

[54] **ENGINE DRAINAGE REUSE SYSTEM**

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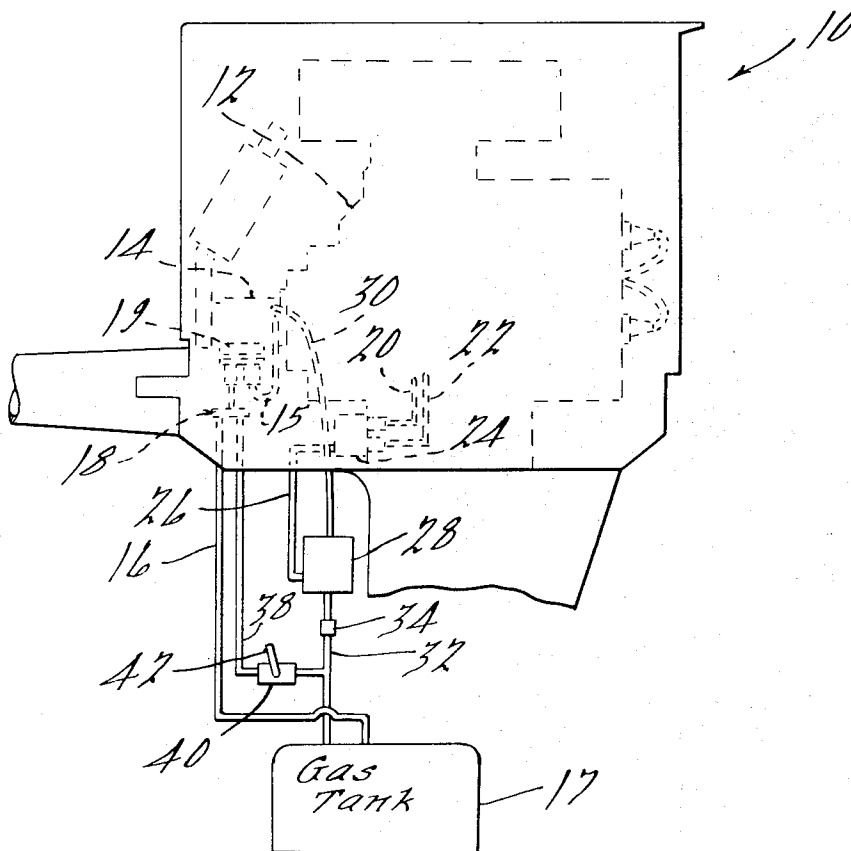
[57] **ABSTRACT**

