United States Patent

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[54] **SYSTEM FOR STORING PETROLEUM PRODUCTS**
15 Claims, 4 Drawing Figs.

[52] **U.S. Cl.** **137/202,** 137/266, 137/409; 220/86
[51] **Int. Cl.** **F16k 31/18**
[50] **Field of Search** ..... 137/202, 266, 267, 213, 214, 401, 403, 409, 404, 190, 427, 583, 587, 388—390; 220/86

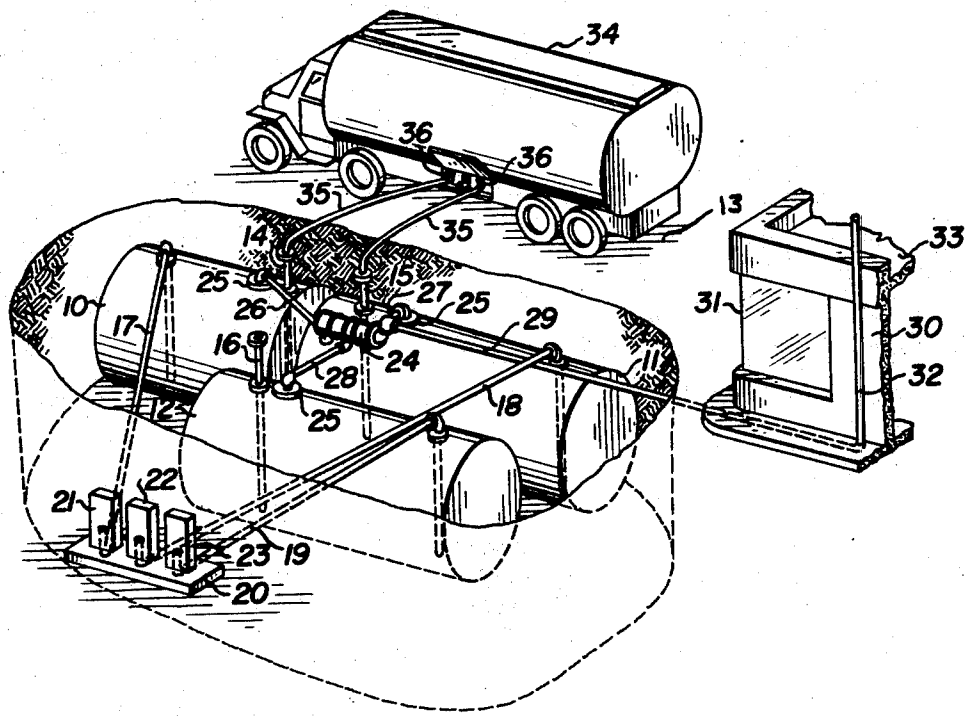
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ABSTRACT: A system and process for storing petroleum products characterized by an underground manifold into which a plurality of underground tanks are vented and which in turn is vented to the atmosphere by a single line. A valving system is employed in conjunction with the vent lines running between the individual tanks and the manifold which automatically closes the vent line during the tank filling operation and stops the flow of the product at a level which provides sufficient additional tank storage capacity to subsequently accommodate the quantity of product in the fill hose. The valving system includes a venting bypass line which can be then opened to recycle the valving system, to permit the quantity of product in the fill line to flow into the tank and to vent the tank to the atmosphere through the manifold.



