United States Patent [19]

Brown

[11] **3,709,202**

[45] **Jan. 9, 1973**

[54] CRANKCASE DRAININGS RECYCLING SYSTEM

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[22] Filed: **Jan. 21, 1971**

[21] Appl. No.: **108,513**

[52] **U.S. Cl.**.....**123/73 R**, 123/136, 123/DIG. 2

[51] **Int. Cl.**.....**F02b 33/04**, F02m 37/00

[58] **Field of Search**.....123/136, 73 R, 73 A, 73 B, 123/DIG. 2, 73 PP, 73 SC

[56] **References Cited**

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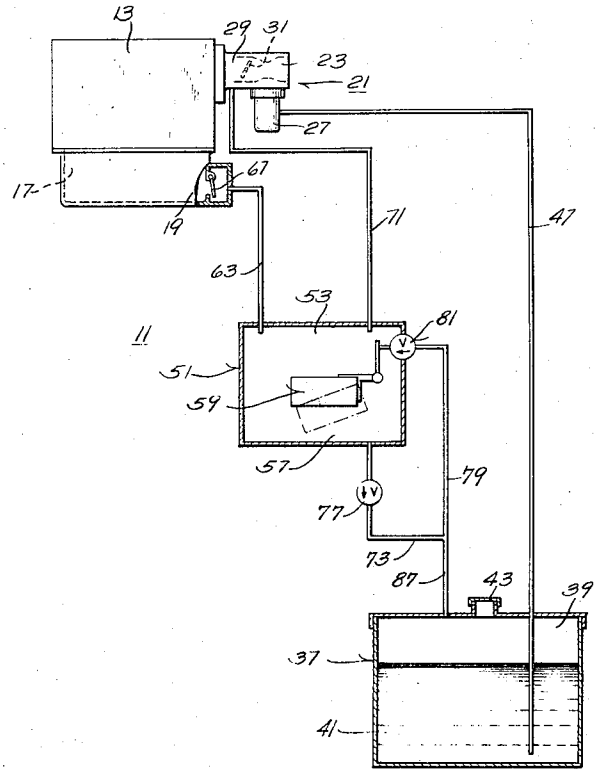
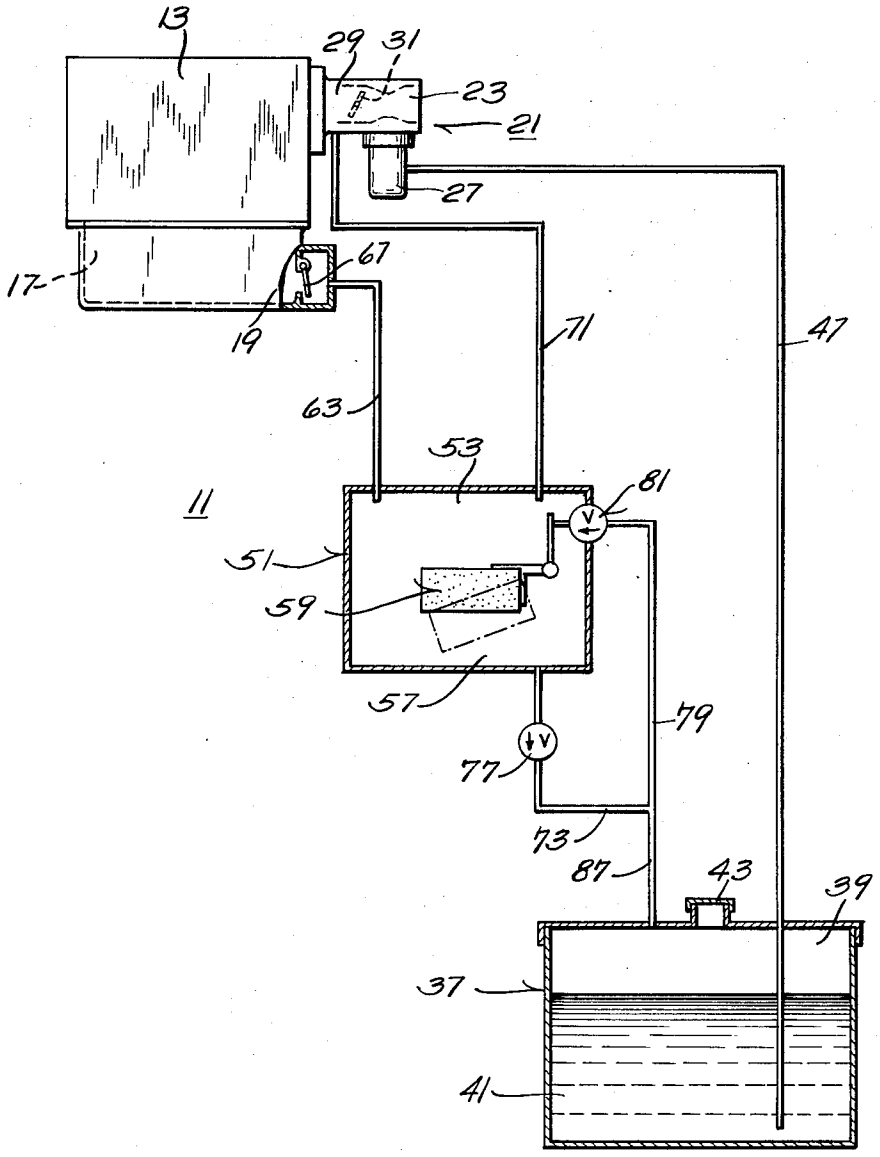
[57] **ABSTRACT**

