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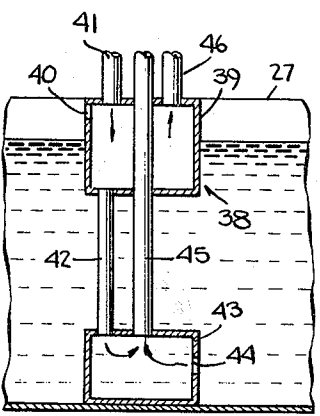
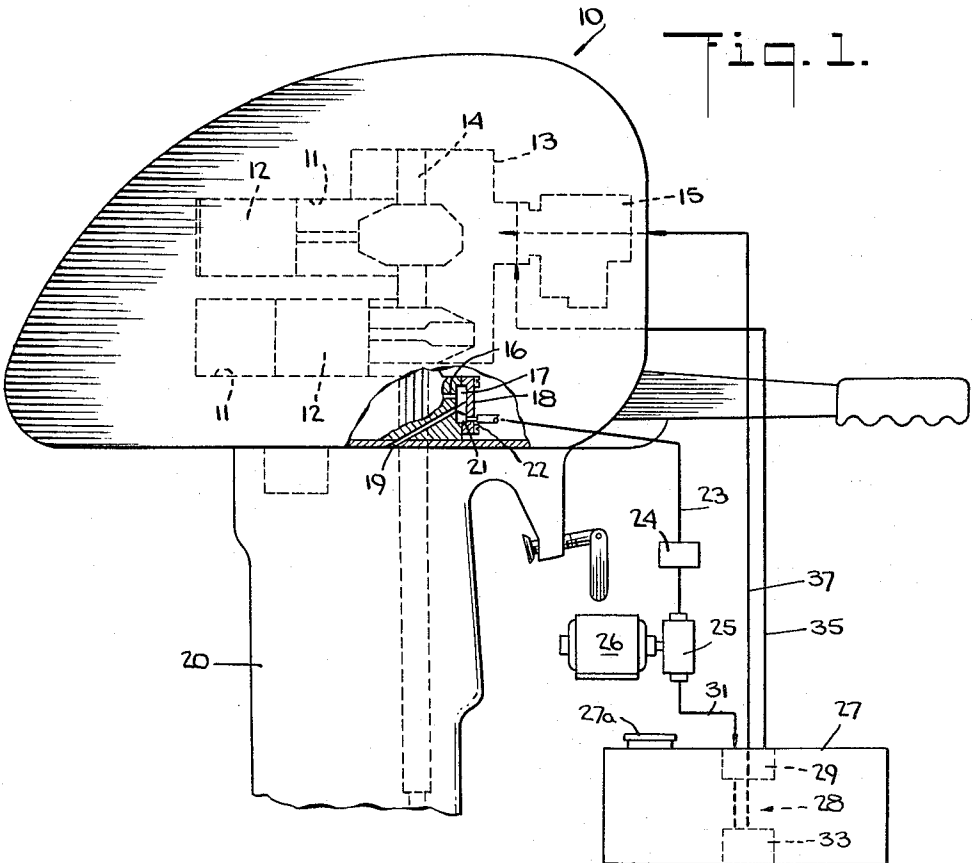


Fig. 2.

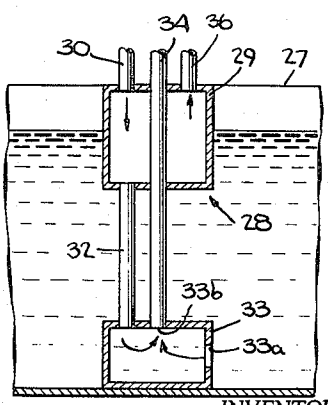


Fig. 3.

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APPARATUS AND METHOD FOR INTRODUCING ENGINE DRAINAGE INTO THE FUEL SYSTEM

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This invention relates to the fuel system of an internal combustion engine and more particularly to apparatus for introducing drainage recovered from the engine crankcase into the fuel system during operation.

