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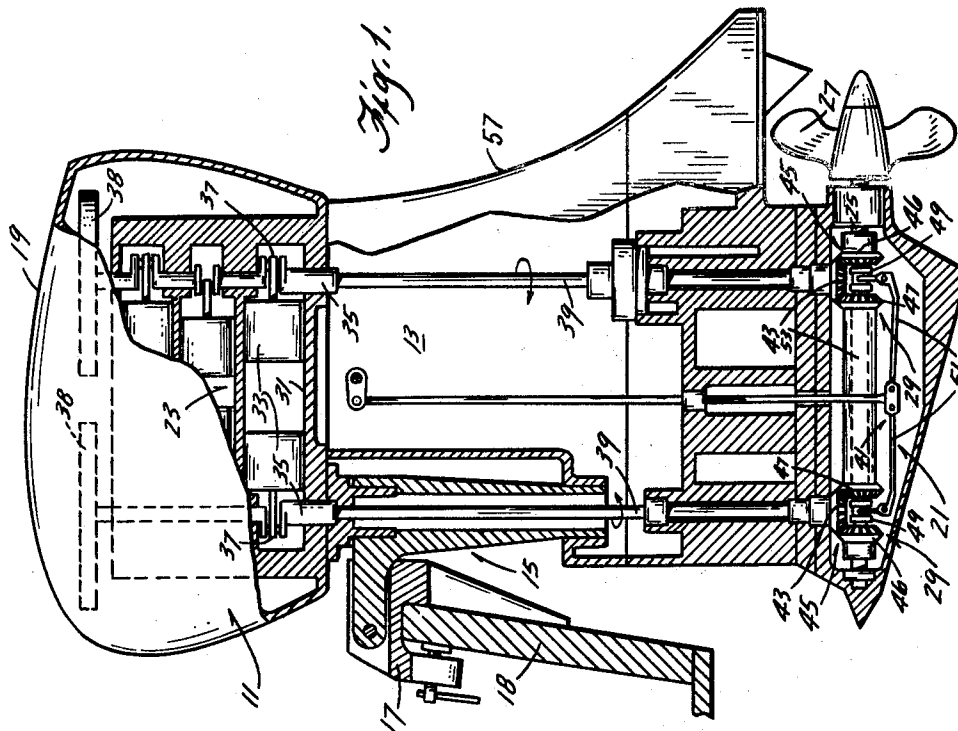
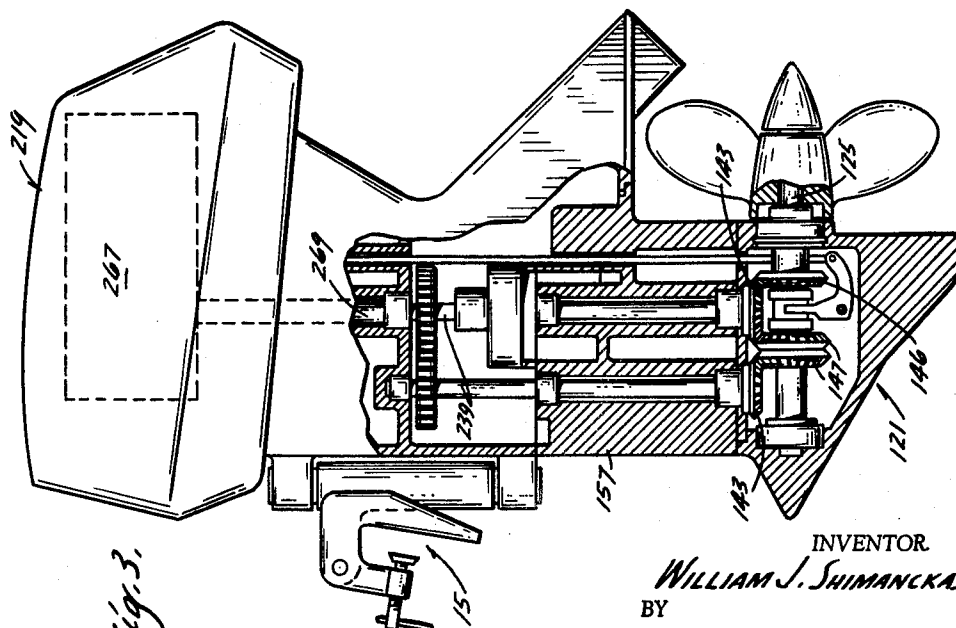
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TWIN COUNTER-ROTATING DRIVE SHAFT ENGINE