Disclosed herein is a fuel supply system for a two-stroke engine including a crankcase and a fuel feeding means, said system comprising a fuel tank communicating with the fuel feeding means and including a filler cap having means for sealing the interior of the fuel tank from the atmosphere, and means including a drainage tank communicating through one-way check valves with the fuel tank and the crankcase for conducting drainings from the crankcase to the fuel tank, for preventing escape of fuel vapor from the fuel tank when the engine is not operating, and for venting of excessive vapor pressure in the fuel tank to the fuel feeding means when the engine is operating.

14 Claims, 1 Drawing Figure





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CRANKCASE DRAININGS RECYCLING SYSTEM

BACKGROUND OF THE INVENTION

Under normal operating conditions a crankcase scavenged two-cylinder engine collects liquid fuel in the lower portion of the crankcase, which liquid fuel is often referred to as "drain." Such drains are not readily vaporized for travel through the transfer passages to the cylinder under normal operating conditions. As a consequence, in the past, such drains have been drained from the crankcase and were commonly wasted overboard by being dumped into the exhaust system.

Various arrangements have been suggested in the past for resupplying such drains to the engine for combustion. Examples of such arrangements are disclosed in the Upton U.S. Pat. No. 2,717,584, issued Sept. 13, 1955, in the Goggi U.S. Pat. No. 3,138,748, issued Apr. 14, 1964, and in the Heidner U.S. Pat. No. 3,132,635, issued May 12, 1964. When such drains are pumped from the crankcase to a holding tank such drains are introduced to the tank under pressure and such accumulating pressure is desirably vented.

Another vent problem occurs when a storage tank with fuel is exposed to sunlight and is heated. Such heating causes fuel vaporization, and in the past, the resulting vapor has been conventionally vented to the atmosphere in the proximity of the engine or engine intake system. Such venting of vapors from a holding tank or from a fuel tank is particularly dangerous when the engine is not in operation as the resulting fuel-air mixture presents a serious hazard in the form of risk of explosion and/or fire.

SUMMARY OF THE INVENTION

The invention provides a fuel supply system which vents fuel vapors from a fuel storage tank to an engine fuel feeding system only when the engine is operating and only if the vapor pressure in the fuel storage tank is relatively high. In addition, the invention also serves to provide an integrated system for conducting drains from a crankcase to a fuel tank for resupply to the engine for ultimate combustion.

More specifically in accordance with the invention, there is provided a vent line which communicates between an otherwise sealed fuel tank and the engine fuel feeding system and which includes a valve movable to an open position to thereby permit venting only as a consequence of engine operation. Still more specifically, valve movement to the open condition requires the presence of an excessive vapor pressure in the fuel tank, together with engine operation to generate a sufficient quantity of drains which accumulate because of the excessive vapor pressure and which cause the opening of the valve.

In the specifically disclosed construction, the valve is opened by a float member which is supported on the surface of the accumulated drains. When there is insufficient vapor pressure, the drains resulting from engine operation will be immediately drained into the fuel tank.

Should excessive vapor pressure develop in the fuel tank, as for instance, by reason of exposure of the fuel tank to the sun, such vapor pressure will prohibit discharge of drains into the fuel tank until the pressure generated by the accumulation of drains is greater than

the vapor pressure or until the accumulation of drains causes operation of the float to open the vent valve. In the absence of engine operation, there would be no material accumulation of drains and therefor no movement of the vent valve to open position.

Also in accordance with the invention, the fuel vapors, as well as any vapor or pressure associated with the discharge drain from the crankcase are supplied to the intake manifold of the engine for induction into and combustion in the engine, thereby precluding pollution, as well as avoiding an explosion and/or fire hazard.

