United States Patent

[11] 3,528,395

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[54] **APPARATUS AND METHOD FOR MIXING ENGINE DRAINAGE INTO THE FUEL FLOW TO AN ENGINE**
12 Claims, 3 Drawing Figs.

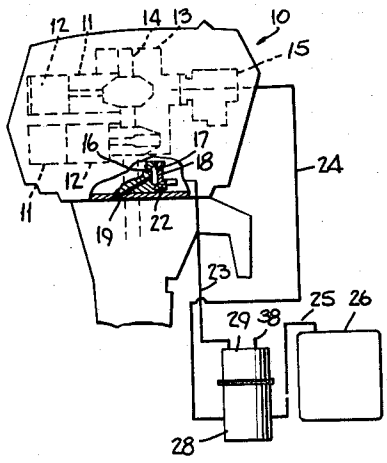
[52] **U.S. Cl.** **123/73**
[51] **Int. Cl.** **F02b 33/04**
[50] **Field of Search** 123/73, 73A, 73A3

[56] **References Cited**
UNITED STATES PATENTS

3,128,748	4/1964	Goggi	123/73
3,132,635	5/1964	Heidner	123/73
3,170,449	2/1965	Goggi	123/73

Primary Examiner—Wendell E. Burns
Attorney—Kenyon and Kenyon

ABSTRACT: Apparatus and method for use associated with an internal combustion engine whereby drainage of fuel, vapor and oil drainage from the crankcase thereof is recovered and introduced in a metered fashion into the principal fuel line of the engine. A dual-chambered device is employed, one chamber connected to the crankcase for accumulating drainage, the other serving as a mixing chamber connected in series with the principal fuel line, whereby fuel from the principal fuel supply is mixed in the mixing chamber with drainage, which is metered into the mixing chamber from the accumulating chamber.



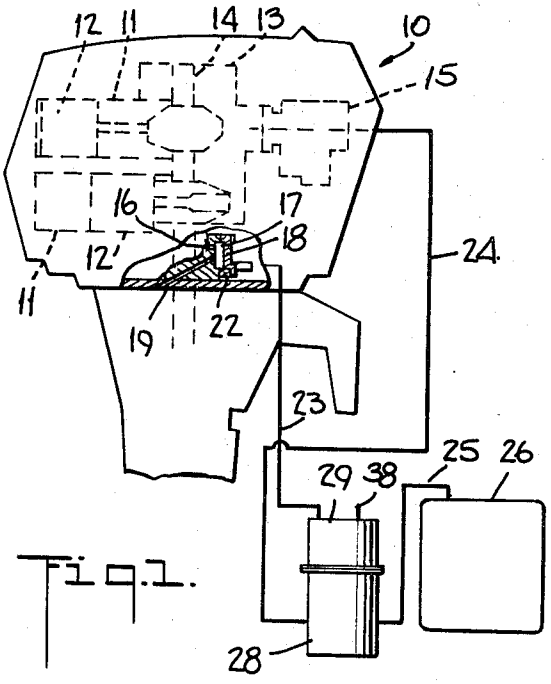


Fig. 1.

