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Overfill prevention valve

Abstract

An overfill prevention valve for use with a tank includes a valve element disposed in a fluid fill path and a float assembly including an actuator and a repositionable float. The float is selectively fixed relative to and moveable relative to the actuator to adjust a target fill level. The float is buoyantly supported by the fluid such that the float and the actuator are shiftable in correspondence with an actual fill level. The actuator is coupled with the valve element such that the valve element shifts to a closed position when the actual fill level nears a target fill level. The float includes discrete buoyant components that are shiftable away from each other and from the actuator to facilitate shifting of the float relative to the actuator and that are securable relative to each other and relative to the actuator to facilitate operation of the float assembly.

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATION 1. Priority Application (1) The present application claims priority from U.S. Provisional Patent Application No. 63/224,739, filed Jul. 22, 2021, and entitled OVERFILL PREVENTION VALVE, the entire disclosure of which is hereby incorporated by reference herein.

BACKGROUND OF THE INVENTION
1. Field of the Invention
(1) The present invention relates generally to a valve for use with a tank for containing a fluid. More particularly, the present invention concerns an overfill prevention valve configured to restrict filling of the tank past a predetermined maximum or target fill level.
2. Discussion of the Prior Art
(2) Those of ordinary skill in the art will appreciate that a variety of conventional means of preventing overfill of a tank or other container are commonly used. For instance, overfill prevention valves are commonly placed near a tank inlet so as to be positioned in a primary filling flow path. When a target fill level is reached within the tank, the valve at least substantially prevents further fluid flow through the inlet and into the tank.
SUMMARY
(3) According to one aspect of the present invention, an overfill prevention valve is provided. The overfill prevention valve is configured for use with a tank defining an interior chamber. The chamber is configured to contain a fluid defining an actual fill level. The valve comprises an inlet element, a valve element, and a float assembly. The inlet element at least in part defines a fluid fill path. The valve element is shiftable between open and closed valve element positions, wherein the valve element at least substantially prevents flow along the fluid fill path when in the closed valve element position. The float assembly includes an actuator and a repositionable float configured to be selectively fixed relative to and moveable relative to the actuator to adjust a target fill level. The float is configured to be buoyantly supported by the fluid such that the float and the actuator are shiftable in correspondence with the actual fill level. The actuator is operably coupled with the valve element such that the valve element shifts to the closed valve element position when the actual fill level nears the target fill level and the actuator has shifted to a valve shut-off position. The float includes a plurality of discrete buoyant components. The buoyant components are shiftable away from each other and away from the actuator to facilitate shifting of the float relative to the actuator. The buoyant components are securable relative to each other and relative to the actuator to facilitate operation of the float assembly.
(4) This summary is provided to introduce a selection of concepts in a simplified form. These concepts are further described below in the detailed description of the preferred embodiments. This summary is not intended to identify key features or essential features of the claimed subject matter, nor is it intended to be used to limit the scope of the claimed subject matter.
(5) Various other aspects and advantages of the present invention will be apparent from the following detailed description of the preferred embodiments and the accompanying drawing figures.

Description

BRIEF DESCRIPTION OF THE DRAWING FIGURES
(1) Preferred embodiments of the present invention are described in detail below with reference to the attached drawing figures, wherein:
(2) FIG. **1** is a partially cross-sectioned environmental view of a tank fitted with an overflow

prevention valve in accordance with a first preferred embodiment of the present invention;
(3) FIG. **2** is an exploded top, front perspective view of the valve of FIG. **1**;
(4) FIG. **3** is an exploded bottom, rear perspective view of the valve of FIGS. **1** and **2**;
(5) FIG. **4** is an enlarged, exploded top perspective view of the float assembly of the valve of FIGS. **1-3**;
(6) FIG. **5** is an enlarged, cross-sectional view of a portion of the float assembly of FIG. **4**, with the float thereof being shifted away from the actuator;
(7) FIG. **6** is a view of the portion of the float assembly shown in FIG. **5**, but with the float being secured relative to the actuator;
(8) FIG. **7** is an enlarged, top perspective view of the valve body of the valve of FIGS. **1-3**;
(9) FIG. **8** is a bottom perspective view of the valve body of FIG. **7**;
(10) FIG. **9** is an elevational cross-sectional view of the valve of FIGS. **1-3**, with the float secured to the actuator in a first float calibration position, the fluid at a low fill level spaced downwardly from the float, and the valve element in an open valve element position;
(11) FIG. **10** is an alternative elevational cross-sectional view of the valve as configured in FIG. **9**, taken along line **10-10** of FIG. **9**;
(12) FIG. **11** is an elevational cross-sectional view of the valve similar to that of FIG. **10**, but with the fluid at a level just past a trigger fill level, the float assembly shifted upwardly such that the actuator obstructs a pilot channel outlet, and the valve element shifted to an intermediate valve element position;
(13) FIG. **12** is an elevational cross-sectional view of the valve similar to that of FIGS. **10** and **11**, but with the fluid at a maximum or target fill level, the float assembly shifted even further upwardly relative to FIG. **11** such that the actuator is at an uppermost actuator position and continues to obstruct the pilot channel outlet, and the valve element shifted to a closed valve element position; and
(14) FIG. **13** is an elevational cross-sectional view of the valve similar to that of FIG. **10**, but with the float secured to the actuator in a second float calibration position and the fluid having reached a fill level similar to that of FIG. **11** yet still not reaching the float, with the second float calibration position thus corresponding to greater trigger and target fill levels than those associated with the first float calibration position of FIGS. **9-12**.
(15) The drawing figures do not limit the present invention to the specific embodiments disclosed and described herein. While the drawings do not necessarily provide exact dimensions or tolerances for the illustrated structures or components, the drawings are to scale with respect to the relationships between the components of the structures illustrated in the drawings.
DETAILED DESCRIPTION
(16) The present invention is susceptible of embodiment in many different forms. While the drawings illustrate, and the specification describes, certain preferred embodiments of the invention, it is to be understood that such disclosure is by way of example only. There is no intent to limit the principles of the present invention to the particular disclosed embodiments.
(17) Furthermore, unless specified or made clear, the directional references made herein with regard to the present invention and/or associated components (e.g., top, bottom, upper, lower, inner, outer, etc.) are used solely for the sake of convenience and should be understood only in relation to each other. For instance, a component might in practice be oriented such that faces referred to as “top” and “bottom” are sideways, angled, inverted, etc. relative to the chosen frame of reference.
(18) Tank System Overview
(19) With initial respect to FIG. **1**, a tank system **10** is illustrated. The tank system **10** includes a tank **12**, a valve **14**, and a coupling assembly **16**. The tank **12** includes a wall **18** defining an opening (not shown) therethrough. In the illustrated embodiment, the coupling assembly **16** and the valve **14** are secured to one another at a junction **20** disposed in or adjacent the opening, such that the coupling assembly **16** is generally disposed in an exterior environment **22** outside the tank **12**

