United States Patent

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[54] **VAPOR EMISSION CONTROL SYSTEM**
12 Claims, 9 Drawing Figs.

[52] **U.S. Cl.** **141/59,** 55/316, 55/385, 55/387, 123/136, 141/52, 141/287
[51] **Int. Cl.** **B65b31/06,** B01d 53/14
[50] **Field of Search** ..... 141/41-—43, 52, 59, 287, 307; 55/316, 387, 182, 385 NS; 123/136

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ABSTRACT: A vapor emission control system suitable for gasoline and other fuel delivery systems, adapted to eliminate the escape of fuel vapors to the atmosphere, and permit utilization of these vapors by the system. The disclosed embodiment of the control system includes a delivery conduit or line having a fuel delivery nozzle, an annular sealing means encircling the nozzle adapted to seal the nozzle within the opening to the container or tank, a vapor return line which may be vacuum operated, and a filter or other means adapted to store the vapors. In the disclosed embodiment of the nozzle assembly, the sealing means includes a flexible annular sleeve which is received within the container opening. The sleeve is expandable in one of the disclosed embodiments to seal the tank opening. In another embodiment, the sealing means is provided with a spring-tensioned annular sealing ring adapted to seal the opening to the tank. In the latter embodiment, the vapors are conducted through apertures in the sleeve to the vapor return line.

