United States Patent

Calisher et al.

[15] **3,674,061**

[45] **July 4, 1972**

[54] LIQUID TRANSFER APPARATUS WITH PRESSURE-SENSITIVE AUTOMATIC SHUT-OFF NOZZLE

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[22] Filed: **Oct. 29, 1969**

[21] Appl. No.: **872,148**

[52] **U.S. Cl.** **141/198,** 137/202, 141/40, 141/226, 141/349

[51] **Int. Cl.** **B67d 5/372**

[58] **Field of Search** 141/192–229, 285-310, 141/348–350, 39, 40, 41, 42, 43; 137/202, 587, 588; 220/86; 222/566

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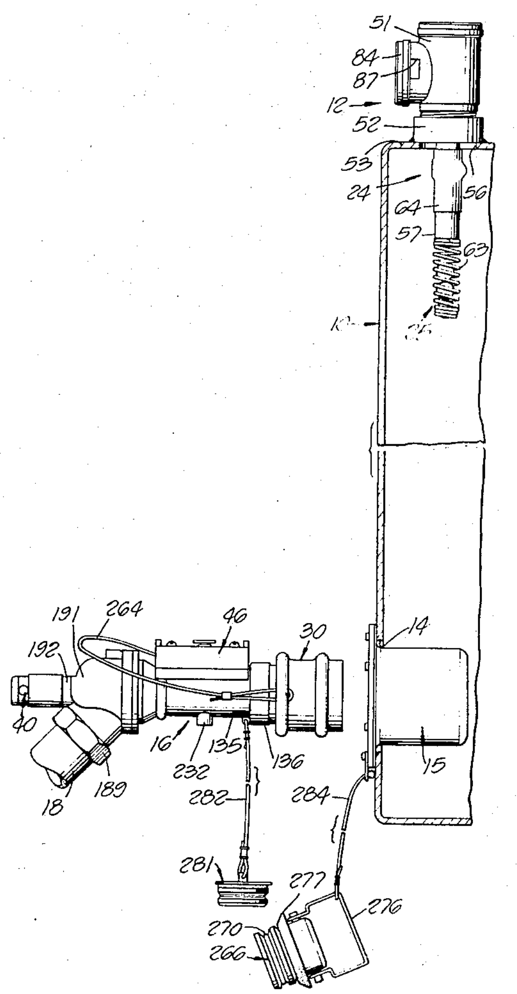
[57] **ABSTRACT**

A vented tank has a receptacle fitting at its fill port that mates with a nozzle on the end of a supply hose. Both the receptacle fitting and the nozzle have normally closed valves which open in response to mating of the two parts. The nozzle fitting is equipped with a normally closed snap acting valve which is cocked open during the filling operation and snaps closed in response to abrupt rise in back pressure. During the filling operation a tank vent is open but closes in response to rise in the liquid level and thereby creates the back pressure. The tank vent also closes automatically if the tank is turned over.

14 Claims, 15 Drawing Figures



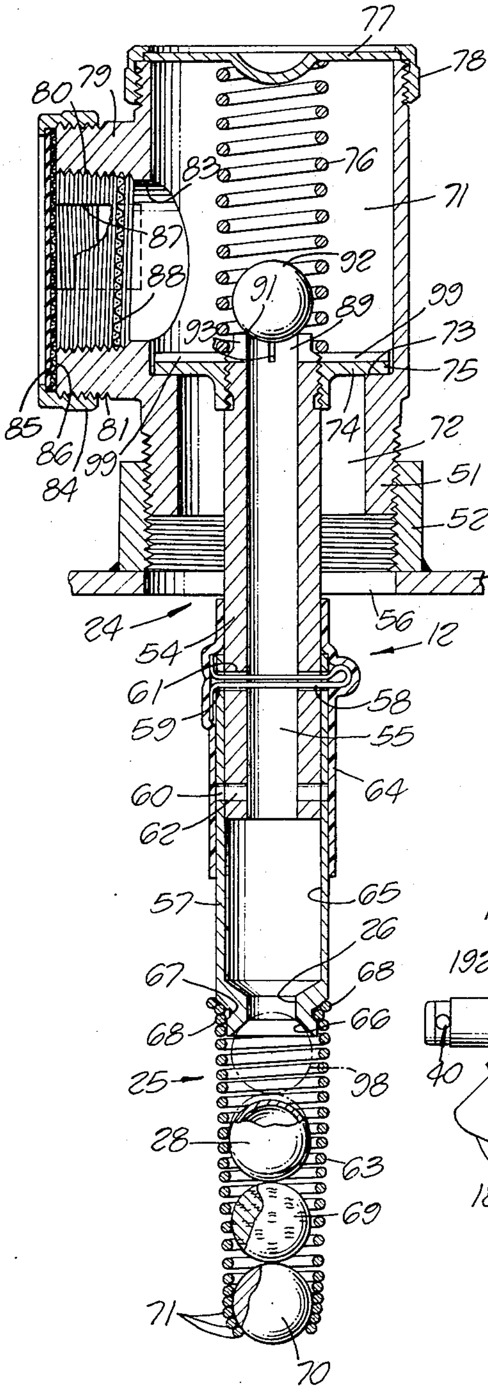


FIG. 2.

