An evaporative loss control apparatus for draining the gas remaining in the carburetor of an internal combustion engine after the engine is stopped to prevent evaporation thereof by the residual engine heat. The evaporative loss control apparatus includes a vacuum tank connected with the intake manifold of an internal combustion engine and a check valve permits flow toward such manifold only. The vacuum tank is connected with the carburetor and a fuel control valve admits flow to such tank when the engine is stopped. The vacuum tank is connected with the automobile gas tank and a dump valve admits flow to the gas tank after the engine is stopped and the carburetor drained. Thus, when the engine is operating the vacuum tank is in communication with the intake manifold to pull a vacuum in such tank. When the engine is stopped the vacuum in such tank is effective to pull the residual gasoline from the carburetor and, when the vacuum tank approaches atmospheric pressure, the gasoline therein will be dumped into the automobile gas tank.

12 Claims, 12 Drawing Figures
EVAPORATIVE LOSS CONTROL APPARATUS

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates generally to smog control devices and, more particularly, to a device for preventing evaporation of gasoline from an automobile carburetor after the engine is stopped.

2. Description of the Prior Art

There are no prior art evaporative loss control devices known to applicant which include a vacuum tank that utilizes the vacuum from the intake manifold of an internal combustion engine to pull the residual gasoline from the engine carburetor when said engine has been stopped.

SUMMARY OF THE INVENTION

The present invention is characterized by a vacuum tank which is in communication with the intake manifold of an internal combustion engine when such engine is in operation to effect a vacuum in such tank. When the engine is stopped, the tank is placed in communication with the carburetor to pull the residual gasoline therefrom and, when the tank approaches atmospheric pressure, such gasoline will be dumped back into the engine gas tank.

Another object of the present invention is to provide an evaporative loss control apparatus for draining the carburetor of an internal combustion engine after such engine has been stopped.

Still another object of the present invention is to provide an evaporative loss control apparatus of the type described that utilizes the vacuum available from the intake manifold to draw such gasoline from the carburetor.

These and other objects and the advantages of the present invention will become apparent from a consideration of the following detailed description when taken in conjunction with the accompanying drawing.

DESCRIPTION OF THE DRAWING

FIG. 1 is a diagrammatic view of an evaporative loss control apparatus embodying the present invention;
FIG. 2 is a top view, in enlarged scale, of a vacuum tank included in the evaporative loss control apparatus shown in FIG. 1;
FIG. 3 is a broken vertical sectional view taken along the line 3--3 of FIG. 2;
FIG. 4 is a vertical sectional view taken along the line 4--4 of FIG. 2;
FIG. 5 is a horizontal sectional view taken along the line 5--5 of FIG. 4;
FIG. 6 is a horizontal sectional view taken along the line 6--6 of FIG. 3;
FIG. 7 is a diagrammatic view of a second embodiment of the evaporative loss control apparatus of present invention;
FIG. 8 is a top view, in enlarged scale, of the vacuum tank included in the evaporative loss control apparatus shown in FIG. 7;
FIG. 9 is a vertical sectional view taken along the line 9--9 of FIG. 8;
FIG. 10 is a vertical sectional view taken along the line 10--10 of FIG. 8;
FIG. 11 is a vertical sectional view taken along the line 11--11 of FIG. 8; and
FIG. 12 is a detail view, in enlarged scale, similar to FIG. 9.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIG. 1, the evaporation control apparatus of present invention includes a cylindrical upright vacuum tank 11 which is connected with the intake manifold 13 of an internal combustion engine by a vacuum tube 15. The tank 11 is connected on its top end with the carburetor 19 by a gasoline 21 and has its bottom end connected with the engine gas tank 25 by a dump line 26. Valves are provided for controlling flow between the vacuum tank, the intake manifold and the gas tank whereby during engine operation the intake manifold 13 will pull vacuum on the tank 11 and when the engine is stopped, the vacuum in the tank 11 will draw the residual gasoline from the carburetor 19 for subsequent drainage into the gas tank 25.