and the valve **14** is disposed in an interior chamber **24** defined by and within the tank **12**.
(20) Is is noted that, although the exterior environment **22** may be associated with the above-ground outdoors, such environment is not limited in that manner. For instance, the tank might be disposed within a building, underwater, underground, etc.
(21) Fluid **26** may be inserted into the interior chamber **24** via the coupling assembly **16** and the valve **14**, as will be discussed in greater detail below. It is noted that the fluid **26** is preferably a liquid, although it is permissible according to some aspects of the present invention for the fluid to be in part gaseous (including but not limited to foam or foamy liquids).
(22) The tank **12** may be any of a variety of shapes and sizes and may be configured for storage and/or transport of any of a variety of fluids. In a preferred embodiment, for instance, the tank **12** is an above-ground diesel storage tank **12** for containing diesel fuel **26**.
(23) In a broad sense, the valve **14** may be understood to be downstream of and at least in part in fluid communication with the coupling assembly **16**, such that the valve **14** and the coupling assembly **16** cooperatively at least in part define a fluid fill path P_fill.
(24) The fluid **26** in the tank chamber **24** preferably presents a top surface **26***a* that defines an actual (i.e., current or instantaneous) fill level L. The position of the actual fill level L will vary as the tank **12** is filled, with the actual fill level L shifting upward as more fluid **26** is added to the interior chamber **24** through the coupling assembly **16** and thereafter the valve **14**.
(25) As will be readily understood by those of ordinary skill in the art, other elements that could hypothetically be associated with the tank system, such as drains, additional inlets, or secondary chambers, could affect the fill level and variations thereof, as well. Although such elements may be included without departing from the scope of at least some aspects of the present invention, for purposes of simplicity and clarity, the invention is described herein in the context of the simple single-inlet, single chamber, and non-draining/enclosed (at least during the filling process) tank system **10**.
(26) As illustrated, the top surface **26***a* is preferably at least substantially flat, although imperfections may occur therealong due to vibration of the tank, turbulence associated with the filling process, rising of bubbles, and so on.
(27) Valve Structure Overview
(28) The valve **14** broadly includes an inlet element **28**, a valve element **30**, a valve element housing **32**, a valve body **34**, a discharge pipe **36**, and a float assembly **38**. The float assembly **38** includes an actuator **40** and a repositionable float **42**.
(29) The inlet element **28** is preferably in the form of a valve cap **28**. The valve cap **28** preferably includes a constricted region or neck **44** that defines an inlet **46** adjacent the coupling assembly **16**.
(30) The valve cap **28** further preferably includes a perimetrically extending sidewall **48** at least in part defining a selectively flow-through valve element chamber **50** in which the valve element **30** and the valve element housing **32** are at least substantially disposed. The sidewall **48** is preferably expanded relative to the neck **44**, with the valve element chamber **50** likewise expanded relative to the inlet **46**.
(31) The sidewall **48** of the valve cap **28** preferably includes a threaded connection region **48***a* for engagement with a corresponding connection region **34***a* presented by the valve body **34**. Any of a variety of connection means fall within the scope of the present invention, however, although it is most preferred that such connection means are at least substantially fluid tight.
(32) The inlet **46** includes upper and lower ends **46***a* and **46***b*, respectively. The valve cap **28** preferably includes an arcuately extending projection **52** defining a valve seat **54** at the lower end **46***b*. The valve seat **54** is preferably annular and most preferably circular, although other shapes fall within the scope of the present invention.
(33) As will be discussed in greater detail below, the valve element **30** is shiftable between an open valve element position, as shown in FIGS. **9**, **10**, and **13**, and a closed valve element position, as shown in FIG. **12**. A preferably continuous (as opposed to discrete) plurality of intermediate valve

