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(54) **FUEL TANK VENTING SYSTEM**

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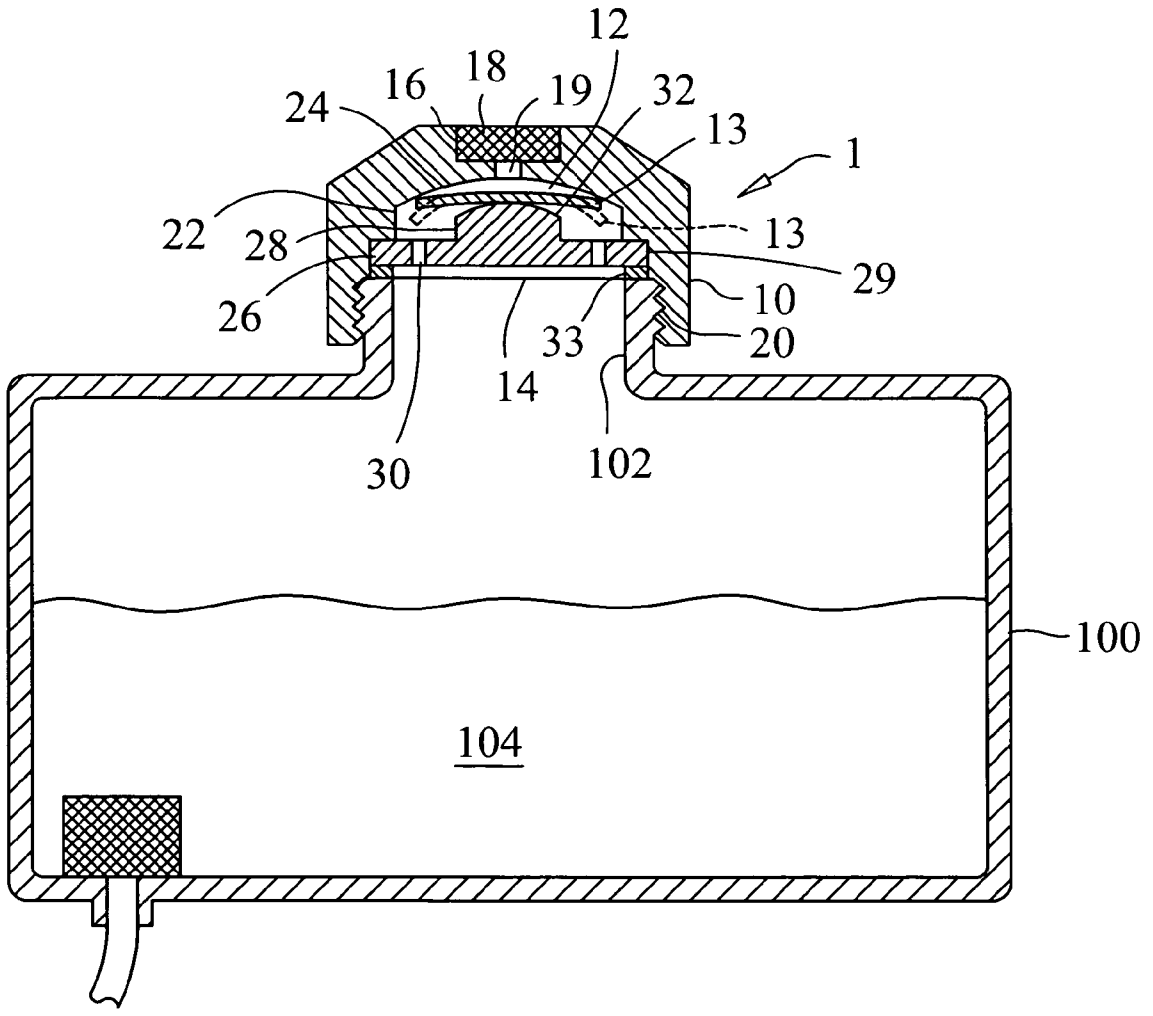
(57) **ABSTRACT**

A fuel tank venting system includes a fuel cap, a vent diaphragm and a vent disc. A valve cavity with a substantially concave bottom is formed in a bottom of the fuel cap. At least one air passage is formed through the vent disc. A substantially convex surface is formed on a top of the diaphragm projection. The vent diaphragm is retained between the substantially concave bottom and the substantially convex surface. When air is needed for fuel flow, a vacuum within the fuel tank pulls the perimeter of the vent diaphragm downward, which breaks a seal with the substantially concave bottom to allow air flow. In a second embodiment, the fuel tank venting system is contained in a wall of the fuel tank. In a third embodiment, the fuel tank venting system is contained in a fuel vent body, which is attached to the fuel tank.



