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MARINE ENGINE WITH BALLAST TANKS

Filed May 17, 1957

2 Sheets-Sheet 1

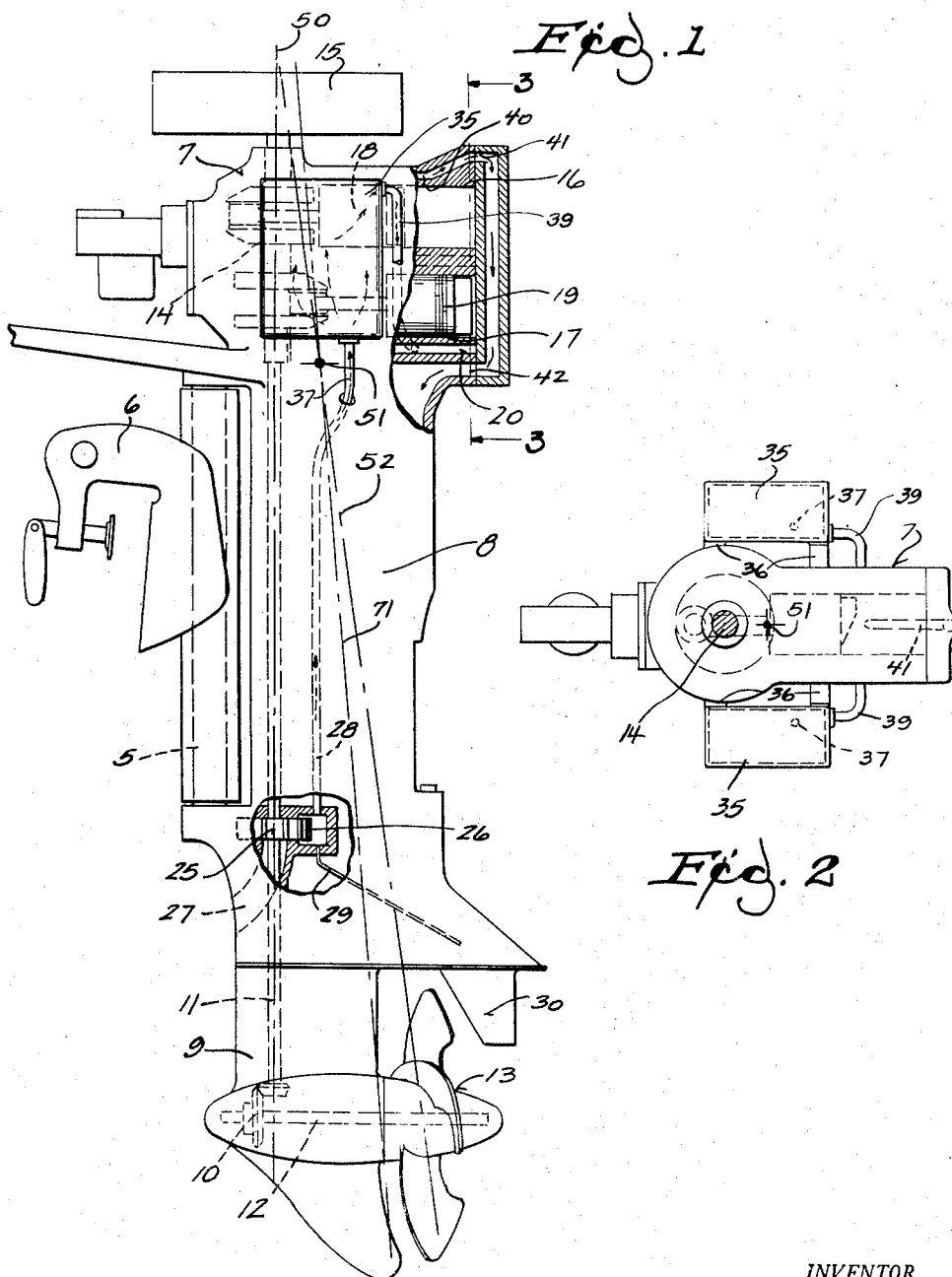


Fig. 2

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Fig. 3

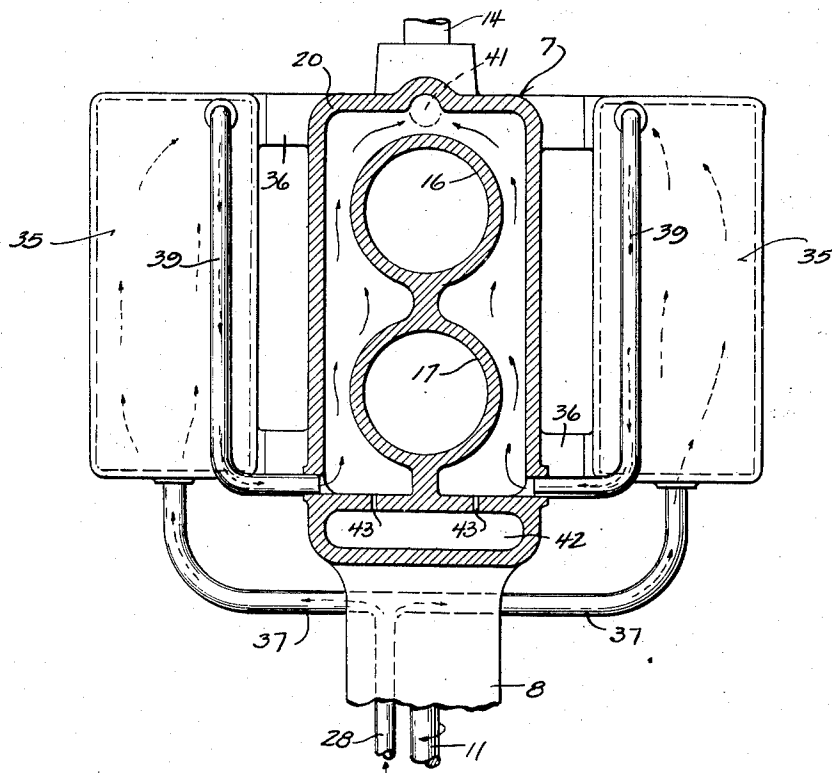
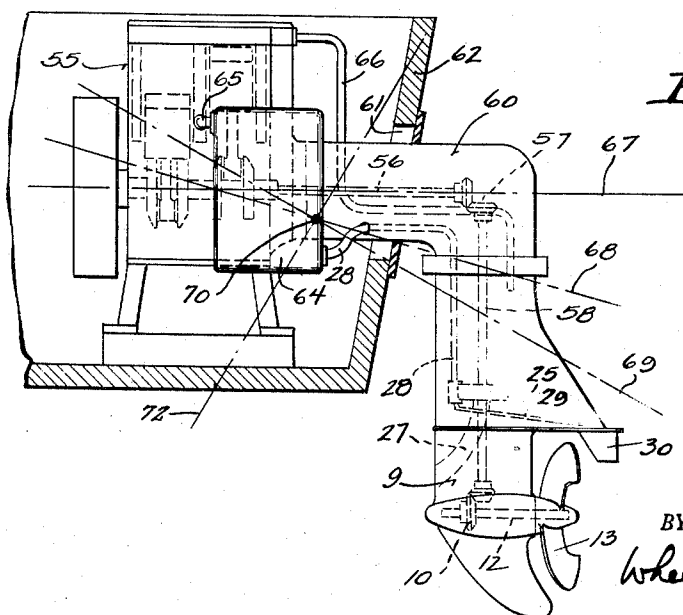


Fig. 4

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MARINE ENGINE WITH BALLAST TANKS

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17 Claims. (Cl. 123—41.72)

This invention relates to a marine engine with ballast tanks for increasing inertia to resist vibration in use.

The invention has particular utility in an outboard motor but may also be incorporated in a drive using an inboard engine. In the case of an outboard motor, it is especially desirable that the outboard motor as a whole shall be readily portable and hence light in weight. This objective would seem to be irreconcilable with the provision of considerable mass to create an inertia effect resistant to vibration about the neutral axis or the steering axis of the device.