In the specifically disclosed construction and in accordance with the invention, the drains are discharged from the crankcase into a drainage or holding tank either for more or less immediate drainage to the fuel tank or for accumulation in the event of excessive vapor pressure in the fuel tank. Also in accordance with the invention, the vent valve when opened, communicates the upper portion of the fuel tank with an upper portion of the drainage tank which, in turn, communicates through a vent line with the fuel feeding means.

One of the principal objects of the invention is the provision of an arrangement for preventing the escape of fuel vapor from a storage tank in the absence of engine operation.

Another of the principal objects of the invention is the provision of an arrangement operable only in response to engine operation to provide for venting of the excess fuel vapor present in a fuel storage tank to an engine fuel feeding system.

Another principal object of the invention is the provision of an arrangement for selectively preventing and affording the venting of a fuel storage tank by means which are integrated in a system which also serves to conduct drains from a crankcase to a fuel tank for resupply to the engine and for ultimate combustion.

Still another principal object of the invention is the provision of an arrangement for desirably discharging crankcase drain to a fuel tank for resupply to the engine and eventual combustion, thereby eliminating a possible source of pollution.

Another principal object of the invention is the provision of a fuel feeding system which is relatively easy to manufacture and economical to install and operate, which will provide a long and useful life, and which serves to avoid pollution of the environment and to avoid the risk of fire and/or explosion.

Other objects and advantages of the invention will become known by reference to the following description and accompanying drawing.

DRAWING

The FIGURE is a schematic view of an engine fuel system in accordance with the invention.

GENERAL DESCRIPTION

The drawing is schematically illustrative of a fuel system **11** for a two-stroke internal combustion engine **13** including a crankcase **17** (indicated schematically in dotted outline) which is subject to pulsating pressure conditions and which includes a portion **19** adapted for collecting drains or drainings. Also included on the engine is a fuel feeding system or means **21** comprising a

carburetor 23 with a float bowl 27 and an intake manifold 29 connecting the carburetor 23 to the engine cylinder (not shown). The carburetor 23 conventionally includes a throttle valve 31 which is substantially closed when the engine 13 is not operating.

Also shown schematically in the drawings is a fuel storage tank 37 having upper and lower portions 39 and 41 respectively. Included in the fuel storage tank 37 is a filling cap 43 including means which, when the filling cap 43 is tightly closed, seals the interior of the fuel tank 37 from the atmosphere.

Connecting the lower part 41 of the fuel tank 37 and the carburetor float bowl 27 of the fuel feeding means 21 is a duct or fuel line 47 which, under normal operating conditions, supplies fuel from the fuel tank 37 to the fuel feeding means 21.

In accordance with the invention, there is provided means for conducting the drainings from the crankcase 17 to the fuel tank 37 and for preventing escape of fuel vapor from the fuel tank 37 when the engine 13 is not operating and for venting of excessive vapor pressure in the fuel tank 37 to the fuel feeding means 21 when the engine 13 is operating. As the vented fuel vapor is permitted to escape from the fuel tank 37 to the fuel feeding means 21 only when the engine 13 is operating, such vapor is fed to the engine cylinder and is not permitted to escape to the atmosphere.

While various other arrangements could be used, in the disclosed construction, such means comprises a drainage or holding tank 51 which is closed, except as otherwise disclosed herein, and which includes upper and lower portions 53 and 57 respectively, and a float or other member 59 mounted on the tank 51 for movement relative to an elevated or raised position in response to accumulation of a predetermined quantity of drainings in the drainage tank 51.

Also in accordance with the invention, drains are discharged from the drains collecting crankcase portion 19 to the upper portion 53 of the drainage tank 51 by a conduit or duct 63 connected between the drainage tank upper portion 53 and the crankcase drains collecting portion 19. The duct 63 includes, preferably adjacent to the crankcase 17, a check valve 67 which affords flow from the crankcase 17 under conditions or relatively high crankcase pressure but which prevents flow to the crankcase 17 under conditions of relatively low crankcase pressure.

Also in accordance with the invention, any gaseous pressure condition which may exist in the drainage tank 51 in response to pumping of drains from the crankcase 17 to the drainage tank 51 is relieved or vented by a duct or vent line 71 communicating between the drainage tank 51 and the fuel feeding system 21 and, in particular, between the drainage tank upper portion 53 and the intake manifold 29. Fuel vapors which may travel from the drainage tank 51 to the intake manifold 29 when the engine 13 is not operating are restrained from travel into the atmosphere because of the substantially closed condition of the throttle valve 31 when the engine is not operating.