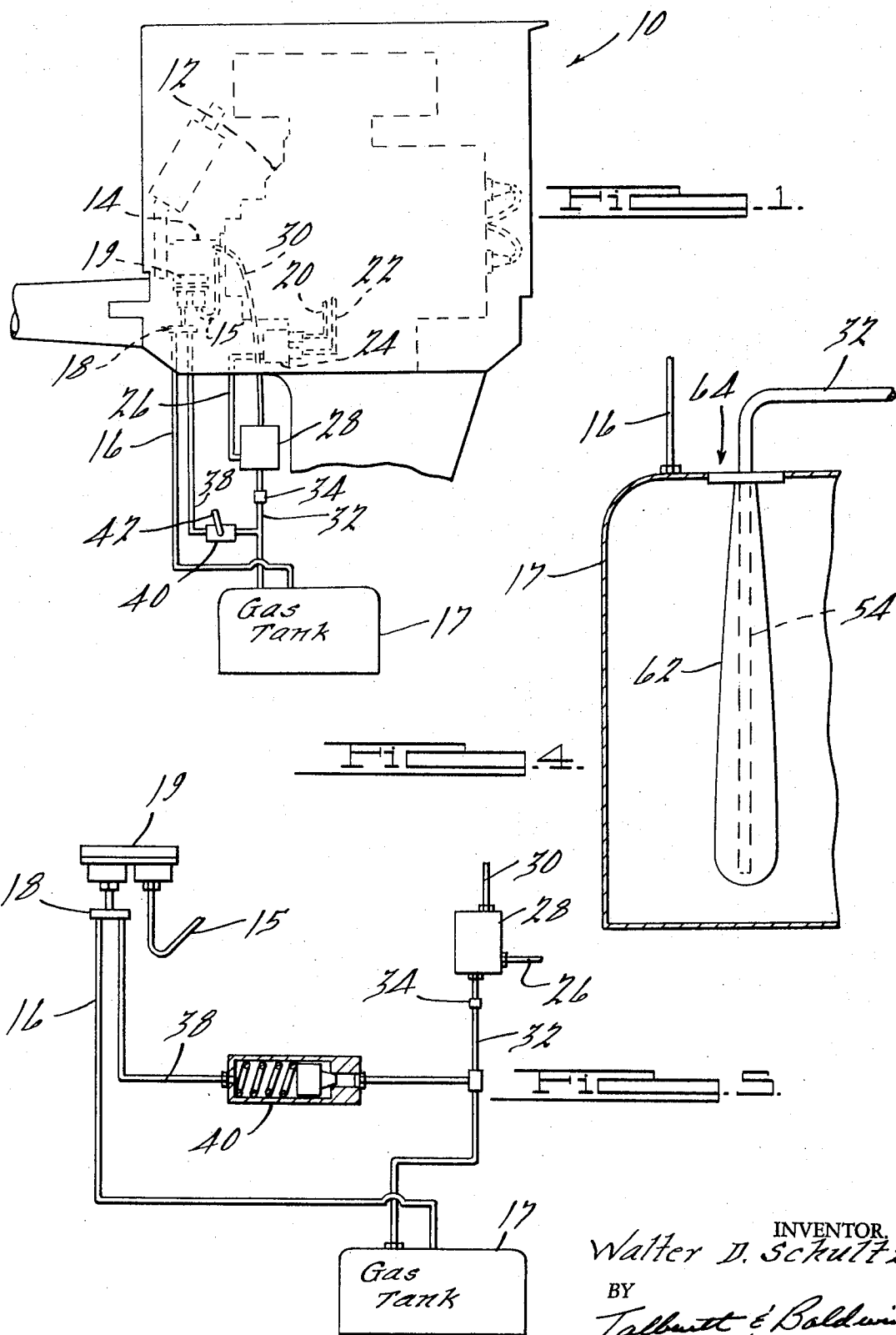
A puddle drainage reuse system, particularly for out-board engines, wherein a valve, closed at low engine speeds, is opened at higher engine speeds to allow puddle drainage to mix with the fresh fuel as it flows to the engine.