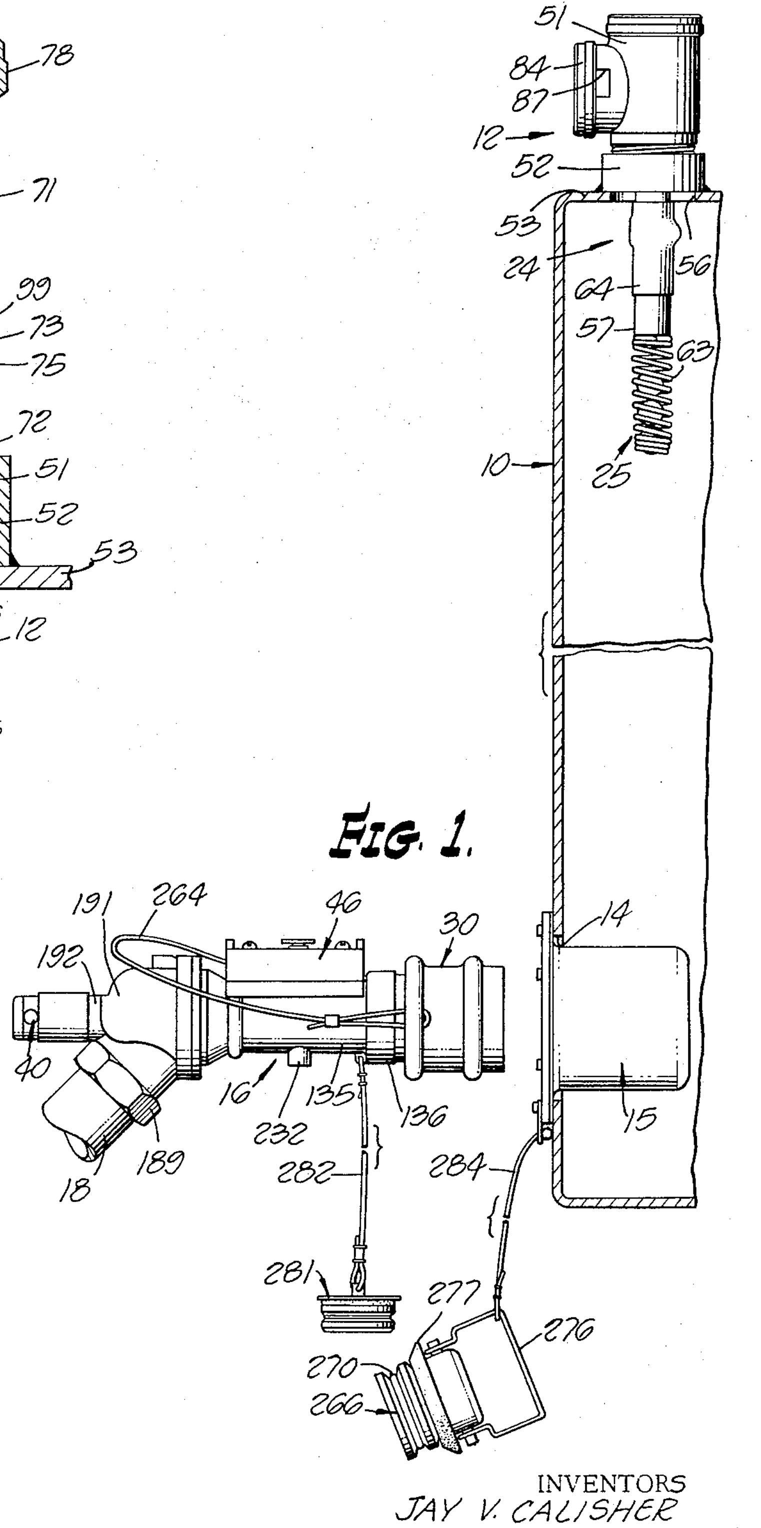


FIG. 1.

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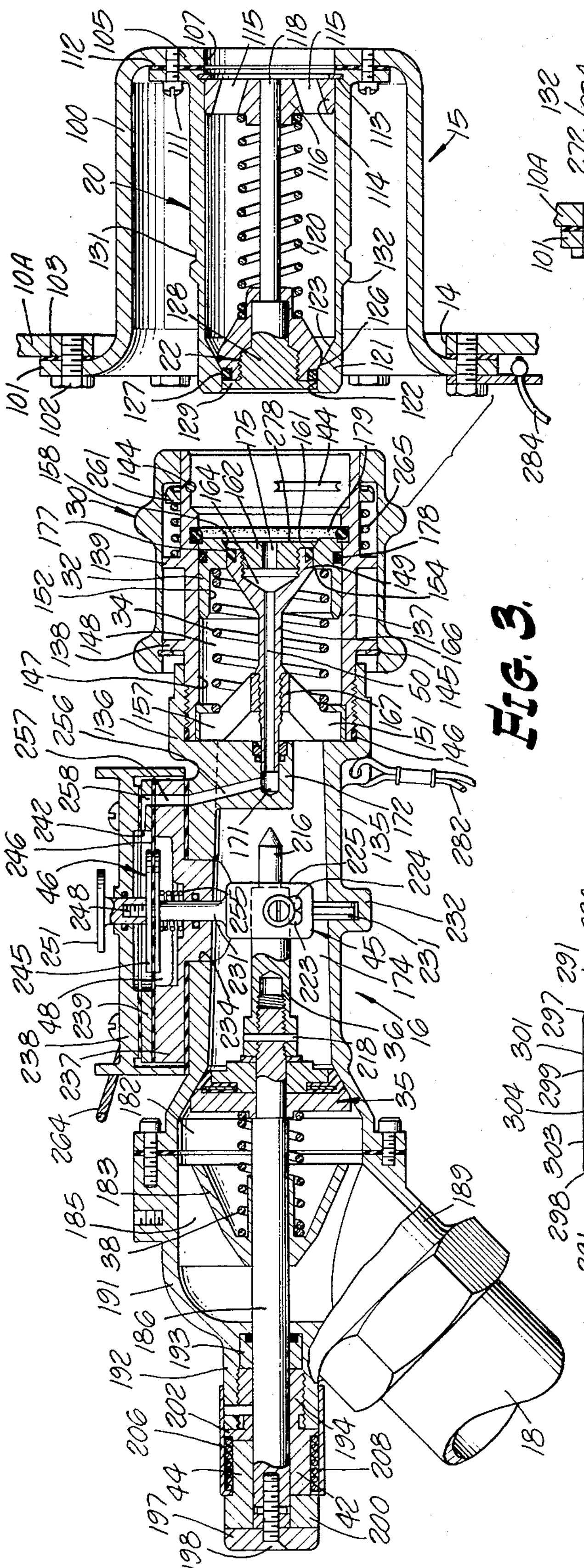

FIG. 3.

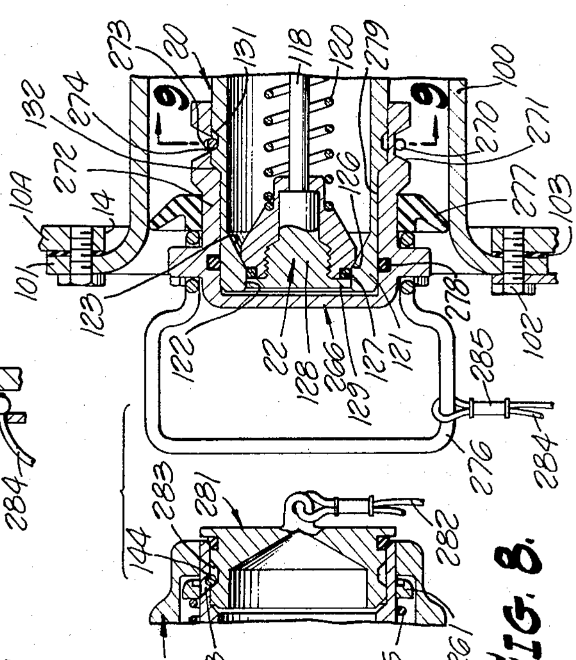

FIG. 8.

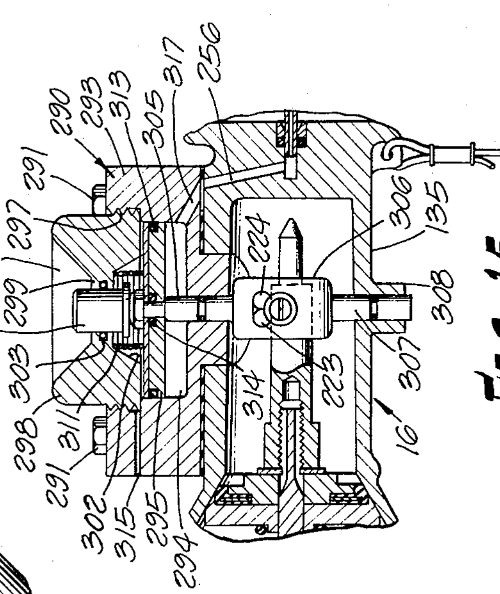

FIG. 15.

