

[54] **APPARATUS FOR PREVENTING
ESCAPE OF FUEL VAPOR FROM
INTERNAL COMBUSTION ENGINE**

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[51] Int. Cl. F02m 59/00, B65b 3/00

[58] Field of Search 123/136; 220/85 VR, 1 VS

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[57] **ABSTRACT**

Apparatus for drawing excess fuel vapors from the carburetor of an internal combustion engine utilizes a

conduit having an inlet disposed adjacent the carburetor and an outlet in communication with the fuel tank for the engine. A pump in the conduit is controlled by a pressure sensitive switch which is actuated by the engine ignition system. A second conduit communicates the fuel tank with the carburetor and the pump in the first-mentioned conduit is operated to maintain a sufficient pressure head on the tank to force fuel from the tank through the second conduit and into the carburetor. The suction head created by the engine during the operation can be utilized to withdraw fumes from the tank which would otherwise escape into the atmosphere whenever the cap on the tank is removed from filling purposes. Thus a third conduit is provided in communication with the tank and with the suction head of the engine. In order to keep the engine running while fumes are being evacuated from the fuel tank, a fourth conduit is provided which intercommunicates the first and second conduits to cause fuel contained in the latter to be delivered to the carburetor for combination with air to form a combustion mixture. Appropriate valve means is operated by a lever which overlies the cap to the fuel tank so that movement of the lever to a position allowing removal of the cap directs the flow of fluid from the first conduit, through the fourth conduit, and into the second conduit while simultaneously opening the third conduit to withdraw fumes from the tank. The invention also encompasses a novel delivery nozzle for supplying fuel to the tank from a storage area, which nozzle includes structure for forming an airtight seal with the tank to cause fuel to be drawn through the nozzle in response to the suction head of the engine which is withdrawing fumes from the tank.

10 Claims, 7 Drawing Figures

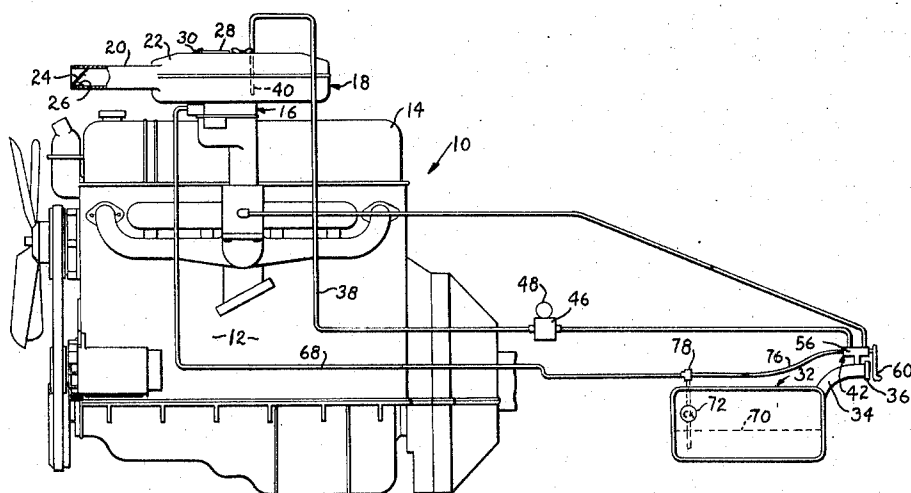


Fig. 1.