The present invention reconciles these objectives in a single structure by providing tanks or cavities normally empty for lightness of weight during transportation but adapted to be filled with water during use of the device to create the desired inertia. In order that the inertia tank or tanks may have maximum effect, I desirably mount these symmetrically at opposite sides of the axis upon which vibration occurs. In order that they may be filled automatically, I connect them to the cooling system of the engine in such a manner that the inertia tanks are filled when engine operation commences and are automatically drained when engine operation ceases. To this end, the water pump may deliver water first to the tank or tanks, the overflow from these tanks being connected to the engine jacket, preferably at the lowest point therein.

An orifice materially less in capacity than the output of the pump drains stored water either from the tanks or the jackets or both when the pump is not in operation. The particular location of the orifice will necessarily depend on the type of pump and the type of installation, the embodiments disclosed including one drain from the vicinity of the pump, one directly from the tank, and one from the jacket.

In the drawings:

Fig. 1 is a view in side elevation of an outboard motor embodying the invention, portions being broken away to expose water passages.

Fig. 2 is a plan view of the motor shown in Fig. 1.

Fig. 3 is an enlarged detail view taken in section on line 3—3 of Fig. 1.

Fig. 4 is a modified embodiment showing the use of inertia ballast tanks in conjunction with an inboard engine having an outboard drive, the engine being shown in side elevation and a boat being fragmentarily illustrated in section.

It is immaterial how the outboard motor is mounted for steering. The particular motor chosen to exemplify the invention in Figs. 1 to 3 happens to be of the type which uses a kingpin 5 to support the propulsion unit of the outboard motor dirigibly of the transom brackets 6 in accordance with known practice. The propulsion unit comprises a powerhead generically designated by reference character 7 at the upper end of a strut 8 rigidly connecting it with the so called lower unit or gear housing 9 wherein gear 10 connects the engine drive shaft 11 with propeller shaft 12 on which propeller 13 is mounted.

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The drive shaft is aligned with the engine crankshaft 14 which carries, at its upper end, a flywheel 15. The powerhead 7 chosen to exemplify the invention is one which comprises superimposed cylinders 16 and 17 in which the pistons 18 and 19 operate oppositely with alternating power strokes on the two cycle principle. The jacket 20 encloses these cylinders according to any conventional practice.

The pump 25 is mounted as usual in strut 8 and has its runner 26 mounted directly on the drive shaft 11 to pump water from the intake 27 through pipe 28 which extends upwardly through strut 8. Some types of pump will drain the pipe 28 through the pump when the pump is not in operation. Other types of pump provide a seal. For draining the pipe 28, in case the pump 25 is of the latter type, I provide a small capacity drain tube 29 which opens from the lower end of pipe 28 into the under water exhaust 30.

For the purposes of the present invention, ballast tanks 35 are rigidly connected with the powerhead 7 as by means of brackets 36 connected with jacket 20 in the manner shown in Fig. 3. In the present embodiment of the invention, the water supply pipe 28 from pump 25 has branches 37 which lead into the ballast tanks 35, preferably at the bottoms thereof, so that the tanks will drain fully when the pump 25 is not in operation. It will be understood that the capacity of the drain tube 29 is desirably much less than that of the pump so that drainage through the tube during the period the pump is in operation will not greatly retard the filling of the tanks 35.

From the tops of the tank or tanks 35 lead passages or pipes 39 which extend into the jacket space 40 around the cylinders, desirably at the bottom thereof to make sure that the jacket will be filled with water during pump operation, the overflow 41 opening from the top of the jacket space into the exhaust passage 42 or otherwise discharging according to any approved practice. For drainage, orifices 43 may be provided to open from the jacket space 40 into the exhaust passage 42 as shown in Fig. 3. Again, the capacity of the orifices is so small in relation to pump capacity that the leakage does not appreciably interfere with circulation of cooling water during pump operation but drains off accumulations of cooling water after pump operation ceases.