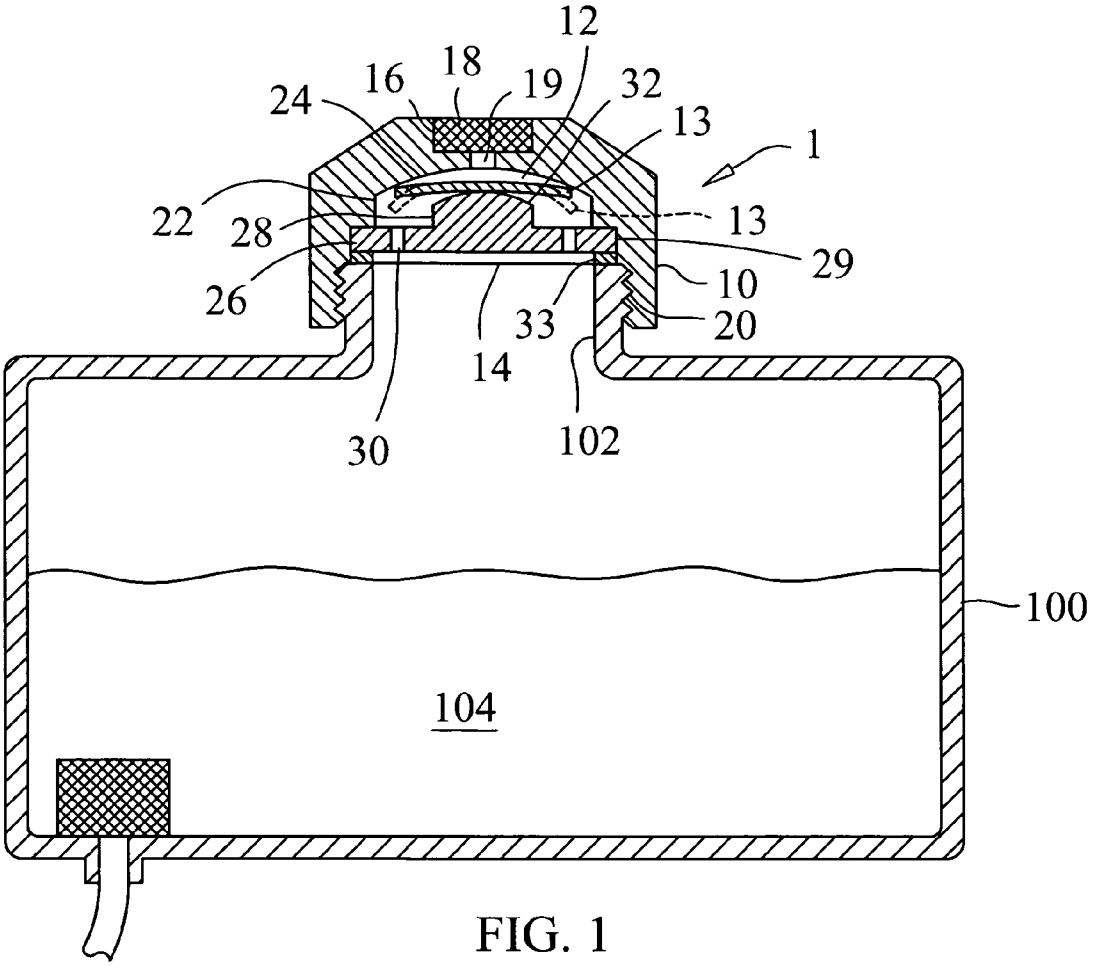

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FIG. 1

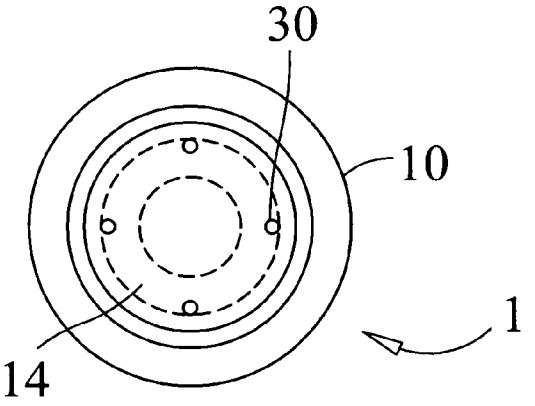
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FIG. 2