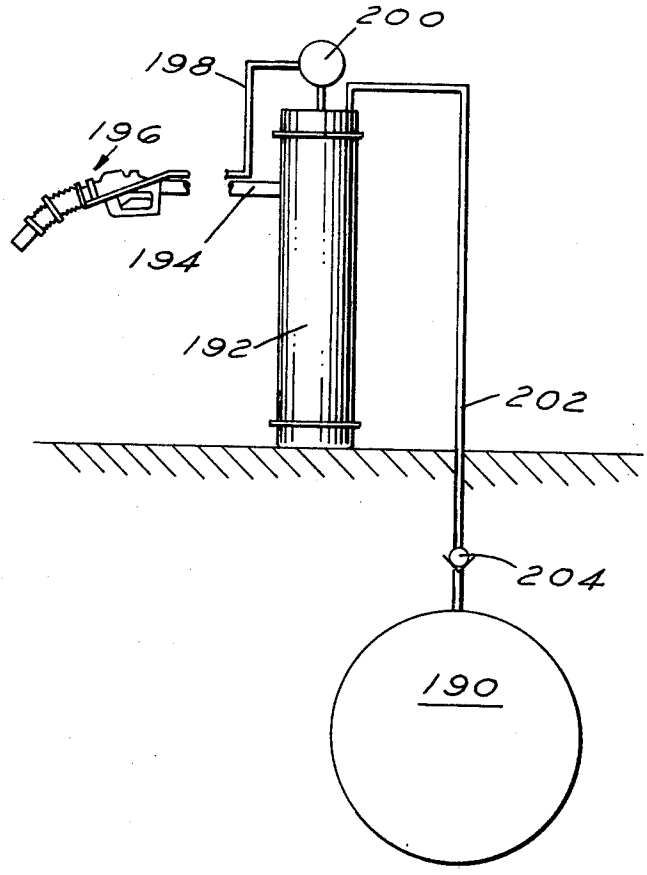


FIG. 1

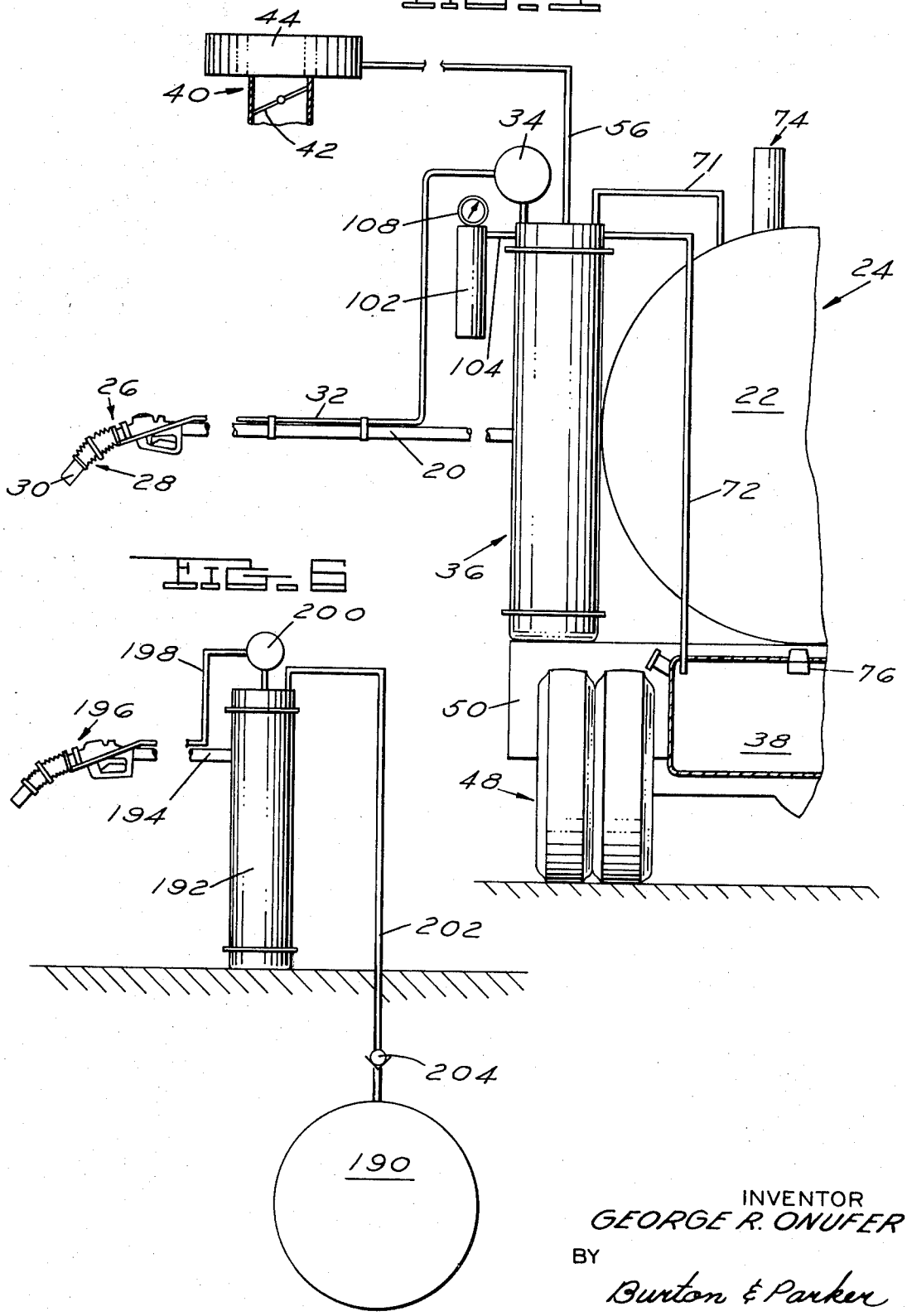


FIG. 6

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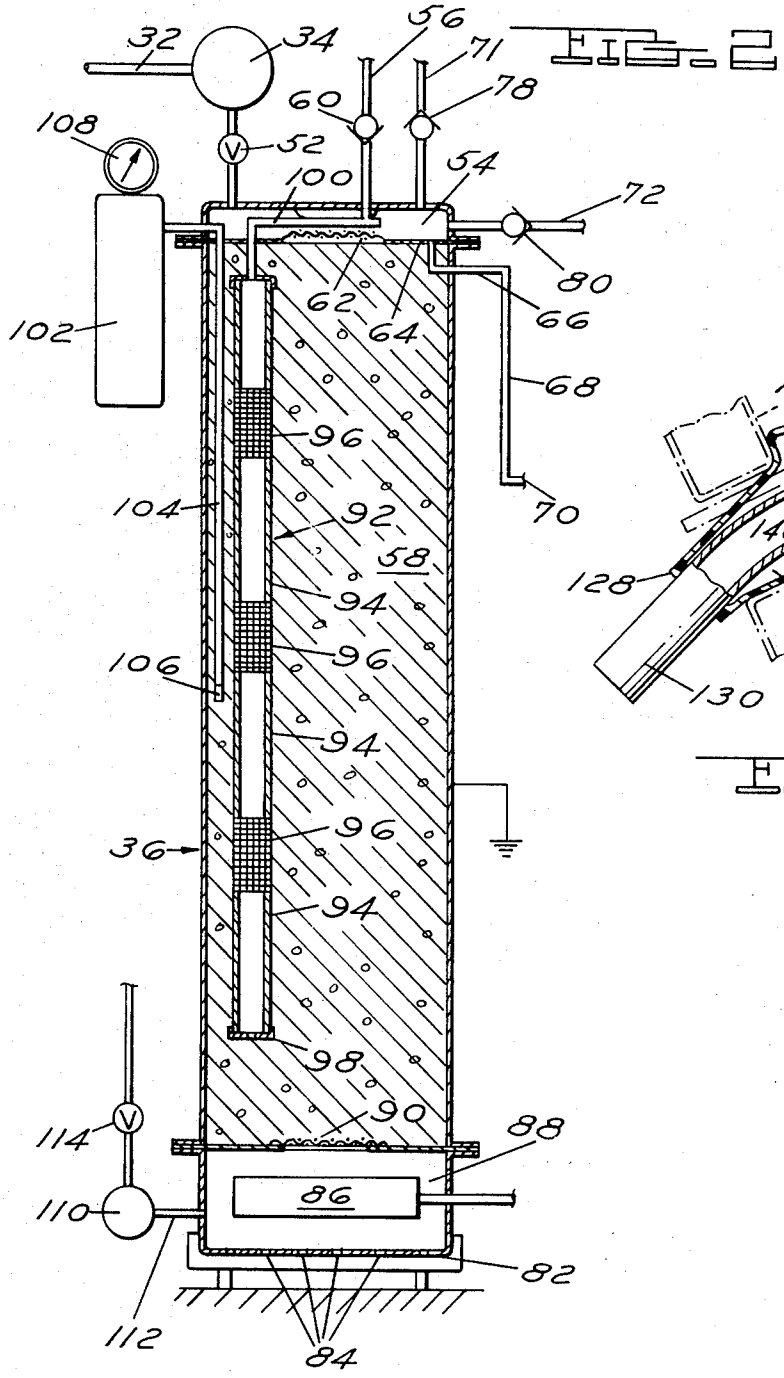