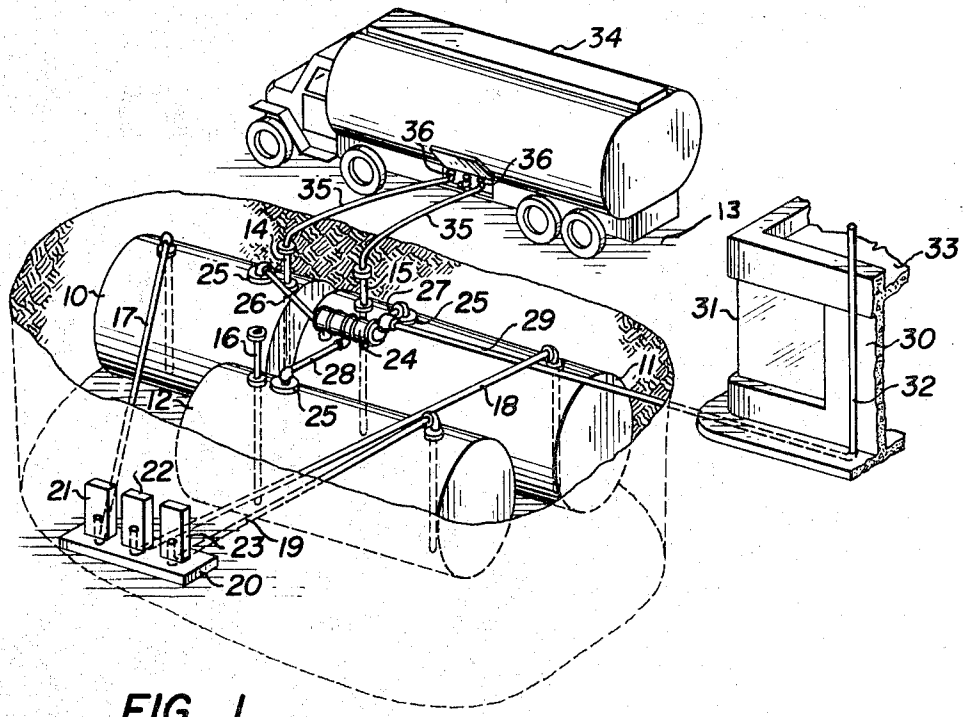


FIG. 1

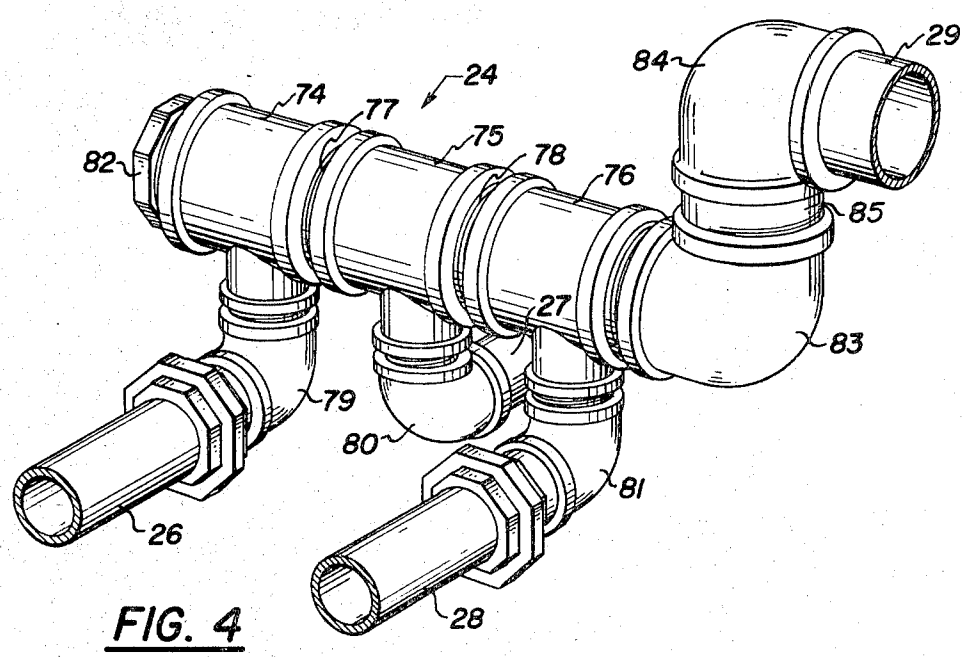


FIG. 4