21 Claims, 5 Drawing Figures

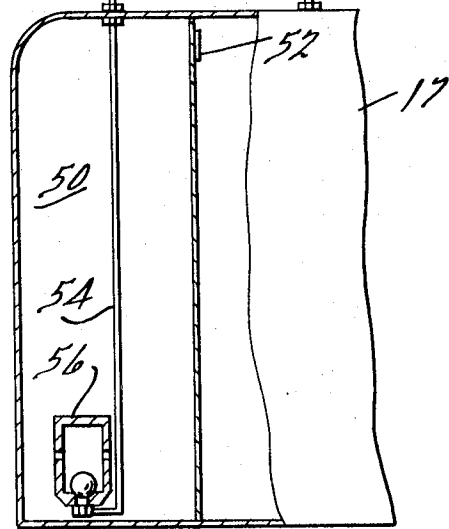
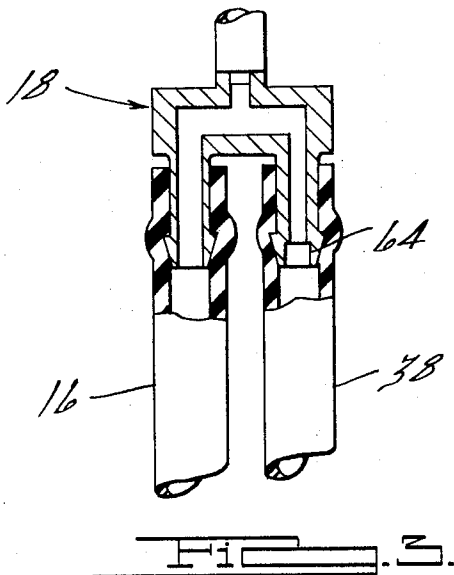
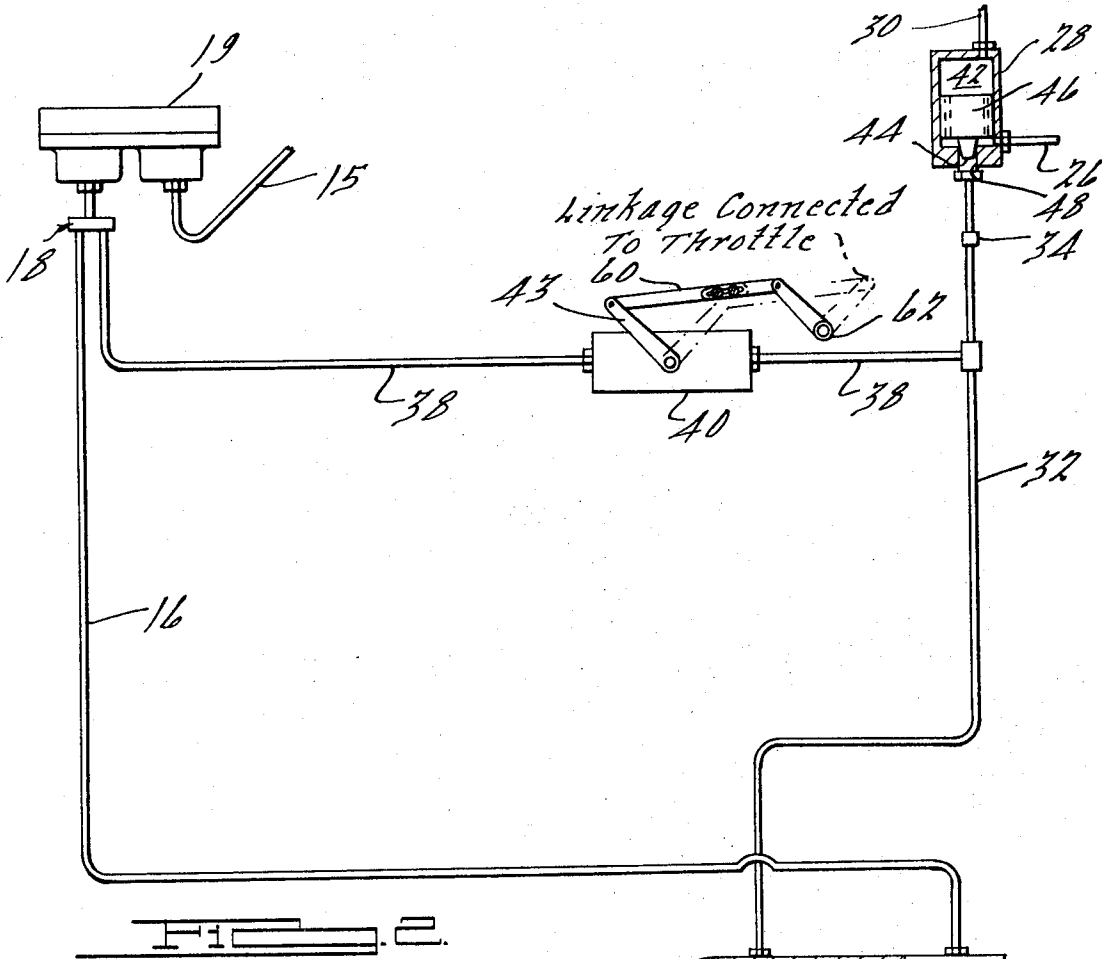
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ENGINE DRAINAGE REUSE SYSTEM

BACKGROUND

This invention is concerned with the reuse of engine drainage which forms in certain types of internal combustion engines, such as two-stroke cycle engines, particularly of the outboard type. Heretofore, the drainage, which is commonly referred to as "puddle drainage", has either been allowed to simply drain from the engine, or it has been collected for disposal or recycling to the engine in various ways to be reused in the engine combustion chambers. This invention provides an improved arrangement of the latter type.