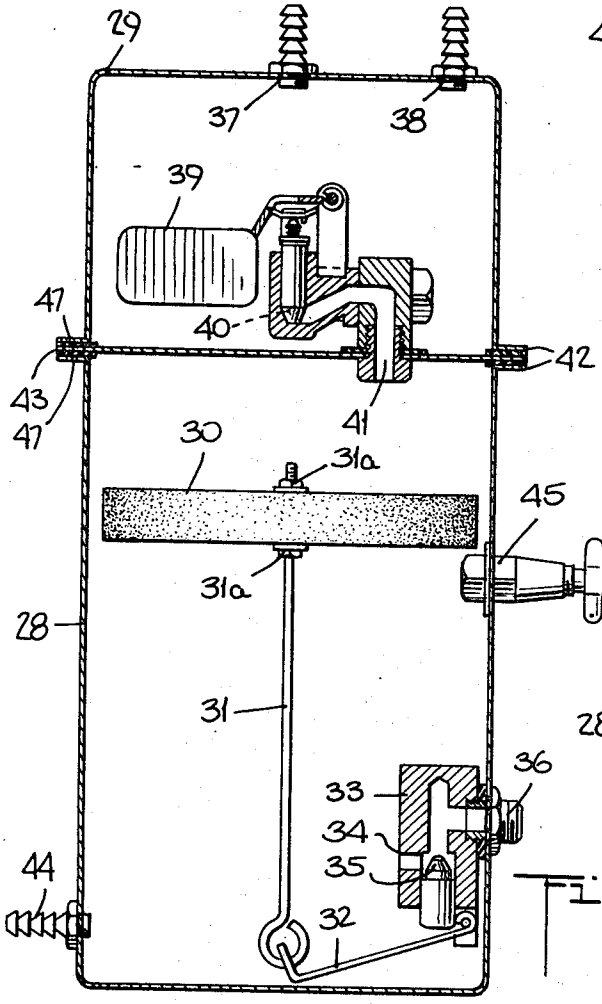


Fig. 2.

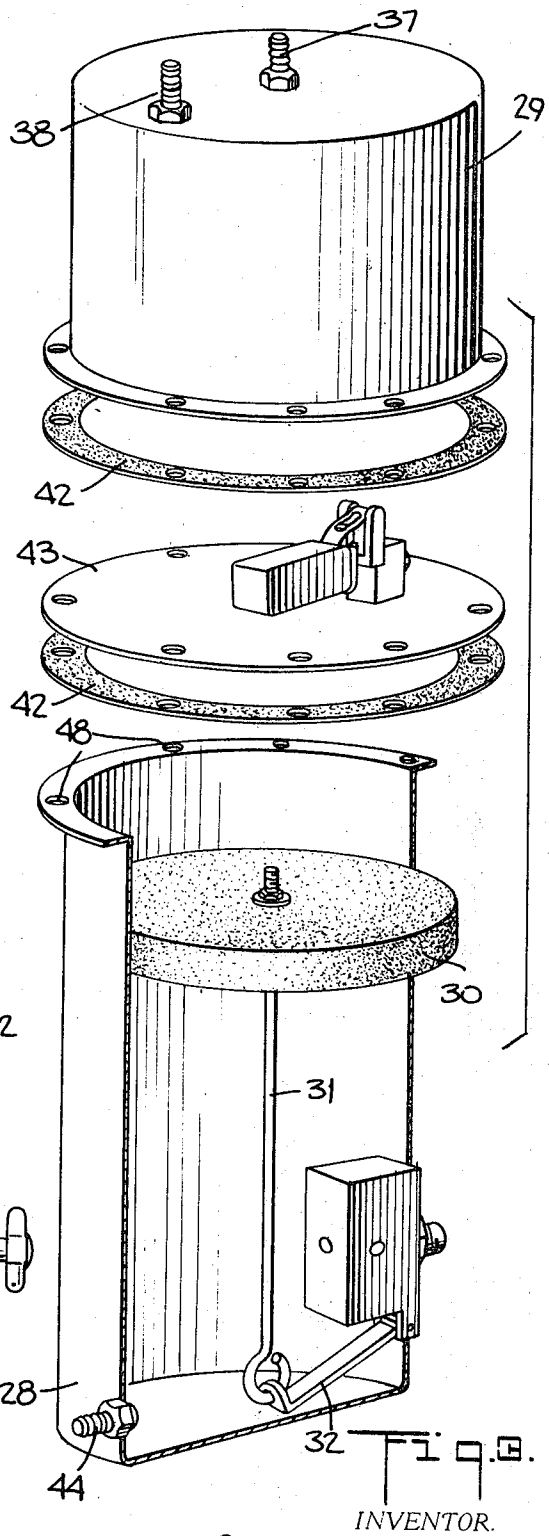


Fig. 3.

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APPARATUS AND METHOD FOR MIXING ENGINE DRAINAGE INTO THE FUEL FLOW TO AN ENGINE

CROSS-REFERENCES

The subject matter of this invention pertains generally to the matter discussed in my issued U.S. Pat. Nos. 3,128,748 "Apparatus and Method for Recovering Engine Drainage", issued on April 14, 1964, and 3,170,449, "Apparatus and Method for Introducing Drainage into the Fuel System", issued on February 23, 1965.