Under normal engine operating conditions, when there is an absence of excessive vapor pressure in the fuel tank 37, drainings which are discharged into the drainage tank are, in accordance with the invention, discharged through a duct or conduit 73 which extends between the drainage tank lower portion 57 and the upper portion 39 of the fuel tank 37. In order to prevent fuel vapor flow from the fuel tank 37 to the drainage tank 51 through the duct 73 in response to the occurrence of excessive vapor pressure in the fuel tank 37, the duct 73 includes, in accordance with the invention, a one-way valve 77 which affords flow from the drainage tank 51 to the fuel tank 37 when the pressure at the drainage tank side of the valve 77 is greater than the vapor pressure in the fuel tank 37 and which prevents fuel vapor flow from the fuel tank 37 to the drainage tank 51 whenever the vapor pressure in the fuel tank 37 exceeds the pressure operative on the drainage tank side of the valve 77, i.e., in the drains or in the gas present in the drainage tank 51. Under normal operating conditions, when there is an absence of excessive vapor pressure in the fuel tank 37, the drains flow by gravity from the drainage tank 51 to the fuel tank 37.

Also in accordance with the invention, there is provided means for venting to the fuel feeding means 21, when the engine is operating, of fuel vapors causing excessive pressure in the fuel tank 37. While other arrangements might be employed, in the disclosed construction, there is provided a duct or line 79 which communicates between the fuel tank upper portion 39 and the drainage tank upper portion 53 and which includes a valve 81 operable by the float 59 in the drainage tank 51. More specifically, the valve 81 is normally closed to seal the fuel tank 37 against escape of fuel vapor except when the float 59 is in its raised position. The float 59 is located in the raised position only in response to the simultaneous occurrence of continued operation of the engine 13, which operation generates drains which flow to the drainage tank 51, and the occurrence in the fuel tank 37 of an excessive vapor pressure which prevents discharge from the drainage tank 51 of the drains flowing from the crankcase 17, whereby to cause accumulation of such drains in the drainage tank 51 and consequent raising of the float 59 so as to open the valve 81. Such opening permits fuel vapor flow to the drainage tank upper portion 53 and through the duct 71 to the engine fuel feeding means 21 and, in particular, to the intake manifold 29. Because of continued engine operation, such fuel vapor as is discharged into the manifold 29 flows into the engine cylinder and does not have an opportunity to enter the atmosphere.

In the disclosed construction, the conduits or ducts 73 and 79 have a common portion 87. However, the conduits or duct 73 and 79 can be separately connected to the fuel tank upper portion 39.

The foregoing disclosed construction provides an arrangement whereby drains may be returned to the fuel tank 37 and whereby vapor pressures which may be generated in the fuel tank 37 are prevented from escaping to the atmosphere. Both functions serve to prevent pollution and are highly desirable. It is to be noted that excessive vapor pressure in the fuel tank 37 is vented only in response to engine operation and that such venting occurs in such manner as to feed or supply the vented fuel vapors into the engine cylinder. In addition, the drains which are returned to the fuel tank are subsequently fed into the engine cylinder thereby affording fuel economy, as well as pollution control.

Various of the features of the invention are set forth in the following claims.

What is claimed is:

1. A fuel supply system for a two-stroke engine including a crankcase and a fuel feeding means, said fuel supply system including a fuel tank connected to said fuel feeding means, and means for preventing escape of fuel vapor from said fuel tank when the engine is not operating and for venting of excessive vapor pressure in said fuel tank when the engine is operating, said means for preventing escape of fuel vapor and for venting excess vapor pressure including a vented drainage tank, a drains conduit communicating between said crankcase and said drainage tank, first conduit and valve means extending between said drainage tank and said fuel tank for providing controlled drainage flow and second conduit and valve means extending between said drainage tank and said fuel tank for providing controlled vapor flow between said drainage tank and said fuel tank.

2. A fuel supply system in accordance with claim 1 wherein said means for preventing escape of fuel vapor and for venting excess vapor pressure also functions to conduct drains from said crankcase to said fuel tank.

3. A fuel supply system in accordance with claim 1 wherein said drain conduit includes a one-way valve affording flow from the crankcase to said drainage tank and preventing flow from from said drainage tank to the crankcase.

4. A fuel supply system in accordance with claim 1 and further including a vent line communicating between said drainage tank and the fuel feeding means.

5. A fuel supply system in accordance with claim 1 wherein the fuel feeding means includes a carburetor and a fuel inlet manifold connecting the carburetor to the engine and further including a vent line communicating between the upper portion of said drainage tank and the intake manifold.