SUMMARY

It has been observed that the major accumulation of puddle drainage occurs at low engine RPM's or engine speeds when the engine temperature and fuel-air mixture velocities are relatively low. Unfortunately, the engine is unable to use the recycled drainage properly at these low speeds. It has been determined that it is desirable to recycle drainage only at higher engine speeds at which the engine can burn it. Due to the increased engine temperatures, and the increased velocity and quantity of the fuel-air mixture prevalent at higher engine speeds, drainage is more readily used by the engine under such conditions.

This invention in its broad sense provides a reuse system wherein puddle drainage is controlled so as to mix with fresh fuel only at higher predetermined engine speeds. At lower speeds, the drainage is simply collected and held for use when the engine speed exceeds the predetermined speed at some later point in its operation.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a simplified and partly schematic side elevation view of the improved puddle drainage reuse system shown in relation to certain portions of an outboard motor which are illustrated in broken lines.

FIG. 2 is a more detailed showing of one embodiment of the reuse system on a larger scale.

FIG. 3 is a detailed sectional view of the inlet connection to the outboard motor fuel pump shown in FIG. 2.

FIG. 4 is a fragmentary sectional view of a more or less standard outboard motor fuel tank showing another embodiment for the storage of puddle drainage wherein a flexible bag is used.

FIG. 5 is a simplified and partly schematic view of another embodiment of the reuse system.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIG. 1, a schematic diagram of an outboard motor 10 is shown having a crankcase 12 and a fuel system. Fuel is introduced to the engine through the fuel system which includes a carburetor 14, a fuel line 15 connected between carburetor 14 and a fuel pump 19, and a fuel line 16 which extends between a fuel tank 17 and an inlet fitting 18 of fuel pump 19. In many two-stroke cycle engines the fuel consists of a mixture of gasoline and oil. Part of the mixture invariably condenses in the engine, as is well known in the art, to form the previously mentioned puddle drainage. Engine 10 includes means, such as drain conduits 20 and 22 for collecting the drainage which may be directed to a common sump 24. Drain line 26 directs the

drainage to collection means 28 for collecting the drainage liquid and any vapor which accompanies it. Vapor is separated in collection means 28 from the liquid drainage and directed back to the engine induction system through line 30 which connects to the intake system of the engine. The puddle liquid is directed through line 32 and check valve 34 for storage in fuel tank 17 or, depending on the engine speed at the time, it may be directed through line 38 and valve means 40, which is included in line 38. Valve means 40 has a control means schematically indicated as lever 43 which opens valve 40 at engine speeds above a selected predetermined speed to transfer puddle fluid from line 32 and fuel tank 17, as will be described in more detail in connection with FIGS. 2 and 5. Line 38 connects to the inlet 18 of fuel pump 19 along with fuel line 16 at which point any drainage passing through the transfer passage provided by line 38 may mix with fresh fuel entering inlet 18 from line 16 and be recycled through the fuel induction system to the engine combustion chambers.

The detailed structure and function of the various parts of the reuse system according to the invention is better understood with reference to FIG. 2 wherein the details of collecting means 28 show that it includes a float chamber 42 into which the engine puddle drainage is introduced through line 26. Since the method utilized to "pump" the drainage in most engines of the two-stroke cycle type with which this invention is particularly concerned consists in using engine crankcase pressure in conjunction with some type of check valve arrangement usually a set of reed valves in the engine, the drainage consists not only of liquid but also a considerable amount of vapor. In float chamber 42, such vapor may leave by means of vent line 30 which is preferably connected to the intake system of the engine. Valve closure member 44 controlled by float 46 and seat 48 cooperate to drain liquid puddle drainage from the chamber into line 32 whenever drainage is introduced into the chamber.

Liquid drainage in line 32 will ordinarily flow to a place of storage such as fuel tank 17, unless the engine is operating at such a high speed that it flows directly through line 38 as will be described below. Drainage storage means in the embodiment of FIG. 2 consists of a separated compartment 50 in main fuel tank 17. Compartment 50 may be vented to the tank by vent 52 to prevent pressurization drainage. Such a vent also allows fresh fuel to enter compartment 50 when tank 17 is filled thus allowing a certain amount of dilution of any puddle drainage present in the compartment at that time. The drainage enters compartment 50 through a filler pipe 54 which is merely an extension of line 32. In the bottom of compartment 50 at the end of filler pipe 54 is a caged hollow ball float 56 which closes the pipe when compartment 50 is empty to prevent the entrance of air into the fuel line.

