United States Patent

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[73] Assignee **Eaton Yale & Towne Inc.**

[54] **VALVE FOR EVAPORATIVE LOSS CONTROL**
13 Claims, 9 Drawing Figs.

[52] U.S. Cl. **123/136,** 123/121
[51] **Int. Cl.** **F02m 25/00**
[50] **Field of Search** 123/120, 121, 136, 139.8, 139.2, 139.17, 140.2; 103/5

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ABSTRACT: Apparatus for evaporative loss control employs a single diaphragm-type valve which is operable in response to pressures developed by fuel vapors, ambient conditions and engine vacuum to control evaporative loss in an automobile fuel system.

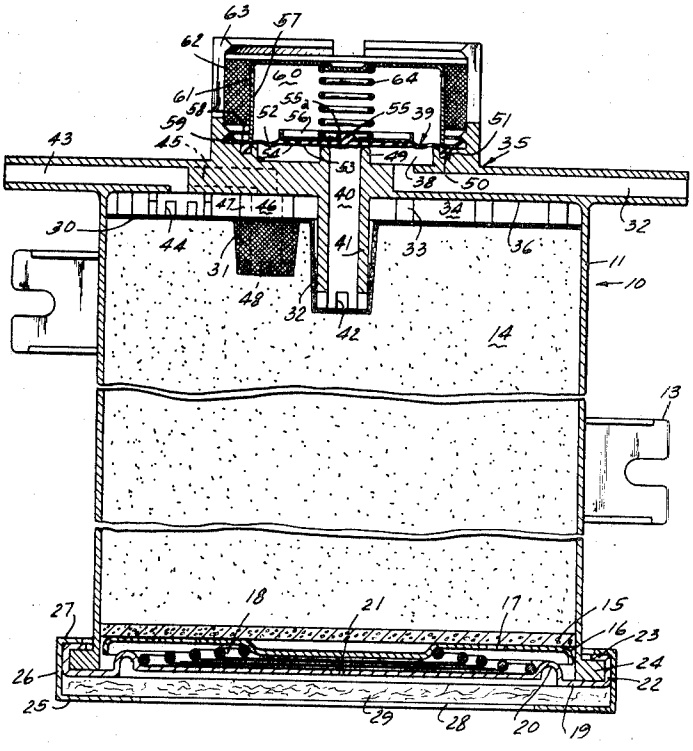


Fig. 1

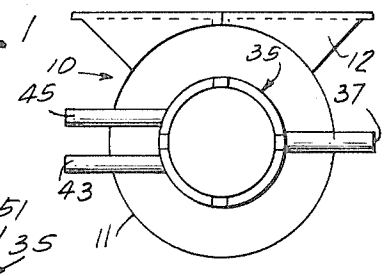


Fig. 2

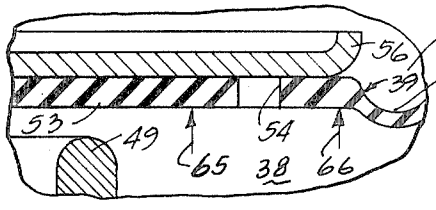
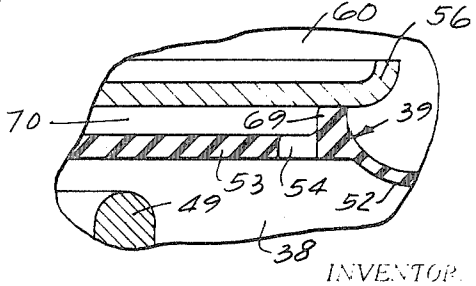