Referring to FIG. 3, the vacuum tank 11 is formed by an upstanding pipe 29 having a top wall 31 and a bottom wall 33. A pair of ports 35 are formed in the top wall 31 and flow therethrough is controlled by a pair of respective solenoid operated gas valves 41 and 43. A resilient gasket 45 overlies the top wall 31 and is sandwiched between such top wall and a mounting flange 47. The mounting flange 47 includes a pair of threaded bores 51 extending down from its top side and in communication with the respective ports 35 by means of reduced-in-diameter bores 53.

The solenoid valves 41 and 43 include downwardly projecting threaded mounting bosses 57 which are screwed into the respective bores 51. Vertical screws 61 are carried from the armatures 63 of the respective valves 41 and 43 and the shank of such screws 61 projects downwardly through the reduced-in-diameter bores 53 and through bores 67 in the resilient gasket 45 whereby energization of the valves 41 and 43 will raise the respective armatures 63 to pull the heads of the respective screws 61 against the gasket 45 surrounding the bores 67 to seal such bores 53.

As best seen in FIG. 3, a bore 68 angles in from the side of the mounting flange 47 to each of the bores 51 under the respective valves 41 and 43. Referring to FIG. 3, the bore 68 leading to valve 41 receives one end of a tube insert 69 and the projecting end of such tube insert is connected with the gasoline 21 leading to the carburetor 19. Referring to FIGS. 2 and 3, the bore 68 leading to valve 43 receives one extremity of a tube insert 66 and the projecting end of such insert is connected with a gas line 70 leading to an afterburner carburetor 71 of a smog control device.

Float valves 72 are included in the gasoline 21 and 70 and include balls 73 (FIG. 3) which are sufficiently buoyant to float in gasoline to permit gasline flow from such valves but to seat when all the gasoline has been drained from one of the carburetors 19 or 71 to restrict flow of air from the carburetor 19 or 71 which is first to drain to maintain the vacuum in the tank 11 while the other carburetor drains.

Referring to FIG. 4, a vacuum port 74 is drilled in the upper vacuum tank wall 31 and is normally covered by the resilient gasket 45. The gasket 45 is formed with a perforation 76 which is offset from the vacuum port 74 and the mounting flange 47 is formed with a recess 77 disposed over both the vacuum port 74 and the perforation 75 whereby the gasket 45 will rise off the port 74 when vacuum is applied to the top side thereof and will seal on the port 74 when the pressure in the recess 77 approaches atmospheric pressure and a subatmospheric pressure exists within the tank 11. An inclined bore 81 leads in from the side of the mounting flange 47 to the recess 77 and receives a tube insert 83 which is connected with the vacuum line 15 leading to the intake manifold 13. The vacuum line 15 and associated fittings offer sufficient resistance to airflow from the vacuum tank 11 to the intake manifold 13 to prevent an in-rush of air to such manifold when the engine is first started.

Referring to FIGS. 3 and 6, the bottom wall 33 of the tank 11 includes a plurality of central dump ports 95 arranged in a circular pattern and confront on their bottom end by a resilient gasket 99. The gasket 99 is formed with an opening 101 disposed centrally of the circular pattern defined by the ports 95. The gasket 99 is sandwiched between the lower end of the gas tank wall 33 and the annular rim of a dump fitting 105 having the central recess 107 which conforms the central opening 101 in the diaphragm 99. The dump fitting 105 is secured to the bottom wall 33 by means of a plurality of studs 109 and is formed
with a central bore which has one end of a tube insert 111 received therein, the other end of such insert connecting with a dump tube 26 leading to the top of the gas tank 25. 

In operation, the vacuum tank 11 is preferentially mounted in an upright position at a higher elevation than the gas tank 25, so that the vacuum device 105 provided in the trunk of an automobile, and must be connected with the gas tank 25 by means of the dump tube 26. The vacuum port 74 is then connected with the intake manifold 13 by means of the vacuum line 15. The gas port to the solenoid valve 41 is then connected with the carburetor 19 by means of the gas line 21. If the engine is connected with an aftertreatment device having a carburetor 71, such carburetor will be connected with the port to the gas valve 43 by means of a conduit 70. The solenoids of the valves 41 and 43 are then connected in series with the engine ignition switch. 