element positions, one of which is illustrated in FIG. **11**, are disposed therebetween.
(34) The valve element **30** is preferably at least substantially received in the valve element housing **32**, with the extent of such receipt varying with the position of the valve element **30**. As will be readily apparent from further discussion below, the valve element **30** is preferably slidably shiftable relative to the valve element housing **32**.
(35) In the illustrated embodiment, the valve element **30** is in the form of a piston **30**, with the valve element housing **32** comprising a piston sleeve structure **32**. More particularly, the valve element **30** preferably includes a generally conical (as illustrated), frusto-conical, or domed top **56**, a hollow skirt **58** extending axially downwardly from the top **56**, and a flange **60** extending radially outwardly from the top **56** and the skirt **58** at a juncture therebetween.
(36) The valve element housing **32**, in contrast, includes a radially extending base **62**, a piston sleeve **64** extending axially upwardly from the base **62**, and a connecting post **66** extending axially downwardly from the base **62**, opposite the piston sleeve **64**.
(37) The piston sleeve **64** is preferably sized and shaped so as to at least substantially circumscribe and overlie the skirt **58** when the valve element **30** is in the open position. The piston sleeve **64** preferably also at least substantially circumscribes and overlies the skirt **58**, albeit with such overlayment being to a lesser axial extent, when valve element **30** is in the closed position or any of the intermediate positions.
(38) When the valve element **30** is in the open position, the flange **60** preferably rests on an upper edge **64***a* of the piston sleeve **64**. The flange **60** is preferably spaced axially upward of the edge **64***a* when the valve element **30** is in intermediate or closed positions, however.
(39) Furthermore, the flange **60** preferably engages the valve seat **54** when the valve element **30** is in the closed position (see FIG. **12**). The valve element **30** thus at least substantially (and preferably entirely) prevents flow along the fluid fill path P_fill when in the closed valve element position.
(40) Entirely different valve element and housing designs may also be utilized without departing from the ambit of some aspects of the present invention. Among other things, for instance, alternative top shapes, including but not limited to flat shapes, fall within the scope of some aspects of the present invention.
(41) The connecting post **66** is preferably configured to receive therein a corresponding peg **68** formed by the valve body **34**. Most preferably, such connection is by means of corresponding threads, although other connection types fall within the scope of the present invention. Similarly to the connection regions **28***a* and **34***a* of the valve cap **28** and the valve body **34** respectively, however, such connection types are preferably at least substantially fluid tight.
(42) The valve element **30** preferably defines an orifice **70** in fluid communication with the inlet **46**. Most preferably, the orifice **70** extends axially through the top **56** into an actuating chamber **72** cooperatively defined by the valve element or piston **30** and the valve element housing or piston sleeve structure **32**. The function of the actuating chamber **72** will be discussed in detail below.
(43) As will also be discussed in greater detail below, a drain **74** is preferably formed in the base **62** of the valve element housing or piston sleeve structure **32**. The drain **74** is preferably in fluid communication with the actuating chamber **72**.
(44) The valve body **34**, as noted previously, is preferably at least substantially disposed downstream of and secured to each of the valve cap **28** and the valve element housing **32** via the connection region **34***a* and the peg **68**, respectively. The valve body **34** preferably also includes a lower portion **76**. As best shown in FIGS. **7** and **8**, the lower portion **76** includes a tube **78** defining a flow-through valve body opening **80** and a strut **82** extending through and bisecting the opening **80**. Alternatively stated, the strut **82** preferably extends diametrically across the tube **78**, connecting diametrically opposed sides thereof. Although it is necessary that some form of flow-through opening be defined by the lower portion **76**, it is permissible for such opening to be alternatively configured. Among other things, for instance, more than one strut might obstruct the opening.
(45) The lower portion **76** and, more particularly, the strut **82** preferably defines therethrough a

