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Resnick et al.

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[54] **DRAINAGE SYSTEM FOR TWO-CYCLE ENGINE**

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[52] **U.S. Cl.** .... **123/73 R,** 123/196 CP
[51] **Int. Cl.** **F02b 33/04,** F01m 3/00
[58] **Field of Search**.. 123/73 R, 73 A, 73 D, 73 PP, 123/196 CP

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[57] **ABSTRACT**

When a two-cycle engine, which has its two cylinders horizontally disposed, is idling, drainage from the bottom chamber of the crankcase to the upper bearing is diverted into the transfer passage of the upper cylinder due to increased suction in the transfer passage of the upper cylinder. As a result, drainage does not flow to the upper bearing in any significant amount at idle. However, with higher speeds of the engine, most of the drainage flows to the upper bearing because of the decreased suction in the transfer passage of the upper cylinder.

6 Claims, 5 Drawing Figures

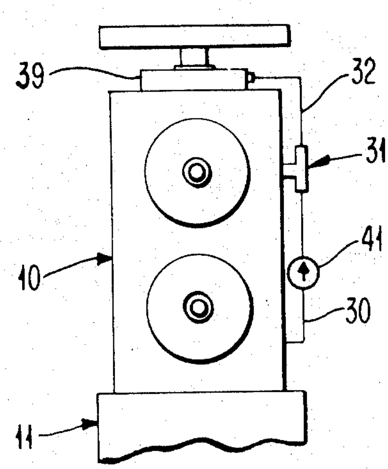


FIG. 1

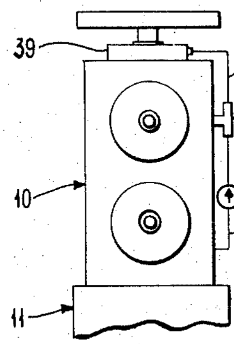


FIG. 2

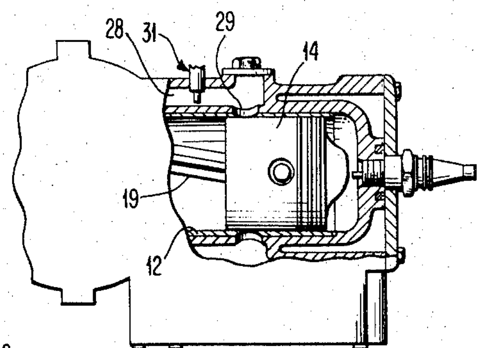


FIG. 3

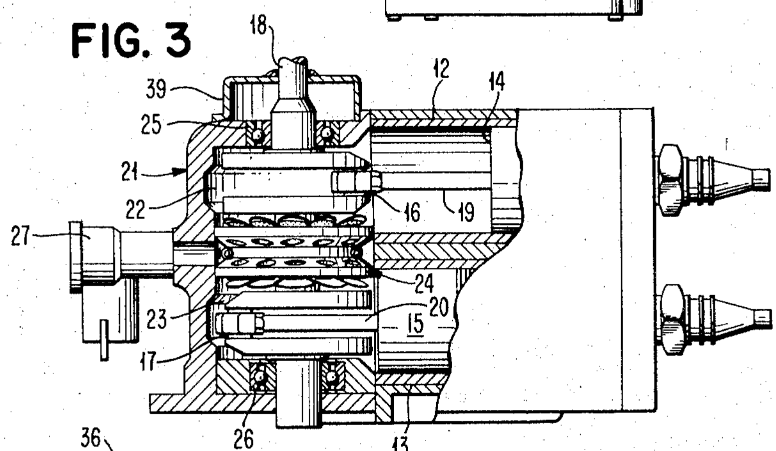


FIG. 4

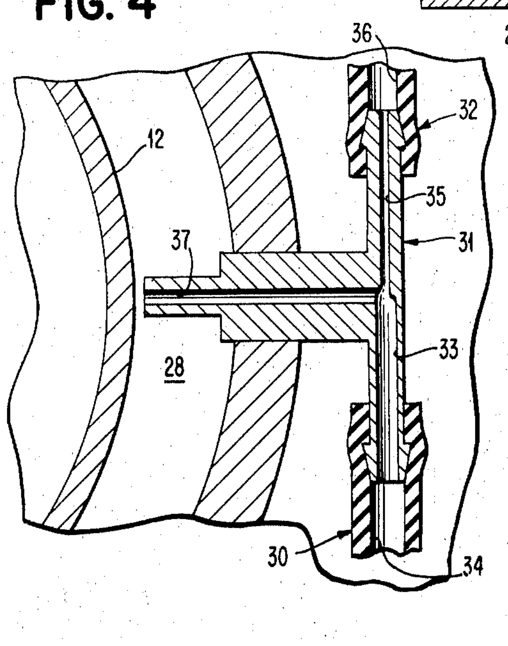
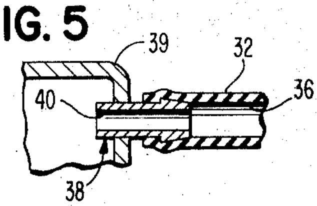


FIG. 5



DRAINAGE SYSTEM FOR TWO-CYCLE ENGINE

In a two-cycle internal combustion engine, the crankcase is part of the fuel supply system. As a result, there is no oil pan in the crankcase as in a four-cycle engine so that the fuel mixture must include both gasoline and oil along with air. The oil is employed to lubricate the internal moving parts.

The problem of the gas-oil mixture collecting in a two-cycle engine crankcase is well-known. By creating a puddle, rough running is created as the liquid mixture is taken into the combustion chamber.

Various means have previously been proposed to avoid this creation of a puddle in the bottom of the crankcase of a two-cycle engine during engine idle. One of these has been to drain the crankcase overboard when the engine has been used as an outboard motor. While tests have indicated that there is no effect on the ecological balance of the water due to this type of drainage, it is desired to avoid this drainage and still not have the puddle created in the crankcase.

