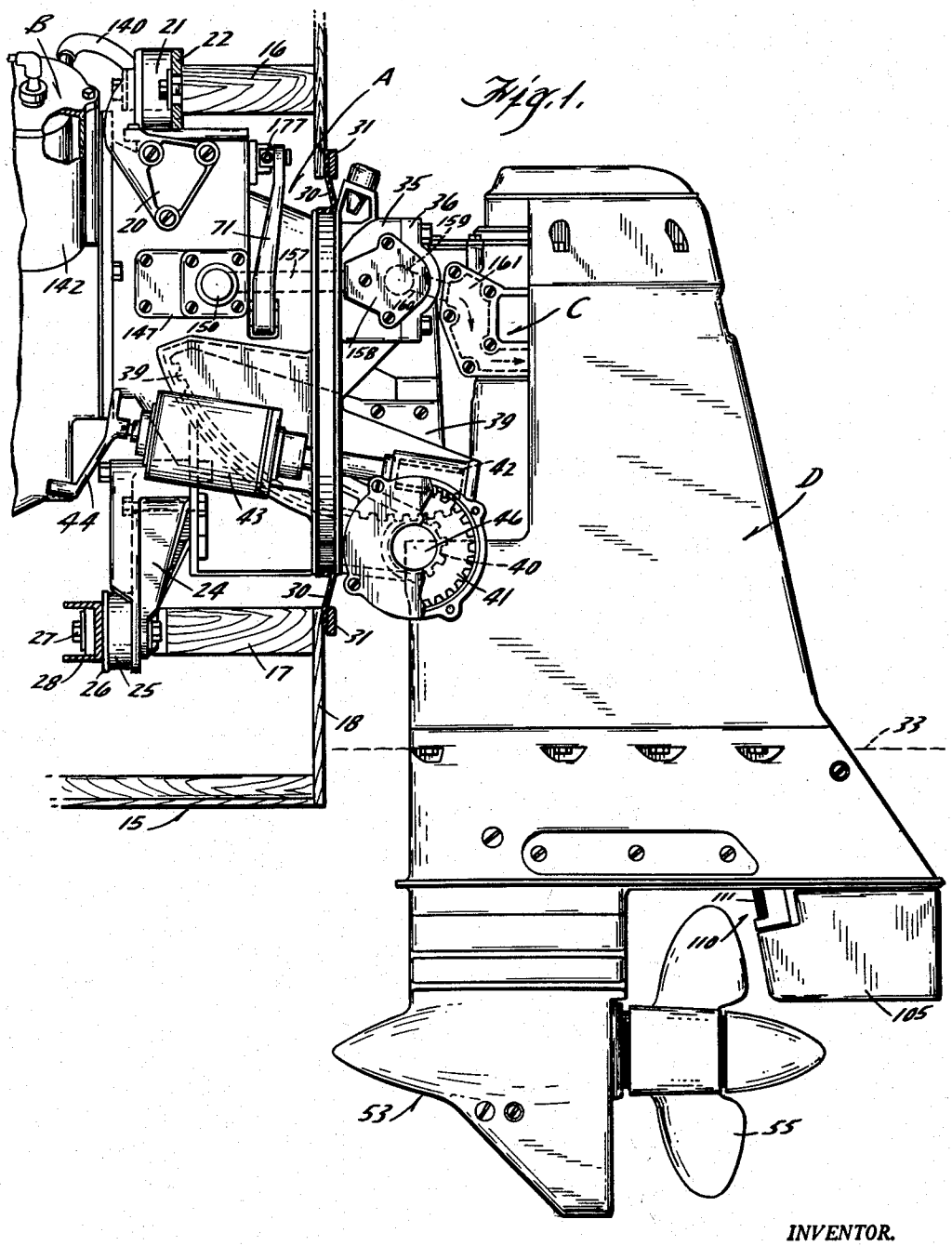
May 18, 1965 W. J. SHIMANCKAS 3,183,880

MARINE PROPULSION DEVICE

Original Filed Oct. 9, 1961 5 Sheets-Sheet 1

Fig. 1.



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Fig. 3.