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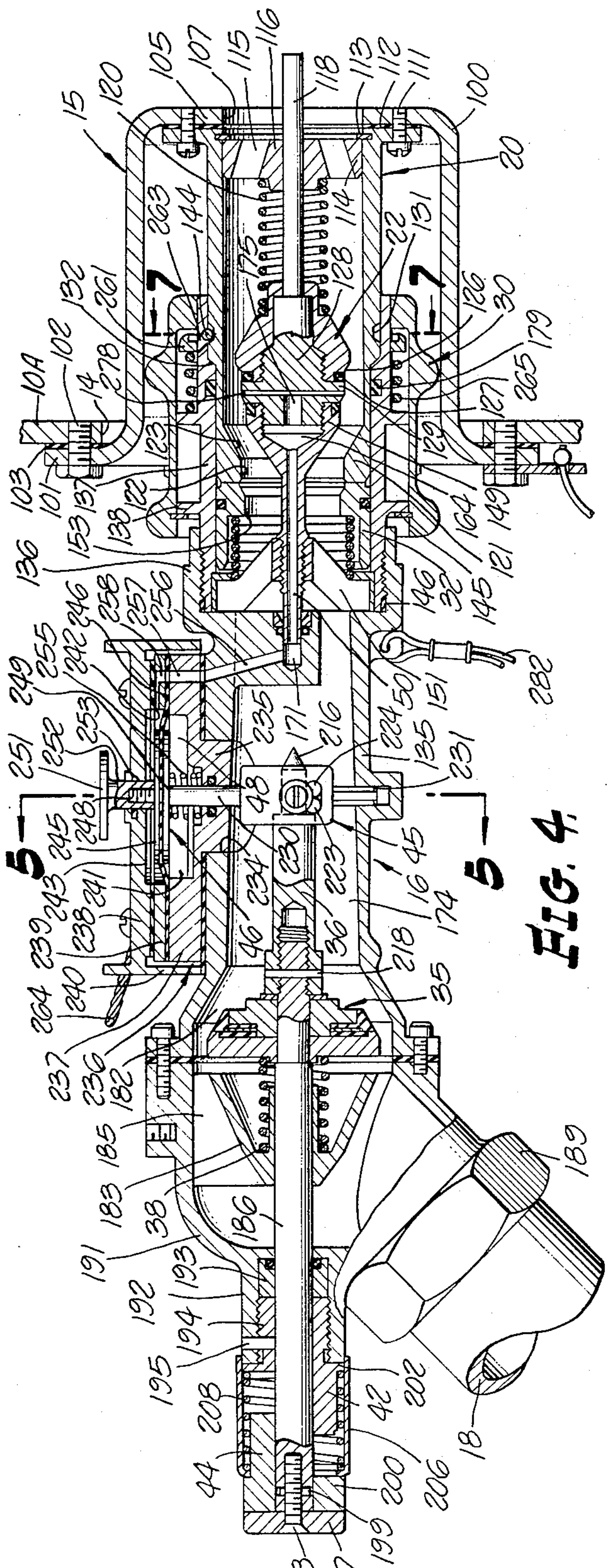

FIG. 4.

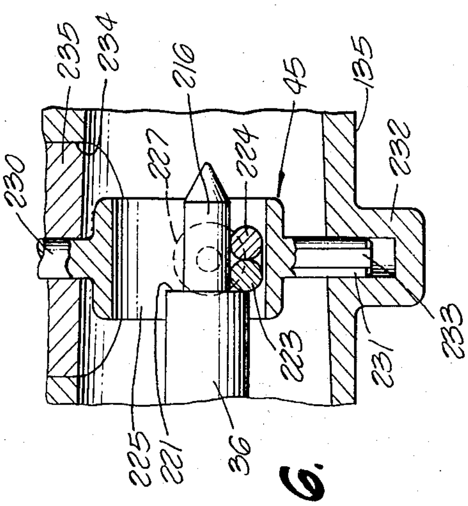

FIG. 6.

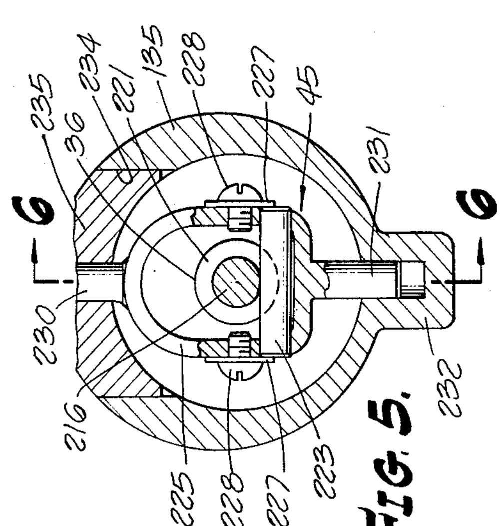

FIG. 5.

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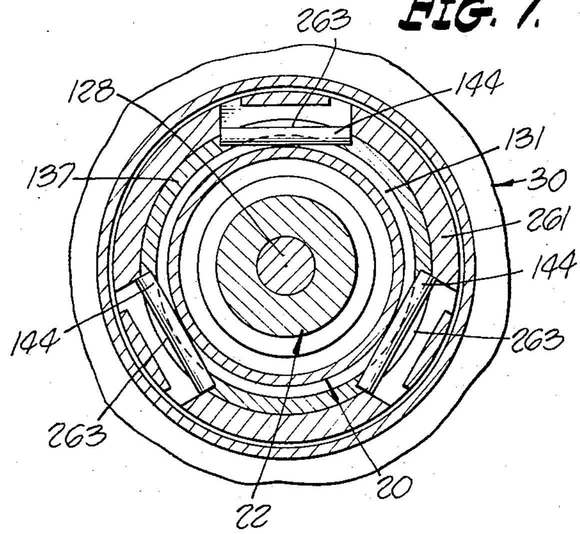
FIG. 7.



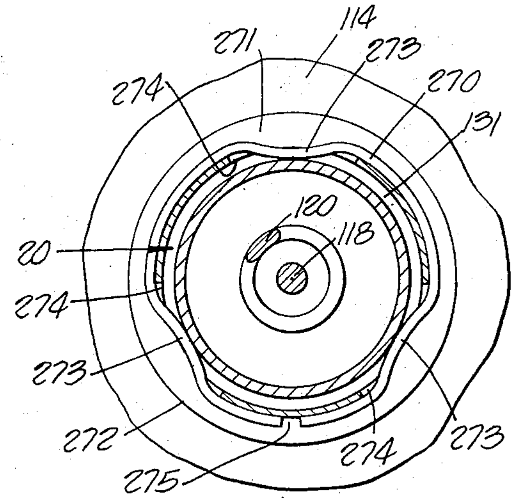
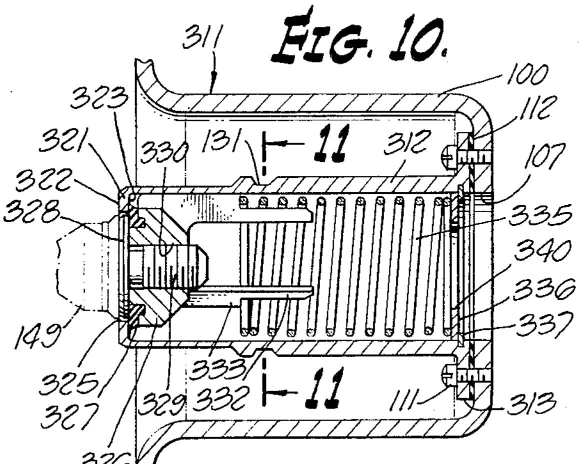


FIG. 9.

FIG. 10.



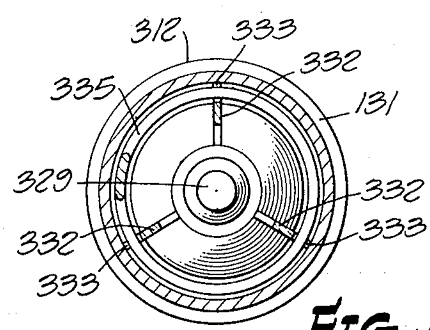
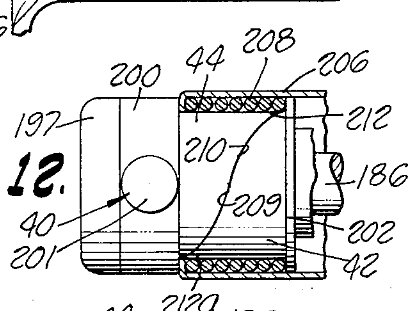


FIG. 11.

FIG. 12.