In certain internal combustion engines such as a two-stroke cycle engine, the crankcase serves as a portion of the engine induction system. There the fuel air mixture from the carburetor passes through a valving arrangement into the crankcase and subsequently through an intake port into the engine cylinder. The outward stroke of the piston creates a suction condition which causes the flow of the fuel air mixture through a pressure responsive valve into the crankcase. The mixture within the crankcase is pressurized by the inward stroke of the piston so that the mixture flows into the cylinder through the intake port whenever it is exposed by the piston. Thus the crankcase serves as an intermediate portion of the induction system between the valve arrangement and the cylinder.

During starting of the engine as well as during operation, portions of the vapor in the fuel air mixture are condensed during passage through the crankcase and accumulate therein. Unsuccessful attempts at starting and excessive choking of the carburetor can add to the accumulation of condensed vapor within the crankcase. In the case of the two-stroke cycle engine where the crankcase serves as a portion of the induction system it is common practice to include the lubricating oil into the fuel supply since the fuel air mixture containing the oil contacts the various operating portions of the engine adjacent the crankcase as well as the cylinder. With lubricating oil included in the fuel it is evident that the condensate within the crankcase includes both fuel and lubricating oil.

It is undesirable to have an accumulation of liquid fuel and oil within the crankcase since the liquid can enter a cylinder and become trapped during the outward stroke of the piston. The trapping of sufficient liquid between the piston and the cylinder head results in "hydraulic-lock" which can be destructive to the engine due to the incompressible nature of the liquid. Furthermore, an accumulation of liquid within the crankcase can vary the fuel air ratio of the mixture being delivered to the cylinder with the result that faulty operation can occur. An excessive quantity of liquid can also promote spark plug fouling.

To eliminate the accumulation of liquid fuel and lubricating oil within a crankcase of two-stroke cycle engines, drain arrangements have been customarily provided which vent the liquid from the crankcase and release it from the engine commonly by way of the exhaust system. Thus valves responsive to the fluctuating pressure within the crankcase have been employed to release the drainage liquid. It can immediately be seen that venting the liquid directly from the engine is an inefficient practice since the liquid is composed of fuel and lubricating oil which would normally be consumed by passing through the engine cylinder. It can also be seen that the venting of the liquid into the exhaust system can serve as the source of obnoxious fumes and vapors as the liquid is swept from the engine along the hot exhaust gas. In the case of outboard motors for boats where the two-stroke cycle is the standard type used, the venting of the liquid

directly overboard or through the exhaust system which passes underwater can cause the contamination of the body of water upon which the boat is operated.

In my co-pending application, Serial No. 167,238 filed January 19, 1962, now Patent 3,128,748, and entitled "Apparatus and Method for Recovering Engine Drainage" there is shown a system for delivering the fuel and oil drainage from the engine to the fuel tank of the engine fuel system. In my co-pending application, Serial No. 180,593, filed March 19, 1962, now abandoned, and entitled "Apparatus and Method for Pumping Engine Drainage" there is shown a system in which a pump delivers the drainage from the engine to the fuel tank of the fuel system. Since the lubricating oil mixed with the fuel is much less volatile than the fuel, it can be understood that the proportion of the oil in the drainage recovered from the crankcase greatly exceeds the proportion of the oil in the fuel that is normally delivered to the fuel system. Thus the ratio of oil to fuel in the drainage is much higher than that of the fuel mixture recommended by the engine manufacturer.

