 and 157 to prevent entry of unwanted material.

When the outboard motor 11 is mounted on the transom 13, the jet housing 19 is preferably located immediately rearwardly of the bottom part of the transom 13 with the anti-spray plate 175 approximately at the bottom of the transom to control and limit upward water flow rearwardly from the transom. Under such circumstances, the pump inlet ports 155 and 157 face directly into the relatively rearwardly flowing water so as to provide the pump with a self-priming action. The inlet 43 of the duct 41 is therefore also located immediately under and rearwardly of the bottom of the transom in facing relation to the relatively rearwardly flowing water. The depth of the housing 19 is therefore held to a minimum below the bottom of the boat while at least an upper part of the central portion 47 of the duct 14 is located above the boat undersurface extending forwardly from the transom.

Erosion of the tips of the rotor blades 119 by grit or other similar material in the water can be effectively minimized by providing the inner cylindrical wall of the central duct portion 47, as shown in FIGURE 8, with a lining 181 of rubber-like material which is in closely adjacent relation to, or in slightly touching relation with, the tips of the circular arc blades 119.

Various of the features of the invention are set forth in the following claims.

What is claimed is:

1. An outboard motor comprising a power head including an internal combustion engine having an exhaust gas discharge port, a reaction jet housing having a duct therein for the passage of water, a rotor, means rotatably mounting said rotor in said duct, a stator having a central hub including means defining an axially open cavity, means mounting said stator in said duct with said cavity opening away from said rotor, a strut connecting said power head and said housing, power transmission means in said strut and said housing connecting said engine and said rotor and including means for selectively coupling said engine to said rotor for rotation thereof in a first direction which is effective to discharge water through said duct toward said stator and in a second direction is effective to draw water through said duct from said stator, exhaust gas passage means in said strut and in said housing connecting said exhaust gas discharge port and said cavity and including means defining an auxiliary exhaust gas outlet in said strut, and means connected with said selective coupling means for permitting the passage of exhaust gases to and the discharge thereof from said duct cavity when said rotor is coupled to said engine for rotation in said first direction and for preventing the passage of exhaust gases to and the discharge thereof from said hub cavity when said rotor is coupled to said engine for rotation in said second direction, whereby said exhaust gases are discharged through said auxiliary outlet when the discharge thereof through said hub cavity is prevented.

2. A marine propulsion device for a boat comprising

a housing having means adapted for the support thereof from a boat and including a duct with an inlet and an outlet, a gear box mounted in said duct, said gear box including a shaft extending from said gear box in said duct toward said outlet, a rotor mounted on said shaft, means in said gear box adapted for connecting said shaft to means for effecting rotation thereof, a stator having a hub with an axially open cavity, and means mounting said stator in said duct between said rotor and said outlet with said cavity being open in the direction of said outlet.

3. A propulsion device in accordance with claim 2 wherein said gear box is streamlined and includes a generally cylindrical main portion, said rotor includes a hub aligned axially with said generally cylindrical main portion of said gear box and a series of generally radially extending blades, and said stator hub is aligned axially with said rotor hub and has extending therefrom a series of generally radially extending vanes.

4. A propulsion device in accordance with claim 3 wherein said generally cylindrical main portion of said gear box and said hubs are substantially the same diameter.

5. A marine propulsion device for a boat comprising a housing including a duct with an inlet, an outlet, a central portion of cylindrical formation between said inlet and said outlet, and an inlet portion between said inlet and said central portion, said inlet portion diverging laterally with respect to said central portion, converging vertically with respect to said central portion, and extending from said central portion to provide said inlet with a vertical opening having a center positioned below the axis of said central duct portion, a shaft supported by said housing and extending at least partially in said central duct portion, a rotor mounted on said shaft and located in said central part, a stator carried by said housing and located in said duct downstream from said rotor, and means for supporting said housing from a boat and including means mounting said housing for pivotal movement about a generally vertical axis.

6. A marine propulsion device in accordance with claim 5 including a coolant water pump connected to said housing above said duct, a coolant water intake in said housing above said inlet duct portion, and conduit means in said housing leading from said intake to said pump.

7. A marine propulsion device in accordance with claim 6 including laterally extending deflector means mounted on said housing above said coolant water intake.

8. The combination of a boat having a transom, and a marine propulsion device comprising a housing including means defining a duct having a cylindrical central portion, an inlet portion extending from one end of said central portion in vertically convergent, in laterally divergent, and in downwardly extending relation thereto, and an outlet portion extending from the other end of said central portion, a gear box mounted in said inlet duct portion and including a shaft extending therefrom into said central duct portion, a rotor mounted on said shaft in said central duct portion, means in said gear box adapted for connecting said shaft to means for effecting rotation thereof, a stator, means mounting said stator in said outlet duct portion, and means supporting said housing from said boat with said inlet duct portion adjacent to and at least partially below said transom and with the upper part of said central duct portion disposed above the boat undersurface extending forwardly from said transom.