pilot channel **84** in fluid communication with the drain **74**, the actuating chamber **72**, the orifice **70**, and the inlet **46** so as to cooperatively therewith at least in part define an actuating fluid path P_act.
(46) In a preferred embodiment, as illustrated, the pilot channel **84** presents an outlet opening **86** at a downstream end of the actuating fluid path P_act. As will be discussed in greater detail below, the outlet opening **86** preferably opens into the interior chamber **24** of the tank **12** during normal filling operations.
(47) It is particularly noted that, whereas the actuating fluid path P_act and the fluid fill path P_fill both are preferably in part defined by the inlet **46**, the paths P_fill and P_act preferably thereafter diverge.
(48) As noted previously, the valve **14** also preferably includes a discharge pipe **36**. The discharge pipe **36** preferably extends axially downwardly from the valve body **34** and is secured thereto by interengaging threads defined by respective overlapping portions **36***a* and **34***b*. As discussed above with regard to other interconnections, alternative connection means fall within the scope of the present invention but are most preferably at least substantially fluid tight.
(49) Although the illustrated discharge pipe **36** extends exclusively axially downwardly, it is permissible according to some aspects of the present invention for the pipe to include one or more bends, curves, and/or branches.
(50) The actuator **40** of the float assembly **38** preferably comprises an axially extending actuator sleeve **88** including a float-engaging portion **90** and an upper portion **92** disposed axially upward of the float-engaging portion **90**. The float-engaging portion **90** is preferably constricted relative to the upper portion **92**, although alternative relative sizing, including at least substantially equal sizing, falls within the scope of the present invention. The preferred sizing is such that the upper portion **92** at least substantially circumscribes and overlies (preferably in a slip or loose fit) the lower portion **76** of the valve body **34**. The float-engaging portion **90** preferably at least substantially circumscribes and overlies (also preferably in a slip or loose fit) the discharge pipe **36**. Thus, as will be discussed in greater detail below, movement of the actuator **40** is preferably generally radially restricted relative to the valve body **34** and the discharge pipe **36** due to complementary diametrical sizing.
(51) The upper portion **92** preferably defines a plurality of arcuately extending, arcuately spaced apart windows **94**. The upper portion **92** also preferably defines an axially extending slot **96**. A fastener **98** (e.g, a set screw, as in the illustrated embodiment) extends through the slot **96** and into the lower portion **76** of the valve body **34** to slidably secure the actuator **40** relative to the valve body **34**. That is, the fastener **98** is preferably set in a radial position at which it does not substantially squeeze the actuator **40**, thereby facilitating axial shifting of the actuator **40** relative to the valve body **34** and the discharge tube **78**. The extent of such relative shifting corresponds to an axial height of the slot **96**, as defined between upper and lower margins thereof.
(52) In addition to specifically defining the range of axial motion of the actuator **40**, the slot **96** and fastener **98** also prevent the actuator **40** from falling off of the valve body **34** and the discharge tube **78** in a general sense.
(53) Although the illustrated configuration is most preferred, it is permissible according to some aspects of the present invention for the actuator to be secured to the discharge tube rather than to the valve body. Furthermore, although it is most preferred that a discrete fastener **98** be provided, similar or at least substantially equivalent functionality might be achieved via the provision of one or more of any sort of stop or projection, including both discretely and integrally formed structures. It is also noted that such structures or fasteners might extend instead into a slot formed in the valve body or discharge tube, instead of the in actuator. Further still, multiple slots and fasteners may be provided without departing from the scope of some aspects of the present invention.
(54) The float **42** preferably includes a plurality of buoyant components **100**. In the illustrated embodiment, two (2) buoyant components **100** are provided, although more may be provided within the ambit of some aspects of the present invention.

(55) Preferably, the buoyant components **100** are identical to one another, although variations fall within the scope of some aspects of the present invention.
(56) Each buoyant component **100** preferably includes a solid central portion **102** and upper and lower hollow shell portions **104** and **106**, respectively, axially above and below the central portion **102**. The shell portions **104** and **106** are preferably air-filled, although other gases or even liquid might permissibly be used, provided suitable buoyancy is maintained. It is also permissible for each buoyant component to be solidly constructed (e.g., of a buoyant material such as foam), for more or fewer hollow shell portions to be provided, and for any hollow portion(s) to be alternatively arranged.
(57) As will be discussed in greater detail below, the buoyant components **100** are preferably securable relative to each other and relative to the actuator **40** to facilitate operation of the float assembly **38**. More particularly, as noted previously, the actuator **40** includes an axially extending actuator sleeve **88**. The buoyant components **100** cooperatively at least in part circumscribe the actuator sleeve **88** when secured relative to the actuator **40** but are radially shiftable away from each other and from the actuator sleeve **88** (and, more broadly, from the actuator **40**) to facilitate selective moveability of the float **42** relative to the actuator **40**.
(58) The float assembly **38** further preferably includes a retaining element **108** shiftable between a buoyant component retaining position (See FIG. **6** and others), in which the retaining element **108** secures the buoyant components **100** relative to each other and to the actuator **40**, and a buoyant component shifting position (see FIG. **5**), in which the retaining element **108** permits shifting of the buoyant components **100** away from each other and away from the actuator **40**.
(59) The retaining element **108** is preferably resiliently deformable and, in the illustrated embodiment, comprises a stretchable band **108** (e.g., a gasket or an O-ring) encircling the buoyant components **100**. Other types of retaining elements, including but not limited to cinches, latches, hooks, fasteners, ties, and combinations thereof, fall within the scope of some aspects of the present invention, however.
(60) In a preferred embodiment, each of the buoyant components **100** and, most preferably, the solid central portions **102** thereof, define a respective externally disposed band-receiving hollow **110**. The band-receiving hollows **110** preferably cooperatively receive the retaining element or band **108**. Other means of receiving the retaining element, including means associated with alternative retaining element designs, fall within the scope of some aspects of the present invention, however.
(61) The float **42** (or, more specifically, the buoyant components **100** cooperatively) presents a radially outer surface **42***a*, a radially inner surface **42***b* that at least substantially circumscribes the actuator **40**, an upper surface **42***c*, and a lower surface **42***d*.
(62) Selectable Fixation of Float Relative to Actuator
(63) As will be discussed in greater detail below, the float **42** is preferably selectively fixed relative to and moveable relative to the actuator **40** to adjust a target fill level (i.e., a desired maximum fill level) for fluid **26** in the interior chamber **24** of the tank **12**. That is, the float **42** is configured to be buoyantly supported by the fluid **26** such that the float **42** and the actuator **40** are shiftable in correspondence with an actual or instantaneous fill level L of fluid **16** in the tank **12**. The actuator **40** is operably coupled with the valve element **30** such that the valve element **30** shifts to the closed valve element position and obstructs the fluid fill path P_fill when the actual fill level L reaches a trigger level near the target fill level and the actuator **40**, as driven by the buoyancy of the float **42**, shifts to a valve shut-off position.
(64) More particularly, in preferred embodiment, a plurality of float calibration positions **112** are defined axially along the actuator **40**. The float **42** is configured to be selectively fixed relative to the actuator **40** at a selected one C of the float calibration positions **112**, wherein the selected one C of the float calibration positions **112** corresponds to the target fill level.
(65) Most preferably, the float calibration positions **112** are discrete (i.e., rather than continuously