BACKGROUND

This invention is concerned with the art of supplying fuel to internal combustion engines. It is more particularly concerned with removing drainage of fuel and oil from the crankcase of the engine and mixing it with fuel from the main fuel supply tank enroute to the intake manifold.

In certain internal combustion engines, such as the two-stroke cycle engine, the crankcase serves as a portion of the engine induction system. There the fuel and air mixture from the carburetor passes through a valving arrangement into the crankcase and subsequently through an intake port to the engine cylinder. The outward stroke of the piston creates a suction condition which causes 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 the starting of the engine, as well as during its 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 in 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, for lubrication purposes, to include the lubricating oil in the fuel supply since the fuel and 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 there during the outward stroke of such piston. If sufficient quantities of liquid become trapped in this way between the piston and the cylinder head, "hydraulic lock" will result. This hydraulic lock can be highly destructive to the engine parts due to the incompressible nature of the liquid. Additionally, an accumulation of liquid within the crankcase can vary the fuel-air ratio of the mixture being delivered to the cylinder. This phenomenon can cause faulty operation. Among the difficulties that can arise therefrom are spark-plug fouling, and extremely difficult starting.

To eliminate the accumulation of liquid fuel and lubricating oil in the crankcase of two-stroke cycle engines, drain arrangements have been customarily provided in the crankcase. These drains vent the liquid from the crankcase and release it altogether from the engine. The common way of such release is by means of the exhaust system. A common valving arrangement is to provide valves which are responsive to the fluctuating pressure within the crankcase.

It is obvious that venting this liquid directly from the engine is an inefficient practice, because the liquid is composed of fuel and lubricating oil, *i.e.*, the ingredients of the normal fuel mixture, which, if recovered, can be consumed by the engine. It is equally clear that venting the liquid into the exhaust system causes the escape of unpleasant fumes and vapors as the liquid is swept from the engine along with hot exhaust gas. In addition, their escape in sufficient volume can constitute a significant fire and explosion hazard.

In the case of outboard motors for boats, where the two-stroke cycle is the standard type of engine used, the venting of the liquid directly overboard through the exhaust system which passes underwater can cause contamination of the water upon which the boat is operated.

In one of my previous inventions, now U.S. Pat. No. 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 crankcase to the fuel tank of the engine fuel system. This can be done by utilization of gravity only, or by means of a pump. The latter idea is shown in my application Ser. No. 180,593, filed March 19, 1962, now abandoned and entitled "Apparatus and Method for Pumping Engine Drainage."

These systems, although alleviating the above-described difficulties, led to some complications. Since the lubricating oil mixed with the fuel is much less volatile than the fuel, the proportion of oil in drainage recovered from the crankcase significantly exceeds the proportion of oil in the fuel mixture that is normally delivered to the engine. Thus, the ratio of oil to fuel in the drainage is much higher than that of the fuel mixture recommended by fuel manufacturers.

Experience showed that during operation of an engine having the drainage recovery provisions of my above-described inventions, there is a tendency for the drainage to enter the fuel tank and accumulate near its bottom, since the oil-rich mixture is denser than the normal fuel and oil mixture within the fuel tank. Unless recovered drainage is well distributed within the mixture contained within the fuel tank, areas or "pockets" of liquid with excessive oil content will appear. When this excessively oil-rich mixture is drawn from the fuel tank into the carburetor and intake manifold, it causes an undue accumulation of deposits within the cylinders and on the pistons. This phenomenon also results in greatly shortened spark-plug life and an undesirable amount of smoke in the engine exhaust.

These difficulties were alleviated to some extent by the invention described in my U.S. Pat. No. 3,170,449, filed October 3, 1962 and entitled "Apparatus and Method for Introducing Engine Drainage Into the Fuel System." This invention embodies two separate chambers built into the fuel tank. An upper chamber, adapted to receive drainage from the engine, contains in its bottom a small orifice from which a pipe extends to a lower chamber or enclosure, near the bottom of the tank. Fuel from the tank is free to enter the lower chamber by means of a small opening provided therein. Thus, drainage and fuel is mixed in this lower chamber, from which the mixture is piped to the carburetor and intake manifold of the engine.