6. A fuel supply system in accordance with claim 1 wherein said first conduit and valve means includes a drain line communicating between said drainage tank and said fuel tank and including a check valve affording flow from said drainage tank to said fuel tank and preventing flow from said fuel tank to said drainage tank, and wherein said second conduit and valve means includes a vent line between said fuel tank and the upper portion of said drainage tank and including a valve and a valve operating member connected to said valve to move said valve to an open position in response to engine operation.

7. A fuel supply system in accordance with claim 6 wherein said valve operating member comprises a float in said drainage tank operable upon the accumulation of a predetermined amount of drains to cause opening of said valve.

8. A fuel supply system for a two-stroke engine including a crankcase having a portion adapted for collecting drains and a fuel feeding means, said system comprising a fuel tank including a filler cap having means for sealing the interior of said fuel tank from the atmosphere, a fuel line connecting said fuel tank and the fuel feeding means, a vented drainage tank, a conduit connecting said drainage tank to the drains-collecting crankcase portion and including means preventing flow from said drainage tank to the crankcase, and first valve and conduit means communicating between said drainage tank and said fuel tank for venting vapor pressure in said fuel tank when a predetermined amount of drains accumulate in said drainage tank and the pressure generated by drains accumulation in said drainage tank is less than the vapor pressure in said fuel tank, and second conduit and valve means communicating between said drainage tank and said fuel tank for discharging drains from said drainage tank to said fuel tank when the vapor pressure in said fuel tank is less than the pressure generated by drains accumulation in said drainage tank.

9. A fuel supply system in accordance with claim 8 wherein said first valve and conduit means comprises a drain line communicating between said drainage tank and said fuel tank and including a check valve affording flow from said drainage tank to said fuel tank and preventing flow from said fuel tank to said drainage tank and wherein said second valve and conduit means comprises a vent line between said fuel tank and the upper portion of said drainage tank and including a valve and a valve operating member connected to said valve to move said valve to an open position only in response to engine operation and the presence of excessive vapor pressure in said fuel tank.

10. A fuel supply system in accordance with claim 9 wherein said valve operating member comprises a float in said drainage tank operable upon the accumulation of a predetermined amount of drains to cause opening of said valve.

11. A fuel supply system comprising a two-stroke engine including a crankcase having a portion adapted for collecting drains and an engine fuel feeding means including a carburetor and an air inlet manifold connecting said carburetor to said engine, a fuel tank including an upper portion, a lower portion, and a filler cap having means for sealing the interior of the fuel tank from the atmosphere, a fuel line connecting said fuel tank lower portion and said carburetor, a drainage tank including an upper portion, a lower portion, and a float mounted on said drainage tank for movement between a raised position and a lowered position in accordance with the quantity of drains in said drainage tank, a conduit connecting said drainage tank to said crankcase portion and including means preventing flow from said drainage tank to said crankcase, a vent line connecting said drainage tank upper portion to said intake manifold, a drain line connecting said drainage tank lower portion and fuel tank upper portion and including a check valve affording flow from said drainage tank to said fuel tank and preventing flow from said fuel tank to said drainage tank, and a duct connecting said fuel tank upper portion and said drainage tank upper portion and including valve means connected to said float and operable when said float is in said raised position to open said valve and to close said valve when said float is lowered from said raised position toward said lowered position.

12. A fuel supply system for a two-stroke engine including a crankcase and a fuel feeding means, said fuel supply system including a fuel tank connected to said fuel feeding means, and means for preventing escape of fuel vapor from said fuel tank when the engine is not operating and for venting of excessive vapor pressure in said fuel tank when the engine is operating, said means

for preventing escape of fuel vapor and for venting excess vapor pressure including a vented drainage tank, a drain conduit communicating between said crankcase and said drainage tank, first conduit means extending between said drainage tank and said fuel tank and including a one way valve affording flow from said drainage tank to said fuel tank and preventing flow from said fuel tank to said drainage tank, and second conduit means extending between said drainage tank and said fuel tank and including normally closed valve means operable to open in response to accumulation of drains in said drainage tank.

13. A fuel supply system including a crankcase and a fuel feeding means, said fuel supply system including a fuel tank connected to said fuel feeding means, a vented drainage tank, a drain conduit between said crankcase and said drainage tank, a drain line communicating between said drainage tank and said fuel tank and including a check valve affording flow from said drainage tank to said fuel tank and preventing flow from said fuel tank to said drainage tank, and a vent line between said fuel tank and the upper portion of said drainage tank and including a valve and a valve operating member connected to said valve, and operable upon the accumulation of a predetermined amount of drains in said drainage tank to cause opening of said valve.

14. A fuel supply system in accordance with claim 13 wherein said valve operating member comprises a float in said drainage tank.

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