Experience has shown that during the operation of an engine having the drainage recovery provisions of my co-pending patent applications, there is a tendency for the drainage to enter the fuel tank and to accumulate along its bottom portion since this oil-rich drainage is denser than the normal fuel-oil mixture within the fuel tank. Due to the efficient operation of the drainage recovery system an appreciable quantity of drainage is returned to the fuel tank in view of the quantity of fuel and lubricating oil consumed. Since the recovered liquid tends to accumulate in the bottom portion of the fuel tank it is evident that the liquid will gradually fill the tank unless it is disbursed within the remainder of the liquid within the tank. If an accumulation of the recovered liquid occurs to the extent that it fills a portion of the tank it is possible for the oil-rich drainage to be transferred directly to the carburetor for combustion within the engine. If this occurs the oil-rich mixture can cause inefficient operation since the excess oil can foul the spark plugs. In addition operation with an excess of lubricating oil can cause an undue accumulation of deposit within the cylinder and at the piston. Besides affecting the operation of the engine, excessive amounts of oil in the mixture can produce an undesirable smoke condition at the engine exhaust.

In addition operation with the drainage recovery provisions of the cited patent applications has shown that a certain portion of the vapor recovered from the crankcase can escape even though the drainage is initially delivered to the fuel system. The presence of the volume of vapor in the recovered drainage also can interfere with fuel systems which are normally sealed from the atmosphere, since in such a system the delivery of the vapor can cause an excessive pressure build-up.

The principal object of the invention is to distribute the drainage recovered from the engine into the fuel and oil mixture being delivered to the engine.

Another object of the invention is to meter the drainage recovered from the engine into the fuel-oil mixture being delivered to the engine at a rate which precludes the accumulation of the drainage within the fuel system.

Still another object of the invention is to condense at least a portion of the vapor in the drainage system in order that it can be delivered as condensate to the fuel system.

A further object of the invention is to condense and deliver at least a portion of the vapor of the drainage system into the fuel system and to return any remaining portion of the vapor to the engine for combustion therein.

Still a further object of the invention is to provide a sealed fuel system in which the drainage is distributed into the fuel-oil mixture being delivered to the engine and in

which the uncondensed vapor from the drainage system is delivered to the engine for combustion therein.

In one embodiment of the invention, there is provided a chamber having an inlet and an outlet through which the fuel-oil mixture is adapted to flow. Means are provided for delivering a liquid such as drainage from the engine into the chamber at a point adjacent the path of flow therein so that the drainage is distributed into the fuel-oil mixture passing through the chamber.

In another embodiment of the invention, the chamber having inlet and outlet openings is adapted to have at least one of the openings in communication with the interior portion of the fuel-oil mixture container.

In still another embodiment of the invention there is provided a chamber which is adapted to receive drainage liquid and vapor from an engine. Means are provided within the chamber for condensing at least a portion of the vapor. The device also includes an additional chamber having an inlet and an outlet through which a fuel-oil mixture is adapted to flow. Means are provided for delivering liquid including the condensed vapor from the condensing means to the additional chamber adjacent the path of flow therein in order that one liquid be distributed into the other.

In an additional embodiment of the invention means are provided for delivering the uncondensed vapor to the engine induction system.

The various objects and features of the invention will be apparent from the following description and claims and the accompanying drawings in which:

FIG. 1 is a schematic representation of an outboard motor in which the drainage recovered from the engine is distributed into the fuel-oil mixture;

FIG. 2 is a fragmentary section view of the device for distributing drainage into the fuel-oil mixture; and

FIG. 3 is a fragmentary section view showing the upper chamber of the device leading to the fuel tank.

Referring now to the drawings, FIG. 1 shows a two-stroke cycle outboard motor 10 comprising cylinders 11 in which reciprocate pistons 12. The cylinders extend from crankcase 13 which contains crankshaft 14. The fuel air mixture is delivered to the crankcase by means of carburetor 15.

The outboard motor can be provided with any of the various drainage recovery provisions set forth in my copending applications. Thus as is shown in FIG. 1 drainage from the crankcase can flow through passage 16 into cavity 17 which is provided with cover 18. Conventional drainage passage 19 which would otherwise release the drainage liquid to the exhaust system within housing 20 is blocked by plug 21 extending from cover 18. With this arrangement the drainage liquid entering into the cavity flows through discharge passage 22 and then into drainage line 23. After passing through filter 24 the drainage liquid is delivered by pump 25 actuated by motor 26 toward fuel tank 27.