Fig. 3

Fig. 5



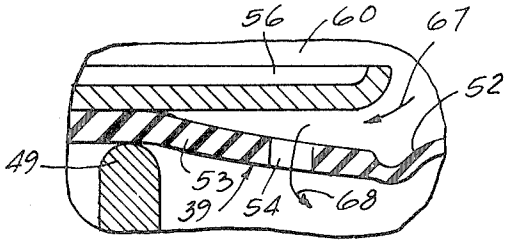


Fig. 4

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Fig. 6

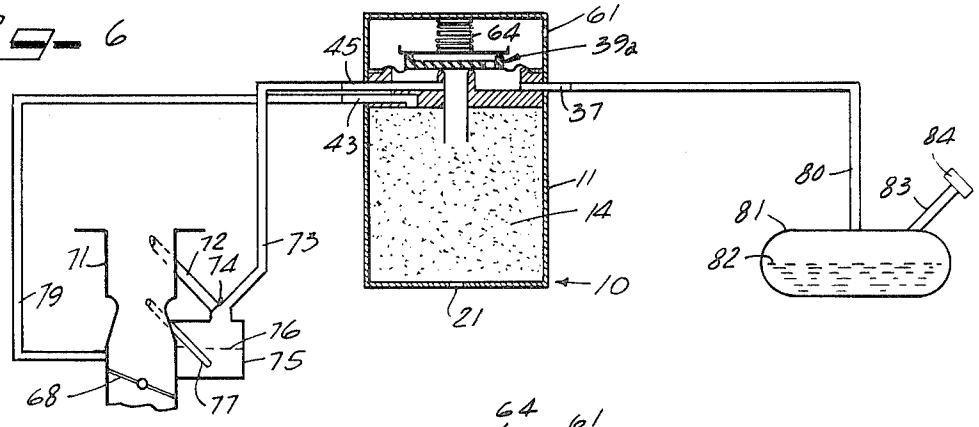


Fig. 7

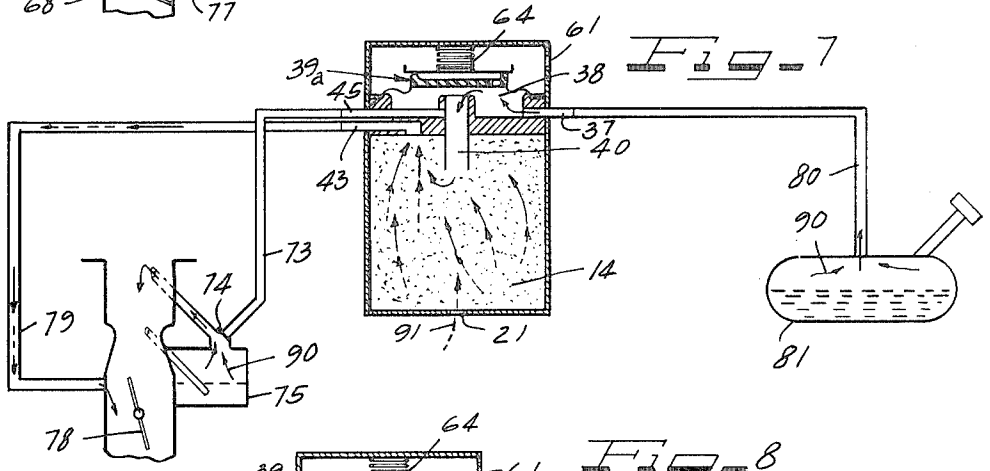
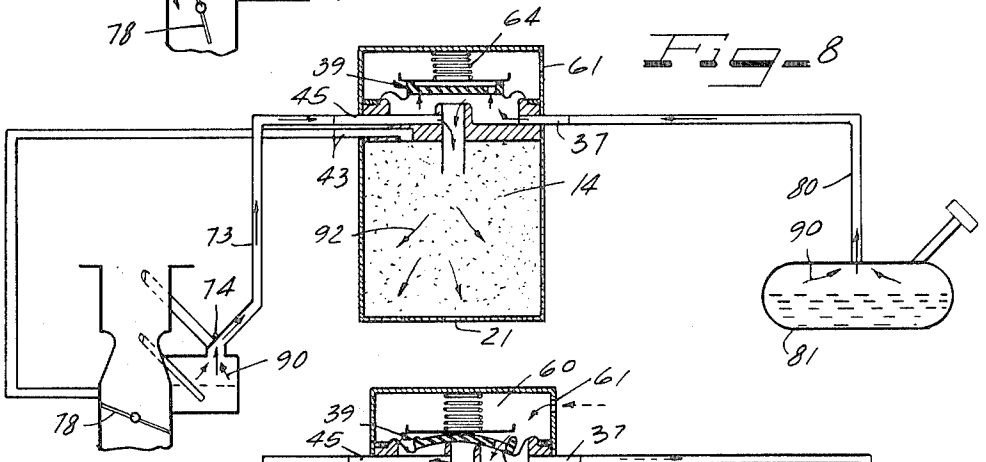