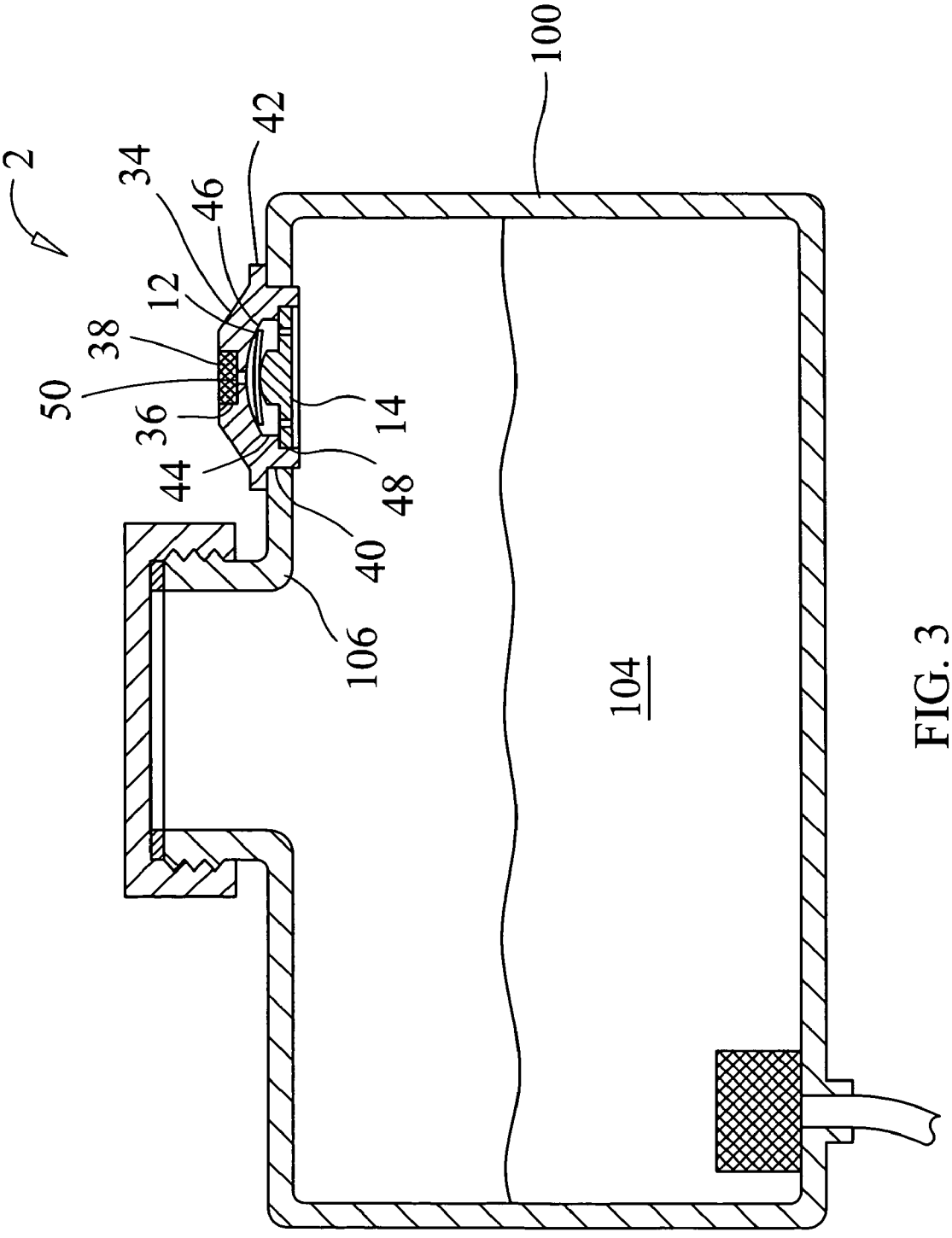

FIG. 3

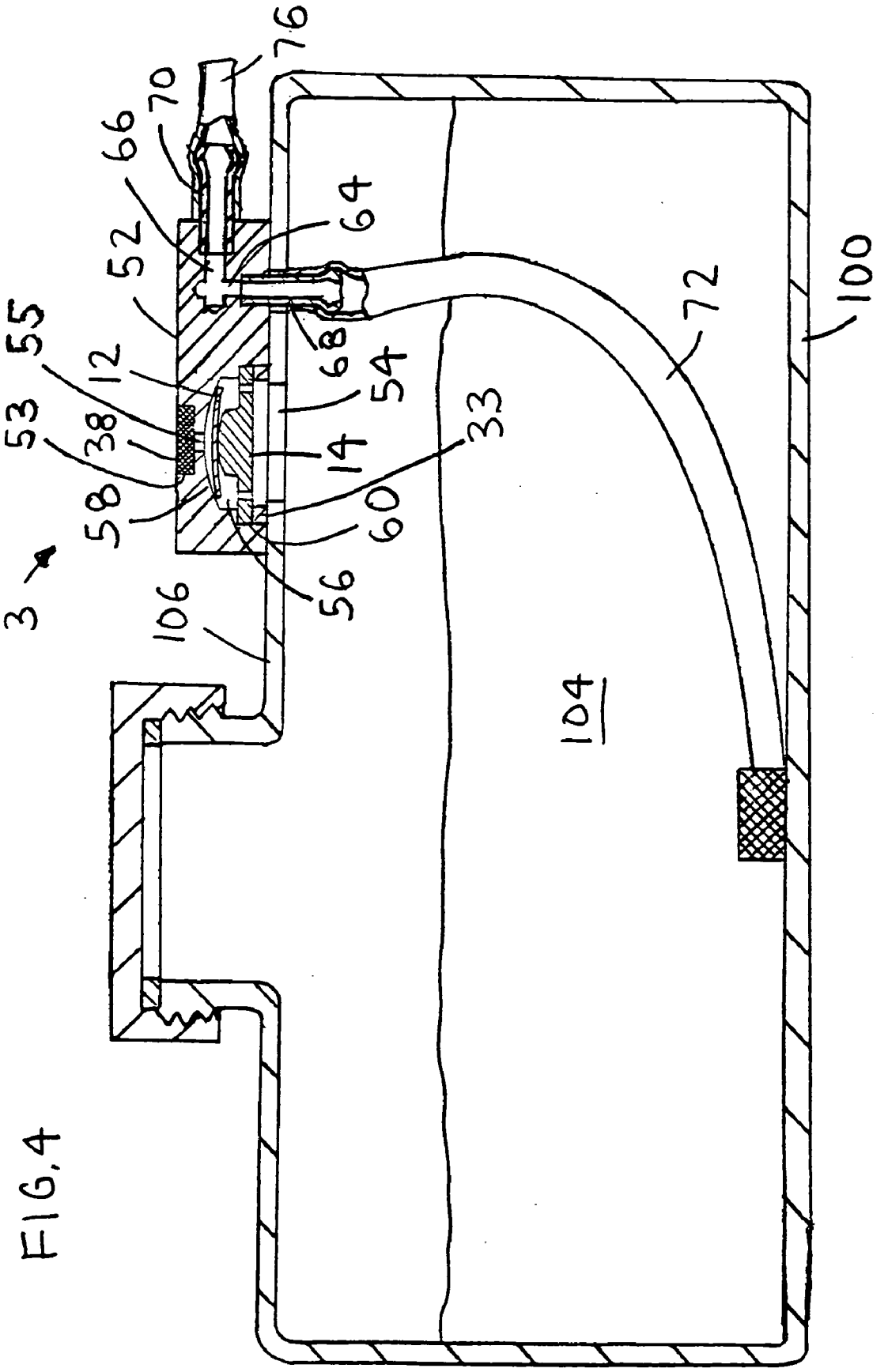

FIG. 4

FUEL TANK VENTING SYSTEM

CROSS-REFERENCES TO RELATED APPLICATIONS

[0001] This is a continuation-in-part patent application taking priority from a utility patent application having Ser. No. 10/846,296 filed on May 14, 2004.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The present invention relates generally to venting fuel tanks and more specifically to a fuel tank venting system, which may be located in a fuel cap or in a wall of the fuel tank.