Distributing unit 28 for metering the liquid from the drainage system into the fuel-oil mixture to be delivered to carburetor 15 is shown in FIGS. 1 and 2 disposed within fuel tank 27. The unit includes upper chamber 29 having pipe 30 which is adapted to be connected to line 31 extending from pump 25. Pipe 30 which opens into the interior of upper chamber 29 enables the chamber to receive the liquid and vapor recovered by the drainage system and directed to the unit by means of pump 25. The vapor passing into upper chamber 29 strikes the interior walls thereof and at least in part condenses within the chamber into liquid form. The condensed vapor as well as the recovered liquid then pass downwardly through pipe 32 to lower chamber 33. Pipe 34 extending upwardly from lower chamber 33 is connected to line 35 which leads to carburetor 15.

Lower chamber 33 includes inlet 33a which communicates to the interior of tank 27. After passing through the inlet the fuel from tank 27 flows through the lower cham-

ber and into pipe 34 on its way to carburetor 15. Pipe 32 entering the lower chamber adjacent pipe 34 enables the drainage liquid from pipe 32 to enter adjacent the path of the flow of liquid passing into outlet 33b and onto pipe 34. Thus it can be seen that the liquid received from the drainage system by the lower chamber is distributed or metered into the liquid passing from the outlet of the lower chamber. Due to the confines of the lower chamber, it is evident that the drainage from pipe 32 must of necessity leave the chamber with the flow passing through outlet 33b so that no accumulation of the drainage can occur. It can also be seen that the lower chamber prevents the drainage from indiscriminately settling into tank 27 and thereby accumulating along its bottom portion.

Vapor which fails to condense within upper chamber 29 is delivered by vapor pipe 36 to line 37 which is connected to a suction region of the induction system such as between the carburetor and the crankcase. Thus the suction of the induction system removes the uncondensed vapors from the upper chamber as they accumulate and delivers the vapors for combustion within the cylinders. With the provision of vapor pipe 36 and vapor line 37 connected to a suction region of the induction system, tank 27 can be sealed with cap 27a closing the opening through which the fuel-oil mixture is inserted into the tank.

Whenever the drainage system of the engine is capable of delivering the drainage effectively without the need of drainage pump 25, pipe 30 and line 31 are connected directly to discharge passage 22. Where the amount of uncondensed vapor is negligible, vapor pipe 36 can be vented to the atmosphere if the tank is to remain sealed or in the case where the tank is vented such as by an opening in cap 27a, vapor pipe 36 can be conditioned to communicate with the interior portion of the tank above the fuel-oil mixture level.

As shown in FIG. 3 the fuel system can be sealed with respect to the engine. In the sealed system distributing unit 38 is provided with upper chamber 39 containing vent opening 40. Pipe 41 delivers the drainage liquid and vapor to the upper chamber where a portion of the vapor can condense and pass with the drainage liquid through pipe 42 into lower chamber 43. Due to the provision of vent opening 40 vapor can pass into the interior portion of tank 27 above the fuel-lubricating oil mixture. The mixture flowing to the engine enters the lower chamber through inlet 44 and passes onto pipe 45 as the drainage liquid is entrained therein. Pipe 46 which is connected to a suction region in the induction system of the engine carries off the uncondensed vapor from the upper chamber as well as the interior of the tank. Thus unit 38 enables the entire fuel system to be sealed and enables the engine to be operated without loss of vapor or undesirable increases in pressure in the fuel system.

It is to be understood that unit 28 can be incorporated as an integral part of a tank or may comprise a separate assembly which is either connected to the interior of the tank at its inlet 33a or which is adapted to be installed into an existing tank by insertion through the filler opening which is covered by cap 27a.

While the invention has been described in some detail it is to be understood that certain changes in the arrangement and fabrication of parts can be employed without departing from the spirit and scope of the invention except as set forth in the appended claims.