or smoothly defined). In the illustrated embodiment, for instance, the float-engaging portion **90** of the actuator **40** includes or defines a plurality of arcuately extending grooves **114** each defining one of the float calibration positions **112**.
(66) The grooves **114** preferably extend continuously around the entirety of the float-engaging portion **90** so as to continuously circumscribe it. More particularly, the grooves **114** are preferably circular grooves. However, intermittent, discontinuous, and/or only partial perimetrical extension is permissible according to some aspects of the present invention. It is also permissible for the grooves to be in the form of one or more non-extending indentations.
(67) The float **42** preferably includes a rib **116** projecting radially inwardly from the inner surface **42***b* thereof. Most preferably, each of the buoyant components **100** defines a radially inwardly projecting rib portion **116***a*, with the rib portions **116***a* cooperatively forming the rib **116**.
(68) The rib **116** preferably extends continuously along the entirety of the inner surface **42***b* of the float **42**, except at junctures between the buoyant components **100**. That is, each rib portion **116** preferably extends continuously along the entirety of the inner surface **42***b* of the float **42** so as to be generally circular in form. However, intermittent, discontinuous, and/or only partial perimetrical extension of either or both of the rib portions is permissible according to some aspects of the present invention. It is also permissible for the rib to be in the form of one or more non-extending projections.
(69) In a broad sense, it is simply preferred that the float and the actuator present complementary elements configured to engage one another to fix the float relative to the actuator. In the illustrated embodiment, such complementary elements are the aforementioned rib **116** and grooves **114**, with the rib **116** being configured to be received in a selected one of the grooves **114** to fix the float **42** relative to the actuator **40** at the selected float calibration position C. However, other complementary configurations, including but not limited to configurations additionally or alternatively using cinches, latches, hooks, fasteners, ties, and combinations thereof, fall within the scope of some aspects of the present invention.
(70) It is particularly noted that a reversal of the preferred presentation of the rib **116** by the float **42** and grooves **114** by the actuator **40** is permissible according to some aspects of the present invention. For instance, the actuator could instead include one or more ribs, with the float instead defining one or more grooves. Furthermore, a plurality of ribs might be instead provided for complementary engagement with a single groove, or plurality of both ribs and grooves might be provided by respective structures. Still further, ribs and grooves might both be provided by both the float and the actuator.
(71) Of course, similar variations utilizing alternative complementary elements also fall within the scope of some aspects of the present invention.
(72) Filling and Shut-Off Process
(73) An exemplary tank filling and shut-off process is illustrated in FIGS. **9-12**. With initial reference to FIG. **9**, fluid **26** initially enters the valve **14** via the inlet **46**. The majority of the fluid **26**, referred to herein as a primary portion thereof, then flows along the primary fluid fill path P_fill, whereas a smaller actuating portion (or pilot portion) of the fluid **26** flows along the actuating fluid path P_act.
(74) More particularly, after the fluid **26** flows through the inlet **46**, the primary portion thereof next flows past the valve element **30** in its open position and through the valve element chamber **50**. More particularly, the primary portion flows over and down the surface of the conical valve element top **56**, through a gap **118** disposed between the valve element flange **60** and the valve seat **54** defined by the valve cap **28**, and alongside the valve element housing **32**. The primary portion of the fluid **26** thereafter flows through the flow-through valve body opening **80** defined on opposite sides of the strut **82**, then downward through the discharge pipe **36** and into the interior chamber **24** of the tank **12**.
(75) As shown in FIG. **9**, and as discussed previously, the fluid **26** contained in the tank **12** presents

an upper surface **26***a* defining an actual or instantaneous fill level L. As will be understood by those of ordinary skill in the art, such actual fill level L will vary as fluid **26** is added to the tank **12** or removed therefrom. Variations in the level L may also occur due to evaporation or disturbances (see more detailed discussion above).