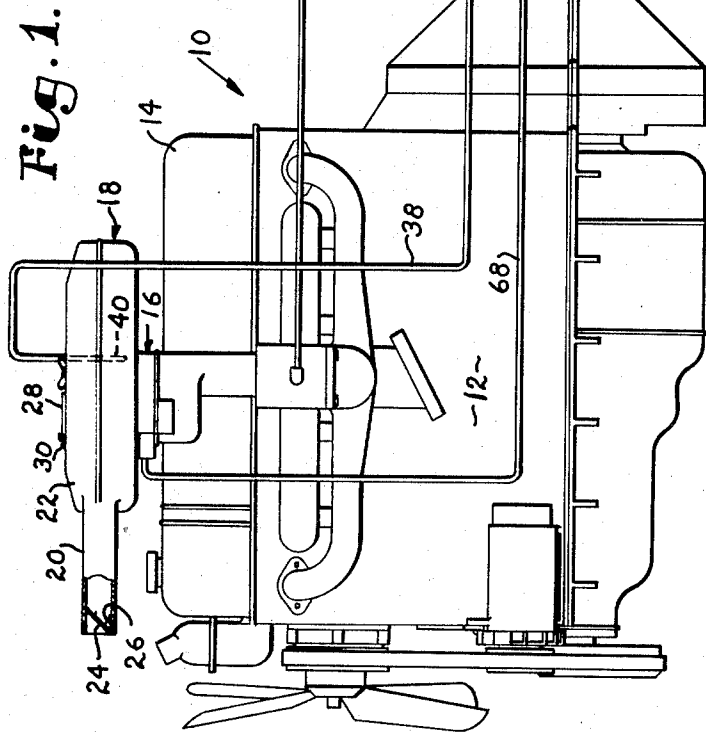


Fig. 5.

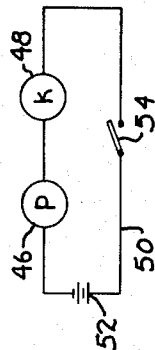


Fig. 7.



Fig. 3.

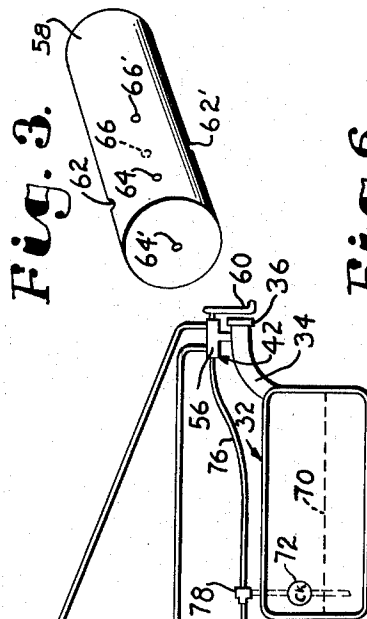


Fig. 6.

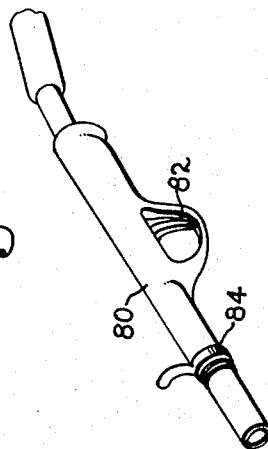


Fig. 4.

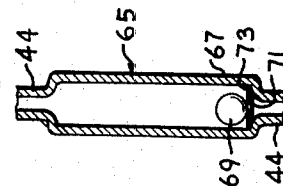
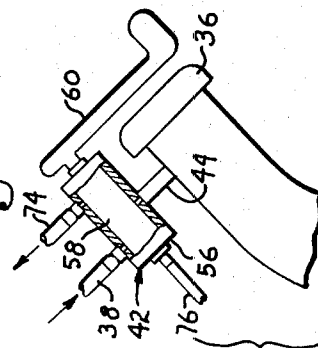


Fig. 2.



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APPARATUS FOR PREVENTING ESCAPE OF FUEL VAPOR FROM INTERNAL COMBUSTION ENGINE

This invention relates to apparatus for preventing contamination of the atmosphere by internal combustion engines and, more particularly, to apparatus for withdrawing excess fuel vapors from the engine carburetor and for withdrawing fumes from the engine fuel tank.

Considerable concern has been raised in recent years with regard to the hydrocarbon emissions from internal combustion engines. While the most attention has been given to the reduction of emissions from the engine exhaust, this is not the only source of air pollution from automobile engines.

In warm weather, there is considerable "boil-off" of fuel from automobile engine carburetors. This boil-off is a result of the fact that the carburetor is generally open to the atmosphere and the heat causes partial vaporization of the fuel which then escapes into the atmosphere. This boil-off of fuel vapors occurs primarily when the engine is not operating and therefore consumes no fuel and there is no inflow of air into the engine which would draw the vapors inwardly rather than allowing them to escape. Particularly in metropolitan areas where a large number of vehicles are concentrated, the boil-off from the internal combustion engines of the vehicles during a warm day is a significant source of air pollution.