When the ignition switch is closed to energize the electric starter, the vacuum line 15 will offer substantial resistance to airflow from the tank 11 to the intake manifold 13 thereby preventing an in-rush of air and upsetting the carburetor balance. Closing of the ignition switch will energize the solenoid valves 41 and 43 to pull the respective armatures 63 upwardly to press the heads of the respective screws 61 firmly against the surrounding gasket 45 to seal the ports 53 thus shutting off communication between the tank 11 and the carburetor 19. 

The vacuum communicated through the vacuum line 15 will effect a subatmospheric pressure in the recess 77 (FIG. 4) thus partially lifting the diaphragm 45 from sealing contact with the upper end of the vacuum port 74 to permit flow of air from the tank 11 to the intake manifold 13. 

The gasket 99 normally blocks the lower ends of the dump ports 95 and as the vacuum builds up in the tank 11, such diaphragm will be pulled into firm sealing engagement with such dump ports 95 thus preventing admission of air from the gas tank 25. During operation of the engine the highest vacuum experienced by the manifold 13, usually during deceleration, will be communicated to the tank 11 and will be trapped thereby by the flapper valve effect of the diaphragm 45 over the upper end of the vacuum port 74. 

When the ignition switch is turned off, the gas valves 41 and 43 will drop open to the position shown in FIG. 3, and vacuum from the tank 11 will be communicated to the carburetors 19 and 71 thereby drawing residual gasoline from the bowls thereof. It will be noted that the balls 73 in the valves 72 will float in the gasoline and permit passage thereof into the gas tank 11. When the first carburetor 19 or 71 is emptied, the associated float valve 72 will be closed by means of the ball 73 seating thus restricting admission of air from the carburetor which is first to empty. The other carburetor will then continue draining until the entire residual gasoline is communicated to the tank 11. 

After drainage of both the carburetors 19 and 71, air will continue to sweep past the balls 73 and into the tank 11 until such tank approaches atmospheric pressure. As the tank 11 approaches atmospheric pressure, the weight of the gasoline therein will deflect the central portion of the diaphragm 99 covering the dump ports 95 downwardly thereby permitting flow of gasoline downwardly through the opening 101 and through the dump tube 26 to the gasoline tank 25. 

The evaporation loss control apparatus shown in FIGS. 7 through 12 is similar to that shown in FIGS. 1 through 6 and includes an upstanding vacuum tank, generally designated 121, for selectively drawing fuel from the respective carburetors 123 and 125. Referring to FIG. 9, the tank 121 includes an intermediate top plate 131 sandwiched between a top plate 132 and a cover plate 133. Referring to FIGS. 9, 11 and 12, the top plate 132 is formed with a pair of inletlets 137 which confront respective ports 139 leading to poppet chambers 141 formed by recesses in the plate 131. Recesses 143 formed in the cover plate 133 confront the respective poppet chambers 141 and are partitioned therefrom by a flexible diaphragm 145 sandwiched between the intermediate plate 131 and the top plate 132 to define vacuum chambers. A valve stem 147 is carried by the diaphragm 145 and projects downwardly through the port 139 (FIG. 12) and has a threaded extremity which receives a nut 149 that holds an O-ring 151 which seals with such port when the stem 147 is raised. Leading from the vacuum cavities 143 are vacuum passages 153 which connect to a collector cavity 154 having a passage 155 (FIG. 10) leading to a vacuum tube 156 connected to the intake manifold. 