Filed March 22, 1962

2 Sheets-Sheet 1



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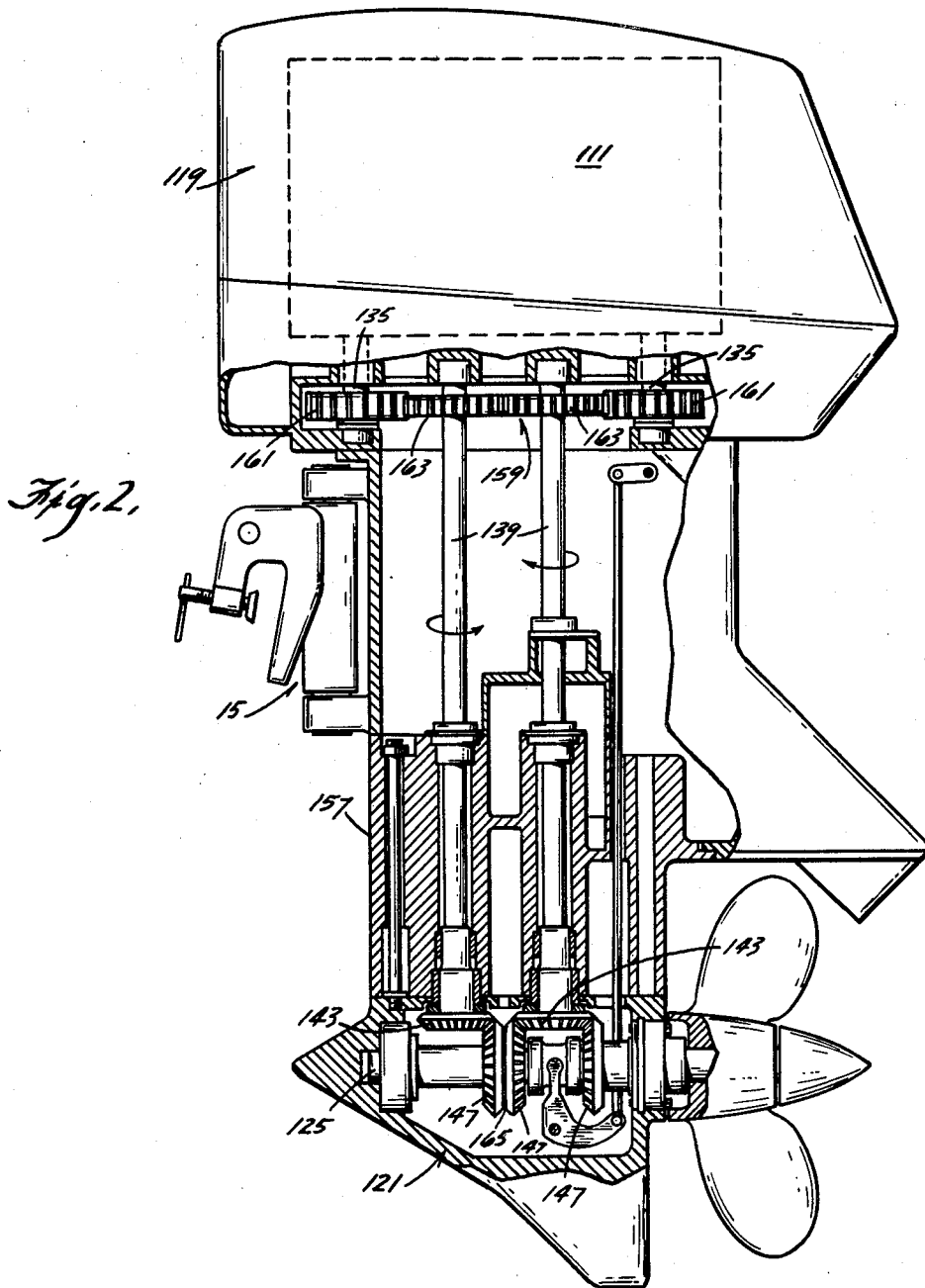
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3,148,557 TWIN COUNTER-ROTATING DRIVE SHAFT ENGINE

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The invention relates to outboard motors, and more particularly, to outboard motors utilizing twin drive shafts as disclosed, for example, in United States Patent No. 1,903,350. The invention also relates to, and has for its principal object, a co-operating power head and drive shafting arrangement, whereby substantially balanced engine operation and torque reaction is obtained.