It will be observed that when the engine operation commences, there will be a slight delay in supplying cooling water to the jackets inasmuch as the ballast tanks are, in the series-connected device illustrated to exemplify the invention, filled before any water reaches the jackets. Assuming proper pump capacity, this delay will not be sufficient to permit the engine to become overheated. However, the delay does have a desirable incidental effect in that it expedites engine warm-up to normal operating temperature.

As will be recognized by those skilled in the art, it is broadly immaterial where the ballast tanks are placed on the outboard motor structure since any increase in the mass or weight of the structure produces corresponding increase in inertia and resistance to vibration about the neutral axis. However, since torque vibration resulting from power impulses generated in the powerhead 7 are the principal source of vibration, it is desirable that the tanks be located at or near the level of the powerhead. The neutral axis upon which vibration occurs is usually at or near the axis of crankshaft 11.

In Fig. 1, the crankshaft axis is designated at 50 and the neutral axis or torque roll axis about which torsional vibration occurs is represented at 71. Vibration may also occur about axis 52. The center of mass is shown at 51.

The desirable location of the ballast tanks is in a sym-

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metrical disposition about the axis 71 at approximately the level of the center of mass. At this level, the several axes upon which vibration tends to occur are extremely close together. The inertia of the water-filled tanks rigidly connected with the powerhead 7 resists oscillation of the propulsion unit about the torque roll axis 71 in particular, but is also effective in resisting oscillation of the unit upon any other axis.

Instead of providing for ballast by providing special tanks or cavities within parts of the engine, it is preferred that the ballast tanks be free of, and laterally offset from, the engine in the manner shown in Fig. 3 because the greater their radius from the axis about which oscillation occurs, the more effective will their increased mass become. It is also preferred that the ballast tank arrangement be symmetrical, although this is not an essential feature of the invention.

Fig. 4 shows an arrangement in which the engine 55 is upright, its horizontal drive shaft 56 being connected by bevel gearing at 57 to a vertical drive shaft 58. These two shafts are disposed in a housing 60 having a generally horizontal portion extending through a sealed opening 61 in the boat transom 62 while the generally upright portion of the housing is at the rear of the boat and supports a lower unit 9 which may be identical with that used in the outboard motor shown in Fig. 1.

A pump which may correspond to that shown in Fig. 1 delivers cooling water through pipe 28 in the same manner described above, the cooling water pipe having a drain duct at 29 of minor capacity as compared with that of pump 25. Pipe 28 leads into the ballast tank 64 mounted at the side of the engine 55. From the top of tank 64 a communicating pipe 65 leads into the engine jacket from which the heated cooling water is discharged through overflow pipe 66 into housing 60 and thence out through the under water exhaust at 30.

In Fig. 4, the crankshaft axis is shown at 67 and the torque roll axis at 68. Principal axes 69 and 72 intersect axis 68 at the center of gravity 70 which happens to be located in the instant design substantially on the crankshaft axis 67. The tank 64 is desirably centered at or near this point, except that it is laterally offset from the engine to increase its moment in resisting torque roll.

I claim:

1. The combination with an engine having a water jacketed cylinder and a piston reciprocable in the cylinder and a support on which the cylinder tends to oscillate in the course of piston reciprocation, of ballast tank means offset from the cylinder, pump means for supplying water to the cylinder jacket and a connection from the pump means to the ballast tank means and the jacket for filling the ballast tank means as well as the jacket when the pump is in operation, and means effective for draining the ballast tank means whenever pump operation ceases.

2. The combination with an engine having a water jacketed cylinder, of ballast tank means offset from the cylinder, pump means for supplying water to the cylinder jacket and a connection from the pump means to the ballast tank means of the jacket for filling the ballast tank means as well as the jacket when the pump is in operation, and means effective for draining the ballast tank means, said connections including a pipe leading from the pump means to the ballast tank means and leading from the top of the ballast tank means to the jacket, whereby the pump means and the ballast tank means and the jacket are connected in series and the ballast tank means is required to be filled before water is supplied to the jacket.