[0004] 2. Discussion of the Prior Art

[0005] Fuel tanks used with small engines usually allow fuel vapors to continually vent to the atmosphere. Sometimes check valves are incorporated in the gas cap to prevent the escape of fuel vapors. Some types of check valves seal well under high pressure, but allow fuel vapor seepage under low pressure. With marine fuel tanks, a thumb screw in the fuel cap is used to seal the marine fuel tank, when not in use. The thumb screw is opened in most cases to run the engine. During the time when the engine is running, fuel vapors are vented to the atmosphere. Some users may never tighten the thumb screw for the sake of convenience, allowing the escape of fuel vapors from the marine fuel tank, at all times.

[0006] Accordingly, there is a clearly felt need in the art for a fuel tank venting system to prevent fuel vapors from being vented to the atmosphere, while allowing atmospheric air to enter the fuel tank for the purpose of fuel flow.

SUMMARY OF THE INVENTION

[0007] The present invention provides a fuel tank venting system for the purpose of providing fuel flow to an engine. The fuel tank venting system includes a fuel cap, a vent diaphragm and a vent disc. An air filter is preferably disposed in a top of the fuel cap. A threaded bore is formed in a bottom of the fuel cap to threadably receive a fuel tank fill spout. A valve cavity with a substantially concave bottom is formed adjacent the threaded bore. The vent disc preferably includes a disc flange and a diaphragm projection. At least one air passage is formed through the disc flange. A disc counter bore is formed in a bottom of the fuel cap, adjacent the valve cavity to receive the disc flange of the vent disc. A substantially convex surface is preferably formed on a top of the diaphragm projection. The vent diaphragm is retained between the substantially concave bottom of the valve cavity and the substantially convex surface of the diaphragm projection. The vent diaphragm is fabricated from a flexible material with memory. When air is needed for fuel flow, a vacuum within the fuel tank pulls the perimeter of the vent diaphragm downward, which breaks a seal with the substantially concave bottom. Air flows around the unsealed perimeter of the vent diaphragm through the at least one air passage. When the vacuum ceases, the vent diaphragm returns to its original sealing position, which does not allow fuel vapors into the atmosphere.

[0008] A second embodiment of the fuel tank venting system includes a vent body, the vent diaphragm and the vent disc. An air filter is preferably disposed in a top of the vent body. A body opening is preferably formed in a wall of a fuel tank that is sized to receive an outer perimeter of the vent body. A valve cavity with a substantially concave bottom is formed in a bottom of the vent body. A disc counter bore is formed in a bottom of the vent body to receive the disc flange of the vent disc. The vent diaphragm is first inserted into valve cavity. The vent disc is then inserted into the disc counter bore. The vent diaphragm is retained between the substantially concave bottom of the valve cavity and the substantially convex surface of the diaphragm projection.

[0009] When air is needed for fuel flow, a vacuum contained in the fuel tank pulls the perimeter of the vent diaphragm downward, which breaks a seal with the substantially concave bottom. Air flows around the unsealed perimeter of the vent diaphragm through the at least one air passage. When the vacuum ceases, the vent diaphragm returns to its original sealing position, which does not allow fuel vapors into the atmosphere.

[0010] A third embodiment of the fuel tank venting system includes a fuel vent body, the vent diaphragm and the vent disc. An air filter is preferably disposed in a top of the fuel vent body. A clearance opening is preferably formed in a wall of a fuel tank that is sized to allow air flow through the vent disc. A valve cavity with a substantially concave bottom is formed in a bottom of the fuel vent body. A disc counter bore is formed in a bottom of the vent body to receive the disc flange of the vent disc. The vent diaphragm is first inserted into valve cavity. The vent disc is then inserted into the disc counter bore. The vent diaphragm is retained between the substantially concave bottom of the valve cavity and a substantially convex surface of the diaphragm projection.

[0011] A fuel pass through is also formed in the fuel vent body. Preferably, a first fuel bore is formed in a bottom of the fuel vent body and a second fuel bore is formed in a side of the fuel vent body. The first fuel bore communicates with the second fuel bore to allow the flow of fuel therethrough. A first fuel tube is inserted into the first fuel bore and a second fuel tube is inserted into the second fuel bore. One end of a first fuel hose is terminated with a fuel filter and the other end is secured over the first fuel tube. One end of a second fuel hose is secured over the second fuel tube and the other end is connected to an internal combustion engine.