FIG. 2

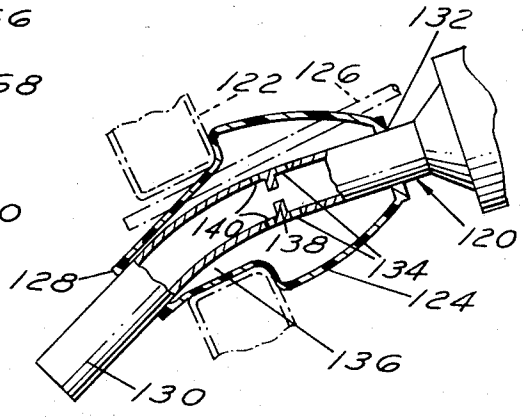


FIG. 3

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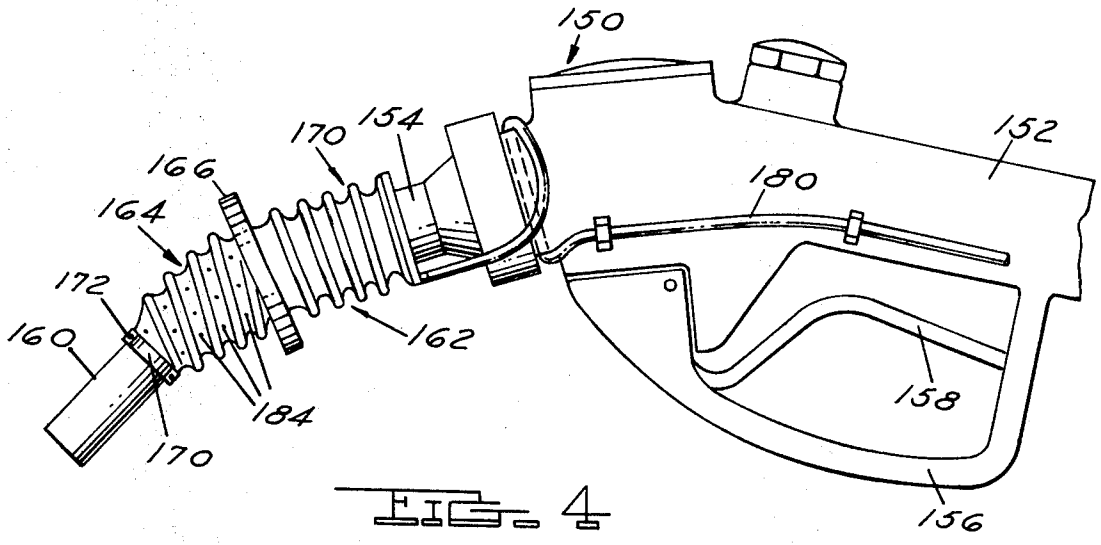
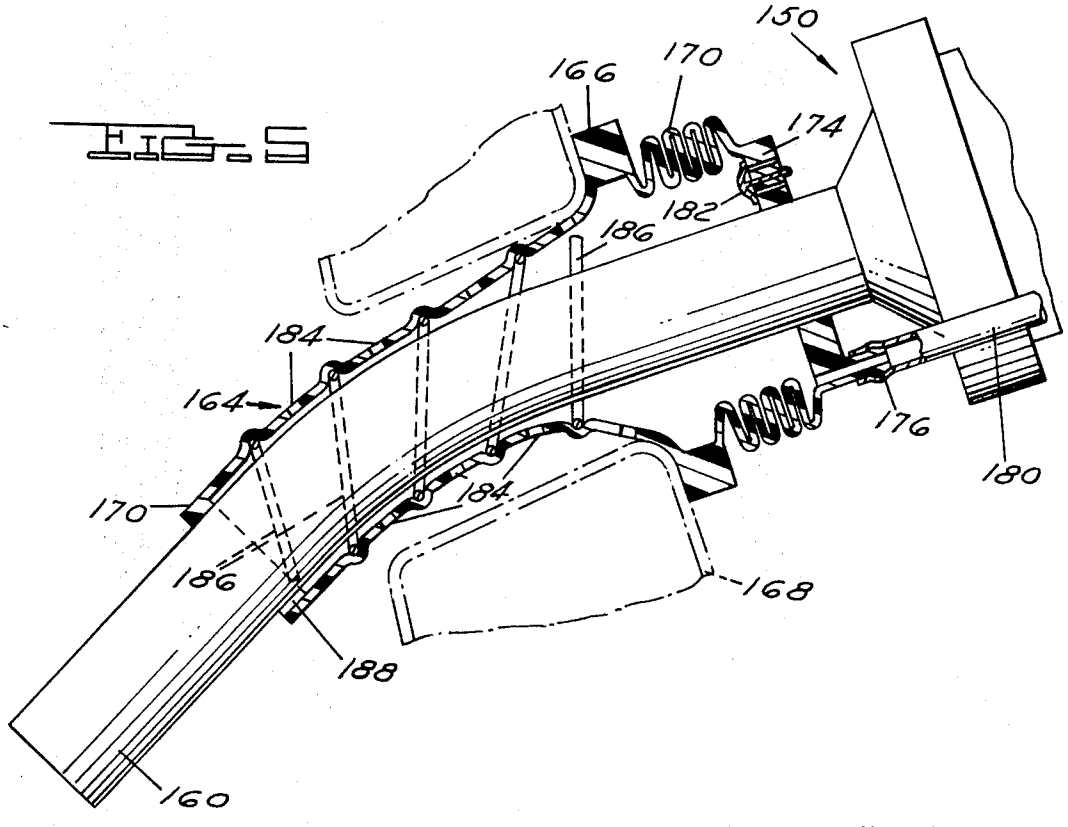