(76) FIG. **10** illustrates the valve **14** in the same state as in FIG. **9** (i.e., with the fluid **26** at the same actual fill level L and all valve components in the same position). However, in contrast to that of FIG. **9**, which clearly illustrates the primary fluid fill path P_fill, the sectioning of FIG. **10** clearly illustrates the secondary or actuating fluid path P_act.

(77) More particularly, as shown in FIG. **10**, the actuating portion of the fluid **26** initially enters the valve **14** via the inlet **46** but thereafter flows into the actuating chamber **72** via the orifice **70** defined by the valve element top **56**. The actuating portion exits the actuating chamber **72** via the drain **74**, and thereafter travels through the pilot channel **84** and out the outlet opening **86**, from which it falls through the interior chamber **24** of the tank **12** to join the contained fluid **26** accumulating therein.

(78) In FIG. **11**, continued filling of the tank **12** has increased the amount of contained fluid **26** therein, resulting in a substantial rise in the actual fill level L. In fact, the actual fill level L has reached and passed the lower surface **42***d* of the float **42** and risen to such a level that the float assembly **38** has become buoyantly supported by the fluid **26**. The float assembly **38** is thus axially shiftable in correspondence to further variations in the actual fill level L.

(79) The level at which the float assembly **38** becomes axially shiftable in correspondence with the actual fill level L is referred to herein as the trigger fill level, with the actual fill level L in FIG. **11** having exceeded the trigger fill level by a small distance that corresponds to the axial distance by which the actuator sleeve **88** has shifted from FIG. **10** to FIG. **11**.

(80) Importantly, the small amount of shifting of the float assembly **38** that has occurred between the states shown in FIGS. **10** and **11** is such that the upper portion **92** of the actuator sleeve **88** has obstructed the outlet opening **86** of the pilot channel **84**. The actuating portion of fluid **26** attempting to flow along the actuating fluid path P_act is unable to exit via the outlet opening **86** and instead becomes “backed up.” More particularly, as more fluid **26** enters the inlet **46** and, in turn, the actuating fluid path P_act, the actuating fluid first fills the pilot channel **84** and thereafter the actuating chamber **72**.

(81) When the actuating chamber **72** in its initial form (i.e., that shown in FIGS. **9** and **10**) is full, the actuating fluid **26** therein applies pressure (i.e., “back pressure”) to the valve element **30** and the valve element housing **32** that define the actuating chamber **72**. This pressure results in axially upward shifting of the valve element or piston **30**. This shifting may alternatively be understood to be an expansion of the actuating chamber **72**.

(82) The piston **30** continues to shift gradually upward as additional fluid **26** enters the still-expanding actuating chamber **72**, with an intermediate position of the piston **30** being illustrated in FIG. **11**.

(83) It is noted that, during the gradual upward shifting of the valve element **30**, the primary fluid fill path P_fill becomes increasingly obstructed but is not yet fully restricted. That is, the primary portion of the fluid **26** continues to flow along the primary fluid fill path P_fill, with the actual fluid level L thus continuing to increase and the float assembly **38**, including both the float **42** and the actuator **40**, continuing to shift upward accordingly.

(84) It is also noted that, due to the decreasing size of the gap **118** as the valve element **30** shifts upward, a pressure drop will occur for fluid **26** flowing therethrough. This pressure drop will assist or accelerate the upward shifting of the valve element **30** by increasing the pressure variation between the gap **118** and the actuating chamber **72**.

(85) In FIG. **12**, the valve element **30** has reached the closed valve element position, in which the flange **60** has engaged the valve seat **54** to cut off further flow along the primary fluid fill path P_fill. The actuator sleeve **88** has also reached its uppermost position, in which it continues to