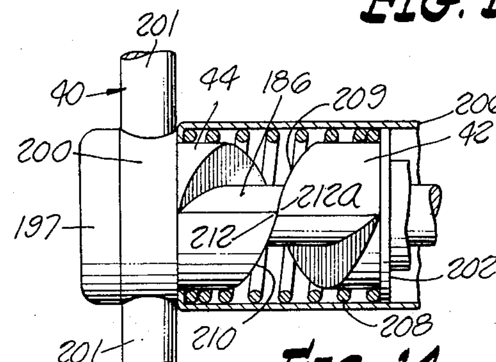


FIG. 14.

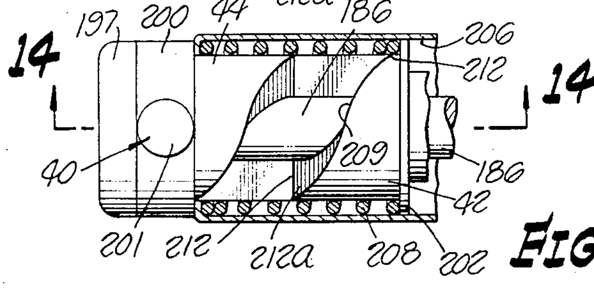


FIG. 13.

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LIQUID TRANSFER APPARATUS WITH PRESSURE-SENSITIVE AUTOMATIC SHUT-OFF NOZZLE

BACKGROUND OF THE INVENTION

The invention relates to apparatus for establishing closed system liquid transfer to liquid storage tanks. The tanks may be the fuel tanks of helicopters and other aircraft or the tanks of road building or other fuel consuming vehicles and equipment needing a rapid resupply of uncontaminated liquids.

Fire hazard and contamination are predominant problems in resupply of liquids, particularly highly volatile fuels. Present apparatuses for filling tanks permit volatile vapor to escape, endangering the equipment. The possibility of contamination exists during fuel transfer due to open lines. In both military and commercial usage a rapid transfer of fuel from a supply to the tank is desired—to save equipment down time and manpower—and high pressure transfer lines are used. However, it is presently necessary even in combat zones to shut off the motors of helicopters being refueled because dust caused by the whirling blades may enter the fuel system,and escaping vapor from the fuel supply is likely to ignite when drawn upwardly by the blade motion around the hot exhaust of the engines.

Road building and heavy construction equipment conventionally has top-filling liquid tanks, accessible only by climbing on the equipment. Liquid and vapor escape from the open tank filler tube, adding to fire and climbing hazards. Contaminants have direct access into the tank. Nozzle discharge ends transfer dirt acquired during careless handling into the tank. The inventive apparatus disclosed herein fills tanks from their lower end, has closed communication between tank and nozzle, and is quickly coupled and uncoupled.

SUMMARY OF THE INVENTION

The invention contemplates apparatus for closed system liquid transfer comprising quickly connecting and disconnecting liquid supply nozzle and tank nozzle receptacle fitting, each with a self-closing valve which opens when the nozzle and fitting are joined. Latch means lock the nozzle and receptacle fitting together in leak-proof fashion. A shut-off valve in the nozzle controls nozzle flow. A spring-loaded latch holds the valve open, but may be released manually. A valve body in the fitting communicates with the tank interior. Valve opening means on the body and on the nozzle open the self-closing valves on coupling for liquid flow from the nozzle through the body into the tank. A tank vent with a float valve inhibits escape of all tank air displaced by incoming liquid. Fluid-actuated pressure-sensitive means on the nozzle linked to the shut-off valve latch respond to increased tank pressure as tank air is compressed to release the latch and close the nozzle. A fluid passage extends from the tank through the valve body and the nozzle to the fluid-actuated pressure-sensitive means. Preferably, the passage is confined within the valve body and the nozzle barrel.

Closed liquid transfer apparatus obviates both fire hazard and contamination by eliminating liquid and vapor escape and preventing dust, dirt, and other contaminants from entering the vehicle tank.

It is therefore an object of the invention to provide apparatus which establishes a closed fueling system to overcome the hazards of fire, accident, and contamination.

It is a further object of the invention to provide such apparatus having a nozzle and a receptacle fitting each with a self-closing valve to eliminate vapor loss, liquid leakage and contamination when the two system components are unconnected.

It is a further object of the invention to provide a nozzle and a receptacle fitting in which connection one to the other automatically opens the self-closing valves to provide a liquid path from the nozzle through the receptacle fitting.

A further object of the invention is to provide apparatus wherein a liquid level-controlled vent closes to pressurize the tank upon the liquid level in the tank reaching a certain desired level such that the increased tank pressure may be sensed to automatically close the supply nozzle responsive to the pressure imposed upon the liquid within the tank.

It is a still further object of the invention to provide a nozzle compatible with a self-closing receptacle fitting wherein the shut-off valve of the nozzle has a latch which may be manually overcome or be overcome responsive to a sudden pressure increase in the tank.

It is a further object of the invention to provide closed system apparatus for refueling wherein a manual control may be actuated to open the nozzle shut-off valve; wherein manual movement of a simple plunger closes the valve, and wherein automatic fluid-actuated pressure-responsive means related to tank liquid level closes the shut-off valve.

The apparatus of the invention thus provides for quick-disconnect closed liquid transfer wherein no vapor or liquid loss occurs during the connecting, disconnecting, or liquid transfer stages, wherein the flow of liquid automatically terminates upon the liquid reaching a certain level in the tank, and wherein no contaminants may enter the tank either during liquid transfer or prior to or after disconnecting the nozzle and receiver of the apparatus.

The preferred vent of the invention not only serves to preclude escape of tank air after the liquid level reaches a certain point, but also guards against liquid spillage due to tank sloshing and has safeguards against overpressurization of the tank. Additionally, vent shut-off means preclude loss of liquid should the tank be overturned or perilously canted either accidentally or deliberately.

These and other advantages of the invention are apparent from the following detailed description and drawings, wherein like parts have been given like reference characters.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a fragmentary elevation, partly in section, showing the tank, vent, receiver, and nozzle of the invention, prior to joining of the nozzle and receptacle fitting;

FIG. 2 is a longitudinal section showing the preferred vent of the invention installed in a tank which is fragmentarily illustrated;

FIG. 3 is a longitudinal section of the unjoined nozzle and tank receptacle fitting of the invention;

FIG. 4 is a similar section of the nozzle and receptacle fitting joined together in condition for liquid transfer;

FIG. 5 is a fragmentary transverse section taken along line 5—5 of FIG. 4;

FIG. 6 is a fragmentary section taken along line 6—6 of FIG. 5;

FIG. 7 is a fragmentary transverse section taken along line 7—7 of FIG. 4, showing details of the latch means for securing the nozzle to the receptacle fitting;

FIG. 8 is a fragmentary section showing the dirt shields of the receptacle fitting and nozzle in place;

FIG. 9 is a fragmentary sectional elevation similar to FIG. 7 showing the dirt skirt latching means;

FIG. 10 is a fragmentary sectional elevation showing an alternate tank receptacle fitting;

FIG. 11 is a transverse section taken along line 11—11 of FIG. 10;

FIG. 12 is a fragmentary elevation, partly in section, of the manual control handle for the nozzle shut-off valve;

FIG. 13 is similar to FIG. 12 with the handle shown in an alternate position;

FIG. 14 is a fragmentary section taken along line 14—14 of FIG. 13; and

FIG. 15 is a fragmentary section illustrating an alternate pressure sensitive latch release means.

DESCRIPTION OF THE PREFERRED EMBODIMENT

FIG. 1 shows a tank 10 with a vent 12 and with a fill opening 14 equipped with a receptacle fitting 15. FIG. 1 further shows a nozzle generally designated 16 on the end of a flexible supply hose 18. In FIGS. 1 and 3 the nozzle is separated from the receptacle fitting and FIG. 4 shows how the nozzle and receptacle fitting mate for a filling operation.