The present invention satisfactorily solves the foregoing problem by providing a system for a two-cycle engine in which the drainage is recycled so that it is not necessary to drain it overboard from an outboard motor nor is there any puddle created in the crankcase during engine idle whereby a smoky exhaust occurs when engine speed increases. The present invention utilizes a system in which drainage flow to the upper bearing is substantially prevented during engine idle and the flow to the upper bearing is increased as the speed of the engine is increased.

This eliminates the puddling problem since the drainage is not directed to the upper bearing in any significant quantity during idle. However, a sufficient quantity of drainage is supplied to the upper bearing at operating speeds so as to satisfactorily lubricate the upper bearing.

The present invention employs a system in which a high suction in the transfer passage of the upper cylinder during idle is utilized to divert most of the flow from the lower crank chamber of the crankcase to the transfer passage of the upper cylinder rather than to allow the drainage to flow to the upper bearing during idle. With the suction in the transfer passage of the upper cylinder decreasing as the speed increases, the proportion of the flow which reaches the upper bearing increases while the flow to the transfer passage of the upper cylinder decreases.

An object of this invention is to provide a drainage recycle system for an outboard motor.

Other objects of this invention will be readily perceived from the following description, claims and drawing.

This invention relates to an improvement in a two-cycle internal combustion engine having a crankcase, a rotatably mounted crankshaft, and bearing means to support the crankshaft. The engine has at least two cylinders with a piston disposed in each of the cylinders and connected to the crankshaft. The crankshaft has a separate chamber for each of the cylinders with separate first means to supply a mixture of gasoline and oil from each of the chambers of the crankcase to the cooperating cylinder. Second means supplies drainage from only one of the chambers of the crankcase to at least one of the bearing means. The improvement comprises the second supply means having means to control the flow of drainage from the one chamber of the crankcase to the one bearing means in accordance with the speed of the engine with the control means allowing flow of a significant quantity of drainage to the one bearing means only when the speed of the engine exceeds a predetermined speed.