Fig. 8



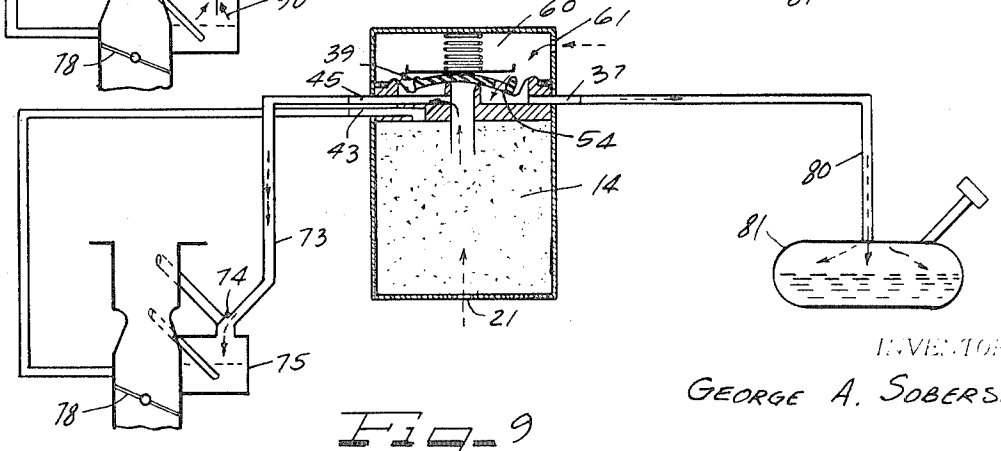


Fig. 9

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VALVE FOR EVAPORATIVE LOSS CONTROL

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to evaporative loss control apparatus, and in particular to valve apparatus for controlling evaporative loss in the fuel system of an automotive engine.

2. Description of the Prior Art

Evaporative loss control devices have found particular use in automotive fuel systems to purge fuel vapors from the fuel reservoirs during engine operation; to store vapors after engine operation when the fuel system is in an immediate overheat condition; and to return vapors to fuel reservoirs for condensation after cool down of the system, in cooperation with the carburetor and a vent switch of the automotive engine.

Heretofore, such apparatus employed at least two separate, but cooperable valves to channel the air and fuel vapors between the plurality of fuel reservoirs and the carburetor. In addition to the obvious disadvantage of requiring additional parts, the provision of a plurality of valves to provide the purging and venting operations, has a number of other disadvantages. One of these is the added design requirements for each valve and the cooperable parts thereof. Furthermore, the additional number of parts requires longer per unit assembly time. It is therefore desirable for evaporative loss control apparatus to employ a single valve for providing the venting and purging operations.

SUMMARY OF THE INVENTION

According to the invention, an evaporative loss control device comprises a hollow housing which forms a chamber for holding an absorbent material. The housing has an orifice therein forming an air-purging passageway in communication between the chamber and the atmosphere.

At the top of the housing are first and second passageways in communication with the chamber. The first passageway is adapted for connection to a carburetor line and through a vent switch to the upper throat portion of a carburetor. The second passageway is adapted for connection to a purge line which is in communication with a vacuum port adjacent the butterfly valve in a lower throat portion of the carburetor as a vacuum input to the device.

A third passageway at the top of the device is adapted for connection to a fuel tank vent line. This third passageway is provided in communication with either the chamber or the atmosphere through a single dual-acting diaphragm valve in accordance with the pressure differences between the atmosphere and the fuel tank.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention, its organization, construction and operation, according to one illustrative embodiment thereof, will be best understood from the following description taken in conjunction with the accompanying drawings, in which:

FIG. 1 is a top plan view of an evaporative loss control device according to the present invention;

FIG. 2 is an elevational view, in section, of the apparatus of FIG. 1 taken along the line II—II;

FIGS. 3 and 4 are more detailed views of the valve apparatus shown in FIG. 2;

FIG. 5 is a modification of the apparatus of FIGS. 2, 3 and 4; and

FIGS. 6–9 are schematic diagrams of an evaporative loss fuel vapor system according to the present invention shown in various operational modes of the associated automobile engine.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

In FIGS. 1–5, an evaporative loss control device is generally shown at 10 as comprising a hollow canister-type housing 11 defining a chamber 14 therein. Mounting flanges 12 having slotted tabs 13 are provided for securing the device within the engine compartment of an automobile.