[0012] When air is needed for fuel flow, a vacuum contained in the fuel tank pulls the perimeter of the vent diaphragm downward, which breaks a seal with the substantially concave bottom. Air flows around the unsealed perimeter of the vent diaphragm through the at least one air passage. When the vacuum ceases, the vent diaphragm returns to its original sealing position, which does not allow fuel vapors into the atmosphere.

[0013] Accordingly, it is an object of the present invention to provide a fuel tank venting system to prevent fuel vapors from being vented to the atmosphere, while allowing atmospheric air to enter the fuel tank for the purpose of fuel flow to an engine.

[0014] These and additional objects, advantages, features and benefits of the present invention will become apparent from the following specification.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] **FIG. 1** is a cross sectional view of a fuel tank venting system contained in a fuel cap, the fuel cap is retained on a fuel spout of a fuel tank in accordance with the present invention.

[0016] **FIG. 2** is a bottom view of a fuel cap of a fuel tank venting system contained therein in accordance with the present invention.

[0017] **FIG. 3** is a cross sectional view of a second embodiment of a fuel tank venting system retained in a wall of the fuel tank in accordance with the present invention.

[0018] **FIG. 4** is a cross sectional view of a third embodiment of a fuel tank venting system retained adjacent a wall of the fuel tank in accordance with the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0019] With reference now to the drawings, and particularly to **FIG. 1**, there is shown a cross sectional view of a fuel tank venting system **1**. With reference to **FIG. 2**, the fuel tank venting system **1** preferably includes a fuel cap **10**, a vent diaphragm **12** and a vent disc **14**. A filter cavity **16** is preferably formed in a top of the fuel cap **10** to receive an air filter **18**. A threaded bore **20** is preferably formed in a bottom of the fuel cap **10** to threadably receive a fuel tank fill spout **102** of a fuel tank **100**. A valve cavity **22** with a substantially concave bottom **24** is formed adjacent the threaded bore **20**. A flow passage **19** is formed through the filter cavity **16** to the substantially concave bottom **24**. The vent disc **14** preferably includes a disc flange **26** and a diaphragm projection **28**. A disc counter bore **29** is formed in a bottom of the fuel cap, adjacent the valve cavity **22** to receive the disc flange **26**. The vent disc **14** is retained in the disc counter bore **29** with a force fit, adhesive or any other suitable method. At least one air passage **30** is formed through the disc flange **26**, but may be formed through the diaphragm projection **28**. A substantially convex surface **32** is preferably formed on a top of the diaphragm projection **28**. A seal gasket **33** may be retained, adjacent a bottom of the disc flange **26**.

[0020] The vent diaphragm **12** is retained between the substantially concave bottom **24** of the valve cavity **22** and the substantially convex surface **32** of the diaphragm projection **28**. The vent diaphragm **12** is fabricated from a flexible material with memory. The vent diaphragm **12** has provided satisfactory performance, when fabricated from the fluoroelastomer Viton, manufactured by DuPont Dow, but other materials may also be used.

[0021] When air is needed to facilitate fuel flow to an engine, a vacuum within the fuel tank **100** pulls the diaphragm perimeter **13** of the vent diaphragm **12** downward, which breaks a seal between the diaphragm perimeter **13** of the vent diaphragm **12** and the substantially concave bottom **24**. Air flows around the unsealed diaphragm perimeter **13** and through the at least one air passage **30**. When the vacuum inside the fuel tank **100** ceases, the vent diaphragm **12** returns to its original sealing position, which does not allow fuel vapors into the atmosphere from fuel **104** in the fuel tank **100**.

[0022] The amount of vacuum (negative pressure) to unseal the vent diaphragm **12** from the substantially concave bottom **24** may be decreased by decreasing the thickness of the vent diaphragm **12** and/or increasing the surface area (perimeter) of the vent diaphragm **12**. The amount of vacuum generated by a gravity feed fuel system is less than that of a fuel pump feed fuel system. Further, a fuel tank filled with fuel generates more vacuum than a nearly empty fuel tank. The size and thickness of the vent diaphragm must be calibrated according to the type of fuel feed system and the vacuum generated when the fuel tank is full and nearly empty.