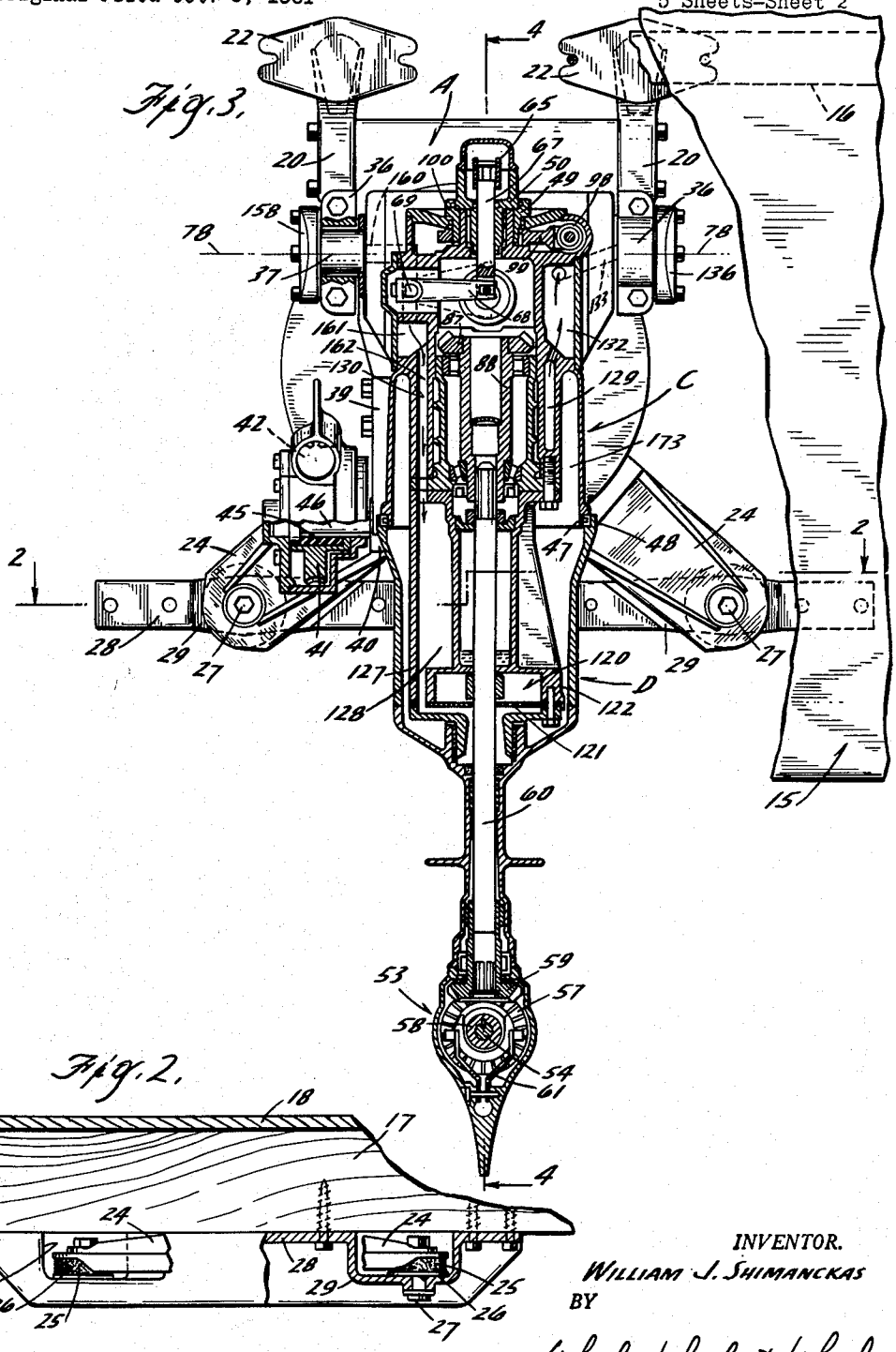


Fig. 2.

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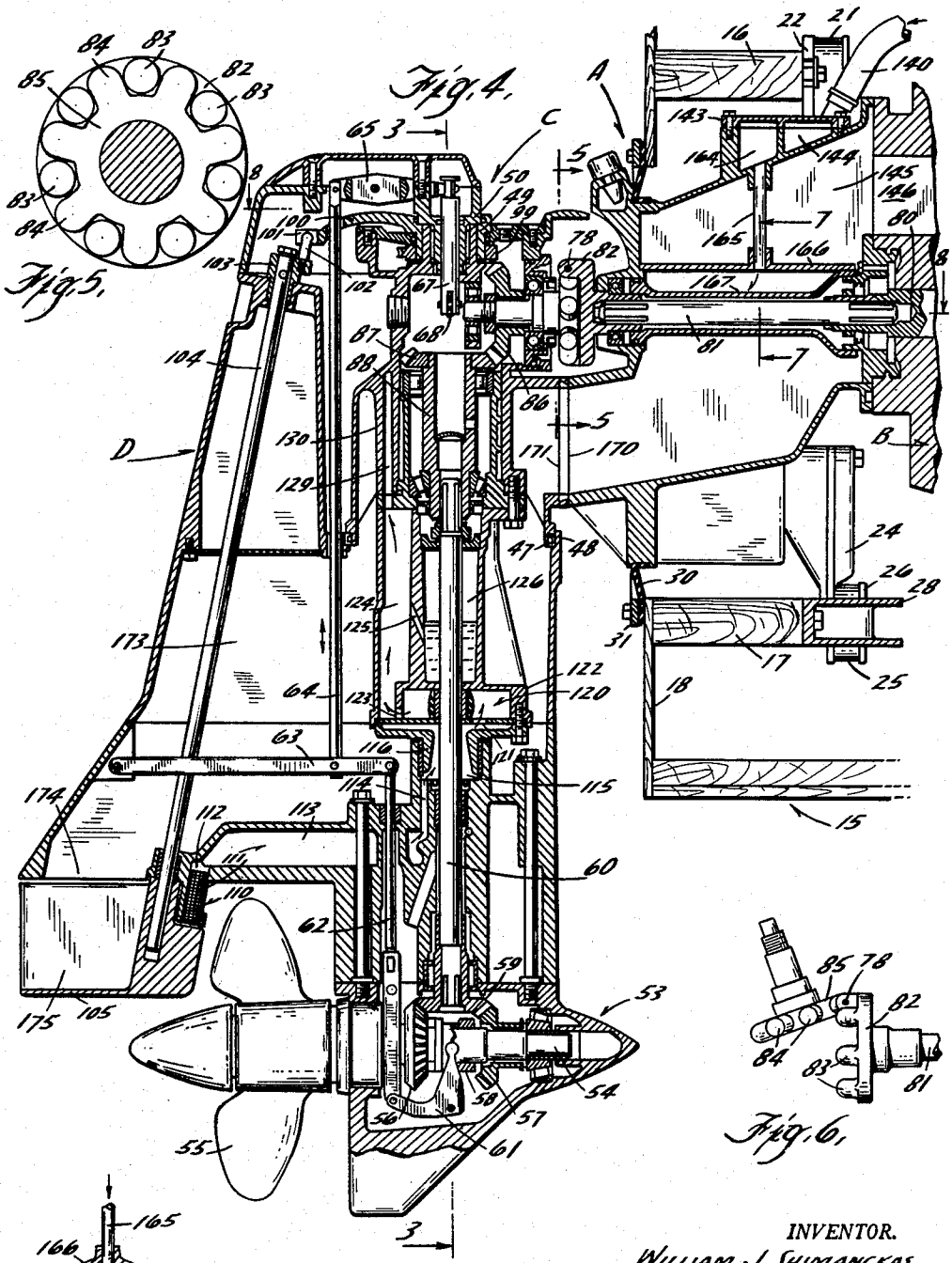


Fig. 4.

Fig. 5.

Fig. 6.

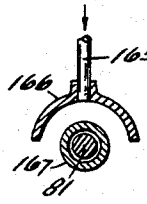


Fig. 7.

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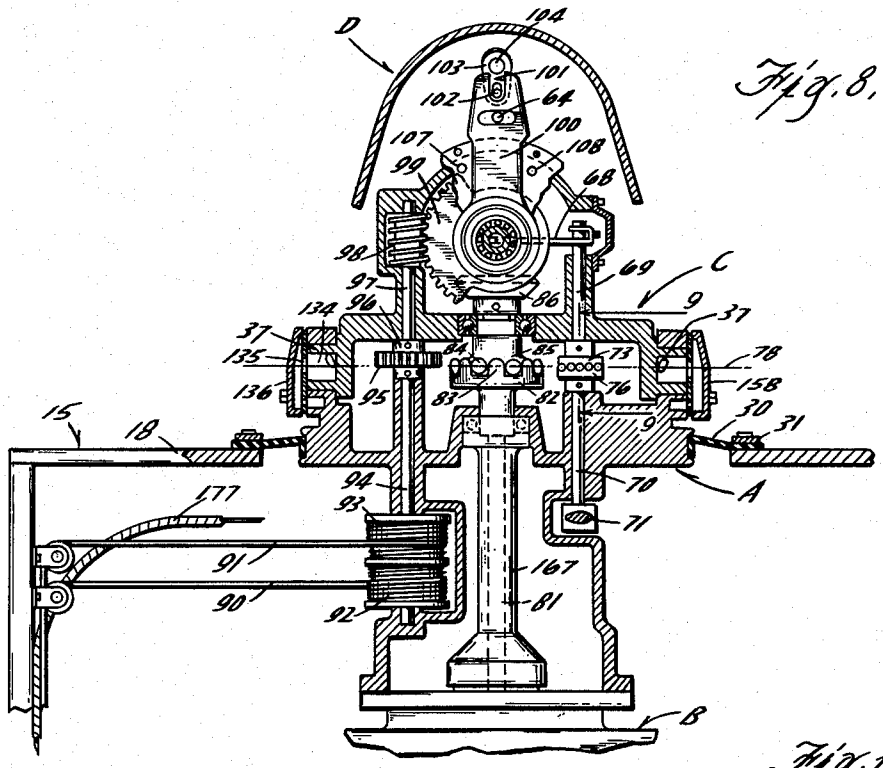


Fig. 8.