Trials indicated that the invention, while helpful in eliminating some of the disadvantages of previous inventions, did not wholly do away with the problems.

The utilization of the U.S. Pat. No. 3,170,449 invention requires either the purchase of a special fuel tank containing within its enclosure the chambers and pipes above described, or the modification of an existing fuel tank to provide for the installation of these chambers. Thus, the invention cannot be used in connection with all existing fuel tanks furnished by the manufacturer with each motor, without some rather expensive and bothersome modifications.

Furthermore, the mixing chamber into which drainage flows from the upper drainage chamber is not totally isolated from the principal supply of fuel and oil mixture contained within the tank. Some oil-rich drainage invariably escapes through the small vent or orifice in the mixing chamber, whence it is free to accumulate in the bottom of the fuel tank. This presents, to some degree, the same difficulty with accumulation of oil pockets as has taken place in the apparatus of my above-described U.S. Pat. No. 3,128,748. Also, the lower chamber is quite small. This is necessitated by its position inside the fuel tank. As a result, the oil fraction in the lower chamber can easily become too great, if the rate of drainage flow suddenly increases.

In my U.S. Pat. No. 3,170,449, the drainage is free to flow into the mixing chamber directly from the drainage chamber as fast as it accumulates therein. This immediacy of injection of the drainage into the fuel line causes wide variations in the oil content of the fuel going to the carburetor, such variation being dependent upon the motor operating speed. The reason for this is that a much greater fraction of the fuel and oil mixture entering the carburetor is accumulated as drainage in the crankcase when the engine runs at low speeds than when it runs at high speeds. At low speeds, when the total fuel being extracted by the engine from the principal fuel tank is relatively small, relatively large quantities of drainage accumulate, and are passed to the drainage chamber, from which point the drainage is passed directly into the fuel system. At high speeds, by contrast, the amount of fuel pulled from the tank and through the mixing chamber by the engine is considerably higher than at low speeds, and less of this mixture fails to combust within the cylinders. Thus, the ratio of oil to gasoline in the mixture drawn into the carburetor varies considerably with engine speed.

SUMMARY OF INVENTION

This invention consists of a single unit completely external to the fuel tank, this unit having two chambers, one atop the other and sharing a common surface. The bottom chamber is the mixing chamber of the device and has an inlet through a needle valve through which the fuel and oil mixture flows from the principal fuel tank. A float device, mechanically connected to the needle valve, serves to maintain the level of liquid within this mixing chamber within a predetermined range so that the chamber neither runs dry nor overflows. An outlet from this mixing chamber is connected to the main fuel line of the engine and runs to the carburetor.

On the top of the upper, or drainage, chamber is an inlet through which drainage is piped through a line or hose from the crankcase of the engine. The drainage chamber also has on its upper surface a small opening or vent for air to escape so that drainage may easily enter the chamber. A small aperture is provided, linking the two chambers through the common surface which serves as the bottom of the drainage chamber and the top of the mixing chamber. A needle valve with an associated float is provided at this aperture to govern the amount of drainage flowing through it into the mixing chamber.

When the drainage accumulated in the drainage chamber reaches a certain predetermined level, the needle valve is opened by the action of the float, allowing drainage to be slowly metered into the mixing chamber. In the mixing chamber, this slowly dispensed drainage is distributed throughout the accumulation of fuel and oil mixture already present there, the quantity of which fuel and oil mixture is kept relatively constant by the action of the mixing chamber float and its needle valve.

Thus, by means of a comparatively compact unit located entirely without the main fuel tank, the oil-rich drainage from the crankcase of the engine is slowly mixed with a relatively constant quantity of normal fuel and oil mixture from the principal fuel tank. This mixed liquid is then drawn by the engine from the outlet of the mixing chamber to the carburetor, and is consumed by the engine.

It is an object of this invention to provide a compact and inexpensive unit, external to the fuel tank, for the recovery of drainage from the crankcase of an internal combustion engine and for introducing this drainage in metered amounts into the primary fuel line, as the fuel undergoes flow adjacent to that of the drainage.