The invention contemplates an opposed piston engine having dual, counter-rotating crankshafts, together with dual, counter-rotating driveshafts, to obtain optimum balance both with respect to engine operation and torque delivery. The invention also provides a dual counter-rotating shafting arrangement for a single driveshaft engine, thereby balancing torque reaction, at least with respect to the driveshafts.

In the preferred embodiment, the driveshafts are connected to each other to obtain counter revolution thereof and of the crankshafts through gearing located adjacent to the propeller shaft. Interconnection of the driveshafts at such location, i.e., remotely from the crankshafts, serves to interpose the length of the driveshafts between such interconnection and the crankshafts, and as a consequence of the increased driveshaft torsional flexibility or yieldability resulting from the relatively substantial length of the driveshafts, provides for elimination or reduction of any non-synchronized condition between the crankshafts. In addition, the use of twin driveshafts serves to permit reduction in the frontal area of the lower unit, thereby decreasing the power required to drive the motor through the water.

Other objects and advantages of the invention will become known by reference to the following description and the accompanying drawings of three embodiments of the invention.

In the drawings:

FIGURE 1 is a side elevational view, partially broken away and partially in section, of one engine embodiment incorporating various of the features of the invention;

FIGURE 2 is a fragmentary, side elevational view, partially broken away and partially in section, showing a second engine embodiment incorporating various of the features of the invention; and

FIGURE 3 is a fragmentary, side elevational view, partially broken away and partially in section, showing a third engine embodiment incorporating various of the features of the invention.

The outboard motor 11 shown in FIGURE 1 conventionally includes a propulsion unit 13 which is dirigible about a generally upright swivel post 15 carried by a transom bracket 17 mountable on the transom 18 of a boat. The propulsion unit 13 conventionally includes a power head 19 in unitary connection through a strut or housing 57 with a lower unit 21 which is spaced substantially below the power head. The power head incorporates an engine 23 which will be hereinafter described, together with accompanying auxiliary equipment (not shown) such as a carburetor, a starter, and an ignition system. The lower unit 21 incorporates a propeller shaft 25 which carries a propeller 27 and power transmission means 29 reversibly connecting the engine 23 to the propeller shaft 25.

The engine 23 is of the opposed piston type, including

at least one cylinder 31, a pair of pistons 33 movable in the cylinder 31, a pair of crankshafts 35, connecting rods 37 respectively connecting the pistons 33 with the crankshafts 35, and a flywheel 38 connected to each of the crankshafts. The crankshafts 35 can be drivingly connected to each other by various means, as will be explained, to effect counter rotation thereof. Such means can be incorporated in the power head 19 or in the power transmission means 29 in the lower unit 21.

As is known, an opposed piston engine having dual, counter-rotating crankshafts is balanced, both with respect to primary and secondary vibrating forces. If more than one cylinder is employed, the pistons can be connected to the crankshafts by well known arrangements avoiding the creation of primary or secondary couples.

The power transmission means 29 connecting the engine 23 to the propeller shaft 25 includes two parallel driveshafts 39 which serve as extensions of the crankshafts 35 and thereby rotate in opposite directions. The driveshafts 39 are connectable, in unison, through clutch means 41 including driving bevel gears 43 at the bottom of each of the respective driveshafts 39, a pair 45 of driven bevel gears 46 and 47 rotatably mounted on the propeller shaft 25 in respective meshing engagement with each of the driving bevel gears 43, and a pair of dogs 49 which are movable, in unison, axially of the propeller shaft, to selectively connect the bevel gears 46 and 47 in driving relation to the propeller shaft by pivotally mounted forks 51 controlled by a suitable linkage not material to the invention.