The principal parts of the illustrated structure include: a cylindrical valve body **20** inside the receptacle fitting **15** which houses a normally closed valve member **22**; a vent valve assembly **24** including a float valve **25** incorporated in the vent structure, the float valve having an outlet port **26** that is normally opened but is closed by a float valve ball **28**; means including a longitudinal movable lock sleeve **30** on the nozzle **16** to releasably connect the nozzle to the valve body **20** in the receptacle fitting **15**; a sleeve valve **32** incorporated in the nozzle **16** and normally held in closed position by a spring **34**, the sleeve valve of the nozzle and the valve member **22** of the receptacle fitting both being shifted to their open positions in response to mating of the nozzle with the receptacle fitting; a normally closed shut-off valve incorporated in the nozzle structure, the shut-off valve including a poppet valve member **35** that has an axial extension **36** and is biased to closed position by a spring **38**; manually operable means including a T-shaped handle **40** and a pair of cams **42** and **44** to shift the poppet valve member to open position in opposition to the spring **38**; a latch generally designated **45** that automatically engages the axial extension **36** of the poppet valve member when the poppet valve member is manually shifted to its open position; and a fluid-actuated pressure sensing means generally designated **46** to release the latch in response to abrupt rise in back pressure, the back pressure being transmitted to an actuating chamber **48** of the fluid pressure responsive means through an axial fluid passage **50** in the nozzle structure.

STRUCTURAL DETAILS

The Vent

As shown in FIG. 2, tank vent body **51** of the vent **12** is fixed by a threaded collar **52** to a top wall **53** of the liquid tank **10**. A hollow valve stem **54** with an axial passage **55** extends downwardly from the body of the vent through a vent port **56** in the tank wall **53**. The valve stem supports the float valve **25**, including a telescoping stem extension **57** fastened to the stem itself by a cotter pin **58**. The extension has a pair of parallel holes **59,60** spaced longitudinally of the extension. The stem has a pair of parallel spaced holes **61, 62**, the former of which receives cotter pin **58**.

The extension supports a helical wire valve ball cage **63**. Assuming a fixed position for the valve stem, the vertical position of the extension and the cage may be changed by aligning the various holes in the extension with different holes of the valve stem.

A plastic sleeve **64**, preferably heat shrunk about the stem and extension, seals the stem and extension holes and maintains the cotter pin in place.

The valve stem extension terminates in the valve port **26**, which is of lesser diameter than the bore **65** of the extension. A frusto-conical surface **66** guides and seats the float ball in the port. An exterior extension annulus **67** receives the end turns **68** of the helical spring which defines the valve ball cage **63**. Three spheres: the valve ball **28**, a flotation ball **69**, and a weighted ball **70** are in the cage. Several bottom turns **71** of the cage are of reduced diameter such that they retain the spheres stacked within the cage. The cage helix is of sufficient lead to leave an interval between the turns such that liquid and air may flow through the cage.

Upper ball **28** has a hard outer surface to maintain sealing contact with the surface **66**. Preferably, the ball is hollow aluminum. Flotation ball **69**, preferably of cork, insures sufficient flotation of valve ball **28** to effectively close port **26** when the liquid level rises within the tank. Weighted ball **70**, preferably of steel, has a safety function. Should the tank **10** be inverted or nearly inverted, the weight of ball **70** thrusts balls **28** and **69** toward port **26** such that ball **28** seals the port and precludes loss of liquid through the inverted vent.

Other hazards besides inversion may threaten the tank, such as over-pressurization, failure of cut-off and liquid sloshing. The invention therefore affords apparatus to overcome such hazards, such as auxiliary safety valves. External vent body **51** has cylindrical walls defining an upper chamber **71** and a lower chamber **72**. The lower chamber is of smaller diameter than the upper chamber, and their juncture forms an annular shoulder **73**. A flanged collar **74** is threadedly engaged with the upper end of valve stem **54**. The collar flange **75** seats upon shoulder **73**, supporting the valve stem, the extension, and the cage within the vent body and the tank. A compression spring **76** urges the flange into sealed contact with the shoulder, but can open if the level of liquid rises beyond opening **56**.

Chamber **71** is closed by a cap **77** held in place by a threaded sleeve **78** engaged with the top of the vent body.

A boss **79** extends horizontally from one side of vent body **51**. The boss has internal threads **80** and external threads **81**. The internal threads are in a vent passage **83** connecting with the chamber **71**. A threaded collar **84** threadedly engaged with the boss retains a rupturable diaphragm **85** and a backup screen **86** across the outer opening of the vent passage **83**. Diametrically opposed slots **87** at the outer end of the boss vent the vent body. The slots taper from the exit of the passage **83** to the juncture of the boss **79** with the vent body **51**. A screen **88** within passage **83** inhibits contamination should the diaphragm **85** be ruptured.

The upper end **89** of stem **54** has a port **91** against which a metallic valve ball **92** seats. A plurality of radial slots **93** in the upper end **89** communicate between passage **55** and chamber **71** of the vent body. Therefore, when port **26** is open, there is a venting path from the interior of the tank through passages **65, 55**, chamber **71** and passage **83** to vents **87**. If the displaced volume of air is greater than the capacity of the slots **93**, the weighted ball **92** is raised by the air pressure from its port **91** to increase the volume of air exchange. Should the pressure within the tank rise dangerously after the valve ball **28** closes, the flange **75** may be displaced from its seat against the pressure of the spring **76** and establish a second air passage through chamber **72**, chamber **71**, and passage **83**. This second vent passage, as previously mentioned, also obviates the overpressurization of the tank should the automatic shut off valve fail or be inadvertently overridden by the manual nozzle control. In such case fluid rising through the vent past valve flange **75** fills chamber **71** and ruptures diaphragm **85**, spilling out of the vent body to quickly relieve pressure which might damage the tank.

In case the tank is inverted, spring **76** still biases the valve flange **75** closed but the passageway **55** would conduct fluid into the vent body and thence through the vent openings **87**. Float ball **28** would normally, under inverted conditions, move away from the port **26**. However, weighted ball **70**, urged by gravity, biases the float ball into closed position shown by dotted lines **98** against the port **26**, precluding leakage of liquid through the vent body.

Should a sudden fluid surge fill chamber **71** with liquid, a plurality of grooves **99** in the flange conduct the liquid to the radial slots **93** of the valve stem and the liquid returns to the tank through valve stem passage **55**, substantially reducing any chances of liquid escape through vents **87**.

The Receptacle Fitting

Turning now to FIGS. 3 and 4, the receptacle fitting **15** has a flanged cylinder **100** concave with respect to the tank. A receiver flange **101** is secured to a vertical tank wall **10A** by a plurality of fasteners **102**. A gasket **103** between the flange and the wall effectively seals about the tank filling port **14**. A back wall **105** of the cylinder **100** has an opening **107**. The cylinder is otherwise open to atmosphere such that the only entry to the tank is through the opening **107**.

The flanged valve body **20** is secured to the wall within the cylinder by screws **111**. A gasket **112** seals about the opening **107** between the flanged body and the back wall. A valve body C-ring **113** backs a support ring **114** in the valve body. The support ring has a plurality of webs **115** which suspend a central boss **116**. A valve stem **118** slidable axially in the boss **116** supports the valve member **22**. A compression spring **120** urges the valve to closed position against a port ring **121** having an inner cylindrical surface **122** joined to a conical surface **123** to define a valve port. Valve member **22** has a conical shoulder **126** and a resilient gasket **127** mounted between the shoulder and a stepped head portion **128** of stem **118**. Valve member **22** is threadedly engaged with head portion **128**. The head portion terminates exteriorly in a disk **129**. The valve stem and head are movable axially within the receiver away from valve port surfaces **122** and **123** in response to connection with the nozzle **16**.