obstruct the pilot channel outlet opening **86**.
(86) The actual fill level L has reached its maximum level or, alternatively stated, the desired or target fill level. As will be readily apparent to those of ordinary skill in the art, the target fill level is inherently higher than the trigger fill level. Most preferably, however, the target and trigger fill levels are relatively similar to minimize or reduce the magnitude of shifting required by the float assembly **38**.
(87) As will also be readily apparent to those of ordinary skill in the art, the initial position of the float **42** along the actuator **40**—i.e., the selected float calibration position C—determines the position of the trigger fill level and, in turn, sets the target fill level.
(88) For instance, if the selected float calibration position were lower than that shown in FIG. **12** (i.e., if the float were initially secured to the actuator sleeve at a lower relative position therealong), the surface of the contained fluid would more quickly rise to a level to support floatation of the float assembly. Thus, the trigger fill level, at which the float assembly begins buoyantly shifting on the top surface of the contained fluid, would be lower than that for the float calibration position C of FIG. **12**. The maximum or target fill level would likewise be lower.
(89) In contrast, as shown in FIG. **13**, positioning of the float assembly at a higher selected float calibration position C than that of FIGS. **9-12** delays triggering of the actuator **40** and facilitates the insertion of a greater volume of fluid **26** into the tank **12** before the valve element **30** shifts to the closed valve element position and shuts off further flow into the tank interior chamber **24**.
(90) In FIG. **13**, for instance, the float **42** is disposed higher up along the actuator sleeve **88** than it is in FIGS. **9-12**. The current actual fill level L illustrated in FIG. **13**, however, is equal to that of FIG. **11**. Whereas that same fill level in FIG. **11** is greater than the trigger fill level, and whereas the actuator sleeve **88** has blocked the pilot channel outlet opening **86** as a result, such actual fill level L in FIG. **13** has not even reached the lower surface **42***d* of the float **42**.
(91) Thus, as will be readily apparent to those of ordinary skill in the art, the target fill level of the tank **12** may be easily adjusted simply through shifting of the float **42** relative to the actuator **40**. Furthermore, due to the design of the float **42**, such shifting may be readily accomplished without the use of tools or complicated procedures.
(92) This enables a single valve design to be readily adapted to a variety of tank sizes and shapes, with the valve **14** (and, particularly, the associated target fill level or “shut-off”) being easily calibrated based on the specific parameters of a given tank.
(93) Shifts of the float **42** relative to the actuator **40** may also be understood to result in at least substantially proportional and, more particularly, at least substantially equal shifts in the trigger fill level and the target fill level. For instance, moving the float **42** to new float calibration position C two (2) inches higher than its initial float calibration position C results in the trigger fill level and the maximum or target fill level likewise shifting upward by approximately two (2) inches.
(94) It is noted that provision of discrete float calibration positions **112** facilitates simple and accurate setting of trigger and target fill levels. Most preferably, each calibration position **112** is spaced from the adjacent positions **112** by a constant increment, as well.
(95) Still further, the float assembly is advantageously simple in its design, being devoid of small, easily dropped or lost elements (e.g., set screws, pins, etc.) requirement adjustment as part of calibration processes.
(96) The illustrated float assembly **38** is also readily usable with or easily adaptable for use with any of a variety of valve types, including but not limited to back-pressure operated valves (such as that illustrated herein) and pressure-drop actuated valves.
(97) In some embodiments, for instance, the actuating sleeve might be directly interconnected to the valve element such that shifting of the float and actuating sleeve in conjunction with a rising actual fill level directly results in proportional upward shifting of the valve element. As the valve element approaches the valve seat, the pressure drop or low-pressure zone associated with increased flow velocity through the narrowing gap therebetween assists in the upward shifting of

the valve element and subsequent securement of the valve element against the seat. (In such an embodiment, the pilot channel might of course be omitted.) Despite the substantial differences in valve operation, however, no modifications would be required to the float design, including the buoyant components and the retaining element thereof.

Conclusion

(98) Features of one or more embodiments described above may be used in various combinations with each other and/or may be used independently of one another. For instance, although a single disclosed embodiment may include a preferred combination of features, it is within the scope of certain aspects of the present invention for the embodiment to include only one (1) or less than all of the disclosed features, unless the specification expressly states otherwise or as might be understood by one of ordinary skill in the art. Therefore, embodiments of the present invention are not necessarily limited to the combination(s) of features described above.

(99) The preferred forms of the invention described above are to be used as illustration only and should not be utilized in a limiting sense in interpreting the scope of the present invention. Obvious modifications to the exemplary embodiments, as hereinabove set forth, could be readily made by those skilled in the art without departing from the spirit of the present invention.

(100) Although the above description presents features of preferred embodiments of the present invention, other preferred embodiments may also be created in keeping with the principles of the invention. Furthermore, as noted previously, these other preferred embodiments may in some instances be realized through a combination of features compatible for use together despite having been presented independently as part of separate embodiments in the above description.

(101) The inventors hereby state their intent to rely on the Doctrine of Equivalents to determine and access the reasonably fair scope of the present invention as pertains to any apparatus not materially departing from but outside the literal scope of the invention.

Claims

1. An overfill prevention valve configured for use with a tank defining an interior chamber, said chamber configured to contain a fluid defining an actual fill level, said valve comprising: an inlet element at least in part defining a fluid fill path; a valve element shiftable between open and closed valve element positions, wherein the valve element at least substantially prevents flow along the fluid fill path when in the closed valve element position; and a float assembly including an actuator and a repositionable float configured to be selectively fixed relative to and moveable relative to the actuator to adjust a target fill level, said float configured to be buoyantly supported by the fluid such that the float and the actuator are shiftable in correspondence with the actual fill level, said actuator being operably coupled with the valve element such that the valve element shifts to the closed valve element position when the actual fill level nears the target fill level and the actuator has shifted to a valve shut-off position, said float including a plurality of discrete buoyant components, said buoyant components being shiftable away from each other and away from the actuator to facilitate shifting of the float relative to the actuator, said buoyant components being securable relative to each other and relative to the actuator to facilitate operation of the float assembly, said actuator extending along an axis, said buoyant components being radially shiftable away from each other and from the actuator.

2. The valve of claim 1, said buoyant components being identical to one another.

3. The valve of claim 1, said float assembly further including a retaining element, said retaining element being shiftable between a buoyant component retaining position and a buoyant component shifting position, said retaining element securing the buoyant components relative to each other and to the actuator when in the buoyant component retaining position, said retaining element permitting shifting of the buoyant components away from each other and away from the actuator when in the buoyant component shifting position.