In addition to contaminating the atmosphere, the boil-off from automobile engines is frequently a source of irritation to drivers because it results in flooding of the engine making it difficult or impossible to start. Even in those cases where the engine is ultimately started, there is nevertheless significant fuel waste.

Another source of air pollution from automobile engines is the fuel tank which must be opened for filling purposes. Whenever the tank is opened, particularly in warm weather, the fumes which collect in the tank are driven out into the atmosphere as the tank is filled with fresh fuel. This presents a certain fire hazard around automobile service stations and also contributes to the atmospheric pollution, particularly in metropolitan areas where a large number of service stations are concentrated.

It is therefore an object of the present invention to provide apparatus for withdrawing excess fuel vapors from the carburetor of an internal combustion engine and returning these vapors to the engine fuel tank to prevent their escape into the atmosphere.

Another object of the invention is to eliminate starting problems as a result of fuel boil-off in internal combustion engines by withdrawing the boil-off vapors from the engine carburetor and returning these vapors to the engine fuel tank.

Still another object of this invention is to incorporate in the apparatus described in the foregoing two objects, structure for delivering fuel to the automobile engine thereby utilizing the apparatus as the engine fuel pump and eliminating the need for a conventional fuel pump.

An important aim of this invention is also to eliminate the problem of vapor lock which is associated with conventional liquid fuel pumps by eliminating all vapor in the fuel line and utilizing an air pump which maintains a pressure head on the fuel tank to assure delivery of the proper amount of fuel to the engine

without the need for the liquid fuel to pass directly through the pump.

Another important object of the invention is a fuel system for an automobile engine which provides a constant uninterrupted flow of fuel to the engine carburetor thereby eliminating the disadvantages previously associated with the pulsating fuel flow of conventional liquid fuel pumps.

It is also an object of this invention to provide apparatus for eliminating escape of engine fuel vapors into the atmosphere to thereby improve operating economy by reducing fuel waste.

This invention also has as one of its primary aims the provision of apparatus for withdrawing fumes from the fuel tank of an internal combustion engine when the tank is being filled with fresh fuel to thereby prevent the escape of these fumes into the atmosphere.

Another object of the invention is to provide apparatus for filling the fuel tank of an internal combustion engine from a fuel storage area, such as a commercial service station, by utilizing the suction head created by the engine during operation to provide a negative pressure in the tank thereby eliminating the need for a fuel pump at the storage area.

In the drawing:

FIG. 1 is a side elevational view, partially schematic, of an internal combustion engine and fuel tank therefor utilizing the apparatus of the present invention;

FIG. 2 is a greatly enlarged detail view of the valve means which is located adjacent the inlet to the fuel tank for controlling the flow of fluid through the various conduits and to and from the fuel tank;

FIG. 3 is a still further enlarged view of the cylindrical valve member which is employed with the valve illustrated in FIG. 2;

FIG. 4 is a greatly enlarged view of the check valve which would be positioned intermediate the valve illustrated in FIG. 2 and the fuel tank to prevent backup of fuel from the tank into the engine;

FIG. 5 is an electrical schematic of the pressure valve, pump means, engine battery, and ignition switch which are utilized in the present invention;

FIG. 6 is a perspective view of the novel fuel delivery nozzle which is utilized to deliver fuel from a storage area to the fuel tank; and

FIG. 7 is a cross-sectional view of a gasket which can be employed with the nozzle shown in FIG. 6 for purposes of forming an airtight seal with the fuel tank.