Control valve means 40 in line 38 controls the supply of puddle drainage to the engine and hence it controls drainage reuse. This valve means may be operated in many ways including mechanical as shown in FIG. 2, vacuum as shown in FIG. 5 or other suitable arrangements so long as any arrangement selected meets two engine operating criteria. First, the puddle drainage must be stored at low speeds where the engine is unable to cleanly burn them. Secondly, the valve must open at certain predetermined higher engine speeds to allow the drainage to be mixed with fresh fuel.

These criteria are determined by the particular type and size of engine involved in any specific instance. However, it will be clear to anyone familiar with this art that at certain predetermined speeds an engine will run satisfactorily on the fuel-drainage mixture and will burn clean whereas below that speed it will not. For illustrative purposes only, tests were made with a 1970 Chrysler 55 H.P. outboard engine wherein a float chamber was mounted to one side of the engine. A gate valve was opened when the engine reached 2200 RPM. A small one-half gallon container was used as a sump to collect puddle drainage. Vapor from the float chamber was introduced into the engine manifold in the vicinity of the upper reed plate on the engine. The Table below shows some of the results obtained when the engine was operated on a Chrysler 14 foot Valiant Cathedral Hull Runabout boat with a two man load (340 pounds). The ambient temperature was 75°F. and the dewpoint was 48°F. As can be seen, about 20cc of puddle drainage formed at about 1900 RPM and increased in amount as engine speed decreased to about 900 RPM at which point about 142-162cc of drainage formed.

TABLE

	Engine RPM	Puddle Accumulation (cc)
TEST 1	900	142
	1350	90
	1500	52
TEST 2	900	162
	1350	100
	1500	60
	1900	20

The engine was observed to operate in a satisfactorily normal manner when the gate valve was repeatedly opened at about 2200 RPM allowing the accumulated puddle drainage to mix with the fresh fuel flowing to the engine. The fresh fuel consisted of a fuel mixture of 50:1. Engine speeds below 2200 RPM would have been satisfactory but, with air pollution as a predominant factor, 2200 was considered a good minimal value for this particular engine.

In the embodiment of FIG. 2, valve means 40 is a simple mechanical gate valve and arm 43 is operated by a mechanical linkage 60 which is connected to the engine throttle control apparatus and controlled thereby such that the valve is opened when the throttle is opened past a predetermined point corresponding to some selected engine speed. In FIG. 2, the valve is shown in solid line in a closed position while the valve shown in broken line is in an open position. In actual practice on outboard engines the end 62 of the linkage may be connected to a vertical tower shaft (not shown) or other means which controls spark advance and/or throttle opening thereby controlling engine speed.

From the foregoing structural description, it is clear that puddle drainage released to line 32 will flow to compartment 50 at low engine speeds. At pre-selected high engine speeds when, valve 40 is opened, puddle drainage in line 32 flowing downward from collecting means or float chamber 28 and drainage in compartment 50 will be drawn into line 38 by the action of fuel pump 19 and will be directed to fuel pump inlet 18, which is shown in detail in FIG. 3. Standard fuel pumps may be readily adapted for use with this invention as only minor modification is required. Basically the inlet fitting 18 must be made to accommodate two lines 16

and 38 as shown in FIG. 3. One connection is used for the incoming fresh fuel mixture through line 16 while the second is used to induct puddle drainage through line 38. The inlet fitting may be modified to provide any desired ratio of fresh fuel to puddle drainage through the use of different sized orifices in the fitting. As shown, for example, a metering cup 64 may be included in the fitting to decrease the flow of drainage into the fresh fuel.

An alternate embodiment for puddle drainage storage is shown in FIG. 4 wherein a flexible bag 62, such as an elastomeric bag or the like, is placed in the filler neck 64 of a standard outboard fuel tank. Bag 62 expands as puddle drainage enters and collapses as the drainage is used at high speeds. When all the drainage is used, the bag acts as a dead end on the filler pipe 32 to which it is connected.