An annular groove **131** intermediate the exterior and internal ends of the valve body is adapted to receive the lock means of the nozzle when the nozzle and receptacle fitting are connected. A sloping shoulder **132** on the valve body exterior cooperates with lock means on the nozzle.

The Nozzle

The nozzle **16**, adapted to combine with the receptacle fitting, has a barrel **135** terminating in an enlarged collar **136** with which a barrel extension **137** is threadedly engaged. Spaced ribs **138, 139** on the extension support the previously mentioned lock actuating sleeve **30** which contains a plurality of chordal lock pins **144** adapted to lodge in recess **131** of the receptacle fitting valve body when the nozzle and fitting are joined in the position of FIG. **4**. A C-ring **145** retains the sleeve on the extension. The barrel extension also contains the sleeve valve **32** of the nozzle.

The barrel extension is hermetically sealed with respect to the barrel by a gasket **146** lodged between the inner wall of the barrel collar and the outer wall of the inner end of the barrel extension. An inner extension wall **147** defines a cylindrical cavity **148** containing the sleeve valve **32** and its cooperating valve head **149**. At the upstream edge of the cavity is a valve stem spider **151**. Sleeve valve **32** lies between the spider and the lock pins **144** and has a cylindrical wall **152** which reduces to a valve port wall **153** defining an annular shoulder **154** against which the compression spring **34** thrusts. The other end of the spring contacts a plurality of webs **157** of the spider **151**. The spring resists upstream displacement of the sleeve valve away from sealing contact with the valve head **149**, thus constituting a normally closed valve at the discharge end of the nozzle **16**.

The sleeve valve port flares outwardly in a frustoconical chamber **158** in which the valve head flange **161** normally resides. The valve head flange has an inner boss **162** threadedly engaged within the valve head **149** in a threaded hole **164**. The hole connects to the fluid passage **50** which extends upstream through a valve head stem **166**. The valve head stem extends upstream through a central boss **167** of the spider **151**, with which it is threadedly engaged. Upstream of the spider the stem is sealed in a fluid conducting bore **171** within a web **172** extending into a flow passage **174** of the nozzle barrel.

The valve head flange **161** opens exteriorly through a central passage **175** which connects passage **50** with atmosphere when the nozzle is uncoupled. The flange also retains an O-ring **177** which seals between the sleeve valve and the valve head, closing cavity **148**. The sleeve valve is similarly sealed with respect to the cylindrical cavity **148** of the barrel extension by an O-ring **178**.

Just downstream of the valve head flange the barrel extension has an O-ring **179**. When the nozzle and receptacle fitting are coupled, O-ring **179** coacts with the valve body to seal the joinder of the two elements, effecting a closed liquid transfer system.

In FIG. **3** the nozzle exit is closed because of the seal between sleeve valve **32** and the valve head **149**. Therefore, no flow can take place from passages **174** and **148**. The upstream portion of passageway **174** is also sealed by the manually openable nozzle shut-off valve member **35**. Passageway **174** is enlarged in a conical port **182** within which the shut-off valve is confined. A spider **183** within a liquid entry chamber **185** supports an upstream valve stem portion **186**, threadedly engaged with valve extension **36**. The compression spring **38** urges valve member **35** closed against the port **182**. A hose coupling **189** enters the nozzle body at an angle to the axis of the valve stem from the supply hose **18**.

An enlarged nozzle body portion **191** has a small axial hollow boss **192**. A sealing element **193** precludes leakage from the body around the valve stem portion **186**. The inner end **194** of the previously mentioned cam **42** is threadedly engaged within boss **192** adjacent to sealing element **193**. A pin **195** through a wall of the boss into the element precludes relative motion between the boss and the cam **42**.

Stem portion **186** terminates in a handle retainer which is secured to the stem by a screw **198** and fixed by a pin **199**. Cam **44** is rotatably mounted on the stem and has an external collar **200** from which handles **201** extend, as shown in FIG. **14**, to define the T-handle **40**. The T-handle is the means whereby valve member **35** is opened against the closing bias of spring **38** and liquid source pressure to provide flow of liquid from the supply line **18** through the nozzle. However, since the delivery rate of the illustrative nozzle can be from 65–150 gallons or more per minute, the liquid pressure against the rear of valve member **35** is considerable. In order to ease manual opening of the valve, the cams **42, 44** on the valve stem are provided to give mechanical leverage to the operator of the T-handle. FIGS. **12–14** illustrate the camming elements which aid moving the shut-off valve between the closed position of FIG. **3** and the open position shown in FIG. **4**.

FIG. **12** illustrates fragmentarily the valve stem portion **186** passing through the fixed cam **42** and a spring flange **202** on the cam. An outer shroud **206** riding on boss **192** shields a compression spring **208** which surrounds the cams and thrusts against fixed cam spring flange **202** to bias the cam **44** outwardly.

The cams have inner faces **209, 210**. In the closed position of the shut-off valve the inner faces **209,210** of the cams are abutted. FIG. **13** illustrates in a similar view the open valve position of the cams after 180° clockwise rotation of the T-handle **40**.

An extreme cam point **212** of cam **44** advances along cam surface **209** of the fixed cam **42** to the point **212*a*** of FIG. **13**. This relationship of the cams is shown in plan section in FIG. **14**. Valve stem portion **186** is thus moved leftwardly as shown in FIG. **4**, carrying the valve member **35** away from the valving surface **182** against both the bias of the liquid under pressure and of the spring **38**. The shroud **206** migrates with the cam **44** and covers the extended spring **208** during its extension.

If the T-handle were released at this point, the combined forces of spring **38** and the supply of fluid pressure would immediately close valve **35**. Therefore, the invention has latch means for the shut-off valve to keep valve **35** open for liquid flow through the nozzle and the receptacle fitting into the tank. The downstream end of axial extension **36** has a latch tip **216**. A pin **218** extends through the extension and the stem portion **186** to fix them against relative rotation. The latch tip is cylindrical with a diameter less than the diameter of extension **36** such that a transverse shoulder **221** is defined.

A pair of latch pins **223, 224** extend transversely of a latch stirrup **225** beneath the latch tip **216**. On each side of the stirrup a washer **227** overlies the external ends of the pins to retain them rotatably within the stirrup. The washer on each side is secured by a screw such as screw **228**.

In order to stabilize the stirrup in carrying the pins between latched and unlatched positions, the stirrup has oppositely extending shafts **230, 231**. Lower shaft **231** extends into the aperture of a nozzle barrel boss **232**. The lower shaft may have a flat **233** to provide a pressure relief channel between the shaft **231** and the cavity wall of barrel boss **232**. The nozzle barrel also has an upper aperture **234** in which a depending cylindrical boss **235** of the fluid-actuated pressure sensing unit **46** seats.

The Pressure Sensing Unit

The sensing unit includes a housing **236** enclosing chamber **48** which comprises a lower chamber case **237** to which the boss **235** is attached, a top case plate **238**, and an intermediate case disc **239**. The case plate **238** may have a protective skirt surround **240**. The lower chamber case has a cylindrical cavity **241** which, together with an aperture **242** of the intermediate disc and an opening **243** in the top case, define the sensing chamber **48** in which a wall **245** is movable. A flexible diaphragm **246** secured between the intermediate disc and the lower chamber case suspends the wall **245** for movement in the chamber.

Upper shaft **230** of the stirrup terminates in a threaded post **248** about which the movable wall **245** is secured. The wall is secured between a shaft shoulder **249** and an internally threaded manual button **251** whose shank **252** passes through the top of case plate **238** into the sensing chamber. An O-ring **253** seals the shank and case plate interface. A biasing spring **255** thrusts upwardly against the moving wall **245** from its base on the lower chamber case **237**. The chamber **48** is connected to the fluid conducting bore **171** of the nozzle by fluid duct segment **256** in the nozzle, segment **257** in the lower chamber case, and segment **258** in the intermediate case disc. The upper surface of the moving wall is thus exposed to fluid pressure communicated through the duct, the bore and fluid passage **50** from the normally closed valve of the nozzle.