What is claimed is:

1. In an internal combustion engine having an induction system for delivering a working charge of air to the engine, said induction system receiving fuel and lubricating oil drainage during operation, and a fuel system for delivering a fuel and lubricating oil mixture from a supply thereof to the engine for combustion therein, the combination of a device for distributing the drainage from the induction system to the mixture being delivered by the fuel system to the engine comprising structure forming a chamber adapted to be serially connected to the fuel sys-

5

tem, said chamber forming a flow passage having an inlet and outlet through which the mixture is adapted to flow, and means connected to said chamber for delivering the drainage from the induction system to said chamber adjacent to the path of flow therein, whereby the drainage is distributed to the mixture as it flows through said chamber.

2. In an internal combustion engine having an induction system for delivering a working charge of air to the engine, said induction system receiving fuel and lubricating oil drainage and the vapor thereof during operation, and a fuel system for delivering a fuel and lubricating oil mixture from a supply thereof to the engine for combustion therein, the combination of a device for distributing the drainage from the induction system to the mixture being delivered by the fuel system to the engine comprising structure forming a chamber adapted to be serially connected to the fuel system, said chamber forming a flow passage having an inlet and outlet through which the mixture is adapted to flow, means connected to said chamber for delivering the drainage and the vapor thereof from the induction system toward said chamber adjacent to the path of flow therein, and means for condensing the vapor within said delivering means, whereby the drainage and the condensed vapor thereof is distributed to the mixture as it flows through said chamber.

3. In an internal combustion engine having an induction system for delivering a working charge of air to the engine, said induction system receiving fuel and lubricating oil drainage during operation, and a fuel system for delivering a fuel and lubricating oil mixture from a container therefor to the engine for combustion therein, the combination of a device for distributing the drainage from the induction system to the mixture being delivered by the fuel system to the engine comprising structure forming a chamber adapted to be serially connected to the fuel system and adapted to be disposed within the interior of the container, said chamber forming a flow passage having an inlet and outlet opening through which the mixture is adapted to flow, said inlet opening being in communication with the interior of the container, and means connected to said chamber for delivering the drainage from the induction system to said chamber adjacent to the path of flow therein from said inlet opening to said outlet opening, whereby the drainage is distributed to the mixture as it flows through said chamber.

4. In an internal combustion engine having an induction system for delivering a working charge of air to the engine, said induction system receiving fuel and lubricating oil drainage and the vapor thereof during operation, and a fuel system for delivering a fuel and lubricating oil mixture from a supply thereof to the engine for combustion therein, the combination of a device for distributing the drainage from the induction system to the mixture being delivered by the fuel system to the engine comprising structure forming a chamber adapted to be connected to the induction system to receive the drainage and vapor therefrom, said chamber being adapted to condense at least a portion of the vapor, structure forming an additional chamber adapted to be serially connected to the fuel system, said additional chamber forming a flow passage having an inlet and outlet through which the mixture is adapted to flow along a substantially predetermined path, and means connected to said chamber for delivering the drainage and the condensed vapor thereof to said additional chamber adjacent to the path of flow therein, whereby the drainage and condensed vapor thereof is distributed to the mixture as it flows through said additional chamber.

5. In an internal combustion engine having an induction system for delivering a working charge of air to the engine, said induction system receiving fuel and lubricating oil drainage and the vapor thereof during operation, and a fuel system for delivering a fuel and lubricating oil mixture from a supply thereof to the engine for combus-

6

tion therein, the combination of a device for distributing the drainage from the induction system to the mixture being delivered by the fuel system to the engine comprising structure forming a chamber adapted to be connected to the induction system to receive the drainage and vapor therefrom, means within said chamber for condensing at least a portion of the vapor, structure forming an additional chamber adapted to be serially connected to the fuel system, said additional chamber forming a flow passage having an inlet and outlet through which the mixture is adapted to flow along a substantially predetermined path, means connected to said chamber for delivering the drainage and the condensed vapor thereof to said additional chamber adjacent to the path of flow therein, and additional means connected to said chamber for delivering the uncondensed portion of said vapor from said chamber to the induction system for combustion within the engine, whereby the drainage and condensed vapor thereof is distributed to the mixture as it flows through said additional chamber.