Referring initially to FIG. 1, an internal combustion engine of the type which is commonly used to power mobile vehicles such as automobiles is designated generally by the numeral 10. The engine 10 includes an engine block 12 which houses the combustion chambers and power train of the engine, and a valve cover 14 which is positioned atop the block 12. The engine 10 also includes a carburetor 16 for combining fuel with air to form a combustible mixture. Air is delivered to the carburetor 16 through an air cleaner 18. The air cleaner 18 includes a duct 20 which presents an air passage into the cleaner and a housing 22 which encloses an appropriate filter element (not shown). The passageway defined by the duct 20 is blocked by a gate valve 24 which is biased by a leaf spring 26 to allow the passage of air into the cleaner 18 while blocking the flow of air or vapors in the opposite direction from the

inside of the cleaner to the atmosphere. Another gate valve 28 is positioned atop the housing 22 which is biased by a spring 30 to prevent the valve 28 from opening outwardly except when there is an abnormal pressure built up within the engine 10 such as would happen if the engine should backfire.

The engine 10 is normally provided with a fuel tank 32 which is disposed at a location remote from the engine. The tank 32 is provided with an inlet tube 34 which extends upwardly from the tank to a location where access from the outside of the vehicle is easily accomplished. The tube 34 is closed by a cap 36 to prevent escape of fuel or fumes from the tank 32 during normal engine operation.

A first conduit 38 extends into the air cleaner 18 and has its inlet 40 disposed adjacent the carburetor 16. The outlet of the conduit 38 communicates with the fuel tank 32 through a valve 42, a tubular connecting line 44 and the tube 34. A pump 46 is disposed within the line 38 and is controlled by a pressure sensitive switch 48.

As illustrated in the electrical schematic of FIG. 5, electrical circuit means 50 couples the pump 46 and pressure switch 48 in series relationship with a source of power such as the automobile battery 52 and an ignition switch 54 which also controls the electric starter (not shown) for the engine 10. Manifestly, closing of the switch 54 activates the pressure switch 48 to allow the latter to control the pump 46.

The valve 42 which is shown in detail in FIGS. 2 and 3 comprises a housing 56 which encloses a valve member 58, and a lever 60 which is coupled with the member 58 for control of the latter. The valve member 58 has a passageway therethrough the inlet of which is designated by the numeral 62 in FIG. 3 and the outlet of which is designated by the numeral 62'. A second passageway through the valve member 58 has an inlet 64 and an outlet 64'. A third passageway through the valve member 58 has an inlet 66 and an outlet 66'.

Immediately beneath the valve member 42, within the line 44, a check valve 65 is located. The valve 65 is shown in FIG. 4 and comprises a tubular race 67 which houses a ball bearing 69. The bearing 69 is constructed from a material having a specific gravity lighter than the specific gravity of the fuel which is to be used in the engine 10, and the bearing 69 is normally seated upon a plate 71 having one or more openings 73 therethrough for purposes to be made clear hereinafter.

A second conduit 68 communicates with the carburetor 16 and with the fuel tank 32, at a point below the fuel level in the tank, which level is designated by the numeral 70 in FIG. 1, for delivering fuel to the engine 10. The conduit 68 is provided with a check valve 72 to prevent the flow of fluid downwardly into the tank 32 while allowing fluid from the tank to pass upwardly through the conduit to the engine 10.

It is well known to those skilled in the art that an internal combustion engine such as the engine 10 is normally provided with a throttle valve (not shown) for controlling the rate of delivery of fuel to the engine. It is also well known that such an engine creates a suction head during operation, and this suction head varies in magnitude depending upon the quantity of air flowing into the engine. The suction head is maximized when the throttle valve is in its closed or nearly closed posi-

tion as would be the case during engine idle. A third conduit 74 communicates with the engine 10 at a point below the aforementioned throttle valve for the purpose of communicating the suction head of the engine with the tank 32 through the valve 42, the line 44, and the tube 34.

A fourth conduit 76 communicates the conduit 38 with the conduit 68 through the passageway which is intermediate the inlet 64 and the outlet 64' in the valve member 58, and an appropriate coupling 78.