FIG. 4

FIG. 5



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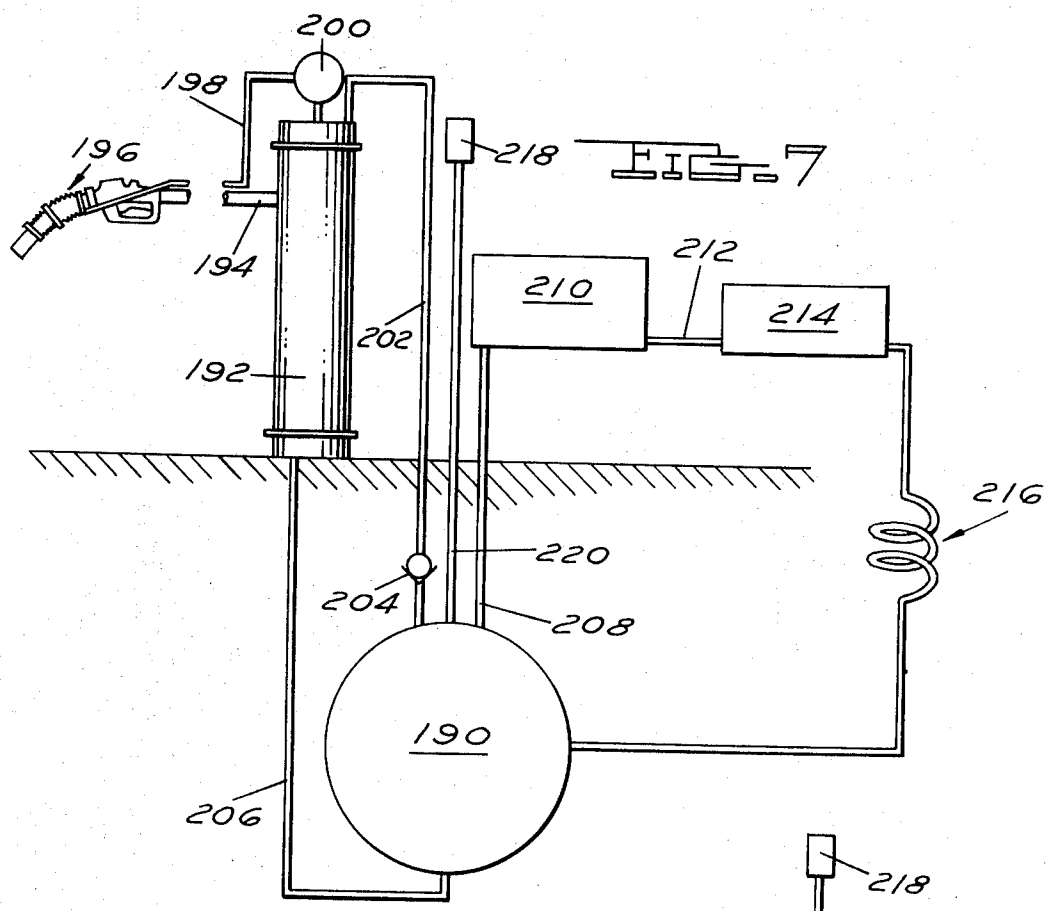


FIG. 7

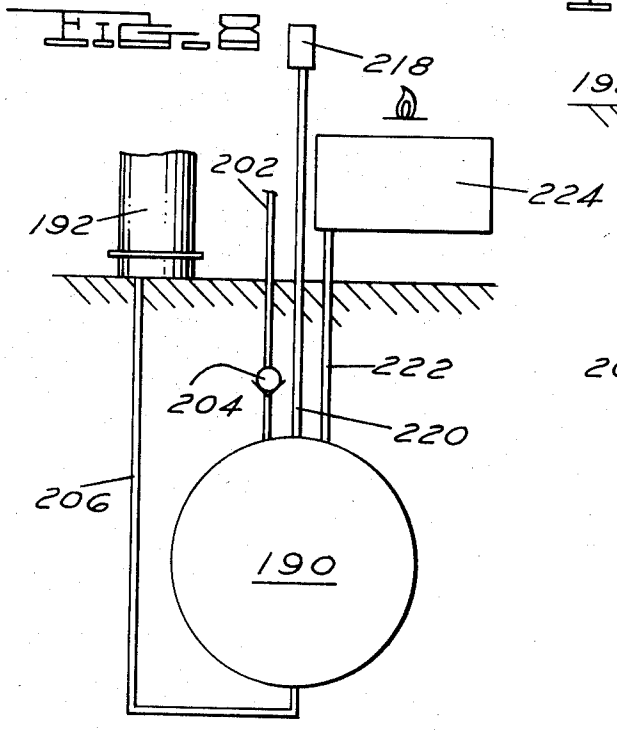


FIG. 8

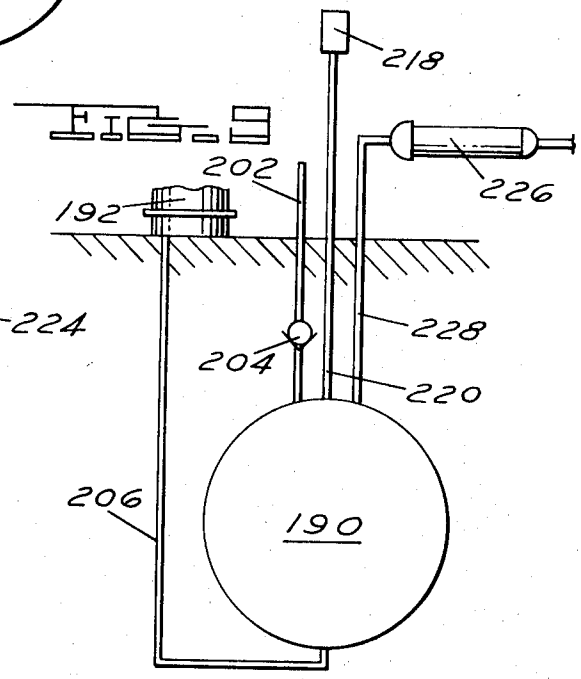


FIG. 9

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VAPOR EMISSION CONTROL SYSTEM

FIELD OF THE INVENTION

The vapor system of this invention is particularly, but not exclusively adapted to prevent the escape of gasoline or other fuel vapors from the system to the atmosphere during filling of a vehicle fuel tank, underground storage tank, or other sealed container. The vapors may be stored for later use in a filter or the like, or utilized by the vehicle directly.