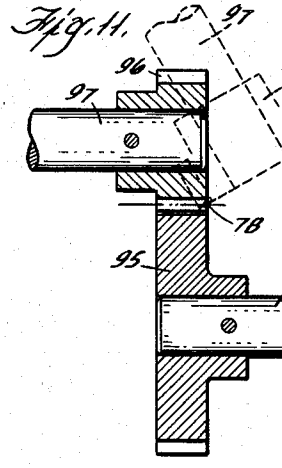


Fig. 11.

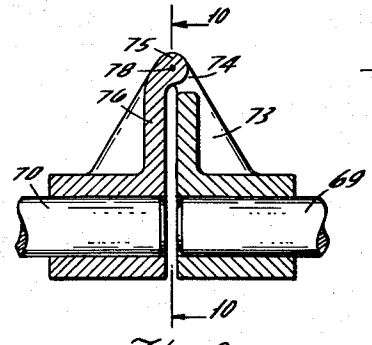


Fig. 9.

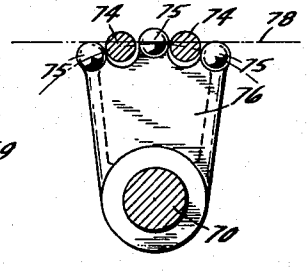


Fig. 10.

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Fig. 12.

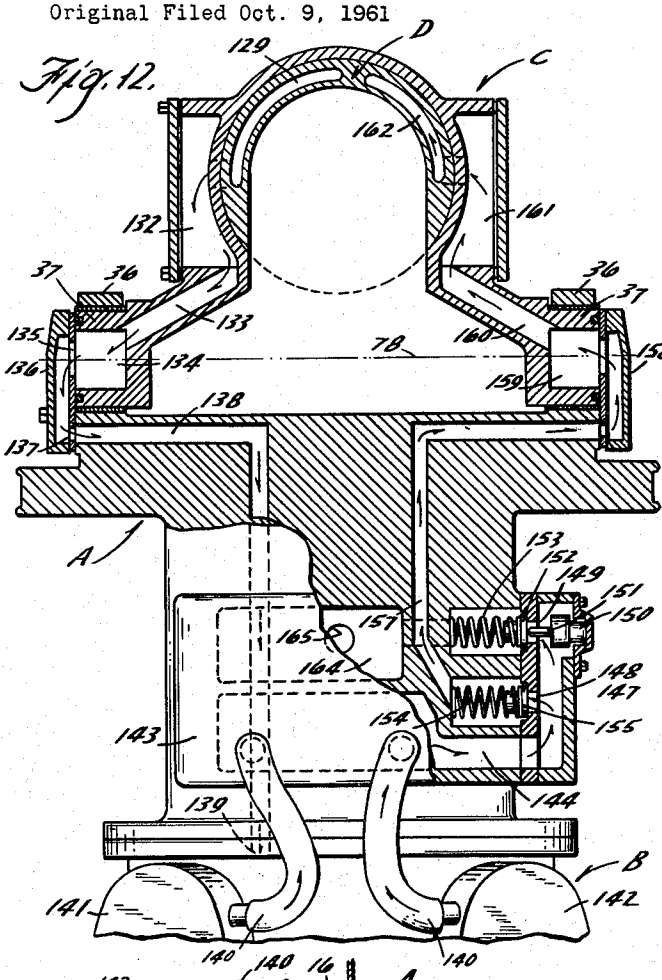
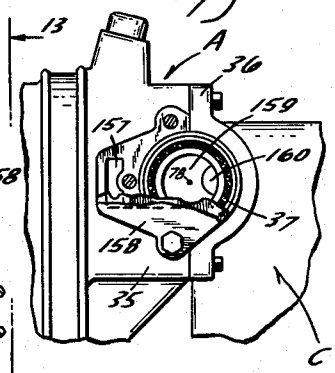


Fig. 13.



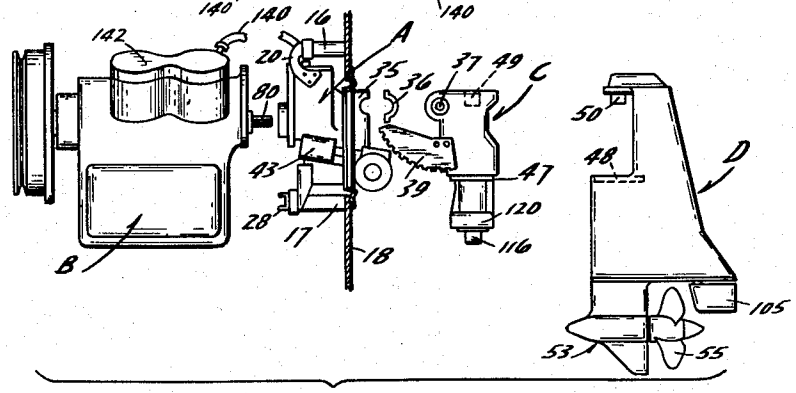


Fig. 14.

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United States Patent Office 3,183,880 Patented May 18, 1965

3,183,880

MARINE PROPULSION DEVICE

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Continuation of application Ser. No. 143,865, Oct. 9, 1961. This application July 10, 1963, Ser. No. 295,594

21 Claims. (Cl. 115—41)

This is a continuation of application Ser. No. 143,865, filed October 9, 1961.

This invention relates to a marine propulsion device of the type known commercially as an inboard-outboard. The engine is mounted within a boat hull and there is an outboard drive to the propeller, the driving power train going through or over the transom.

A feature of the instant device consists in a construction which includes separately prefabricated units, including an intermediate unit attached to the boat at the transom, an engine unit mounted on the intermediate unit within the boat, a swivel bearing support tiltably mounted on the intermediate unit, and a propulsion unit dirigible in the swivel bearing and aft the transom where it is tiltably and dirigibly supported from the intermediate unit. The driving connections and all necessary controls and fluid conduits extend through the intermediate unit and are devised to accommodate the tilting of the propulsion unit on a transverse axis and the steering thereof on an upright axis. The tilting enables the propulsion unit to clear submersed obstacles and it is also valuable to facilitate bearing the boat, and transporting it upon a highway.