As previously mentioned, whenever the engine 10 is allowed to stand unoperated for a period of time on a warm day, there is a certain amount of vaporization of fuel within the carburetor 16. This vaporized fuel which would normally enter the atmosphere, is prevented from leaving the air cleaner 18 by the gate valve 24. Manifestly, the vapors are collected within the air cleaner 18 and the carburetor 16 until such a time as the engine is again started. When the engine is running, the ignition switch 54 is closed, thereby activating the pressure switch 48 which controls the pump 46. The pressure switch 48 will cause the pump 46 to operate to draw the vapors which have previously collected in the cleaner 18 and carburetor 16 through the conduit 38 and into the fuel tank 32. In this regard, it is to be noted that the lever 60 which controls the valve member 58 is normally disposed in a position blocking removal of the cap 36. With the lever 60 in this position, the inlet 62 is aligned with the conduit 38 to permit the flow of fluid through the conduit and into the tank 32.

By adjusting the pressure switch 48 to normal fuel pump pressure, the pump 46 can be utilized to maintain a pressure head on the tank 32 sufficient to force fuel through the conduit 68 and into the carburetor 16. This eliminates the need for a conventional fuel pump and is an inherent benefit obtained when the conduit 38 and the pump 46 are employed for drawing excess fuel vapors from the carburetor 16. An important advantage of utilizing the pump 46 to deliver fuel to the engine 10 is the fact that the fuel does not have to pass directly through the pump, therefore eliminating the possibility of vapor lock which could inactivate the pump.

When the fuel tank 32 is to be filled with fuel, the lever 60 must first be rotated 90° in a clockwise direction before the cap 36 can be removed. Rotation of the lever 60 in this manner rotates the valve member 58 to bring the inlet 64 into alignment with the outlet of the conduit 38 and the outlet 64' of the passageway within the member 58 into alignment with the conduit 76. Similarly, the inlet 66 is brought into alignment with the line 44 and the outlet 66' of the passageway within the member 58 is brought into alignment with the inlet to the conduit 74. Thus, the suction head of the engine is now in communication with the tank 32 by virtue of the passageway in the member 58 which communicates the conduit 74 with the line 44. This allows the engine to evacuate the tank 32 of the fumes which inherently collect in the tank as a result of partial vaporization of the fuel. Since evacuation of the tank is dependent upon continued operation of the engine 10 to maintain the suction head, it is necessary to apply fuel to the engine through an alternative route. There is normally sufficient fuel in the fuel conduit 68 of the en-

gine to run the engine for several minutes and this fuel is utilized during the filling operation. To this end, the conduit 38 is communicated with the conduit 68 through the conduit 76 and by virtue of the fact that the inlet 64 in the member 58 is now in alignment with the outlet of the conduit 38, and the outlet 64 in the member 58 is now in communication with the inlet of the conduit 76. The check valve 72 assures that there will be no backflow of fluid into the tank 32. With certain engines of very large horsepower, it may be desirable to include an auxiliary reservoir (not shown) in the fuel conduit 68, to assure an adequate supply of fuel to keep the engine running during the filling operation.

To eliminate the possibility of any fuel being drawn into the engine 10 through the conduit 74, the check valve 65 is provided in the line 44. Any fuel flowing up through the line 44 will cause the bearing 69 to float within the race 67 until the bearing blocks off the line 44 at the top of the race. This prevents fuel from being drawn into the engine and also shuts off the vacuum to the tank 22. On the other hand, when fuel vapors or air are to be delivered to the tank 32 through the line 44, this is possible as a result of the opening 73 in the plate 71 at the bottom of the race 67.

It is also contemplated that the suction head of the engine 10 which is utilized to withdraw fumes from the tank 32, can be employed to cause the flow of fuel into the tank from a storage area as a result of the negative pressure. For this purpose, a delivery nozzle designated by the numeral 80 is shown in FIG. 6, and it is to be understood that this nozzle would normally communicate with a fuel storage area. A trigger 82 on the nozzle 80 operates an on-off valve (not shown) to permit the flow of fuel through the nozzle. A coupling 84 is disposed at the end of the nozzle 80 and is designed in complementary fashion to the outlet end of the tube 34. Thus when the cap 36 is removed, the coupling 84 can be secured to the tube 34 to provide an essentially airtight seal and the trigger 82 can be pulled to cause fuel from the storage area to flow into the tank 32. Any need for a fuel pump at the storage area is eliminated since the reduced pressure within the tank 32 as a result of the engine suction head being in communication therewith can be completely relied upon to fill the tank with fuel.