Referring to FIG. 11, leading from each of the fuel cavities 141 is a drain passage 157 which opens upwardly into a bore 159 formed in the top cover 133. An insert 161 is screwed into the threaded bore 159, such insert 161 being connected with the passage 155 and is formed with a plurality of divergent passages 163 which eject fuel downwardly into the bore 159 on opposite sides of a float 171 which carries a vertical stem 172 formed with a conical portion 173 that seals against the upper extremity of the passage 157 when the fuel has been fully drained from the respective carburetors 123 and 125. The conical portion 173 provides for slight seepage therearound when in its sealing position to enable air to seep into the tank 121. Referring to FIG. 10, the intermediate top plate 131 has a vacuum bore 175 drilled therethrough for selective communication between the collector port 154 and the tank 121. The top end of the bore 175 is normally sealed by the diaphragm 145 which is formed with a port 177 offset from the bore 175. 

The bottom wall 181 of the tank 121 is formed with a plurality of circularly arranged drain ports 183 which are confronted on their bottom ends by a flexible gasket 187 having a central opening 189 which opens into a drain fitting 191 that is connected with the automobile fuel tank 193 by means of a drain tube 195. 

Operation of the evaporation control apparatus shown in FIGS. 7 through 12 is substantially similar to that of the apparatus shown in FIGS. 1 through 6. When the automobile is started the manifold vacuum will be communicated to the respective vacuum cavities 143 to create a vacuum above the diaphragm 145 and pull the valve stems 147 upwardly to seal the O-rings 151 against the walls of the ports 139 thereby discontinuing communication between the tank 121 and the respective carburetors 123 and 125. 

The vacuum in the collector port 154 will lift the diaphragm 145 off the upper end of the bore 175 to enable communication of vacuum through such bore 175 into the interior of the tank 121. At any time when the vacuum from the engine manifold is lowered below that in the tank 121, the gasket 145 will seal on the upper end of the bore 175 thereby discontinuing communication from the manifold and maintaining the high vacuum in the tank 121. 

When the engine is turned off and the intake manifold pressure rises, the gasket 145 will be pushed into engagement over the port upper end of the bore 175 to prevent communication between such manifold and the interior of the tank 121. Loss of the vacuum in the valve vacuum cavities 143 will enable the valve stem 147 to drop downwardly thereby providing for communication between the respective carburetors 123 and 125 and the interior of the vacuum tank 121 to draw the residual fuel from such carburetors. During drainage of the respective carburetors 123 and 125 the fuel drawn therefrom will pass through the passages 163 in the respective inserts 161 to be directed downwardly and outwardly to clear the floats 171 to prevent interference therewith. The floats 171 will be buoyed upwardly to raise the conical portions 173 off the bores 159 to prevent the fuel drained into the tank 121. 

When drainage of either of the carburetor 123 or 125, which ever is the first to drain, is completed the associated bore 159 will empty to enable the corresponding float 171 to lower to seal the conical portion 173 on the upper extremity of the respective passage 157 to restrict admission of air and prevent the vacuum tank 121 from rapidly rising at atmospheric pressure to thereby discontinue drainage from the carburetor which is last to drain. When such last-to-drain carburetor is emptied, the respective float 171 will drop to seal the associated bore 157 but seepage of air will continue until
the vacuum tank 121 rises to atmospheric pressure to thereby enable the weight of the fuel on the gasket 187 below the drain ports 183 to bend such gasket downwardly and enable drainage through the central aperture 189 to the fuel tank 193. Obviously, the drainage time of the carburetors could be determined and a capillary tube inserted in the fuel line of the first-to-drain to decrease its drain rate so both would finish draining at the same time thereby eliminating the requirement for the floats 171.

From the foregoing, it will be apparent that the evaporative loss control apparatus of present invention provides an economical and convenient means for drawing residual gasoline from the carburetor of an internal combustion engine to thereby prevent evaporation of such gasoline by the residual heat in such engine. Further, the drainage is accomplished automatically by the vacuum readily available from the intake manifold of the engine.

Various modifications and changes may be made with regard to the foregoing detailed description without departing from the spirit of the invention.