Special resilient mountings are attached to a specially built vertical transverse frame within the transom. As disclosed in the companion application of Warren C. Conover, filed December 9, 1960, Serial No. 74,898, now Patent No. 3,083,679, the transom itself may be merely a water excluding panel of no substantial strength, the transverse vertical frame carrying the entire weight of the engine unit as well as the propulsion unit and the intermediate section upon which both of the other units are mounted for support from the boat. The intermediate section extends through an opening in the transom and the space between the intermediate unit and the transom is sealed by a flexible diaphragm type seal.

The engine drive shaft is horizontal and extends aft through the intermediate unit. In the plane of the transverse axis on which the propulsion unit is pivoted for tilting movement, the engine shaft terminates in a specially built gear which is somewhat similar to a crown gear. The transverse axis upon which tilting occurs is tangent to the top of the pitch circle of this gear. A driven shaft mounted in the propulsion unit and connected through the drive shaft of that unit to the propeller, has a special ball toothed spur gear meshing with the driving gear and arranged to stay in mesh with the driving gear in all positions of tilt of the propulsion unit.

Somewhat similar gears which remain in mesh in all positions of the propulsion unit also transmit motion of a steering shaft and motion of a shaft which operates the reverser. In each case, the special gears maintain a driving connection between driving and driven shafts because the axis upon which the propulsion unit tilts is tangent to the pitch circles of both meshing gears.

It is also necessary to provide for the circulation and/or recirculation of cooling water and for the discharge of exhaust gases through the intermediate unit so that notwithstanding relative movement between the propulsion unit and the engine, cooling water can move to and from the engine, and the exhaust gases from the engine can pass to the propulsion unit and be discharged below water level.

A feature of exhaust gas discharge consists in the arrangement whereby the exhaust gases are delivered into the propeller slip-stream through a so-called trim tab which is a relatively small rudder pivotally movable in opposition to the desired steering movement to assist in, or effect, steering movement of that portion of the propulsion unit which houses the propeller shaft and propeller, the propeller slipstream thereupon being used for steering the boat to which the device is applied.

The intermediate unit mounted on the transom frame also contains a thermostatic control mechanism which directs the flow of cooling water to maintain at desired temperature the cooling water which circulates in the engine jacket. The trunnions upon which the propulsion unit pivots for tilting are used as part of the conduit system for conducting the cooling water from the pump of the propulsion unit to the jacket and return for circulation.

In the drawings:

FIGURE 1 is a view largely in side elevation fragmentarily illustrating a propulsion unit, an intermediate unit and a part of an engine assembled in accordance with the invention, portions of the boat and the mounting frame being illustrated in section;

FIGURE 2 is a fragmentary detail view partially in plan and partially broken away to a horizontal section and showing the preferred means of attachment of an intermediate unit of the disclosed embodiment to the boat transom frame upon which it is mounted;

FIGURE 3 is a view in vertical section in a transverse plane indicated in 3—3 in FIGURE 4;

FIGURE 4 is a view in vertical section in a fore and aft plane indicated at 4—4 in FIGURE 3;

FIGURE 5 is an enlarged fragmentary detail view in section on the line 5—5 in FIGURE 4;

FIGURE 6 is a fragmentary detail view in side elevation through the power transmission gear set shown in FIGURE 4, the gears being shown in the extreme position that they take when the propulsion unit is tilted;

FIGURE 7 is a detail view taken in section on the line 7—7 in FIGURE 4;

FIGURE 8 is a partially diagrammatic view generally taken on the line 8—8 in FIGURE 4, portions of the boat being fragmentarily illustrated in section;

FIGURE 9 is an enlarged vertical view taken on the line 9—9 in FIGURE 8;

FIGURE 10 is a view taken in section on line 10—10 in FIGURE 9;

FIGURE 11 is a fragmentary detail view on an enlarged scale taken through the jointed steering shaft on the line 11—11 in FIGURE 8;

FIGURE 12 is a view partially in plan and partially in horizontal section diagrammatically illustrating cooling water circulation between the propulsion unit and the engine through thermostatically controlled passages provided in the intermediate mounting unit;

FIGURE 13 is a fragmentary side elevational view on the line 13—13 of FIGURE 12, portions being broken away; and

FIGURE 14 is an exploded view on a reduced scale diagrammatically illustrating in relatively separated positions the engine unit, the intermediate mounting unit, the swivel bearing unit, and the propulsion unit.

As best shown in FIGURE 14, four prefabricated units are involved in the assembly portrayed in FIGURE 1. There is an intermediate unit A upon which all of the other units are mounted. The intermediate unit is connected with a boat transom, preferably being mounted on a transverse transom frame in the manner hereinafter to be described. Within the boat the intermediate unit supports the engine unit B. Aft of the transom it carries a swivel bearing support C and dirigibly mounted on this is the propulsion unit D. The swivel bearing sup-

port is, in a sense, a part of the propulsion unit, these two sections of the device being pivoted on a transverse axis for unitary tilting movement respecting the supporting intermediate unit A.

FIGURE 1 shows an actual physical assembly of the several units in accordance with the invention. The boat hull 15 is provided with a transverse frame which includes upper and lower hull members 16 and 17. The adjacent transom 18 will normally be aft of this frame and may be relatively light since the frame carries the weight of the assembly. The intermediate unit A is mounted on the boat hull in any desired manner, but is preferably resiliently connected with the frame members 16 and 17 in the manner best shown in FIGURES 1, 2, and 3. Bolted to the sides of the intermediate unit A are the upwardly extending arm 20 to which are vulcanized the rubber cushions 21 which are also vulcanized to plates 22 bolted to the frame member 16.

Projecting downwardly and laterally from intermediate unit A are the arms 24. The resilient cushions 25 which support arms 24 have mounting plates bolted to these arms as shown in FIGURES 1 and 3. The cushions are also vulcanized to plates 26 anchored by bolts 27 to a bar 28 which is fastened to the lower frame member 17 and is provided with offsets at 29 in which the cushions 25 are received as clearly appears in FIGURES 2 and 3. Since the engine unit B and the propulsion unit D derive support through the intermediate unit A from the boat hull, it will be evident that all vibration is damped by the resilient cushions 21 and 25 to minimize transmission of vibration and sound to the boat.

The intermediate unit A projects through the transom 18. A flexible diaphragm seal 30 surrounds the intermediate unit A and is secured, as by molding 31, to the transom 18 to exclude water, spray, and exhaust gas from the boat. The seal 30 is ordinarily well above the water line indicated at 33 in FIGURE 1.

It is desirable that the propulsion unit D shall be dirigible on an upright axis as well as pivoted for tilting about a transverse axis. The provision for these movements will first be described and it will then be explained how these movements can be accommodated without interference with the cooling water connections and controls.