9. The combination of a boat having a transom and a marine propulsion device comprising a power head including an internal combustion engine having an exhaust gas discharge port, a reaction jet housing having means defining a duct with a generally cylindrical central portion, an inlet portion extending from one end of

said central portion in laterally divergent, vertically convergent, and in downwardly extending relation thereto, and an outlet portion extending from the other end of said central portion, a gear box mounted in said inlet portion of said duct and including a rotatably mounted shaft extending therefrom into said central portion of said duct, a rotor mounted on said shaft in said central portion of said duct, a stator having a central hub including means defining an axially open cavity, means mounting said stator in said outlet portion of said duct with said cavity opening away from said rotor, a strut connecting said power head and said housing, power transmission means in said strut, said housing, and said gear box connecting said engine and said shaft and including means for selectively coupling said engine to said shaft for rotating said rotor in a first direction which is effective to discharge water through said duct toward said stator and in a second direction which is effective to draw water through said duct from said stator, and exhaust gas passage means in said strut and in said housing connecting said exhaust gas discharge port and said cavity and including means defining an auxiliary exhaust gas outlet in said strut, and means connected with said selective coupling means for permitting the passage of exhaust gases to and the discharge thereof from said cavity when said rotor is coupled to said engine for rotation in said first direction and for preventing the passage of exhaust gases to and the discharge thereof from said cavity when said rotor is coupled to said engine for rotation in said second direction, whereby said exhaust gases are discharged through said auxiliary outlet when the discharge thereof through said cavity is prevented, and means supporting said propulsion unit on said boat with the inlet portion of said duct adjacent to and at least partially below said transom and with the upper part of said central portion of said duct disposed above the boat undersurface extending forwardly from said transom.

10. A marine propulsion device comprising an internal combustion engine having a crankshaft and an exhaust gas discharge port, a reaction jet housing having therein a duct with an inlet and an outlet, a gear box mounted in said duct, said gear box including a shaft extending from said gear box in said duct toward said outlet, a rotor mounted on said shaft, a stator mounted in said duct between said rotor and said outlet and including a central hub having means defining a cavity opening on the outlet side of said stator, and a series of vanes extending generally radially from said hub to said housing, strut means connecting said engine with said housing, drive means in said gear box and said strut means connecting said shaft to said crankshaft, and exhaust gas passage means in said strut means and in said housing communicating between said exhaust gas discharge port and said cavity and including means in at least one of said vanes defining an interior passage communicating with said cavity and with said exhaust gas discharge port.

11. A marine propulsion device comprising an internal combustion engine having a crankshaft and an exhaust gas discharge port, a reaction jet housing having therein a duct with an inlet and an outlet, a gear box mounted in said duct, said gear box including a shaft extending from said gear box in said duct toward said outlet, a rotor mounted on said shaft, a stator mounted in said duct between said rotor and said outlet and including a central hub having means defining a cavity opening on the outlet side of said stator, and a series of vanes extending generally radially from said hub to said housing, each of said vanes having a cross section of air foil shape in a plane extending parallel to the center line of said stator and normal to a radius from the center line of said stator, said cross sections being constant in all such planes between the hub and the housing, strut means connecting said engine with said housing, drive means in said gear box and said strut means connecting said shaft to said crankshaft,

and exhaust gas passage means in said strut means and in said housing communicating between said exhaust gas discharge port and said cavity and including means in at least one of said vanes defining an interior passage communicating with said cavity and with said exhaust gas discharge port.

12. A marine propulsion device comprising a power head including an internal combustion engine having an exhaust gas discharge port, a reaction jet housing having a duct therein, a rotor rotatably mounted in said duct to effect passage of water through said duct, a stator mounted in said duct and having a central hub, and means defining a cavity opening axially downstream from said stator and exhaust gas passage means communicating between said exhaust gas discharge port and said cavity.

13. A marine propulsion device comprising a power head including an internal combustion engine having an exhaust gas discharge port, a reaction jet housing having a duct therein for the passage of water, means connecting said power head and said housing, a stator having a central hub including means defining an axially open cavity and a series of generally radially extending vanes, means mounting said stator in said duct with said cavity opening downstream, and exhaust gas means communicating between said exhaust gas discharge port and said cavity and including means in at least one of said vanes defining an interior passage communicating with said cavity and with said engine discharge port.

14. A marine propulsion device comprising an internal combustion engine having a crankshaft and an exhaust gas discharge port, a reaction jet housing having therein a duct with an inlet and an outlet, a gear box mounted in said duct, said gear box including a shaft extending from said gear box in said duct toward said outlet, a rotor mounted on said shaft, a stator mounted in said duct between said rotor and said outlet and including a central hub having means defining a cavity opening on the outlet side of said stator, strut means connecting said engine and said housing, drive means in said gear box and in said strut means connecting said shaft to said crankshaft, and exhaust gas passage means in said strut means and in said housing communicating between said exhaust gas discharge port and said cavity in said central hub.

15. A marine propulsion device comprising a power head including an internal combustion engine having an exhaust gas discharge port, a reaction jet housing having a duct wherein for the passage of water, means connecting said power head and said housing, a rotor, means rotatably mounting said rotor in said duct, power transmission means connecting said power head and said rotor and including means for reversing the direction of rotation of said rotor, a stator having a central hub, means mounting said stator in said duct downstream of said rotor, means on said hub defining a cavity opening downstream, and exhaust gas passage means communicating between said exhaust gas discharge port and said cavity in said hub, and including means connecting with said rotor-rotation reversing means for controlling the flow of exhaust gas to said duct in accordance with the direction of rotation of said rotor.

16. A marine propulsion device comprising a power head including an internal combustion engine having a crankshaft and an exhaust gas discharge port, a reaction jet housing having a duct therein for the passage of water and including an inlet and an outlet, a gear box mounted in said duct, said gear box including a driveshaft extending from said gear box in said duct toward said outlet, a rotor mounted on said driveshaft between said gear box and said outlet, a stator mounted in said duct between said rotor and said outlet, strut means connecting said power head and said housing, drive means in said gear box and in said strut means connecting said driveshaft to said crankshaft and including means for reversing the direction of rotation of said driveshaft, and an exhaust gas passage means in said strut means and in said housing com-

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municating between said exhaust gas discharge port and said duct and including means connected with said drive-shaft-rotation-reversing means for controlling the flow of exhaust gas to said duct in accordance with the direction of rotation of said driveshaft.

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