Since the wall is mechanically secured to an extension of the latch stirrup, any motion of the moving wall is communicated to the latch pins **223, 224**. In the position shown in FIG. 3, the latch stirrup **225** and its pins have been moved from latched position and bear against the periphery of extension **36**. The shut-off valve **35** of the nozzle is closed, as is the normally closed valve head **149** of the nozzle. In FIG. 4 the latch pins bear against the periphery of the latch tip **216** under the urging of the bias spring **255**. This condition is achieved by manipulation of the T-handle **40** to withdraw the shut-off valve **35** from the valve seat **182** against the bias of liquid pressure and spring **38**.

Even when the shut-off valve **35** is open, no flow takes place through the nozzle unless self-closing sleeve valve **32** is opened by the joinder of the nozzle to the receptacle fitting. FIG. 4 illustrates this latter condition. The nozzle has been inserted into cylinder **100** of the fitting such that the lock pins **144** of the nozzle lodge in the annular groove **131** of the valve body. The chordal attitude of the pins **144** when in locked position is shown in FIG. 7, in which three pins lodge in the annular groove. The pins are retained by a retaining collar **261** which overlies the outer ends of the pins, preventing their migration up the slotted ramp **263** in which each pin lies within the nozzle extension **137**. The pins are unlocked by moving the lock actuating sleeve **30** axially along the nozzle barrel by means of a lanyard **264**. Such axial movement of the sleeve **30** overcomes a lock spring **265**, and moves the retaining collar **261** to free the slot for upward migration of the pins out of the annular groove **131**.

FIGS. **8** and **9** show an alternate locking arrangement applied to a dust plug **266** in which a discontinuous spring ring **270** lies in a groove **271** of a plug barrel **272** of the dust plug **266**. Peripherally spaced concave arcuate indentations **273** of the spring ring are depressed through radially spaced slots **274** of the plug barrel such that they protrude into the annular groove **131** of the valve body **20**. Since the lock ring is discontinuous at **275**, a sharp pull on a plug handle **276** expands the ring as the plug is pulled axially away from the valve body, such that the arcuate indentations **273** may migrate from the groove **131**. The plug has a resilient annular skirt **277** which sealingly engages cylinder **100** and an O-ring **278** in internal plug wall **279** to seal between the plug and the valve body **20**. The O-ring acts as a secondary seal should the valve **22** be damaged and as a shock absorber to combat wear between the plug and the valve body due to vibration of the equipment using the tank.

While the chordal pin locks of FIG. 7 are the presently preferred means for achieving locked orientation between the nozzle and the receptacle fitting, many different types of locks may be used within the scope of the invention. Prior patents such as the U.S. Pat. No. to Torres, No. 2,888,278 issued May 26, 1959 and U.S. Pat. Nos. 2,409,650 and 2,425,500 issued to E. B. Wiggins on Oct. 22, 1946 and Aug. 12, 1947, respectively, illustrate lock arrangements which permit ready assembly and disassembly of cylindrical mating parts such as the nozzle and the receptacle fitting of the present invention.

Operation

In order to make automatic the opening of the normally closed valves of each of the nozzle and the receptacle fitting, means is provided on each to axially displace the valve member of the other when the nozzle and the fitting are connected. By the time the lock pins **144** lock within the annular groove of the receptacle fitting, the valves of the receptacle fitting and nozzle are open. The port ring **121** of the valve body contacts sleeve valve **32** as the nozzle and fitting are joined, displacing the sleeve valve axially away from valve head **149** against the bias of spring **34**. The valve member **22** of the valve body **20** is similarly displaced axially away from valve ports **122, 123** against spring **120** by the thrust of nozzle valve head **149** which is fixed within the nozzle. In this condition valve member **22** of the valve body and valve head **149** of the nozzle are abutted along a plane transverse to the axis of movement of the valves. This relationship is maintained by the lock pins **144** until lock actuating sleeve **30** is moved to release the lock pins.

With the orientation of FIG. **4** achieved, fuel flows from hose **18** through the nozzle past shut-off valve **35** and the web **172** in the nozzle barrel **135** and through the valve aperture defined by port wall **153** into the valve body through valve ports **122, 123** and into the tank through the opening **107**. The flow may be manually determinated by pressure upon manual button **251**, unseating the latch such that valve **35** snaps closed while the nozzle and receptacle fitting are still coupled. While in the latched condition, T-handle **40** is inoperative, being free to turn about the valve stem portion **186** in a limited arc without affecting the position of shut-off valve **35**.

Under normal conditions button **251** is not utilized. Instead, the operator couples the nozzle and the receptacle fitting and manipulates T-handle **40** to open the shut-off valve. Since the nozzle and fitting are firmly locked by pins **144** and sealed against leakage by O-rings **179** and **178**, the operator may leave the nozzle to attend to other duties or couple other supply nozzles to other tanks, depending upon the fluid-actuated pressure sensing means **46** of the nozzle to terminate flow when the liquid is being transferred reaches the proper level within the tank.

As the level rises in the tank, the float balls of the vent **12** ascend in the cage until ball **28** achieves the broken line position **98**, closing port **26** of the vent. Since the delivery rate of the nozzle is high, the level rises rapidly, compressing the air now trapped in the tank. The air continues to be compressed and the pressure imposed upon the advancing liquid interface increases. This pressure is transmitted through the liquid into the valve body **20** through opening **107** and around the valve member **22** to a groove **278** in the flange face **161** of nozzle valve head **149**. The groove crosses passage **175**. There is therefore communication through fluid passage **50** and bore **171** and through the fluid duct segments **256, 257, 258** to the pressure sensitive chamber **48** above movable wall **245**.

The pressure is transmitted through the fluid occupying the ducts. Normally liquid in the ducts and passage drains as the nozzle is moved from one receptacle fitting to another, leaving air as the passage fluid.

Spring **255** is calibrated to resist displacement of the wall **245** within the sensing chamber until the transmitted pressure reaches a certain level. Thereafter, the wall moves in the chamber to reduce the volume of the chamber and displace the latch pins, releasing the shut-off valve for closure.

When the operator wishes to remove the nozzle after the tank has been filled, he draws lanyard **264** away from the tank, causing lock actuating sleeve **30** to release the lock pins **144** and the nozzle is then withdrawn from the receptacle fitting. Upon withdrawal of the nozzle, the springs **120** and **34** immediately close the normally closed valves **32, 22** of the nozzle and fitting, preventing further liquid or vapor transfer from either the tank or the nozzle.

It is desired to protect the discharge end of the nozzle and the receptacle fitting against contamination while they are disconnected. A dust plug **281** which is attached to the nozzle by a line **282** is shown in FIG. **8** in the barrel extension of the nozzle where it is secured by the nozzle lock pins **144**. The pins seat in a plug annulus **283** and the plug is locked and unlocked with respect to the nozzle in the same manner that the nozzle and receptacle fitting are joined and unjoined.

Previously described dust plug **266** for the receptacle fitting has the handle **276** attached to the fitting by a securing cord **284** and a tab **285**.