The intermediate unit A has rearwardly opening bearing blocks 35 with bearing caps 36 which confine the transversely aligned trunnions 37 of the swivel bearing support generically identified by reference character C. This support is separately illustrated in FIGURE 14. It is bodily tiltable to and from upright positon by the rotation of its trunnions 37 in the bearing blocks 35 as capped at 36. Its position of tilt is controlled by a segmental rack 39 which meshes with a pinion 40. The pinion 40 is connected with a worm gear 41 driven by worm 42 on the armature shaft of motor 43. Desirably the armature shaft is also provided with manually operable rotating means such as crank 44. As best shown in FIGURE 3, the drive between the worm gear 41 and the pinion 40 is effected through an annular rubber slip clutch 45 so that if a submerged obstacle is encountered by the propulsion unit hereinafter described, the slippage between the elastomeric annulus 45 and the pinion shaft 46 will permit the propulsion unit to tilt notwithstanding the irreversible drive between the worm 42 and worm gear 41. The friction between the annulus 45 and shaft 46 will, however, be sufficient to permit the propulsion unit to be raised or lowered either by power or manually, and will hold the propulsion unit in any desired position of tilt, subject only to yielding in the event of excessive shock stress.

The swivel bearing support C has bearing portions at 47 which coact with complementary bearing portions 48 of the propulsion unit D (see FIGURES 3, 4, and 14). Bearings are also provided at 49 in the swivel bearing support C to receive the stud 50 of the propulsion unit D. Thereby, aligned bearings are provided between the propulsion unit and the bearing support joint above and below the tilting axis 78 which extends transversely through the trunnions 37. The propulsion unit alone is dirigible. Steering movement occurs upon the axis of the bearings provided at 49 and 47. The propulsion unit D and the bearing support C move unitarily in tilting movement upon the transverse axis 78 of the trunnions 37.

The propulsion unit D is provided with the usual gear housing 53 having bearings for the propeller shaft 54 which carries propeller 55. A pair of driven gears 56 and 57 are selectively clutched to the propeller shaft by the shiftable jaw clutch 58 to transmit forward or reverse motion to propeller shaft 54 from the driving gear 59 on the drive shaft 60. Shifting movement of the clutch collar 58 is effected by a bell crank 61 actuated by a link 62 from lever 63. This lever, in turn, is actuated by link 64 from a lever 65 in the upper end of the propulsion unit.

To allow for relative dirigible movement between the propulsion unit D and the bearing support C, motion is transmitted to lever 65 by means of a push rod 67 coaxial with the bearings 47 and 49 upon which the propulsion unit turns for steering. The push rod 67 extends through the stud 50 and is swiveled and pivoted to the arm 68 of a rock shaft 69 which, in the normally upright driving position of the propulsion unit, is aligned with the reversing clutch rock shaft 70 which carries reverse handle 71 as shown in FIGURE 8.

To maintain driving connection between rock shafts 70 and 69 notwithstanding the relative tilting operation, the normally aligned shafts 69 and 70 have driving connections through gear-type universal joint fittings shown in detail in FIGURES 9 and 10. The fitting 73 on shaft 69 comprises a plurality of ball like teeth 74 intermeshing with the ball like teeth 75 of the fitting 76 on shaft 70. Since the throw of the clutch collar on the propeller shaft is short, the range of angular movement required in shafts 69 and 70 is not great and consequently there are only two ball teeth 74 coacting with three ball teeth 75 on fittings 73 and 76 respectively. The axis 78 upon which tilting occurs between the bearing support and the intermediate unit A is tangent to the pitch circle of mesh between the teeth 74 and 75, as shown in FIGURE 10.

The power drive from the engine crank shaft 80 to the drive shaft 60 in the propulsion unit is carried across the axis of tilt in similar fashion. Shaft section 81 is splined to the crank shaft 80 and provided independently thereof with bearings in the intermediate unit A as best shown in FIGURE 4. It carries at its end a driving fitting 82 from which ball like teeth 83 project axially in annular series, somewhat like the teeth of a crown gear. The teeth 83 mesh with radial teeth 84 of a driven fitting 85, which is connected with bevel gear 86 to drive bevel gear 87 on shaft 88, to which is splined the upright drive shaft 60 of the propulsion unit.

A boat equipped with an embodiment of the invention is steered by oscillating the propulsion unit D on the aforesaid bearings at 47 and 49 in which it is mounted in the swivel bearing support C. Not only is the lower part of this unit streamlined to function somewhat as a rudder, but shifting the direction of propeller thrust to one side or the other gives prompt steering response.

Within limits the energy of the propeller slip stream is used to control the oscillation of the propulsion unit for steering. This is done by shifting the so-called trim tab or pilot rudder 105 in the propeller slip stream and using the resulting reaction to shift the entire propulsion unit on its steering axis. However, the pilot rudder has only very limited oscillatory movement respecting the propulsion unit and at the extremes of permitted movement the steering action operates directly and positively to oscillate the propulsion unit.

The steering cables 90 and 91, coming from any appropriate remote control point, pass in opposite directions

about the drums 92 and 93 on shaft 94 which extends aft in the intermediate unit as shown in FIGURE 8. The gear 95 on shaft 94 meshes with gear 96 on shaft 97. The tilt axis 78 is substantially in the plane of the rear faces of the meshing gears 95 and 96 and is tangent to them at the point in their pitch circles at which they mesh. Thus, the tilting of the swivel bearing support C (in which shaft 97 is mounted) may tilt shaft 97 and driven gear 98 to the extreme position shown in dotted lines in FIGURE 11 without unmeshing gear 96 from gear 95.

In the swivel bearing support C, shaft 97 carries a worm 98 meshing with worm gear segment 99 (FIGURES 3, 4, and 8). This segment is on the hub of an arm 100, which is slotted to clear the reversing-clutch push rod 64. The arm 100 also has a terminal slot 101 engaged with the pin 102 of a tiller lever 103 at the upper end of tiller shaft 104. This shaft is oscillatory in the propulsion unit D and carries the trim tab or pilot rudder 105, disposed in the path of the slip stream aft of the propeller 55.

Only a very limited independent movement of the arm 100 and the pilot rudder 105 is permitted, there being stops at 107, 108 at the opposite sides of arm 100 as best shown in FIGURE 8. When the arm engages either of these stops, any further movement of the arm is communicated positively to the propulsion unit to effect steering oscillation thereof. Normally, however, the initial oscillation of the pilot rudder 105 in the slip stream of the propeller, assuming the propeller to be in operation, will develop a thrust reaction which will oscillate the entire propulsion unit in a direction opposite to that in which the pilot rudder has been moved. After a greater or lesser angle of movement of the propulsion unit, the slip stream thrust upon the pilot rudder will find a position of balance which will depend upon the extent to which the pilot rudder has been displaced. Consequently, the steering response to the propulsion unit as a whole will normally be proportional to the movement of the pilot rudder, but in an opposite direction of oscillation.