I claim:

1. In an evaporative loss control apparatus for drawing fuel from an engine fuel bowl and of the type having a first fuel port connected with said fuel bowl, a vacuum port connected with a vacuum source, a dump port connected with a fuel tank and control means responsive to operation of an engine to close said fuel port and dump port and render said vacuum port communicative with said vacuum source and to said engine being rendered inoperative to close said vacuum port, open said fuel port and after a selected time open said dump port, the improvement comprising:
   a vacuum tank including a valve fuel port connected with said fuel bowl, a valve vacuum port connected with said vacuum source, and a valve dump port disposed below said fuel port for having fuel entering through said fuel port drawn directly thereto by gravitational attraction whereby in response to operation of said control means when said engine is operative said dump and fuel ports will be closed and said vacuum port rendered communicative with said vacuum source to draw a vacuum in said tank and when said engine is rendered inoperative said fuel port will be opened to enable the residual fuel from said bowl to be drawn into said vacuum tank and after said selected time said dump port will be opened to enable said residual fuel to be dumped into said fuel tank.
2. Evaporative loss control apparatus as set forth in claim 1 wherein:
   said dump control means is means including a dump port normally covered by a movable element and arranged to be held closed by a pressure differential thereacross resulting from a vacuum in said tank and to be opened by the weight of said fuel in said tank when said tank resumes atmospheric pressure.
3. An evaporative loss control apparatus as set forth in claim 1 wherein:
   said valve fuel port includes a sealing member responsive to a predetermined head of fuel action thereon and a predetermined pressure drop thereacross to open and dump fuel into said fuel tank.
4. Evaporative loss control apparatus as set forth in claim 1 wherein:
   said dump port is formed in the bottom wall of said vacuum tank.

5. Evaporative loss control apparatus as set forth in claim 1 wherein:
   said vacuum tank is vertically elongated and is open throughout its length to maintain said vacuum port and fuel port in direct communication with said dump port.
6. Evaporative loss control apparatus as set forth in claim 1 wherein:
   said vacuum tank is disposed above the elevation of said fuel tank whereby when said dump port is open said residual fuel will be drawn from said vacuum tank by gravitational force.
7. Evaporative loss control apparatus as set forth in claim 1 wherein said engine includes an auxiliary carburetor and wherein:
   said vacuum tank includes a second fuel port for connection with said auxiliary carburetor; and
   said fuel control means includes first and second float valves connected with said respective first and second fuel port valves and each including a poppet element having a specific gravity which will cause it to float off its seat as long as fuel is draining from the respective carburetors and will seat as soon as said drainage is complete.
8. Evaporative loss control apparatus as set forth in claim 1 wherein:
   said first and second valves are electric and are in circuit with the ignition system of said engine to be held closed while said ignition system is energized and to be opened when said ignition system is deenergized.
9. Evaporative loss control apparatus as set forth in claim 1 wherein:
   said fuel control means includes a normally open electric valve in series with the ignition switch of said engine for controlling flow in said fuel port whereby said valve will be held closed while said switch is closed and will be opened when said switch is opened.
10. Evaporative loss control apparatus as set forth in claim 1 wherein:
    said control means includes a movable element arranged to be held closed over said dump port by the pressure differential thereacross resulting from the vacuum in said vacuum tank and to be opened by the weight of the fuel in said vacuum tank when said vacuum tank resumes atmospheric pressure.
11. Evaporative loss control apparatus as set forth in claim 1 wherein:
    said dump control means is connected with the engine fuel tank and is responsive to the subatmospheric pressure in said vacuum tank approaching atmospheric pressure to dump the fuel in said vacuum tank into said fuel tank; and at least one of said poppet elements is shaped to provide restricted seepage of air thereby when it is seated on its seat to cause the subatmospheric pressure in said vacuum tank to approach atmospheric pressure when said one of said poppet elements is seated to thereby actuate said dump control means.
12. Evaporative loss control apparatus as set forth in claim 1 wherein:
    said fuel control means includes a poppet for seating in said fuel port, a pressure-responsive member controlling said poppet and a vacuum cavity on one side of said pressure-responsive member for connection with said intake manifold whereby the intake manifold pressure applied to said cavity will flex said pressure-responsive member to seat said poppet on said fuel port.

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