It may be desirable to simplify the path of the pressure sensing duct between the nozzle fluid passage **50** and the pressure sensing chamber. Therefore, another preferred embodiment of the invention has the configuration shown fragmentarily in FIG. **15**. In that figure nozzle **16** has a pressure sensing unit **290** secured to the nozzle barrel **135** by fasteners **291**. The sensing unit comprises chamber case **293** which has a chamber **294** in which a movable wall **295** reciprocates. Chamber **294** has a threaded portion **297** which receives a threaded plug **298**. The plug has a central web **299** separating oppositely oriented conical hollows **301, 302**. An O-ring **303** within the web seals a guide shaft **304** which rests on the upper end of the upper shaft **305** of a latch stirrup **306**. A lower shaft **307** extends from the stirrup through a nozzle boss **308**. Like the stirrup of the previously described embodiment, the stirrup **306** supports roll pins **223, 224**, which rest alternatively against the shank of the valve extension **36** or in latch position on the latch tip **216**.

The wall **295** is operatively secured to the stirrup by the guide shaft **304** and is biased toward the valve extension by a compression spring **311** housed in the conical hollow **302** of the plug **298**. The wall is suitably sealed against leakage by exterior O-ring **313** and interior O-ring **314**. The chamber space above the wall is vented to atmosphere through duct **315**.

The web of the nozzle barrel contains a fluid duct segment **256** which connects with a duct segment **317** opening directly into the sensing chamber **294** below the wall **295**.

The embodiment of FIG. **15** affords a pressure sensing unit which is easily assembled and maintained. The pressure duct is shorter and the assembly of the unit simpler than one in which a diaphragm must be anchored within the casing.

In operation the sensing unit and latch of FIG. **15** are similar but opposite to the previously described embodiment, the stirrup being inverted since the moving wall responds oppositely with respect to the illustrated orientation than from the previously described embodiment. Manual inward pressure on lower guide shaft **307** also releases the latch.

The alternate embodiment shown in part in FIGS. **10** and **11**, wherein a receptacle fitting **311** of differing configuration has a cylinder **100** within which a flanged valve body is secured is somewhat similar to the previous embodiments. The cylinder has a rear aperture **107** communicating to the interior of the tank (not shown). A valve body flange **313** is secured against a gasket **112** by bolts **111**. The external periphery of the tube has a lock annulus **131** for receiving the lock pins of a lock device upon the mating nozzle.

The exterior end of the valve body has an inward flange **321** with parallel external and internal surfaces **322, 323**, respectively. External surface **322** is adapted to thrust against valve head **149** (shown in broken lines) of the nozzle to open the normally closed valve **32** of the nozzle. Internal surface **323** surrounds a valve port **325** and a seated valve head **326** thrusts against that surface. An effective seal is achieved by means of a shaped resilient gasket **327** carried by the head. The gasket is retained on the head by an exterior flange **328** secured to the valve body by a threaded shank **329** within a threaded bore **330** of the head.

A plurality of radially spaced vanes **332** extend from the valve head. The vane spacing is best shown with respect to FIG. **11**. Each vane has an axially extending contact surface **333** which seats against the inner wall of the valve body and guides the valve head in its axial reciprocation. The downstream end of each flange is reduced in radial extent to receive one end of a compression spring **335** which urges the valve head closed. The compression spring thrusts against a retaining ring **336** backed by a split ring **337** seated in the valve body. Ring **336** has an inner wall **340** which defines a port which is effective to meter the maximum delivery rate of the liquid. By altering the diameter of wall **340** the tank entry orifice can act to meter flow.

In FIG. **10** the valve head **149** of the nozzle is in the position when the nozzle is initially joined to the receptacle fitting and prior to achieving the locked position. As the nozzle advances along the valve body toward locked position, valve head **149** thrusts the valve head **326** away from the valve seat **323** against the bias of spring **335**, opening the valve body for liquid flow. When the valve **326** is in open position, a pressure path exists from the tank through the valve body to the grooved face of the nozzle valve head **149**, from which point the fluid passage and ducts transmit fluid pressure to the sensing means on the nozzle in the manner previously described.

Each of the illustrative embodiments affords apparatus whereby liquid may be transferred from a source to a tank at a rapid delivery rate without the dangers of escaping vapor or liquid and without contamination of the liquid supplied. The components of the apparatus disconnect easily and once joined, need no attendant during filling since the nozzle is supported by the receptacle fitting and is automatically cut off when the proper liquid level within the tank is reached.

We claim:

1. In an apparatus for filling a tank with liquid wherein the tank has a fill port, the combination comprising a receptacle fitting in the fill port of the tank, a nozzle to releasably engage the receptacle fitting, said nozzle being in connection with a source of fluid under relatively high pressure, means to raise the pressure of the interior of the tank abruptly to substantially the pressure of the source in response to the rise of the volume of liquid in the tank to a predetermined magnitude, means to sense the abrupt rise in pressure in the tank, and a shut-off valve responsive to the sensing means to cut flow through the nozzle.

2. Apparatus in accordance with claim **1** wherein the means to raise the pressure in the tank includes a vent opening in the tank, and float-operated valve means to close the vent opening.

3. Apparatus in accordance with claim **2**wherein the float-operated valve means includes a cage adjacent saidopening, and a buoyant valve member in the cage to float upwardly to close the vent opening.

4. Apparatus in accordance with claim **3** further including a body of higher specific gravity than the fluid positioned in the cage at a normal position below the buoyant valve member to serve as a weight to urge the buoyant valve member to closed position in the event that the tank is turned over.

5. Apparatus for filling a tank with liquid wherein the tank has a fill port, the combination comprising a liquid supply nozzle, a receptacle fitting in the fill port opening into the tank, a self-closing shut-off valve in the nozzle for controlling nozzle flow, a latch for holding the shut-off valve in open position; a normally closed valve in the flow path of the nozzle; releasable coupling means adapted to join the nozzle and the receptacle fitting for liquid interchange therebetween; a second normally closed valve adapted to open and close said receptacle fitting; valve opening means on the receptacle fitting adapted to open the normally closed valve of a coupled nozzle; valve opening means on the nozzle adapted to open the normally closed valve of the coupled receptacle fitting; a tank vent including a vent opening; means responsive to liquid level for closing the vent opening to increase tank pressure; and fluid-actuated pressure sensing means on the nozzle responsive to increased tank pressure for releasing the shut-off valve latch.

6. Apparatus in accordance with claim **5** wherein the liquid level responsive means comprises float-operated valve means.

7. Apparatus in accordance with claim **6** wherein the float-operated valve means includes a cage adjacent said opening, a buoyant valve member in the cage to float upwardly to close the vent opening.

8. Apparatus in accordance with claim **7** wherein the float-operated valve means includes a body of higher specific gravity than the fluid positioned in the cage at a normal position below the valve member to serve as a weight to urge the buoyant valve member to closed position in the event that the tank is turned over.

9. Apparatus in accordance with claim **5** wherein the fluid-actuated pressure sensing means to release the latch includes a chamber with a movable wall, said movable wall being operatively connected to said latch; and means to bias the wall to contract the chamber whereby a rise in pressure within the chamber displaces the wall to overcome the bias and release the latch.

10. Apparatus in accordance with claim **9** wherein said movable wall comprises a piston.

11. Apparatus in accordance with claim **10** wherein said movable wall comprises a diaphragm.

12. Apparatus in accordance with claim **9** further comprising manually operable means to release the latch.

13. Apparatus in accordance with claim **10** wherein the manually operable means to release the latch comprises an exteriorly extending button operatively connected to said movable wall.

14. Apparatus for filling a tank with liquid wherein the tank has a fill port, the combination comprising a liquid supply nozzle, a receptacle fitting in the fill port opening into the tank, releasable coupling means adapted to join the nozzle and the receptacle fitting for liquid interchange therebetween, valve means including a self-closing shut-off valve in the nozzle for controlling flow through said nozzle and said receptacle fitting, a latch for holding the shut-off valve in open position, a tank vent including a vent opening, means responsive to liquid level for closing the vent opening to increase tank pressure; and fluid-actuated pressure sensing means on the nozzle responsive to increased tank pressure for releasing the shut-off valve latch.

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