6. In an internal combustion engine having an induction system for delivering a working charge of air to the engine, said induction system receiving fuel and lubricating oil drainage and the vapor thereof during operation, and a fuel system for delivering a fuel and lubricating oil mixture from a supply thereof to the engine for combustion therein, the combination of a device for distributing the drainage from the induction system to the mixture being delivered by the fuel system to the engine comprising structure forming a chamber adapted to be connected to the induction system to receive the drainage and vapor therefrom, means within said chamber for condensing at least a portion of the vapor, structure forming an additional chamber adapted to be serially connected to the fuel system, said additional chamber forming a flow passage having an inlet and outlet through which the mixture is adapted to flow along a substantially predetermined path, means connected to said chamber for delivering the drainage and the condensed vapor thereof to said additional chamber adjacent to the path of flow therein, and means connected to said chamber for venting the uncondensed portion of said vapor from said chamber, whereby the drainage and condensed vapor thereof is distributed to the mixture as it flows through said additional chamber.

7. In an internal combustion engine having an induction system for delivering a working charge of air to the engine, said induction system receiving fuel and lubricating oil drainage and the vapor thereof during operation, and a fuel system for delivering a fuel and lubricating oil mixture from a container therefor to the engine for combustion therein, the combination of a device for distributing the drainage from the induction system to the mixture being delivered by the fuel system to the engine comprising structure forming a chamber adapted to be serially connected to the fuel system, said chamber forming a flow passage having an inlet connected to the interior of the container and an outlet connected to the engine, the mixture adapted to flow through the flow passage, means connected to said chamber for delivering the drainage and the vapor thereof from the induction system to said chamber adjacent to the path of flow therein, and additional means connected to said chamber for delivering the uncondensed vapor of said drainage to the interior of said container, whereby the drainage is distributed to the mixture as it flows through said chamber.

8. In an internal combustion engine having an induction system for delivering a working charge of air to the engine, said induction system receiving fuel and lubricating oil drainage and the vapor thereof during operation, and a fuel system for delivering a fuel and lubricating oil mixture from a container therefor to the engine for combustion therein, the combination of a device for distributing the drainage from the induction system to

the mixture being delivered by the fuel system to the engine comprising structure forming a chamber adapted to be disposed within the interior of said container and adapted to be serially connected to the fuel system, said chamber forming a flow passage having an inlet for communication with the interior of said container and an outlet, the mixture being adapted to flow through the flow passage, means connected to said chamber for delivering the drainage and the vapor thereof from the induction system to said chamber adjacent to the path of flow therein, said chamber having a vent adapted for communication with the upper interior portion of said tank which extends above the mixture therein, and means connected to said chamber for delivering the uncondensed vapor of the drainage from said chamber to the induction system for combustion within the engine, whereby the drainage is distributed to the mixture as it flows through said chamber.

9. The method of distributing fuel and lubricating oil drainage fluid from the induction system of an engine, the drainage fluid containing liquid and condensed vapor, the induction system being adapted to deliver a working charge of air to the engine, the engine having a fuel system for delivering a fuel and lubricating oil mixture from a container therefor to the engine for combustion therein, the method comprising the steps of flowing a stream of the mixture through the fuel system toward the engine and delivering the liquid and the condensed

vapor of the drainage fluid into the stream of the mixture flowing in the fuel system.

10. The method of distributing fuel and lubricating oil drainage fluid from the induction system of an engine, the drainage fluid containing liquid and vapor, the induction system being adapted to deliver a working charge of air to the engine, the engine having a fuel system for delivering a fuel and lubricating oil mixture from a container therefor to the engine for combustion therein, the method comprising the steps of flowing the mixture through the fuel system from the container toward the engine, condensing at least a portion of the vapor of the drainage fluid, delivering the condensed vapor and the liquid of the drainage fluid from the induction system into the mixture flowing in the fuel system toward the engine.

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