As an alternative to the coupling 84, a gasket 86 which is shown in FIG. 7, can be provided for the nozzle 80. The gasket 86 is constructed from a resilient material and can be slipped onto the end of the nozzle 80 in place of the coupling 84. The nozzle 80 can then be positioned within the tube 34 and the resilient nature of the gasket 86 relied upon to accomplish an essentially airtight seal within the tank 32. It will be appreciated that it is not necessary to effect a perfectly airtight seal at the inlet to the tube 34, since any leakage of air will be in the direction of flow of fuel into the tank 32, and while decreasing efficiency somewhat, will not prevent the suction head of the engine from filling the tank 32 as a result of the evacuation of air through the conduit 74.

From the foregoing description it will be apparent that this invention significantly reduces air pollution from internal combustion engines while contributing to the efficiency and economy of the engine operation. Similarly, the invention also provides apparatus for reducing substantially the cost of equipment for filling the fuel tank of engines from storage areas.

Having thus described the invention what is claimed as new and desired to be secured by Letters Patent is:

1. In an internal combustion engine having a fuel tank, ignition means for starting the engine, and a carburetor for combining fuel with air to form a combustible mixture, the improvement of apparatus for drawing excess fuel vapors from the carburetor, said apparatus comprising:

a conduit having an end extending into said carburetor and an outlet extending into said fuel tank for the passage of excess fuel vapors through the conduit prior to the introduction of said excess vapors into the combustion chamber,

pump means disposed in the conduit for creating an airstream through the latter in the direction of said tank to draw said excess fuel vapors through the conduit; and

circuit means coupling said pump means with said ignition means whereby said pump means is activated by said ignition means whenever the engine is started to draw said excess fuel vapors from the carburetor through said conduit and deposit the vapors in said tank.

2. The invention of claim 1, including a second conduit communicating said tank with said carburetor below the fuel level in the tank, and wherein said pump means includes pressure sensitive switch means coupled with said circuit means, said switch means being activated by said ignition means and operable to control operation of said pump means in accordance with the pressure in the first-mentioned conduit whereby a pressure head is maintained in said tank sufficient to force fuel from the latter through the second conduit and into said carburetor.

3. The invention of claim 2, wherein said engine creates a suction head during operation, and including third conduit means coupling said tank with said suction head; fourth conduit means intercommunicating the first and second conduit means; and valve means operable to block the flow of fluid from said first conduit means into the tank while simultaneously directing the flow of fluid from the first conduit means into said second conduit means whereby the fuel in said second conduit means is delivered to said carburetor to run the engine and any fumes in said tank are evacuated through said third conduit means.

4. The invention of claim 3, wherein said valve means is also operable to block the flow of fluid through said fourth conduit means while simultaneously directing the flow of fluid from the first conduit means into said tank.

5. The invention of claim 4, wherein said tank has an opening therein for filling the tank with fuel; and including a removable cap for closing the opening; and a lever coupled with said valve for moving the latter from a first position blocking said third and fourth conduits to a second position blocking said first conduit, said lever being disposed to prevent removal of said cap when the lever is in the first position, and said cap being removable when the lever is in the second position.

6. The invention of claim 4, wherein said second conduit is provided with a one-way check valve at a point below the point of communication of the fourth conduit therewith, whereby fluid flowing from the fourth conduit into the second conduit is precluded from entering said tank.

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7. The invention of claim 4, wherein said engine includes air cleaner means coupled with said carburetor, and said first conduit extends into the interior of said air cleaner means.

8. The invention of claim 7, wherein said air cleaner means has a passageway for the introduction of air, and including gate means operable to prevent escape of said excess fuel vapors from the air cleaner means.

9. The invention of claim 8, wherein said air cleaner means includes pressure relief means operable to open said air cleaner means to the atmosphere in the event of

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excessive pressure buildup within the engine.

10. The invention of claim 4, wherein is included a delivery nozzle for delivering fuel from a storage area to said tank, said nozzle being provided with coupling means for sealingly securing the nozzle to the tank whereby fuel is drawn from the storage area and into the tank in response to the reduced pressure in the tank as a result of the suction head of the engine being in communication therewith.

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