It is a further object of this invention to provide a device as described in the preceding paragraph which introduces drainage into the adjacently flowing fuel in such a manner that the ratio of fuel to oil remains basically independent of engine operating speed.

DESCRIPTION OF DRAWINGS

FIG. 1 is a schematic diagram of this invention employed in connection with an outboard motor.

FIG. 2 is a vertical cross-sectional view of a unit embodying this invention, showing the two chambers involved, and the associated valve and float systems with the appropriate inlets and outlets to and from said chambers.

FIG. 3 is a partially exploded, partially cross-sectional view of the unit embodying this invention, the cross-sectional view being of the lower or mixing chamber.

Referring to FIG. 1, this figure contains a schematic diagram of an outboard motor **10** having cylinders **11**, crankcase **13**, and pistons **12**. Fuel is introduced to carburetor **15** through fuel line **24** whence it is vaporized and eventually combusted; however, part of this fuel and oil mixture accumulates in the lower region of the crankcase, escaping through reed drain valve **16** into area **17**. If the engine is provided with passage **19** for carrying drainage out of the engine, such as into the exhaust system, passage **19** is blocked in accordance with my U.S. Pat. No. 3,128,748. This drainage is removed from enclosed area **17** by line **23** running to inlet **37** of drainage chamber **29**, at which point it enters the chamber.

Referring now to FIGS. **2** and **3**, the unit embodying the invention comprises two chambers; mixing chamber **28** and drainage chamber **29**. Through a wall in mixing chamber **28** is provided inlet **36** with its associated fittings. Needle valve assembly **33** is provided to govern the intake of fuel from fuel tank **26** through inlet **36** into mixing chamber **28**. The action of needle valve assembly **33** is governed by float **30**, provided within mixing chamber **28** and connected to the needle valve apparatus by nuts and bolts **31***a*, and mechanical linkages comprising rod **31** and lever **32**.

Mixing chamber **28** is provided with outlet **44** from which the principal fuel line **24** runs to the carburetor intake. Fuel has access to the mixing chamber by means of line **25** running from inlet **36** to fuel tank **26**.

The level of fuel and oil mixture in mixing chamber **28** is governed by the action of float **30** on needle valve assembly **33**. When the level of liquid in chamber **28** rises to a predetermined level, the float, rising with that level, actuates lever **32**, closing needle valve assembly **33** and preventing the further intake of fuel. Conversely, when fuel is drawn through outlet **44** from chamber **28**, the level of the fuel drops below the predetermined level and the float drops, thereby allowing more fuel to enter the chamber from the tank. Mixing chamber **28** is also provided with normally closed manually operated valve **45**, which can be opened to drain the chamber when desired, such as for flushing the system.

The walls of chambers **28** and **29** can be made of any suitable metal or plastic material. Aluminum has been found to be satisfactory. Chambers **28** and **29** are basically cylindrically shaped and made of separate single pieces of metal. Both pieces of metal comprising the walls of the two chambers have, around their open ends, flanges **42** extending outwardly therefrom. These flanges are provided with corresponding holes **48** spaces regularly around their edges. Thus, the two chambers can be connected, open ends facing, by means of screws or bolts and nuts.

Between the two chambers is interposed disc **43** containing around its edges holes corresponding to holes **48**. Disc **43** which can be fabricated from aluminum forms the bottom wall of drainage chamber **29** and the top surface of mixing chamber **28**. Upon assembly, gaskets **42** can be placed on either side of disc **43** so that the unit will not leak when it is fastened together.

Disc **43** is provided with opening **41** into which is fitted a commercially available needle valve assembly **40**. The action of needle valve assembly **40** is governed by float **39** attached thereto. When drainage enters drainage chamber **29** by means of drainage line **23** and inlet **37**, it accumulates at the bottom of chamber **29** until a predetermined level of drainage accu-

mulates. When the predetermined level of drainage is reached, float **39** is raised sufficiently to open needle valve assembly **40**. When this occurs, the opening of needle valve **40** allows accumulated drainage to flow slowly through opening **41** into mixing chamber **28**.