Because the pilot rudder 105 and its arm 103 are on opposite sides of the axis of tiller shaft 104, the steering pressure of the arm 100 upon the respective stop 107 or 108 will be in the same direction in which the slip stream reaction on the pilot rudder is urging the propulsion unit.

Assuming that the prime mover is an internal combustion engine having a water jacket, it is necessary to provide a supply of cooling water normally taken from the water traversed by the assemblage when in use. A water-receiving opening 110 is desirably formed in the pilot rudder on trim tab 105 immediately aft of the propeller 55 so that the propeller slip stream tends to urge water into the opening 110. A screen 111 is desirably provided. The passage 112 in the pilot rudder communicates with a passage 113 in the propulsion unit and leads to a duct 114 extending toward a chamber 115 in the propulsion unit into which the tubular extension 116 of bearing support C is extended as shown in FIGURE 4.

Drive shaft 60 extends through chamber 115 and is centered within the tubular extension 116. Mounted on this shaft is the pump 120. A water inlet is provided at 121 in the pump casing 122 and a water discharge outlet is provided at 123. From the passage 124 leading from outlet 123 a duct 125 opens into chamber 126 to admit water about shaft 60 to provide a seal which prevents the pump from aspirating air along the shaft.

A housing element 127 integral with the pump casing 122 is compartmented to provide a water recirculating passage 128 separate from the water supply passage 124 and communicating around the pump casing 122 with inlet 121 as shown in FIGURE 3. That portion 130 of the bearing support C which lies above housing member 127 is similarly compartmented. The water inlet passage 129 extends part way around this housing as will be evident by comparing FIGURES 3 and 4 with the diagrammatic view of the water circulation system in FIGURE 12.

In all angular steering positions of unit D respecting unit C passage 129 of unit D opens into a chamber 132 at one side of the bearing support section C and this, in turn, communicates through duct 133 with the cavity 134 in the tubular trunnion 37. From this cavity, water is passed through the ported gasket 135 into a hollow cap plate 136 which extends across the end of the trunnion and is fixed against rotation when the trunnion oscillates in the tilting of the swivel bearing support C and the propulsion unit D. The cap plate 136 is bolted to the intermediate section A and the intake water passes through the port 137 from the interior of the cap plate into the duct 138 of the intermediate section. The delivery end 139 of duct 138 leads directly into the engine jackets.

The return hoses 140 from the respective ends of the engine cylinder blocks 141 and 142 lead through the cover plate 143 into a chamber 144 of the intermediate section of the device. This is immediately over an expansion chamber 145 with which the engine exhaust gas passage 146 communicates. Thus the returned cooling water assists in cooling the exhaust gases in chamber 145.

The water outlet from chamber 144 is through the interior of a hollow closure 147 having valve ports and seats at 148 and 149. A thermostat 150 has a finger 151 which, upon thermostat expansion, pushes open the spring-biased valve 152 which normally closes the port 149. The biasing spring 153 acting on the thermostatically operated valve 152 is relatively heavy as compared with spring 154 which urges check valve 155 to its seat to close port 148.

Until the thermostat 150 reacts, the heavy spring 153 holds the valve 152 closed and the water used for cooling escapes through port 148 into duct 157 which leads through the hollow and relatively fixed cap 158 into the cavity 159 of the trunnion 37 which is at the right of FIGURE 12. The cap and its ports are similar to the cap 136 above described. From the trunnion cavity 159, duct 160 leads into chamber 161 in section D. In all relative positions of sections D and C, chamber 161 communicates with duct 162 in housing 130 of section C, this duct leading into the passage 128 above described, whereby water is returned to the inlet 121 of the centrifugal pump 120. Thus, util the thermostat warms up, water is recirculated through the engine jacket.

As soon as the thermostat 150 becomes warm enough to displace valve 149, the coolant is no longer recirculated but escapes past valve 149 into the chamber 164 (FIGURES 4 and 12) from which drain 165 opens through the exhaust gas baffle 166 and flows around the tube 167 in which shaft 81 is housed. The water and the baffle 166 protect the shaft and its lubrication from the heat of the exahust gases. Together the exhaust gases and the expelled cooling water issue from the intermediate mounting section A through the discharge port 170. In the normal upright position of the swivel bearing unit and the propulsion unit, the exhaust gases and water pass directly into port 171 of the swivel bearing support, the surfaces of these units about ports 170 and 171 being in contact as shown in FIGURE 4. However, when the propulsion unit and the swivel bearing support are tilted, the port 171 is separated from port 170 and the expansion chamber 145 is opened directly to the atmosphere through port 170.

During normal functioning, the engine exhaust gases, and the water which enters the swivel bearing support through port 171, as guided downwardly through the bearing 47 into the expansion chamber 173 of the propulsion unit D. This has a submerged port 174 opening into an escape passage 175, formed in the rear of the pilot rudder or trim tab 105. Hence the exhaust gases are discharged below normal water level into the slip stream from the propeller 55. The turbulance of the slip stream tends to distribute the gases in the form of fine bubbles with a minimum of noise or other evidence of exhaust.

While a preferred structure has been illustrated in the

disclosed embodiment of the invention, it is desired to emphasize the fact that the invention is not limited to details of the preferred arrangement. One of the advantages of mounting both the engine and the propulsion unit upon a prefabricated intermediate unit is the adaptability of the device to a variety of boat structures. Hence, while it is preferred to provide boats having transverse frames for the support of the intermediate unit, nevertheless the frame as shown may be regarded as merely a part of any strong transom structure, so far as the present invention is concerned. Not only is the disclosed arrangement versatile so far as its adaptability to different boats is concerned, but it provides a means whereby a single set of resilient mounts protects the boat and its users from vibrations originating in the engine as well as those from the propulsion unit.

The reverse control lever 71 is well adapted for remote control such as that which can be effected through a conventional Bowden wire 177 (FIGURES 1 and 8), but relatively complex motion transmitting connections within the swivel bearing support and propulsion unit can be eliminated through the use of electrical controls for the clutch collar. The use of an air-cooled engine will, of course, eliminate the relatively complex water passage which is required in the instant device. However, because of the great advantage of having an ample supply of cooling water subject to thermostatic control, the arrangement disclosed is preferred.

What is claimed is:

1. In an inboard-outboard drive for a boat, the combination with a boat-mountable intermediate unit having a drive shaft extending aft therethrough and means journalling said drive shaft, of a prime mover having a shaft connected with the drive shaft, said prime mover being disposed forwardly of said unit and mounted thereon to be supported through said unit from the boat, and a propulsion unit aft of the intermediate unit and having means supporting it through the intermediate unit from the boat, said propulsion unit having a propeller and propeller shaft and means connecting the propeller shaft with said drive shaft.