SUMMARY OF THE INVENTION

The fuel delivery systems presently utilized permit the escape of fuel vapors directly to the atmosphere, resulting in a loss of fuel, and a serious safety hazard. The escape of fuel vapors occurs at gasoline service stations during the filling of vehicle fuel tanks from the underground storage tanks, and during the filling of the underground storage tank from the fuel delivery truck. When fuel is delivered to a closed container, an equal volume of fuel vapor is normally displaced to the atmosphere, depending on temperature and pressure conditions. Fuel delivery trucks are also presently utilized to directly fill vehicles in businesses requiring a large number of vehicles, such as cab companies and delivery and service facilities. The problem is compounded when the vehicles are stored indoors, because municipal codes generally prohibit refilling of the vehicles in an enclosed area. The vehicles must therefore be individually driven out of the storage area or garage and refilled outdoors. This procedure results in considerable time and cost. The escape of fuel vapors during the refilling of automobiles has also made it impossible to enclose the pump area of service stations, and has resulted in explosions and fires resulting from the careless use of cigarettes or other lighted material. It is an object of this invention to eliminate the escape of fuel vapors during refilling, thus eliminating the loss of fuel, and reducing the safety hazard.

In the vapor control system of this invention, a fuel delivery line and nozzle is adapted to deliver fuel or the like to a closed container, such as an automotive fuel tank, an annular sealing means encircles and seals the nozzle within the container opening, a vapor return line communicates through the sealing means, and is adapted to provide sealed communication with the container, through the sealing means, to remove vapors displaced from the container, and a vapor storage means may be provided to store the vapors displaced from the container. In the preferred embodiment of the nozzle assembly of this invention, the annular sealing means includes a flexible annular sealing sleeve, disposed about the nozzle adjacent the fluid delivery end, and adapted to be received within the container opening. An annular sealing portion is provided to sealingly engage the exterior of the container adjacent the opening. The flexible annular sealing sleeve may be expandable, and in one of the disclosed embodiments the sealing sleeve is tensioned radially outwardly to seal the nozzle within the container opening. In this embodiment, the nozzle is provided with an aperture, communicating with the interior of the annular sleeve, and a fluid passage restriction downstream of the aperture is adapted to expand the sleeve radially outwardly under fluid pressure when fluid is passed through the nozzle. Another disclosed embodiment of the nozzle assembly of this invention includes an annular sealing ring, which is tensioned toward the fluid delivery end of the nozzle to seal the nozzle in the container opening. A spiral spring is received about the nozzle end to provide the tensioned engagement. A bellows may also be provided to permit axial movement of the sealing ring, and provide the sealed engagement opposite the fluid delivery end of the nozzle. In this embodiment the vapor return line is disposed in the bellows portion to communicate with the interior of the annular sealing ring and the sleeve portion.

In the preferred embodiment of the control system of this invention, the vapor return line communicates with a filter means, which absorbs the fuel vapors displaced from the vehicle fuel tank. The filter may be heated to aid in the stripping of the vapors from the filter means. Where the fuel vapor control system is utilized in combination with a fuel delivery truck, or the like, the filter means may communicate with the carburetor of the truck to permit utilization of the vapors by the truck engine. The filter of this embodiment also communicates with the fuel tank of the truck engine, and the delivery fuel tank. Where the vapor control system of this invention is utilized in combination with an underground storage tank, the vapor return line may communicate directly with the underground storage tank, adjacent the bottom thereof, to permit circulation of the fuel vapors through the liquid fuel in the tank. In the latter embodiment, the fuel vapors in the tank may then be distilled, and returned to the underground storage tank.

Other advantages and meritorious features will more fully appear from the following description, claims and accompanying drawings, wherein:

FIG. 1 is a partially cross-sectioned, partially schematic view of the vapor emission control system of this invention utilized in a fuel deliver truck;

FIG. 2 is a cross-sectional view of a filter canister shown in FIG. 1;

FIG. 3 is a partially cross-sectioned view of one embodiment of the nozzle assembly of this invention;

FIG. 4 is a side elevation of another embodiment of the nozzle assembly of this invention;

FIG. 5 is a partially cross-sectioned view of the nozzle assembly shown in FIG. 4, received in the opening of a fuel tank;

FIG. 6 is a schematic view of the vapor emission control system of this invention utilized in conjunction with an underground storage tank;

FIG. 7 is a schematic side view of another embodiment of the vapor emission control system of this invention utilized in conjunction with an underground storage tank;

FIG. 8 is a schematic side view of another embodiment of the vapor emission control system of this invention utilized in conjunction with an underground storage tank; and

FIG. 9 is a schematic side view of another embodiment of the vapor emission control system of this invention utilized in conjunction with an underground storage tank.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The embodiment of the vapor control system shown in FIG. 1 includes a fuel delivery line or hose **20**, communicating at one end with the mobile storage tank **22** of a fuel delivery truck **24**, and terminating at the opposite end in an improved nozzle assembly **26**. The nozzle assembly includes a sealing means **28** adapted to seal the fuel delivery end **30** of the nozzle within the opening to a fuel container, such as the filler neck of an automotive gas tank. The details of the nozzle assembly of this invention will be described more fully hereinbelow. A vapor return line **32** communicates with the interior of the fuel tank, not shown, through the sealing means **28**. In certain vapor control system applications, the pressure of the vapor displaced by the delivered fuel will be sufficient to remove the vapors from the tank, however in this application a vacuum pump **34** is provided to sustain a constant positive flow. In this embodiment, the fuel vapors displaced from the tank are delivered to a filter canister **36** which will be described more fully in the description of FIG. 2.