Chamber 14 is filled with an absorbent material, preferably activated charcoal or a shredded rubber compound for collecting fuel vapors. At the lower end of device 10 and against the absorbent material is a screen or porous material 15 against which is located a pressure plate 16 having a plurality of holes 17 therein. A spring retainer 19 having a raised ridge portion 20 compresses spring 18 against the bottom of the pressure plate 16 and is secured to the hollow housing 11 by edge portions 22 and 23 which form a groove for accepting an annular ridge 24 at the lower end of the housing. A removable plastic cover 25 having a large opening 28 in the center thereof holds a filter 29 against the spring retainer 19 and releasably engages the spring retainer 19 by the overlapping portions 26 and 27 which overlappingly engage portions 22 and 23 of the retainer. The air passage into the bottom of the device 10 is therefore defined by opening 28, filter 29, hole 21, holes 17 and screen 15.

At the top of the device 10, and adjacent the top surface of the absorbent material is a screen 30 which is spaced from the top of the chamber 14 by spacers 33 to define chamber 34 therebetween. The top of the housing further defines a plurality of passageways including a first passageway 37 which is defined by wall 36 of top portion 35. Passageway 37 is adapted for connection to a fuel tank line for venting and purging vapors with respect to the fuel tank. Passageway 37 is in communication with a chamber 38 which is formed between the top portion 35 of housing 11 and a rubber diaphragm 39 which is secured by its bead portion 51 which is held in groove 50 by a spring housing 57. The spring housing 57 is secured to the top portion 35 by means of portions 59 forming a snap fit with an annular groove 58 of the top portion 35.

Spring housing 57 holds spring 64 against a pressure plate 56 having an aperture 55*a* therein for receiving a snap button 55 of diaphragm 39. The spring 64 therefore urges diaphragm 39 downwardly against rounded end portion 49 of cylinder 41 formed in the upper portion 35, the cylinder 41 extending downwardly into a well 32 of screen 30 within the chamber 14.

Under conditions of positive pressure, symbolized by arrows 65 and 66, from the fuel tank line through passageway 37 into chamber 38, diaphragm 39 and pressure plate 56 operate against the action of the spring to open the seal between the flat portion 53 of the diaphragm and the rounded end portions 49 of cylinder 41 to permit fluid communication between the fuel tank and chamber 14 via a path including passageway 37, chamber 38, passageway 40 of cylinder 41, slots 42 at the lower end of cylinder 41 and the screen well 32.

Under conditions of negative pressure within the fuel line and accordingly within passageway 37 and chamber 38, the spring 64 closes the above-mentioned path at end 49 of cylinder 41. Further, ambient air pressure transmitted through slot 63 of portion 35, filter 62, and holes 61 in spring housing 57 into chamber 60 acts on a first flexible portion 52 of diaphragm 39 to flex portion 53 thereof sufficiently to provide a continuation of the just-traced path through holes 54 of diaphragm 39 into chamber 38 and on through passageway 37 to the fuel tank line.

FIG. 5 illustrates a variation of the valve shown in detail in FIGS. 3 and 4 wherein a diaphragm 39*a* includes an annular upstanding ridge as a seal against the pressure plate 56. The operation of diaphragm 39*a* is substantially the same as that of the diaphragm 39.

A top portion 35 has two additional passageways formed therein. One of these passageways 43 is adapted for connection to a carburetor line and communicates the carburetor line with chamber 14 by way of slots 42 (for greater vapor dispersion) of a downwardly extending portion of passageway 43. This passageway is for communication between the throat of the carburetor and the chamber 14 by way of a purge line 79, as illustrated in FIGS. 6–9, whereby a vacuum may be supplied to the chamber 14.

Another passageway 45 has a depending cylindrical portion 47 defining a further passageway 46 having a slotted end (slots 48) extending into screen well 31 of screen 30 within chamber

14, the passageway 45 being adapted for connection to a line 73 for providing communication between the chamber 14 and a vent switch 74 and a fuel bowl 75 of a carburetor, as also illustrated in FIGS. 6–9.

OPERATION

The various operational modes of the evaporative loss control vapor system according to the present invention are shown in FIGS. 6–9 wherein a limited number of reference characters are employed for sake of clarity.

FIG. 6 describes a condition wherein the automotive engine is inoperative and cold, the fuel system also being cold and no fuel vapors being generated in the fuel tank 81 or in the carburetor hole 75.