[0023] A second embodiment of the fuel tank venting system **2** includes a vent body **34**, the vent diaphragm **12** and the vent disc **14**. A filter cavity **36** is preferably formed in a top of the vent body **34** to receive the air filter **38**. A body opening **40** is formed through a wall **106** of a fuel tank **100** that is sized to receive an outer perimeter of the vent body **34**. A flange **42** preferably extends from a perimeter of the vent body **34**. The vent body **34** may be attached to the fuel tank **100** by welding, threading or any other suitable process. A valve cavity **44** with a substantially concave bottom **46** is formed in a bottom of the vent body **34**. A flow passage **50** is formed through the filter cavity **36** to the substantially concave bottom **46**. A disc counter bore **48** is formed in a bottom of the vent body **34** to receive an outer perimeter of the vent disc **14**.

[0024] The vent diaphragm **12** is first inserted into the valve cavity **44**. The vent disc **14** is then inserted into the disc counter bore **48**. The vent disc **14** is retained in the disc counter bore **48** with a force fit, adhesive or any other suitable method. The vent diaphragm **12** is retained between the substantially concave bottom **46** of the valve cavity **44** and the substantially convex surface **32** of the diaphragm projection **28**. When air is needed to facilitate fuel flow to an engine, a vacuum within the fuel tank **100** pulls the diaphragm perimeter **13** of the vent diaphragm **12** downward, which breaks a seal between the diaphragm perimeter **13** of the vent diaphragm **12** and the substantially concave bottom **46**. Air flows around the unsealed diaphragm perimeter **13** and through the at least one air passage **30**. When the vacuum inside the fuel tank **100** ceases, the vent diaphragm **12** returns to its original sealing position, which does not allow fuel vapors into the atmosphere from the fuel **104** in the fuel tank **100**.

[0025] The vent diaphragm **12** acts as a check valve to allow air into the fuel tank **100**, but not allow fuel vapors to escape the fuel tank **100**. The shape of the vent diaphragm **12** and the vent disc **14** are shown as being round, but may be formed in any suitable shape.

[0026] A third embodiment of the fuel tank venting system **3** includes a fuel vent body **52**, the vent diaphragm **12** and the vent disc **14**. A filter cavity **53** is preferably formed in a top of the fuel vent body **52** to receive the air filter **38**. The fuel vent body **52** is attached to the fuel tank **100** with any suitable process. A clearance opening **54** is preferably formed in a wall **106** of the fuel tank **100** that is sized to allow air flow through the vent disc **14**. A valve cavity **56** with a substantially concave bottom **58** is formed in a bottom of the fuel vent body **52**. A flow passage **55** is formed through the filter cavity **53** to the substantially concave bottom **58**. A disc counter bore **60** is formed in a bottom of the fuel vent body **52** to receive the disc flange **26** of the vent disc **14**. The vent diaphragm **12** is first inserted into valve

cavity **56**. The vent disc **14** is then inserted into the disc counter bore **60**. The vent diaphragm **12** is retained between the substantially concave bottom **58** of the valve cavity **56** and the substantially convex surface **32** of the diaphragm projection **28**. The gasket **33** may be inserted between the wall **106** and a bottom of the vent disc **14**.

[**0027**] A fuel pass through is also formed in the fuel vent body **52**. Preferably, a first fuel bore **64** is formed in a bottom of the fuel vent body **52** and a second fuel bore **66** is formed in a side of the fuel vent body **52**. The first fuel bore **64** communicates with the second fuel bore **66** to allow the flow of fuel **104**. A first fuel tube **68** is inserted into a first fuel counter bore formed concentric with the first fuel bore **64**. A second fuel tube **70** is inserted into a second fuel counter bore formed concentric with the second fuel bore **66**. One end of a first fuel hose **72** is terminated with a fuel filter **74** and the other end is secured over the first fuel tube **68**. One end of a second fuel hose **76** is secured over the second fuel tube **70** and the other end is connected to an internal combustion engine (not shown).

[**0028**] When air is needed for fuel flow, a vacuum contained in the fuel tank **100** pulls the perimeter **13** of the vent diaphragm **12** downward, which breaks a seal with the substantially concave bottom **58**. Air flows around the unsealed perimeter **13** of the vent diaphragm **12** through the at least one air passage **30**. When the vacuum ceases, the vent diaphragm **12** returns to its original sealing position, which does not allow fuel vapors into the atmosphere.

[**0029**] While particular embodiments of the invention have been shown and described, it will be obvious to those skilled in the art that changes and modifications may be made without departing from the invention in its broader aspects, and therefore, the aim in the appended claims is to cover all such changes and modifications as fall within the true spirit and scope of the invention.