2. In an inboard-outboard drive for a boat, the combination with a boat-mountable intermediate unit having a drive shaft extending aft, of a prime mover having a shaft connected with the drive shaft, said prime mover being disposed forwardly of said unit and mounted thereon to be supported through said unit from the boat, and a propulsion unit aft of the intermediate unit and having means supporting it through the intermediate unit from the boat, said propulsion unit having a propeller and propeller shaft and means connecting the propeller shaft with said drive shaft, the means supporting the propulsion unit through the intermediate unit from the boat includes means for hingedly mounting the propulsion unit on the intermediate unit for tilting movement upon a transverse axis, the means connecting the propeller shaft with the drive shaft including normally aligned relatively tiltable shaft sections having bearing support from the relatively tiltable units and having gear toothed coupling elements normally in full tooth-for-tooth mesh on a pitch circle to which said axis is tangent, the teeth of said elements remaining in motion-transmitting mesh in all positions of tilting movement of the propulsion unit respecting the intermediate unit.

3. In an inboard-outboard drive for a boat, the combination with a boat-mountable intermediate unit having a drive shaft extending aft, of a prime mover having a shaft connected with the drive shaft, said prime mover being disposed forwardly of said unit and mounted thereon to be supported through said unit from the boat, and a propulsion unit aft of the intermediate unit and having means supporting it through the intermediate unit from the boat, said propulsion unit having a propeller and propeller shaft and means connecting the propeller shaft with said drive shaft, the means supporting the propulsion unit through the intermediate unit from the boat includes means for hingedly mounting the propulsion unit on the intermediate unit for tilting movement about a transverse axis, and the drive shaft has sections independently journalled in relatively tiltable units, the said drive shaft sections having coupling elements provided with meshing teeth, the teeth of one of said elements being crown teeth projecting axially across the plane of said axis and the teeth of the other element projecting radially into mesh with the axially projecting teeth of said one element, said axis intersecting the pitch circle of mesh of said teeth at a point which is tangent to the pitch circle.

4. In an inboard-outboard drive for powering a boat having a transom, the combination with an intermediate unit having means including widely spaced elastomeric cushions disposed substantially in a common plane for mounting the intermediate unit from a boat at the transom thereof, of a prime mover in supported detachable connection with said unit forwardly of the unit and the transom, a swivel bearing unit having means connecting it pivotally with the intermediate unit for tilting about a transverse axis, said swivel bearing unit being disposed aft of the intermediate unit, and a propulsion unit in steerable swiveled connection with the swivel bearing unit and adapted to partake of tilting movement of the swivel bearing unit upon its pivotal connection with the intermediate unit, the propulsion unit having a drive shaft and a propeller shaft provided with a propeller and means for driving the propeller shaft from the drive shaft, a power shaft in operative connection with the prime mover and extending aft through the intermediate unit, a shaft journalled in the swivel bearing unit, gearing means for operatively connecting the power shaft with the shaft journalled in the swivel bearing unit, and means for operably connecting the shaft journalled in the swivel bearing unit with the drive shaft of the propulsion unit.

5. In an inboard-outboard drive for powering a boat having a transom, the combination with an intermediate unit having means including widely spaced elastomeric cushions disposed substantially in a common plane for mounting the intermediate unit from a boat at the transom thereof, of a prime mover in supported detachable connection with said unit forwardly of the unit and the transom, a swivel bearing unit having means connecting it pivotally with the intermediate unit for tilting about a transverse axis, said swivel bearing unit being disposed aft of the intermediate unit, and a propulsion unit in steerable swiveled connection with the swivel bearing unit and adapted to partake of tilting movement of the swivel bearing unit upon its pivotal connection with the intermediate unit, the propulsion unit having a drive shaft and a propeller shaft provided with a propeller and means for driving the propeller shaft from the drive shaft, a power shaft in operative connection with the prime mover and extending aft through the intermediate unit, the power shaft having means providing a joint on the axis of the pivotal connection upon which the swivel bearing unit tilts respecting the intermediate unit, said means comprising toothed elements in permanent mesh and disposed on parts of the power shaft at both sides of the axis, the said teeth of the respective elements meshing in an arc to which said axis is tangent, and gearing means for operatively connecting the power shaft with the drive shaft of the propulsion unit.

6. An inboard-outboard driving mechanism for powering a boat, said mechanism comprising the combination with a prime mover, means for mounting said prime mover on a boat, a jointed power shaft extending aft from the prime mover and driven therefrom and including driving and driven elements having meshed teeth disposed circumferentially of said shaft; of a propulsion unit having a drive shaft, a propeller shaft, means connecting the drive shaft and propeller shaft, and a propeller on the propeller shaft; means for tiltably mounting the propulsion unit from the prime mover mounting means

for pivotal movement on an axis tangent to the pitch circle of mesh of the teeth of said elements, whereby said elements continue in mesh notwithstanding tilting of the propulsion unit respecting the first mentioned unit; and means for effecting driving connection between the driven section of the power shaft and the drive shaft of the propulsion unit.

7. The device of claim 6 in further combination with reversing means in the propulsion unit for reversing the direction of propeller thrust, and means for steering the propulsion unit, and motion transmitting connections for the reversing and steering means and including pairs of driving and driven coupling elements having teeth meshing upon respective pitch circles to which said axis is tangent, whereby the teeth of all of said motion-transmitting connections remain in mesh notwithstanding the tilting of the propulsion unit respecting the unit first mentioned.

8. The device of claim 6 in which the means for pivotally mounting the propulsion unit from the prime mover mounting means includes oppositely disposed trunnions provided internally with water passages, means with respect to which the trunnions rotate in the tilting of the propulsion unit for providing complementary water passages remaining in communication with respective trunnion passages during such relative trunnion rotation, a water pump in the propulsion unit, water jacket means in the prime mover, and means providing connections to and from the jacket means through the respective trunnions.

9. In a boat powering device of the inboard-outboard type, the combination with a dirigible propulsion unit having a propeller shaft, a drive shaft in gear connection therewith and a pump operatively connected with said drive shaft to receive motion therefrom; of a swivel bearing unit having bearing means for supporting the propulsion unit for steering oscillation; means including ports in the respective units and passages in the respective units leading to and from said ports for providing dual water flow connections between said units notwithstanding the oscillation of the propulsion unit in steering, means pivotally supporting the swivel bearing unit for tilting upon a transverse axis, means providing dual water conduit connections across said axis effective notwithstanding the tilting of the swivel bearing unit and the propulsion unit mounted thereon; and a prime mover fixed with reference to said pivotal supporting means and having jacket means with which said conduit means is connected for receipt and discharge of cooling water through said conduit means.