The fuel delivery truck **24** shown in FIG. 1 may be a conventional gasoline delivery truck having a mobile storage tank **22**, a truck motor fuel tank **38**, a carburetor **40** controlled by a conventional butterfly valve **42**, and an air cleaner **44**. The details of the carburetion system are shown schematically to permit description of the entire vapor control system of this invention, and are not considered a portion of this invention. The truck wheels **48**, and the cab support **50**, are shown to illustrate one suitable location of the vapor control system filter canister **36**.

The fuel vapors displaced from the vehicle tank or container are vented through the vapor return line **32** into the

upper portion of the filter canister **36**, as shown in FIG. **2**. A check valve **52** is provided between the vacuum pump **34** and the filter canister to prevent air intake during the description cycle described hereinbelow. The fuel vapors enter a chamber **54** at the top of the canister, where they may be conducted directly to the carburetion system **40** of the fuel delivery truck, through line **56**, or received into the filter area **58** of the canister. During normal operation of a vehicle engine, a vacuum is established in the carburetor, which will draw the fuel vapors delivered to the chamber **54** into the carburetor, to be burned by the engine as shown in FIG. **1**. The fuel vapors preferably enter the carburetor above the butterfly valve **42**, so as not to disturb the normal carburetion of the engine. A ball check valve **60**, or the like, prevents the flow of fuel vapors through the line **56** when the truck engine is not operating, and there is no vacuum in the carburetor.

The filter area **58** of the canister is filled with a suitable filter medium capable of absorbing hydrocarbon vapors, such as commercially available activated charcoal. Activated charcoal has an absorption capacity of approximately 8 percent by weight. A filter canister containing 17.3 pounds of activated charcoal will thus absorb 1,000 gallons of gasoline vapors, which should be suitable for most applications. It will be understood, however, that other suitable filter materials may also be utilized; for example, composite materials including charcoal, molecular sieves, and silica gel. The fuel vapors enter the filter area through the screen filter **62**, which is adapted to entrap foreign materials. The screen filter **62** is slightly raised above the surrounding plate **64** to entrap water, which may be carried by the entering fuel vapors. The water may then be drained from the canister through line **66**, which communicates through a visual indicator or sight glass **68**, and drain **70**.

In this embodiment of the vapor control system, the filter area **58** of the canister also communicates with the interior of the delivery fuel tank **22**, through line **71**, and with the delivery truck fuel tank **38**, through line **72**. The delivery tank **22** and fuel tank **38** are also provided with conventional one-way flow-filtering valves **74** and **76**, respectively, which permit the entrance of air as the fuel is removed, but does not permit the escape of fuel vapors. The fuel vapors in the tanks **22** and **38** are thus conducted to the filter canister, into chamber **54**, and one-way flow ball check valves **78** and **80**, or the like, prevent reverse vapor flow.

The base **82** of the filter canister **36** is provided with a plurality of perforations **84** which permit circulation of air into the filter area **58**. A heating element **86** may also be provided in the chamber **88**, beneath the filter area, to aid in the desorption of vapors from the filter medium. Where the vapor control system of this invention is utilized in conjunction with a fuel delivery truck, such as shown in FIG. **1**, the truck exhaust may be utilized as the heating medium. If not, other suitable heating elements may be employed. Air is thus circulated through the apertures **84** in the base of the canister, past the heating element **86**, and into the filter area **58** to desorb the fuel vapors entrained by the filter medium. A screen filter **90** has also been provided at the bottom opening to the filter area to entrap foreign matter. In this embodiment of the canister, a relief tube **92** has been provided to permit the free flow of air through the compacted filter medium. The relief tube consists of alternative communicating sections of hollow tubes **94** and filter screens **96**, which provide a low-pressure path for the entering air and desorbed fuel vapors. The base of the relief tube is provided with a perforated cap **98** which permits the entry of vapors, but prevents entry of the filter medium. Air and desorbed fuel vapors may also enter the screen sections **96**. The desorbed fuel vapor and air is finally received in the line **100**, where it is conducted to the carburetion system **40** of the truck, through line **56**.

This embodiment of the vapor control system of this invention includes several safety features, some of which have already been described, including the check valves. A carbon dioxide fire extinguisher **102**, or other suitable fire extinguisher, may be provided which communicates through line **104** with the interior of the canister filter area **58**. A fusible plug **106**, such as the Wood's metal plug utilized in conventional fire extinguisher sprinkler systems is provided at the end of the line **104**, which normally seals the line. In the event of an abnormal increase in temperature, the plug melts, releasing carbon dioxide throughout the entire system. A conventional pressure gauge **108** is provided on the extinguisher to permit periodic checks of the carbon dioxide pressure. An indicator-detector **110** having a line **112** communicating with the base chamber may also be provided which detects the presence of fuel vapors in the chamber **88**, indicating that the filter medium is saturated. The preferred embodiment of the indicator-detector includes a check valve **114** connected to the vacuum pump **34** to stop the flow of fuel vapors when the filter medium is saturated, and an indicator, such as a light to signal the operator of the saturated condition. The filter canister may then be replaced, and the filter medium replenished.