The attached drawing illustrates a preferred embodiment of the invention, in which:

FIG. 1 is a schematic elevational view of a two-cycle internal combustion engine in which the drainage system of the present invention is employed;

FIG. 2 is a sectional view of a portion of one of the cylinders of the engine of FIG. 1 with which the drainage system of the present invention is employed;

FIG. 3 is a sectional view, partly in elevation, of a portion of the engine using the drainage system of the present invention;

FIG. 4 is an enlarged sectional view of a portion of one of the cylinders and showing details of the drainage system of the present invention; and

FIG. 5 is a sectional view showing a portion of the drainage system of the present invention.

Referring to the drawing and particularly FIG. **1**, there is shown a two-cycle internal combustion engine **10** used as an outboard motor. The engine **10** is shown supported on a driveshaft housing **11** of the outboard motor.

The engine **10** has a pair of horizontally disposed upper and lower cylinders **12** and **13** (see FIG. **3**) with the cylinders **12** and **13** having pistons **14** and **15**, respectively, slidably disposed therein. Each of the piston **14** and **15** is connected to cranks **16** and **17** of a crankshaft **18** by connecting rods **19** and **20**, respectively.

The crankshaft **18** is supported within a crankcase **21**, which is divided into upper and lower crank chamber **22** and **23** by a bearing block **24** and reed valve. An upper bearing **25** supports the upper end of the crankshaft **18** while a lower bearing **26** supports the lower end of the crankshaft **18**.

The mixture of gasoline and oil along with air is introduced through a carburetor **27** into the crank chambers **22** and **23** in the normal manner through reed valve block **24**. The mixture is introduced into the lower crank chamber **23** 180° of rotation of the crankshaft **18** after the mixture is introduced into the upper crank chamber **22** and vice versa.

From the upper crank chamber **22** of the crankcase **21**, the mixture of gasoline, oil, and air is sucked through a transfer passage **28** (see FIGS. **2** and **4**) and an intake port **29** (see FIG. **2**) into the upper cylinder **12**. This occurs due to the increase of the pressure within the upper crank chamber **23** of the crankcase **21** above atmosphere by the piston **14** moving into the upper crank chamber **22** of the crankcase **21**. This closes the reeds and prevents any additional supply from the carburetor **27** to the upper crank chamber **22** of the crankcase **21** of the mixture while the mixture is being directed through the transfer passage **28** to the intake port **29**.

When the piston **14** is moved within the upper cylinder **12** by rotation of the crankshaft **18** so as to close the intake port **29** as shown in FIGS. **2** and **3**, suction exists within the upper crank chamber **22** of the crankcase **21** and the transfer passage **28**. At this time, additional mixture of the gasoline, oil, and air is supplied to the upper crank chamber **22** of the crankcase **21** from the carburetor **27**.

A similar arrangement (not shown) exists for the lower cylinder 13. The same sequence of events occurs after 180° of rotation of the crankshaft 21.

Drainage is supplied from the lower crank chamber 23 of the crankcase 21 to the upper bearing 25 through a conduit 30 (see FIG. 1), a fitting 31, and a conduit 32. The fitting 31 is T-shaped and has a first passage 33 (see FIG. 4) communicating with a passage 34 in the conduit 30 and a second passage 35 communicating with a passage 36 in the conduit 32. As shown in FIG. 4, the first passage 33 has a larger diameter than the second passage 35. The diameters of the passage 34 in the conduit 30 and the passage 36 in the conduit 32 are the same and are larger than either the first passage 33 or the second passage 35 in the fitting 31.

The fitting 31 has a third passage 37 connected to the first passage 33 at the junction of the first passage 33 and the second passage 35. The third passage 37 communicates with the transfer passage 28 of the upper cylinder 12. The third passage 37 of the fitting 31 has a smaller diameter than either the second passage 35 or the first passage 33.

The passage 36 in the conduit 32 communicates with the upper bearing 25 through an ejector fitting 38 (see FIG. 5) in an end cap 39. The end cap 39 covers the upper bearing 25 as shown in FIG. 3.