1. A method of venting air to a fuel tank without allowing fuel vapors to escape to the atmosphere, comprising the steps of:

providing a vent body having a valve cavity in a bottom thereof, forming at least one flow passage through said vent body to said valve cavity;

inserting a diaphragm into said valve cavity; and

inserting a vent disc into a bottom of said vent body, said vent disc including a diaphragm projection, forming at least one air passage through said vent disc, securing said vent body to a wall of the fuel tank, a moveable outer perimeter of said diaphragm sealing a bottom of said valve cavity, a vacuum in the fuel tank unsealing said diaphragm to provide air flow to the fuel tank through said at least one flow passage and said at least one air passage.

2. The method of venting air to a fuel tank without allowing fuel vapors to escape to the atmosphere of claim 1, further comprising the step of:

providing said valve cavity with a substantially concave bottom.

3. The method of venting air to a fuel tank without allowing fuel vapors to escape to the atmosphere of claim 1, further comprising the step of:

forming a substantially convex surface on a top of said diaphragm projection.

4. The method of venting air to a fuel tank without allowing fuel vapors to escape to the atmosphere of claim 1, further comprising the step of:

said diaphragm being fabricated from a flexible material having memory.

5. The method of venting air to a fuel tank without allowing fuel vapors to escape to the atmosphere of claim 1, further comprising the step of:

forming a filter cavity in a top of said vent body, inserting an air filter into said filter cavity.

6. The method of venting air to a fuel tank without allowing fuel vapors to escape to the atmosphere of claim 1, further comprising the step of:

providing a fuel vent body for said vent body, routing fuel through said fuel vent body from the fuel tank to an engine.

7. A method of venting air to a fuel tank without allowing fuel vapors to escape to the atmosphere, comprising the steps of:

providing a vent body having a valve cavity in a bottom thereof, said valve cavity having a substantially concave bottom, forming at least one flow passage through a top of said vent body to said valve cavity;

inserting a diaphragm into said valve cavity, said diaphragm being fabricated from a flexible material having memory, a moveable outer perimeter of said diaphragm sealing said substantially concave bottom;

inserting a vent disc into said valve cavity, said vent disc including a diaphragm projection with a substantially convex surface on a top thereof, forming at least one air passage through said vent disc; and

securing said valve body to a wall of the fuel tank.

8. The method of venting air to a fuel tank without allowing fuel vapors to escape to the atmosphere of claim 7, further comprising the step of:

forming a filter cavity in a top of said valve body, inserting an air filter into said filter cavity.

9. The method of venting air to a fuel tank without allowing fuel vapors to escape to the atmosphere of claim 7, further comprising the step of:

providing a fuel vent body for said vent body, routing fuel through said fuel vent body from the fuel tank to an engine.

10. A method of venting air to a fuel tank without allowing fuel vapors to escape to the atmosphere, comprising the steps of:

providing a vent body having a valve cavity in a bottom thereof, said valve cavity having a substantially concave bottom, forming at least one flow passage through said vent body to said valve cavity;

inserting a diaphragm into said valve cavity; and

inserting a vent disc into a bottom of said vent body, said vent disc including a diaphragm projection, forming at least one air passage through said vent disc, securing said vent body to a wall of the fuel tank, a moveable outer perimeter of said diaphragm sealing a bottom of

said valve cavity, a vacuum in the fuel tank unsealing said diaphragm to provide air flow to the fuel tank through said at least one flow passage and said at least one air passage.

11. The method of venting air to a fuel tank without allowing fuel vapors to escape to the atmosphere of claim 10, further comprising the step of:

forming a substantially convex surface on a top of said diaphragm projection.

12. The method of venting air to a fuel tank without allowing fuel vapors to escape to the atmosphere of claim 10, further comprising the step of:

said diaphragm being fabricated from a flexible material having memory.

13. The method of venting air to a fuel tank without allowing fuel vapors to escape to the atmosphere of claim 10, further comprising the step of:

forming a filter cavity in a top of said vent body, inserting an air filter into said filter cavity.

14. The method of venting air to a fuel tank without allowing fuel vapors to escape to the atmosphere of claim 10, further comprising the step of:

providing a fuel vent body for said vent body, routing fuel through said fuel vent body from the fuel tank to an engine.

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