The embodiment of the nozzle assembly of this invention shown in FIG. **3** includes a delivery nozzle **120**, which is adapted to be received in the conventional filler neck or opening of a motor vehicle fuel tank, shown in phantom at **122**. The filler nozzle may be a conventional gasoline service station nozzle, such as shown in more detail in FIG. **4**, except for certain details which will be described hereinbelow. A flexible sealing member, in the form of an annular sealing sleeve or boot **124**, seals the delivery end of the nozzle within the filler neck or tank opening, and the vapor return line **126** communicates with the interior of the fuel tank to receive the fuel vapors displaced from the tank as described hereinabove. The sleeve is sealingly secured at one end **128** adjacent the fuel delivery end **130** of the nozzle, and at the other end **132** adjacent the handle portion of the nozzle, not shown. The tubular portion of the nozzle is provided with a plurality of apertures **134** which communicate with the interior of the sleeve **136**, and a fluid passage restriction **138** which increases the fluid pressure adjacent the apertures. The flexible sleeve is thus caused to expand during the passage of fluid through the nozzle, sealing the nozzle within the tank opening, as shown in FIG. **3**. A plurality of smaller apertures **140** may be provided in the nozzle, downstream of the fluid passage restriction **138**, to permit draining of the sleeve **124**.

The embodiment of the nozzle assembly **150** shown in FIGS. **4** and **5** is also adapted to seal the delivery end of the nozzle within the tank opening, and remove the fuel vapors displaced by the delivered fuel. The gasoline delivery nozzle shown in FIG. **4** includes handle portion **152** and a nozzle delivery tube **154**. The nozzle disclosed in FIGS. **4** and **5** may be the conventional nozzle used in gasoline service stations, which include a metering valve, not shown, a pistol-type trigger guard **156** and an operating lever or trigger **158**, and generally includes an automatic shutoff, not shown, adapted to stop the flow of fuel when the level of fuel in the vehicle tank reaches a predetermined level, such as the delivery end **160** of the nozzle. The sealing member, indicated generally at **162**, includes an annular sleeve portion **164** adjacent the delivery end **160** of the nozzle, a sealing ring **166** adapted to sealingly abut the entrance to the vehicle fuel tank, or filler pipe shown in phantom in FIG. **5** at **168**, and an annular bellows portion **170**, connected to the sealing ring **166** opposite the sleeve portion **164**.

The sleeve portion is generally conical, and is adapted to be received within the tank opening **168**, with the delivery end **160** of the nozzle. The forward end of the sleeve portion is secured to the delivery end of the nozzle by a collar **170**, secured by screws **172**, or the like, and the rearward end of the sleeve may be integral with the sealing ring portion **166**, as shown, The bellows portion **170**, in this embodiment, includes an integral collar **174**, which is sealingly secured to the nozzle delivery tube **154**, adjacent the handle portion **152**. The collar **174** also includes an integral nipple portion **176** which receives the vapor return line **180**, and provides communication between the vapor return line and the interior of the bel-

lows portion **170**, the sealing ring portion **166**, and the sleeve portion **164**. An "umbrella-type" overload type **182**, or the like, may be provided in the collar **174** of the bellows portion to admit air into the bellows portion in the event that the vacuum established by the vapor return line **180** exceeds a predetermined limit, and prevent liquid fuel from being drawn into the line. The sleeve portion is provided with a plurality of vapor intake apertures **184** which receive the fuel vapors displaced from the fuel tank. The vapors are then transmitted through the sealing ring portion and bellows portion to the vapor return line **180**, as described hereinabove.

The sealing ring portion **166** in this embodiment is tensioned toward the delivery end **160** of the nozzle to aid in the sealing of the nozzle within the fuel tank opening. A coil spring **186** is secured at one end to the collar **170** securing the sleeve portion, and the opposite end is operatively secured to the sealing ring **166**. The spring may be molded into the sleeve portion, where a suitable material is used, such as the commercially available synthetic rubber compositions. The "normal" or free position of the sealing ring portion **166** is shown in FIG. **4**. When the fuel delivery end **160** of the nozzle and the sleeve portion **164** are inserted into a vehicle filler pipe, and the sealing ring abuts the area adjacent the pipe, the ring portion is forced rearwardly toward the handle portion **152** under the weight of the nozzle. The rearward movement of the ring portion tensions the coil spring **186**, providing tensioned engagement between the sealing ring and the area adjacent the filter pipe opening, as shown in FIG. **5**. The bellows portion is also collapsed during the movement of the ring portion, but maintains sealed communication between the vapor return line **180** and the sleeve portion **164**. A liquid drain aperture **188** is provided in this embodiment in the collar **170**, to permit draining of liquid fuel separated from the vapor in the sleeve. The fuel vapors will normally contain a small amount of entrained liquid fuel, which will be separated and drain off because of the increasing area, and reduced vacuum, within the sleeve portion toward the rearward end. The conventional shutoff valve of the conventional gasoline delivery nozzle may also be connected to the sealing ring portion **166**, such that fuel will not be delivered through the nozzle unless the ring portion is retracted a predetermined distance, assuring sealed engagement by the ring portion during refueling.

FIG. **6** illustrates schematically a simple vapor control system utilized in conjunction with an underground fuel storage tank **190**, such as the storage tanks used in gasoline service stations. The filter canister **192**, fuel line **194** and nozzle assembly **196**, vapor return line **198**, and vacuum pump **200** may be identical to the embodiments disclosed hereinabove, except that the fuel line normally communicates to a stationary pump, not shown, and the filter canister **192** includes only two inlet lines communicating with the upper chamber of the canister, as shown at **54** in FIG. **2**. The second line **202** communicates with the underground fuel storage tank **190** to permit fuel vapors displaced from the underground tank during refilling and variations in temperature to be received in the filter canister **192**, and absorbed by the filter medium. A one-way ball check valve **204**, or the like, prevents vapor flow from the canister to the storage tank, and the tank may be vented with a unidirectional valve, not shown which permits entry of air, but prevents the escape of fuel vapors to the atmosphere. The filter medium is replenished as required.