The fitting 38 has a passage 40 of a diameter substantially the same as the diameter of the third passage 37 of the fitting 31. Thus, the third passage 37 and the passage 40 in the fitting 38 form restrictions.

As an example, the passage 33 in the fitting 31 has a diameter of 0.078 inch and the passage 35 in the fitting has a diameter of 0.040 inch. The passage 37 in the fitting 31 has a diameter of 0.030 inch while the passage 40 in the fitting 38 has a diameter of 0.028 inch.

During each cycle of operation, suction is produced within the transfer passage 28 of the upper cylinder 12 because of the piston 14 moving out of the upper crank chamber 22 of the crankcase 21 and closing the transfer port 29 at the same time that a pressure above atmospheric is produced in the lower crank chamber 23 of the crankcase 21 by the piston 15 moving into the lower crank chamber 23. This relationship of the pistons 14 and 15 is shown in FIG. 3.

Thus, the pressure for supplying the mixture of oil, gasoline, and air from the bottom of the lower crank chamber 23 of the crankcase 21 to the passage 34 in the conduit 30 occurs at the same time as the suction is produced in the transfer passage 28 of the upper cylinder 12. As a result, a portion of the drainage flowing from the passage 34 in the conduit through the first passage 33 in the fitting 31 is sucked into the third passage 37 by the suction in the transfer passage 28.

When the engine is at idle, the suction in the transfer passage 28 is higher than as the speed of the engine increases. As the speed of the engine increases, a much weaker suction exists in the transfer passage 28 of the upper cylinder 12.

Accordingly, because of the restriction formed by the third passage 37 in the fitting 31 and the increased suction in the transfer passage 28 at idle, most or all of the drainage flowing from the lower crank chamber 22 of the crankcase 21 through the first passage 33 in the fitting 31 is diverted into the transfer passage 28 of the upper cylinder 12. The restriction at the passage 40 in the fitting 38 enables this increased suction to be more effective.

Because of the heat and vacuum in the transfer passage 28, the oil and gasoline are partially vaporized in the transfer passage and do not return to the upper crank chamber 22 of the crankcase 21 through the transfer passage 28 in any significant amount. Therefore, some of the drainage passes into the upper cylinder 12 and is burned therein. However, because of the continuous supply of a samll quantity of drainage during each cycle, there is no smoky exhaust problem as would exist after idle with an engine not using the present invention and having no drainage system.

Since the suction of the transfer passage 28 of the upper cylinder 12 weakens as the speed of the engine increases, the suction in the transfer passage 28 becomes less effective as the engine speed increases so that the drainage tends to flow through the second passage 35 in the fitting 31 to the upper bearing 25. Therefore, the upper bearing 25 receives a sufficient quantity of lubricant as the speed of the engine increases; this is when the upper bearing 25 requires the most lubricant.

Because the pressure supplying the drainage from the lower crank chamber 23 of the crankcase 21 through the passage 34 in the conduit 30 increases as the speed of the engine increases, this increased pressure also enables most, if not all, of the drainage to flow through the second passage 35 in the fitting 31 to the upper bearing 25 rather than through the third passage 37. Thus, the weakening of the suction in the transfer passage 28 as the engine speed increases along with the increase in the drainage flow from the lower crank chamber 23 of the crankcase 21 as the engine speed increases results in a greater flow of drainage to the upper bearing 25 as the speed of the engine increases. Therefore, below a predetermined speed, the present invention prevents most, if not all, of the drainage from being supplied to the upper bearing 25.

As a result, the upper bearing 25 does not receive too much lubricant at idle, and puddling does not create a problem.

As shown schematically in FIG. 1, the conduit 30 preferably has a check valve 41 therein to prevent any reverse flow to the lower crank chamber 23 of the crankcase 21 when suction exists in the lower crank chamber 23 of the crankcase 21. The valve 41 would normally be in the fitting (not shown) between the conduit 30 and lower crank chamber 23.

While the present invention has shown and described the engine 10 as having only two cylinders, it should be understood that the engine 10 may have any number of cylinders. It is only necessary that the third passage 37 in the fitting 31 communicate with the transfer passage of the cylinder which fires 180° from the cylinder from which the oil is being removed.