Valve assembly **40** serves an additional function. Most outboard engines today no longer use pressurized fuel tanks. Instead, they have pumps, which suck fuel from the tank. This requires that there be no air inlets on the fuel tank, lest the vacuum needed to pass fuel become inordinately high.

Drainage chamber **29**, as shown, necessarily possesses vent **38**. If valve **40** were open at all times, the needed vacuum would be broken when no drainage covered opening **41**. To prevent this, valve **40** and float **39** cooperate to close valve **40** and seal mixing chamber **28**, whenever no drainage is available to perform that function, *i.e.* when the drainage level drops below a predetermined level.

In operation, this device is installed upon or near the transom of the boat on which the associated engine is used. It is to be noted that this entire recovery unit is completely separate from the fuel tank itself and its utilization requires no modification of the principal fuel tank. Fuel from tank **26** enters mixing chamber **28** through inlet **36** until the level of fuel and oil mixture in mixing chamber **28** rises sufficiently that float **30**, by its mechanical linkage, closes valve assembly **33**. When the engine is started it draws fuel from mixing chamber **28** through line **24** to carburetor **15** by means of outlet **44**. When the fuel level in mixing chamber **28** drops sufficiently, float **30** allows needle valve **33** to admit added fuel mixture, raising the level of liquid in mixing chamber **28**.

When the engine is operating, a significant fraction of fuel entering the carburetor through line **24** fails to combust completely, and accumulates as drainage at the bottom of the crankcase from which it flows through line **23** and inlet **37** into drainage chamber **29**. There, drainage accumulates until it reaches a level sufficiently high so that valve assembly **40** is actuated by float **39**, allowing some of the drainage to flow slowly through opening **41** into mixing chamber **28**. In mixing chamber **28**, the oil-rich drainage is distributed into a relatively large quantity of normal fuel/oil mixture flowing through mixing chamber **28** from tank **26** to carburetor **15**. It should be noted that the drainage in this device does not flow directly and in unlimited quantity from mixing chamber **28** to drainage chamber **29**.

For reasons discussed above, the fraction of fuel mixture entering the carburetor which accumulates as drainage in the crankcase is much greater at low speeds than at high. In previous devices of this sort, therefore, the drainage to fuel mixture ratio in the mixing chamber **28** is much greater at low speeds than at high. This is undersirable for reasons discussed above. This problem is alleviated to an appreciable extent by this invention due to the fact that drainage chamber **29** serves to collect a small reservoir of drainage before allowing any of it to flow into the mixing chamber **28**. Thus, when the engine is operated for a short time initially at low speeds, the drainage does not immediately flow into the mixing chamber **28**, but is kept in the drainage chamber **29**. As long as the period of low speed operation is not unduly long, there will be no problem with excessive drainage entering the mixing chamber **28** at these low speeds. This drainage will be allowed to mix with the fuel and oil in mixing chamber **28** only after the engine has been run for some time, that is, after the engine has begun to be run at high speeds, when fuel runs through the mixing chamber **28** at a relatively high rate and thus serves to dilute the excessively oil-rich drainage.

In addition it should be noted that whenever drainage is released into mixing chamber **28**, there is a predetermined level of fuel in mixing chamber **28** and therefore a comparatively large volume of fuel to receive the drainage. As a result an excessively rich concentration of drainage oil is avoided in mixing chamber **28**.

It should also be noted that drainage chamber **29** also serves as a means for condensing fuel vapors which may be present with the drainage being passed from the crankcase of the engine. The reason for this is that the aluminum walls of the drainage chamber **29** are relatively cool as compared with the warm liquids and hot gases coming from the crankcase. This condensation of fuel vapor enhances the proportion of recovery of fuel by this device, thus increasing efficiency of the engine and fuel systems.

I claim:

1. A device for distributing drainage and the condensed vapor thereof from the induction system of an internal combustion engine to the fuel mixture delivered by a fuel system to the engine, said device comprising a mixing chamber having an inlet and an outlet passage, said mixing chamber being adapted to be connected in series with the fuel system, a drainage chamber adapted to receive drainage from the engine, means providing a passage for drainage between said mixing and drainage chambers, and first means for blocking said passage means upon there being less than a predetermined level of drainage in said drainage chamber and allowing the flow of drainage from said drainage chamber to said mixing chamber through said passage means upon there being more than a predetermined level of flow in said drainage chamber.