One of many alternate types of control valve embodiments is shown in FIG. 5 which includes a pressure differential type valve 40 which is spring loaded to the closed position at low engine speeds. The valve opens by pressure or vacuum at higher engine speeds. There are several areas of pressure differential brought about by increased engine speed which can be used to achieve the function of valve operation in this embodiment. In the valve shown, the increased fuel pump inlet vacuum at higher speeds opens the valve.

Having described the invention and several preferred embodiments thereof, what is claimed is:

1. Apparatus for reuse of the puddle drainage from an internal combustion engine of the two stroke cycle type wherein the crankcase performs the function of an intake manifold and operates relatively cool by reason of the characteristics of the rapid expansion of the fuel air mixture from the carburetor into the crankcase which in turn tends to form more puddle drainage at low fuel air mixture flow velocities than at high velocities, the apparatus comprising:

means for collecting the drainage formed at the said low velocities;

drainage passage means between the collecting means and the engine fuel system, and valve means in the passage means operable only at the said high velocities for enabling drainage to pass from the collecting means to the engine fuel system whereby the puddle drainage is consumed under conditions of higher compression pressures associated with higher engine speeds and the said high velocities.

2. The apparatus according to claim 1 wherein the drainage passage means is connected to the fuel system at a point between the fuel tank and the carburetor.

3. The apparatus according to claim 1 wherein the drainage passage means is connected to the fuel system at the fuel pump inlet.

4. The apparatus according to claim 1 wherein: the means for collecting drainage includes means for separating fuel vapors from the liquid drainage.

5. The combination according to claim 1 wherein the drainage collection system comprises:

a drainage collecting chamber for receiving drainage from the engine, the chamber including normally closed drain valve means;

a drainage storage chamber for receiving drainage from the collecting chamber when the drain valve means is opened; and

means for opening the drain valve means when drainage is received in the collecting chamber.

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6. The combination according to claim 5 wherein the drain valve opening means comprises a float and needle valve arrangement including a valve seat in the collecting chamber.

7. The combination according to claim 6 wherein the collecting chamber includes vent means for venting drainage vapors therefrom.

8. The combination according to claim 7 wherein the vent means directs the drainage vapors to the engine induction system.

9. The combination according to claim 5 wherein the drainage storage chamber comprises a separate section of the main fuel tank of the fuel supply system.

10. The combination according to claim 5 wherein the drainage storage means is comprised of a separate container.

11. The combination according to claim 8 wherein the drainage inlet to the storage chamber portion of the fuel tank includes a normally closed float valve which opens when drainage is present in the chamber and closes when the chamber is empty.

12. The combination according to claim 1 wherein the valve means and the control means together comprise a normally closed valve and means responsive to engine speed for opening the valve when the speed exceeds the predetermined speed.

13. The combination according to claim 12 wherein the means responsive to engine speed comprises a mechanical linkage arrangement connected to the engine throttle control means and actuated thereby.

14. The combination according to claim 1 wherein the valve means is normally closed and is of the pres-

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sure operated type suitable for sensing pressure differentials at various engine speeds and opening at the predetermined speed.

15. The combination according to claim 1 wherein the drainage passage means connection point to the fuel supply system is between the fuel tank and the carburetor.

16. The combination according to claim 1 wherein the drainage passage means connection point to the fuel supply system is at the fuel pump inlet.

17. The combination according to claim 16 wherein the fuel pump includes an inlet fitting having two inlet connections, the engine fuel supply being connected to one and the drainage passage means being connected to the other, whereby the two fluids are inducted and mixed at the fuel pump.

18. The combination according to claim 16 wherein the inside diameter of the two fuel pump inlets are sized relative to each other whereby the drainage is metered into the fuel to provide a predetermined ratio of fresh fuel to drainage fuel flowing to the engine.

19. The combination according to claim 16 wherein a metered fitting is installed in the passage means to provide a predetermined ratio of fresh fuel to drainage fuel flowing to the engine.

20. The combination according to claim 5 wherein the drainage storage chamber comprises flexible bag means adapted to receive the drainage.

21. The combination according to claim 20 including a standard fuel tank with the bag means supported in the filler neck thereof and carried inside the tank.

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