While the present invention has shown and described the cylinders of the engine 10 as being horizontally disposed, it should be understood that such is not a requisite for satisfactory operation of the present invention. Thus, the cylinders could be vertically disposed. In such an arrangement, it would be desirable to have the crankcase 21 arranged so that the drainage will collect in one of the crank chambers and have the passage 34 in the conduit 30 communicate therewith. This will enable the drainage to be collected and removed from the crankcase.

While the present invention has shown and described the drainage as being supplied to the upper bearing 25, it should be understood that it could by supplied to an intermediate bearing or to more than one bearing, particularly where there are a number of cylinders connected to the crankshaft. Thus, the present invention may be utilized to lubricate any bearing, other than the lowermost bearing, of a two-cycle internal combustion engine.

An advantage of this invention is that it eliminates overboard drainage of an outboard motor. Another advantage of this invention is that it adds further assurance that an outboard motor does not affect the environment in which it is operating. A further advantage of this invention is that it increases the efficiency and performance for the engine since there is more complete combustion.

For purposes of exemplification, a particular embodiment of the invention has been shown and described according to the best present understanding thereof. However, it will be apparent that changes and modifications in the arrangement and construction of the parts thereof may be resorted to without departing from the spirit and scope of the invention.

What is claimed is:

1. In a two cycle engine having a plurality of cylinders and utilizing crank case compression, means for recirculating the residual oil and gas mixture accumulating in the crank case thereof, comprising;

a first line communicating with a bottom portion of the engine crank case where the residuals puddle,

a second line connected to said first line and communicating with a transfer passage of one of the cylinders of the engine, and

a third line connected to one of said first and second lines and communicating with the upper main bearing of the engine,

the minimum cross-sectional area occurring within said third line being sufficiently smaller than the minimum cross-sectional area occurring within said first and second lines, so that substantially all of the residuals are recirculated into the transfer passage of said one cylinder at idle, and substantially all of said residuals are recirculated to said upper main bearing at high engine rpm.

2. The device of claim **1** wherein said second line communicates with the transfer passage of a cylinder other than the one associated with that portion of the crank case from which the residuals are taken.

3. In a two cycle engine having a plurality of cylinders and utilizing crank case compression, means for recirculating the residual oil and gas mixture accumulating in the crank case thereof, comprising;

a first line communicating with a bottom portion of the engine crank case where the residuals puddle,

a second line communicating with said first line and a fuel-air input to one of the cylinders of the engine, and

a third line communicating with said first line and a main bearing of the engine,

and flow dividing means in series with said first, second and third lines for directing substantially all of the recirculated residuals to the fuel-air input at low engine rpm and for directing substantially all of the recirculated residuals to said bearing at high engine rpm,

said flow dividing means comprises a T-shaped fitting the extremities of which are connected to said three lines and

wherein that portion of said fitting connected to said third line is substantially smaller than those portions connected to said first and second lines.

4. The device of claim **3** further including a check valve in said first line to prevent flow into said crank case.

5. In a two cycle engine utilizing crank case compression, having at least two cylinders and means for introducing a fuel-air mixture into each of said cylinders, means for recirculating the residual oil and gas mixture accumulating in the crank case thereof, comprising;

a first line communicating with a bottom portion of the crank case of one of said cylinders at a point where said residuals tend to puddle and the fuel-air input means to a second of said cylinder,

a second line communicating with said bottom portion of the crank case of said one cylinder and a main bearing housing of said engine, and means to prevent back flow of the residuals from said lines into the crank case, the minimum cross-sectional area occurring in said second line being substantially smaller than the minimum cross-sectional area occurring in said first line,

whereby substantially all of the residuals are drawn into said fuel-air mixture input means by the low pressure therein at idle, and substantially all of said residuals are pumped to said bearing at high rpm by the high pressure in said crank case.

6. The device of claim **5** wherein said first and second lines communicate with said crank case through a common opening therein.

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