4. The valve of claim 3, said retaining element being resiliently deformable.
5. The valve of claim 3, said retaining element comprising a stretchable band encircling the buoyant components.
6. The valve of claim 5, each of said buoyant components defining a band-receiving hollow, said band-receiving hollows configured to cooperatively receive the stretchable band.
7. The valve of claim 1, said actuator including an axially extending sleeve, said buoyant components cooperatively at least in part circumscribing said axially extending sleeve.
8. The valve of claim 1, a plurality of discrete float calibration positions being defined along the actuator, said float configured to be selectively fixed relative to the actuator at a selected one of the float calibration positions, wherein the selected one of the float calibration positions corresponds to the target fill level.
9. The valve of claim 8, one of said actuator and said float including a first complementary element, the other of said actuator and said float including a plurality of second complementary elements, each of said second complementary elements at least in part defining a discrete float calibration position, said float configured to be selectively fixed relative to the actuator at a selected one of the float calibration positions, wherein the selected one of the float calibration positions corresponds to the target fill level.
10. The valve of claim 9, said first complementary element comprising a projection, each of said second complementary elements comprising an indentation configured to at least in part receive the projection.
11. The valve of claim 1, said valve element defining an actuating chamber configured to be filled with an actuating portion of the fluid upon shifting of the actuator to the valve shut-off position, said valve element configured to shift to the closed valve element position as result of pressure exerted thereon by the actuating portion of the fluid in the actuating chamber, said valve element defining an orifice extending between and fluidly interconnecting the inlet and the actuating chamber, said overfill prevention valve defining a pilot channel in fluid communication with the actuating chamber, such that the inlet, the orifice, the actuating chamber, and the pilot channel cooperatively at least in part define an actuating fluid path, said actuator configured to obstruct flow of fluid through the actuating fluid path when the actuator is in the valve shut-off position, such that the actuating chamber fills with the actuating portion of the fluid.
12. An overfill prevention valve configured for use with a tank defining an interior chamber, said chamber configured to contain a fluid defining an actual fill level, said valve comprising: an inlet element at least in part defining a fluid fill path; a valve element shiftable between open and closed valve element positions, wherein the valve element at least substantially prevents flow along the fluid fill path when in the closed valve element position; and a float assembly including an actuator and a repositionable float configured to be selectively fixed relative to and moveable relative to the actuator to adjust a target fill level, said float configured to be buoyantly supported by the fluid such that the float and the actuator are shiftable in correspondence with the actual fill level, said actuator being operably coupled with the valve element such that the valve element shifts to the closed valve element position when the actual fill level nears the target fill level and the actuator has shifted to a valve shut-off position, said float including a plurality of discrete buoyant components, said buoyant components being shiftable away from each other and away from the actuator to facilitate shifting of the float relative to the actuator, said buoyant components being securable relative to each other and relative to the actuator to facilitate operation of the float assembly, one of said actuator and said float including a first complementary element, the other of said actuator and said float including a second complementary element, said complementary elements configured to engage one another to fix the float relative to the actuator, said float including said first complementary element, said actuator including a plurality of said second complementary elements, each of said second complementary elements at least in part defining a discrete float calibration position, said float configured to be selectively fixed relative to the

actuator at a selected one of the float calibration positions, wherein the selected one of the float calibration positions corresponds to the target fill level, said float presenting a radially inner surface at least in part circumscribing said actuator, said first complementary element comprising an arcuately extending float rib projecting radially inwardly from said inner surface, each of said second complementary elements comprising a respective arcuately extending actuator groove defined by the actuator, said float rib being received in a selected one of said actuator grooves when the float is fixed relative to the actuator.

13. The valve of claim 12, said float rib including a plurality of arcuately extending float rib segments, each of said buoyant components including one of said float rib segments.

14. The valve of claim 12, said buoyant components being identical to one another.

15. The valve of claim 12, said float assembly further including a retaining element, said retaining element being shiftable between a buoyant component retaining position and a buoyant component shifting position, said retaining element securing the buoyant components relative to each other and to the actuator when in the buoyant component retaining position, said retaining element permitting shifting of the buoyant components away from each other and away from the actuator when in the buoyant component shifting position.

16. The valve of claim 15, said retaining element being resiliently deformable.

17. The valve of claim 15, said retaining element comprising a stretchable band encircling the buoyant components.

18. The valve of claim 17, each of said buoyant components defining a band-receiving hollow, said band-receiving hollows configured to cooperatively receive the stretchable band.

19. The valve of claim 12, said actuator including an axially extending sleeve, said buoyant components cooperatively at least in part circumscribing said axially extending sleeve.

20. The valve of claim 12, said valve element defining an actuating chamber configured to be filled with an actuating portion of the fluid upon shifting of the actuator to the valve shut-off position, said valve element configured to shift to the closed valve element position as result of pressure exerted thereon by the actuating portion of the fluid in the actuating chamber, said valve element defining an orifice extending between and fluidly interconnecting the inlet and the actuating chamber, said overfill prevention valve defining a pilot channel in fluid communication with the actuating chamber, such that the inlet, the orifice, the actuating chamber, and the pilot channel cooperatively at least in part define an actuating fluid path, said actuator configured to obstruct flow of fluid through the actuating fluid path when the actuator is in the valve shut-off position, such that the actuating chamber fills with the actuating portion of the fluid.