Under such conditions, the butterfly valve 78 of carburetor 71 is closed there being no vacuum supplied through purge line 79 to passageway 43 of device 10. The vent switch 74 is positioned to close line 72 which extends to the upper throat area of the carburetor 71 and open to line 73 to place the fuel bowl 74 in communication with chamber 14 via passageway 45. In FIGS. 6–9 reference 76 indicates fuel level and reference 77 indicates a fuel line extending between the carburetor and the fuel of the fuel bowl 75. There being no pressure difference between the fuel tank 81 and ambient conditions, diaphragm 39*a* is closed.

FIG. 7 illustrates the conditions of fuel system when the automotive engine is in operation, the engine being on an hot and the fuel system being sufficiently warm so that fuel vapors are generated in the fuel tank 81 and the carburetor bowl 75.

Under these conditions, the diaphragm 39*a* is opened to the positive pressures developed in fuel tank 81, symbolized by arrows 90. The butterfly valve 78 is opened providing a vacuum through purge line 79 to passageway 43 of the loss control device 10. The vent switch 74 is opened to the carburetor, but closed to line 73 and passageway 45. Therefore, vapors from tank 81 pass to the carburetor over a path comprising line 80, passageway 57, chamber 38, passageway 40, chamber 14, passageway 43 and purge line 79. In chamber 14 air is drawn in through hole 21, (symbolically representing the holes and filters at the lower part of the canister), the air being mixed with the fuel vapors 90 and the material of chamber 14 being purged of fuel vapors by the vacuum supplied by the carburetor.

FIG. 8 illustrates the condition of immediate overheat wherein the engine has just been turned off and is still hot and the system is hot wherein fuel vapors are still being generated to positive pressures in the fuel tank 81 and the carburetor bowl 75.

In this situation, the butterfly valve 78 is closed and no vacuum is supplied to chamber 14. The vent switch is closed to the carburetor, but opened to lines 73 and passageway 43 into chamber 14 so that fuel vapors 90 may traverse this path into chamber 14. Also fuel vapors 90 from fuel tank 81 establish a positive pressure on the lower side of diaphragm 39*a* urging the diaphragm against the action of spring 64 so that these vapors are also passed into the chamber 14. In such a case the activated charcoal or shredded rubber compound absorb these fuel vapors until the fuel system has cooled sufficiently in that no further vapors are being generated.

FIG. 9 illustrates the venting of the system to the atmosphere under conditions of negative pressure wherein the engine if off and has cooled down and the system fuel vapors are cooling sufficiently for condensation.

In FIG. 9, a negative pressure is established in chamber 38 (see FIG. 4) so that diaphragm 39*a* is flexed to the extent that fluid communication is established between the atmosphere and the fuel tank 81 over a path comprising holes 61, chamber 60, holes 54 of diaphragm 39*a*, passageway 37 and fuel tank line 80. By this action, any vapors within chamber 38, passageway 37 and fuel tank line 80 are forced back into the fuel tank 81 for condensation.

Inasmuch as the engine is off and the butterfly valve 78 is closed, no vacuum is supplied to the chamber 14 via passageway 43; however, fluid communication is established between the atmosphere and fuel bowl 75 since vent switch 74 is opened to the evaporative loss control device. Such communication comprises the path of hole 21, chamber 14, passageway 43 and carburetor line 73, the negative pressures established in the fuel bowl drawing air through hole 21 to force vapors over the just-traced path for condensation within the fuel bowl.

Although I have described my invention by reference to specific illustrations, many changes and modifications thereof will be evident to those skilled in the art without departing from the spirit and scope of my invention as set forth in the appended claims.

What I claim as my invention is:

1. Apparatus for controlling evaporative loss in a fuel system having a source of vacuum and a plurality of fuel reservoirs in which there is a positive or negative fuel vapor pressure, said apparatus comprising:
   - a housing defining a chamber;
   - absorbent material disposed in said chamber;
   - a first passageway in said housing in communication with said chamber and adapted for fluid connection to one of said fuel reservoirs;
   - a second passageway in said housing for communication with said chamber and the atmosphere and adapted for fluid connection with a second of said fuel reservoirs;
   - a third passageway in said housing in communication with said chamber and adapted for connection to said source of vacuum; and
   - valve means interposed between said second passageway and said chamber, said valve means being in fluid communication with the atmosphere and operable to connect said second passageway in fluid communication with said chamber in response to positive pressure in said second passageway and to the atmosphere in response to negative pressure in said second passageway.