2. The device of claim **1**, in which said drainage chamber includes at least one wall portion thereof formed of material having a sufficiently high thermal conductivity to enable said wall portion to condense at least a portion of the vapor to the interior of said drainage chamber.

3. The device of claim **1** and further comprising means for maintaining a predetermined minimum volume of fuel mixture in said mixing chamber.

4. The device of claim **3** in which said means for maintaining a predetermined minimum volume of fuel mixture in said mixing chamber comprises further valve means for governing flow through said inlet passage of said mixing chamber into said mixing chamber, and float means being connected to said valve means and responsive to the volume of liquid in said mixing chamber for maintaining a predetermined minimum volume of fuel and oil mixture in said mixing chamber.

5. The device of claim **4**, in which said drainage chamber is mounted above and directly adjacent to said mixing chamber.

6. The device of claim **1**, in which said first means comprises a valve connected to said passage means and a float means responsive to a predetermined level of drainage in said drainage chamber for opening said valve, whereby said valve is opened, allows a flow of drainage through said passage means into said mixing chamber when the quantity of drainage in said drainage chamber exceeds a predetermined level, and whereby said valve is closed when the level of said drainage falls below said predetermined level in order to effect a substantially airtight seal between drainage and mixing chambers.

7. A device for distributing the drainage from the induction system of an internal combustion engine having a fuel supply system into the fuel mixture delivered to said engine by said fuel system comprising a mixing chamber serially connected in said fuel system, a drainage chamber adapted to receive the drainage from the induction system of an internal combustion engine, passage means connecting said chambers, and means for blocking flow of drainage through said passage means connecting said chambers upon less than a predetermined amount of drainage being in said drainage chamber.

8. The device of claim **7** and further comprising means for maintaining a predetermined quantity of fuel in said mixing chamber.

9. A device for distributing the drainage from the induction system of an internal combustion engine having a fuel supply system to the mixture being delivered by the fuel system to the engine comprising a mixing chamber serially connected in said fuel system, a drainage chamber, an aperture connecting the interior portions of said chambers, means for passing said drainage to said drainage chamber from said induction system, and metering means, including a valve and float, for enabling drainage to pass from said drainage chamber to said mixing

chamber when a predetermined quantity of drainage in said drainage chamber is exceeded, said metering means actively preventing passage of air from said drainage chamber to said mixing chamber when the amount of drainage chamber falls below a predetermined quantity.

10. A method of distributing drainage and the condensed vapor thereof from the induction system of an internal combustion engine to the fuel mixture delivered by a fuel system to the engine, said method comprising the steps of:

a. maintaining a reservoir of a substantially predetermined quantity of the fuel mixture being delivered by the fuel system to the engine;

b. transferring the drainage into the reservoir of a predetermined quantity of the fuel mixture upon there being detected an accumulation of at least a predetermined quantity of drainage from the induction system of the internal combustion engine and blocking the flow of drainage into the reservoir upon there being detected less than a predetermined quantity of drainage from the induction system of an internal combustion engine; and

c. delivering the combined fuel mixture and drainage to the engine.

11. A method in accordance with claim **10** in which the step of maintaining a reservoir of a predetermined quantity of the fuel mixture delivered by a fuel system to the engine comprises the maintaining of a substantially predetermined level of the fuel mixture in a chamber serially connected to the fuel system.

12. A method in accordance with claim **10** in which the step of transferring drainage into the reservoir of a predetermined quantity of fuel comprises the step of maintaining an additional reservoir of a predetermined quantity of drainage wherein the transferring of drainage into the reservoir includes directing drainage thereto from the additional reservoir upon there being more than the predetermined quantity of drainage detected in the additional reservoir.

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,528,395 Dated September 15, 1970

Inventor(s) CHARLES P. GOGGI

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 7, line 4, After "drainage" insert -- in said drainage --

Signed and sealed this 11th day of July 1972.

(SEAL)
Attest:

EDWARD M.FLETCHER, JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents

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