Preferably, the adjacent bevel gears 47 of each of the pairs 45 are unitarily connected so as to rotate in unison, thereby drivingly connecting the driveshafts, at a point remote from the crankshafts, to effect counter rotation of the driveshafts and of the crankshafts. In the disclosed construction, the bevel gears 47 are unitarily connected by a sleeve or torque tube 53. If desired, the crankshafts and driveshafts can be alternatively drivingly connected by meshing gears located in or adjacent to the power head 19. However, with such alternate interconnection, the before-mentioned desirable torsional flexibility, obtained by interconnecting the driveshafts remotely from the crankshafts, is sacrificed.

In FIGURE 2 there is shown another engine embodiment wherein an opposed piston engine 111 is connected through dual driveshafts 139 to a propeller shaft 125. However, in order to reduce the fore and aft length of the lower unit 121 and the housing 157 connecting the lower unit to the power head 119, and thereby reduce the wetted area, the crankshafts 135 are connected through gearing 159 in or adjacent to the power head 119, whereby the driveshafts 139 are located in closer parallel relation to each other. More specifically, the crankshafts 135 each terminate in gears 161 in meshing engagement with the gears 163 carried adjacent the top of the driveshafts 139. The driveshafts are preferably driven at the same speed, but if desired the gearing can be arranged to drive one shaft at a different speed from the other. If desired, the gears 163 can be in meshing relation with each other whereby the crankshafts 135 and driveshafts 139 will be counter-rotating or, in the lower unit 121, the bevel gears 147 may comprise a unitary element 165 drivingly connected to the driveshafts 139 to effect counter rotation thereof and of the crankshafts 135.

The use of gearing 159 between the crankshafts 135 and the driveshafts 139 permits speed reduction therebetween. Moreover, if the speed reduction between the propeller shaft 125 and the crankshafts 135 is entirely accomplished by the gearing 159, the bevel gears 143, 146, and 147 can all be of the same size.

In FIGURE 3 there is shown another engine embodi-

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ment wherein a power head 219 includes an engine 267 having a single crankshaft 269 which is coupled to one of a pair of driveshafts 239 in a counter-rotating drive-shaft arrangement, such as shown in FIGURE 2. This construction affords the advantage of decreased wetted area together with substantial elimination of torque reaction within the lower unit.

Balancing of the torque reaction by the use of a pair of counter-rotating driveshafts serves to eliminate, or, in the case of the engine embodiment shown in FIGURE 3, to at least minimize, the tendency exhibited by propulsion units having a single crankshaft and driveshaft toward rotation, during engine operation, about the swivel post in the absence of some restraining force.

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

What is claimed is:

1. The combination in an outboard motor of a unitary propulsion unit, and a bracket supporting said propulsion unit for dirigible movement about a generally upright axis, said propulsion unit comprising a power head, a lower unit spaced substantially beneath said power head, a generally upright strut connecting said lower unit and said power head, an opposed piston engine mounted in said power head and including a pair of parallel, generally upright crankshafts, a propeller shaft, means in said lower unit rotatably mounting said propeller shaft, power transmission means including a pair of upright drive shafts extending through said strut, said pair of driveshafts being respectively connected to said pair of crankshafts and to said propeller shaft, and means for causing said driveshafts to be counter rotating.

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2. An outboard motor in accordance with claim 1 wherein

said counter-rotating means includes gear means mounted in intermeshing relationship on each of said crankshafts.

3. An outboard motor in accordance with claim 1 wherein

said counter-rotating means includes gear means in said lower unit in intermeshing relationship on each of said driveshafts so as to effect rotation thereof at a predetermined speed ratio to each other.

4. An outboard motor in accordance with claim 1 wherein

said gear means includes a gear on each of said driveshafts, said gears being in direct enmeshing relation with each other.

5. An outboard motor in accordance with claim 1 wherein said means for causing counter-rotation of said crankshafts includes

a driving bevel gear on each of said driveshafts, and a unitary gear member rotatably supported on said propeller shaft and having oppositely facing driven bevel gears respectively enmeshed with said driving bevel gears on said driveshafts.

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