10. In a boat powering device of the inboard-outboard type, the combination with a jacketed internal combustion engine and a propulsion unit having a drive shaft and means operatively connecting it with said engine, of a coolant pump in the propulsion unit, an intermediate unit with which the propulsion unit is connected, said intermediate unit having means for mounting it upon a boat between the engine and the propulsion unit, means providing coolant conduit connections from the coolant pump through the propulsion unit and the intermediate unit to said jacket, means providing an exhaust gas discharge conduit, means providing a coolant return conduit from the engine jacket into the intermediate unit, an overflow duct leading from the return conduit to the means providing the exhaust gas discharge conduit, and means including a thermostatic valve for controlling coolant flow from the coolant return conduit through the overflow duct.

11. The combination set forth in claim 10 in which said intermediate unit and propulsion unit include means for providing coolant recirculating connections from said return conduit to said pump, and a spring-loaded check valve in said connections constituting means for accommodating recirculation of coolant to said pump when said thermostatic valve is closed to preclude flow of coolant to said exhaust conduit means.

12. The combination set forth in claim 10 in which said exhaust conduit means is within the intermediate unit, said intermedate unit having a first chamber with which the coolant return conduit communicates, said first chamber being provided with a plurality of valve seats and ports opening therethrough, said intermediate unit further having a second chamber with which one of said ports communicates and a third chamber with which the other of said ports communicates, said thermostatic valve engaging one of said ports for controlling communication between the first chamber and second chamber, the said duct leading from the second chamber into the exhaust gas passage within the intermediate unit, means for providing coolant recirculating passages extending from the third chamber into the propulsion unit and leading to said pump, and a spring-loaded valve seating on the port between the first and third chambers and adapted to open under coolant pressure when the thermostatically controlled valve is closed.

13. The combination set forth in claim 12 in which means is provided for tiltably mounting the propulsion unit respecting the intermediate unit, and means for maintaining communication for coolant flow and recirculation through said last mentioned means.

14. In a device of the character described, an internal combustion engine having a fixed mounting, a propulsion unit provided with a mounting upon which it is tiltable relative to said engine about a transverse pivotal axis, said unit having a propeller shaft and propeller, a drive shaft, means for connecting the drive shaft with the propeller shaft, means for connecting the engine with the drive shaft for the operation thereof, an oscillatory tiller shaft aft of the drive shaft and provided with a mounting in the propulsion unit, a rudder mounted on the tiller shaft behind the propeller, and means including motion transmitting connections having parts relatively pivotal on said axis for transmitting motion to said tiller shaft.

15. The device in accordance with claim 14 wherein said rudder is provided with an internal cavity and with a discharge port opening aft, and means providing an exhaust passage through said propulsion unit from said engine to said cavity.

16. The combination with a marine propulsion unit, of means including a swivel bearing support for mounting said unit for steering oscillation, a pilot rudder mounted on said unit, a tiller shaft connected with said rudder for the oscillation thereof, a worm gear mounted coaxially with the unit and provided with a tiller arm, means for operatively connecting the tiller arm with said pilot rudder, means connected with the propulsion unit and disposed in the path of oscillation of the arm for communicating motion directly from the arm to the propulsion unit after limited independent oscillation of the arm for actuation of the pilot rudder, and a worm meshing with said worm gear and provided with a mounting on the swivel bearing support.

17. An inboard-outboard driving mechanism applicable to the stern of a boat for powering the boat, said mechanism comprising the combination with a boat-mounted intermediate unit having means for connecting it to a boat, a swivel bearing unit aft of the intermediate unit, means including trunnions and bearings transversely aligned upon a transverse pivotal axis for accommodating tilting movement of the swivel bearing unit respecting the intermediate unit, a propulsion unit having propelling thrust means, means mounting said propulsion unit for steering oscillation in the swivel bearing unit, the propulsion unit being adapted to partake of tilting movement of the swivel bearing unit respecting the intermediate unit, a prime mover forward of the intermediate unit, a first motion transmitting means for connecting the prime mover with the propelling thrust means of the propulsion unit, a thrust reverser in the propulsion unit, a reverser control on the intermediate unit, a second set of motion-transmitting connections for transmitting motion from

said control to said reverser, means for turning the propulsion unit respecting the swivel bearing unit for steering, steering control means mounted on the intermediate unit, means including a third set of motion-transmitting connections for transmitting motion from the steering control means to the means for turning the propulsion unit, each of the first, second and third sets of motion-transmitting connections including portions at opposite sides of said axis and pivotally movable respecting each other when the swivel bearing unit is tilting respecting the intermediate unit.

18. The combination of a boat hull, an intermediate unit having a drive shaft extending aft therethrough, means mounting said intermediate unit on said boat hull including elastomeric means for preventing transmission of vibration from said intermediate unit to said boat hull, a prime mover having a shaft connected with said drive shaft, said prime mover being disposed forwardly of said intermediate unit and mounted thereon to be supported through said intermediate unit, and a propulsion unit aft of said intermediate unit and having means supporting it through said intermediate unit, said propulsion unit having a propeller and propeller shaft and means connecting said propeller shaft with said drive shaft.

19. A combination in accordance with claim 18 wherein said boat hull includes a transom and said elastomeric means is located forwardly of said transom.

20. The combination of a boat hull having a transom, an intermediate unit, means mounting said intermediate unit from said boat hull at the transom thereof and including elastomeric cushion means, a prime mover in supported connection with said intermediate unit forwardly thereof and of the transom, a swivel bearing unit having means connecting it pivotally with said intermediate unit for tilting about a transverse axis, said swivel bearing unit being disposed aft of said intermediate unit, and a propulsion unit in steerable swiveled connection with said swivel bearing unit and adapted to partake of tilting movement of said swivel bearing unit upon its pivotal connection with said intermediate unit, said propulsion unit having a drive shaft and a propeller shaft provided with a propeller and means for driving said propeller shaft from said drive shaft, a power shaft in operative connection with said prime mover and extending aft through said intermediate unit, and gearing means for operatively connecting said power shaft with said drive shaft of said propulsion unit.

21. A combination in accordance with claim 20 wherein said elastomeric cushion means is disposed forwardly of said transom.

References Cited by the Examiner

UNITED STATES PATENTS

1,582,391	4/26	Flettner	114—163
1,900,180	3/33	Harvey	115—41
1,990,387	2/35	Linthwaite	115—41
2,091,247	8/37	Williams	115—41 X
2,644,434	7/53	Watkins	123—41.47
2,681,029	6/54	Canazzi	115—41
2,752,875	7/56	Hills	115—41
2,993,464	7/61	Conover	114—163
3,006,311	10/61	Hansson et al.	115—35
3,029,769	4/62	Kiehaefer	115—18
3,083,679	4/63	Conover	115—41
3,088,296	5/63	Barker et al.	115—41 X
3,091,211	5/63	Hansen	115—41

FOREIGN PATENTS

1,311	1866	Great Britain.

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