The vapor control systems shown in FIGS. **7** to **9** are similar to the system shown in FIG. **6**, except that certain additional control elements have been added. The same reference characters have therefore been used to identify similar or identical elements to simplify the description. The vapor control system shown schematically in FIG. **7** includes a fuel vapor line **206** extending from the canister **192** into the underground fuel storage tank, where the vapors are bubbled through the liquid fuel in the tank. The vapors which are not absorbed in the liquid fuel are vented through line **208** to a second filter canister **210**, where the vapor is temporarily stored. The filter canister **210** communicates through line **212** with a compressor **214** and a refrigerant coil **216**, where the vapors are distilled and eventually returned to the tank **190** as liquid fuel. The filter **210** is provided to avoid the necessity of continuous operation of the compressor. It should be noted that the filter canister **192** shown in FIGS. **7** to **9** may not be necessary in certain applications, in which case the vapor return line **198** will be vented directly to the underground storage tank **190**, similar to line **206**. The filtered one-way intake valve **218**, provided in the embodiments shown in FIGS. **7** to **9**, admits air to the storage tank **190** through line **220**, but does not permit the escape of fuel vapors.

The embodiment of the vapor control system shown in FIG. **8** vents the fuel vapors through line **222** to a catalyst contained in canister **224**. The catalyst oxidizes the hydrocarbon vapors displaced from the storage tank **190**. Alternatively, the vapors may be burned in a controlled system. The embodiment of the vapor emission control system shown in FIG. **9** includes a replaceable and/or disposable filter canister **226**, which communicates with the underground storage tank through line **228**. The filter canisters may be supplied and replaced by the delivery truck operator.

What I claim is:

1. A vapor emission control system for preventing escape of fuel vapor to the atmosphere during transfer of liquid fuel to a fuel-holding tank, comprising, in combination:

a delivery tank adapted to contain a supply of liquid fuel for delivery to the holding tank,

a delivery conduit communicating at one end with liquid fuel in the delivery tank and terminating at the other end in a delivery nozzle, sealing means at the nozzle adapted to establish a vaportight connection between the nozzle and the holding tank,

means for absorbing fuel vapors in the holding tank during filling thereof by the nozzle comprising a canister of absorptive material, said canister having means venting the absorptive material to the ambient atmosphere,

a vapor return line communicating at one end through said sealing means with the holding tank to which the nozzle is sealingly connected and communicating at the opposite end with said means for absorbing fuel vapor,

means establishing communication between the vapor return line and the absorptive material in the canister spaced from the means for venting the absorptive material to the atmosphere whereby fuel vapors entering the canister are compelled to pass through the absorptive material before discharge to the atmosphere, and means in said vapor return line for pumping fuel vapors therethrough from the holding tank to said means for absorbing fuel vapors at a volumetric rate substantially equal to the displacement rate of fuel vapor in the holding tank by liquid fuel entering it from said nozzle and imposing a positive pressure upon the absorptive material in the canister compelling vapors to defuse through the absorptive material in the canister between the vapor return line and said means venting the absorptive material to the atmosphere.

2. The vapor emission control system defined in claim **1** characterized in that said sealing means includes a flexible annular sealing sleeve, disposed about said nozzle and adapted to be received within the holding tank opening, and an annular sealing portion adapted to sealingly engage the exterior of the holding tank opening.

3. The vapor emission control system defined in claim **2**, characterized in that said flexible annular sealing sleeve is expandable and tensioned radially outwardly to seal said nozzle within the holding tank opening.

4. The vapor emission control system defined in claim **3**, characterized in that said nozzle includes an opening communicating with the interior of said annular sealing sleeve and a fluid passage restriction downstream of said opening adapted to expand said sleeve radially outwardly under fluid pressure when fluid is passed through said conduit.

5. The vapor emission control system defined in claim 2, characterized in that the end of said annular sealing sleeve is secured to the nozzle, and said sleeve includes a spring means biasing said sealing portion toward the free end of the nozzle into sealing engagement about the holding tank opening.

6. The vapor emission control system defined in claim 5, characterized in that said sealing portion is a flexible annular ring, and said sealing means includes a bellows portion secured to said sealing ring opposite said sleeve and to said conduit opposite said ring portion, permitting axial movement of said ring portion into sealing engagement adjacent the holding tank opening.

7. The vapor emission control system defined in claim 6, characterized in that said vapor return line is received within said bellows portion in communication with the interior of said ring portion and said sleeve portion, and said sleeve portion includes an aperture establishing communication with said holding tank.

8. The vapor emission control system defined in claim 1, characterized in that said filter means communicates with the delivery tank, to permit transfer of vapors therebetween.

9. The vapor emission control system defined in claim 1, characterized in that said means for storing fuel vapors communicates with said delivery tank to permit stripping of the vapors from the fuel storing means and return to the fuel delivery tank.

10. The vapor emission control system defined in claim 9, characterized in that said means for storing fuel vapors is heated to aid in the stripping process.

11. The vapor emission control system defined in claim 1, characterized in that said delivery tank is the bulk fuel storage tank of a fuel delivery truck, and said means for storing fuel vapors communicates with the vacuum side of the carburetor of the delivery truck to draw the vapors stored in the storage means into the intake of the truck engine.

12. The fuel vapor control system defined in claim 1, characterized in that said delivery tank is an underground fuel storage tank, and said holding tank is the fuel tank of a vehicle.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,581,782 Dated June 1, 1971

Inventor(s) George R. Onufer

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

In column 7, line 20, delete "filter";
following "means" insert --for absorbing fuel vapors--.

In column 8, line 5, change "storing" to --absorbing--;
line 8, change "storing" to --absorbing--;
line 12, change "storing" to --absorbing--;
line 15, change "storage" to --absorbing--.

Signed and sealed this 2nd day of November 1971.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Acting Commissioner of Patents