3. The combination with an engine having a water jacketed cylinder, of ballast tank means offset from the cylinder, pump means for supplying water to the cylinder jacket and a connection from the pump means to the ballast tank means of the jacket for filling the ballast tank means as well as the jacket when the pump is in

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operation, and means for draining the ballast tank means, the draining means comprising a constantly open drain port of such small capacity as compared with the pump means that it does not preclude the filling of the ballast tank means while the pump is in operation, while being effective to drain the ballast tank means when pump operation ceases.

4. In a marine propulsion device comprising an engine and a cooling pump having a normally submerged inlet, the engine including a cooling water jacket, a ballast tank means having portions radially offset from an axis upon which the engine tends to vibrate when in operation, means for draining the ballast tank means, the said draining means having a capacity materially less than that of the pump, and a connection from the pump to the ballast tank means for filling the ballast tank means when the pump is in operation, means for supplying to the jacket water pumped by said pump, said pump including a runner connected with said engine to be actuated thereby when the engine operates.

5. The device of claim 4 in which the ballast tank means comprises parts disposed substantially symmetrically at opposite sides of the axis.

6. The device of claim 4 in which the ballast tank means is connected in series between the pump and the engine jacket and has an outlet connection from its top to the engine jacket whereby the ballast tank means is filled in advance of the jacket when the engine is started.

7. The device of claim 4 in which the marine propulsion device comprises an outboard motor having an upright drive shaft and substantially aligned crankshaft and horizontal cylinders, the ballast tank means comprising a pair of tanks at opposite sides of the crankshaft and at substantially the level of the cylinders.

8. The device of claim 4 in which the marine propulsion device comprises an engine having a generally horizontal crankshaft and upright cylinders, the ballast tank means comprising a tank offset laterally from the crankshaft beside the cylinders.

9. A marine propulsion device comprising the combination with an engine having jacketed cylinders and a crankshaft, of a drive shaft connected with the crankshaft to receive power from said engine and provided with a housing, a pump in the housing having a runner connected to receive power from the drive shaft, said pump having a submersible inlet, an outlet pipe extending from said pump toward said jacket and a ballast tank having portions radially offset from the crankshaft and connected with said pipe to receive water from the submersible inlet during pump operation, said ballast tank having a top outlet, whereby it will be substantially filled with water during pump operation, and means for draining the tank when the pump is not in operation.

10. The device of claim 9 in which the draining means comprises a permanently open port of materially less capacity than the pump.

11. The device of claim 10 in which the top of the ballast tank opens into the jacket, the tank and jacket being connected in series with the pump.

12. The device of claim 11 in which the ballast tank portions aforesaid comprise separate tank units symmetrically disposed at opposite sides of the engine.

13. The combination with a marine engine having cylinder means and piston means and a mounting upon which the engine is subject to oscillation upon a torque roll axis, of ballast tank means connected with the engine in a position offset from the axis and means automatically dependent on engine operation for filling and automatically operable when the engine operation ceases for draining the ballast tank means, the inertia of the filled ballast tank means opposing oscillation of the engine upon said axis solely during engine operation.

14. The device of claim 13 in which the ballast tank means is disposed substantially symmetrically respecting

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said axis and at substantially the level of the center of mass of said engine.

15. The device of claim 14 in which the cylinder means is jacketed and the engine is provided with a cooling system including a pump and means for circulating cooling water in the jacket, the means for filling and draining the ballast tank means comprising a connection with the engine cooling system.

16. A method of opposing vibration about a predetermined axis of an engine provided with reciprocating parts and mounted for oscillation about said axis, said method comprising the addition of weight to said engine at a point spaced from said axis substantially solely during engine operation.

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17. A method of resisting vibration about a predetermined axis of an internal combustion engine provided with a cooling system for the circulation of a coolant, which method comprises confining a given volume of said coolant in substantially rigid connection with said engine at a point offset from said axis during engine operation and releasing the coolant when the engine is not operating.

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