2. The apparatus defined in claim 1 wherein said absorbent material is activated charcoal.

3. The apparatus defined in claim 1 wherein said absorbent material is a shredded rubber compound.

4. The apparatus defined in claim 1 wherein said valve means comprises a subhousing defining a valve chamber, a fourth passageway having a port in said subhousing and in communication with said chamber, a flexible diaphragm extending across said valve chamber and dividing said valve chamber into first and second valve chambers, the first valve chamber being in communication with the atmosphere and the second valve chamber being in communication with said second passageway, biasing means urging said diaphragm against said port, and a passageway in said diaphragm for connecting said first and second valve chambers in communication when said diaphragm is flexed in response to a lower pressure in said second valve chamber than in said first valve chamber.

5. The apparatus defined in claim 4 wherein said housing has an annular groove therein and said diaphragm includes a peripheral bead disposed in said groove, and wherein said subhousing includes means for securing said bead in said annular groove.

6. The apparatus defined in claim 4, wherein said diaphragm includes first and second portions, said passageway for connecting said first and second valve chambers extending through said first portion, and said biasing means includes a pressure plate adjacent said first portion and spring means disposed between said pressure plate and said subhousing for urging said diaphragm against said port, and wherein a higher pressure in said second chamber than in said first valve chamber is effective to urge said first diaphragm portion against said pressure plate to close said connecting passageway.

7. The apparatus defined in claim 4, wherein said housing includes a hollow body portion for receiving said absorbent material, said body including a closed end portion, a formed screen disposed spaced apart from said end portion to form a chamber section which is free of absorbent material, a pair of well-shaped portions in said screen, said third passageway being in communication with said chamber section, said first and fourth passageways extending into separate ones of said well-shaped screen portions to communicate with the absorbent material of said chamber.

8. The apparatus defined in claim 7, wherein said first and fourth passageways include formed openings within said well-shaped screen portions, said formed openings including a plurality of fluid passages directed at an angle to the direction of the respective passageways to obtain vapor dispersion.

9. The apparatus defined in claim 1, wherein said housing includes a hollow body portion having an open end for receiving the absorbent material, a ridge extending along the outer surface of the body portion at its open end, filter means disposed adjacent said absorbent material, a pressure plate having at least one hole therethrough disposed against said filter means, spring means bearing against said pressure plate, and a spring retaining means having at least one hole therethrough disposed against said spring means and including means engaging said ridge of said hollow body portion.

10. The apparatus defined in claim 9, comprising another filter disposed adjacent said spring retaining means and cover means having at least one hole therethrough disposed against said other filter means and including means engaging the engaging means of said spring retaining means.

11. An evaporative loss controlled fuel system for an automotive engine comprising, in combination,

a carburetor operatively connected to the engine including at least two fuel vapor ports one of which is a vacuum port having a vacuum during engine operation,

a fuel bowl connectable to the other of said fuel vapor ports for containing an evaporative fuel,

a fuel tank for containing an evaporative fuel,

evaporative loss control apparatus for absorbing and releasing fuel vapor including a housing defining a chamber, said chamber being in communication with the atmosphere and with said vacuum port and connectable for communication with said fuel bowl,

a venting switch for selectively connecting said fuel bowl in communication with said other vapor port during engine operation and with said chamber when said engine is not operating, and

valve means in said evaporative loss control apparatus, said valve means including a flexible diaphragm in communication with the atmosphere and with said fuel tank and being flexibly operable to connect said fuel tank in communication with said chamber in response to positive vapor pressure in said fuel tank, and to connect said fuel bowl in communication with said chamber in response to negative vapor pressure in said fuel tank.

12. The combination set forth in claim 11, comprising absorbent material in said chamber for absorbing fuel vapors when said engine is not operating and said valve means and said venting switch are conditioned to connect said chamber in communication with said fuel tank and with said fuel bowl.

13. The apparatus defined in claim 1, wherein said valve means comprises a subhousing defining a valve chamber, a fourth passageway having a port in said subhousing and in communication with said chamber, a flexible diaphragm extending across said valve chamber and dividing said valve chamber into first and second valve chambers, said first valve chamber being in communication with the atmosphere and said second valve chamber being in communication with said second passageway, and biasing means urging said diaphragm against said port, said diaphragm being moved against the bias of said biasing means and away from said port in response to a pressure in said second valve chamber that is above atmospheric pressure.

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