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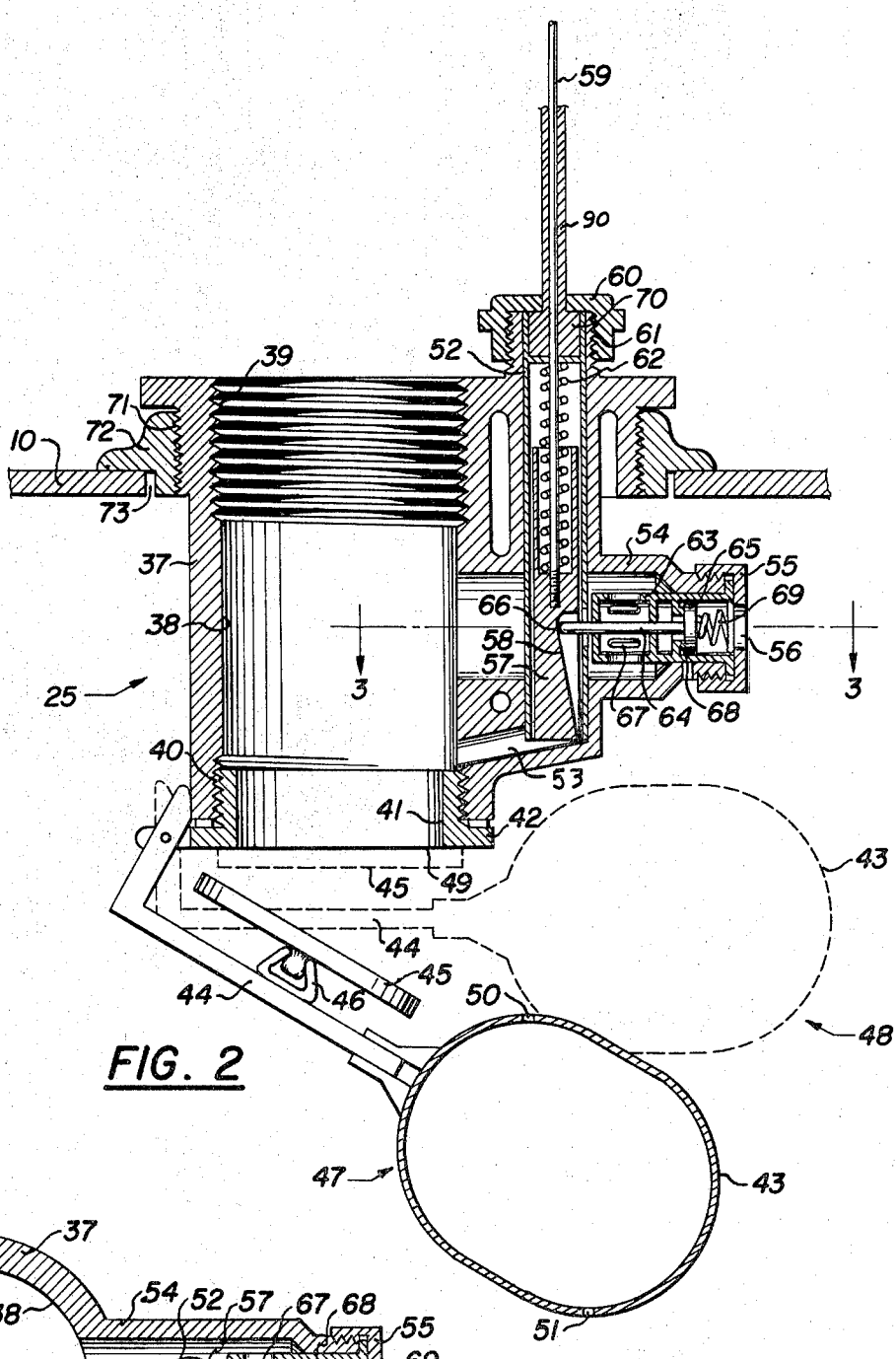


FIG. 2

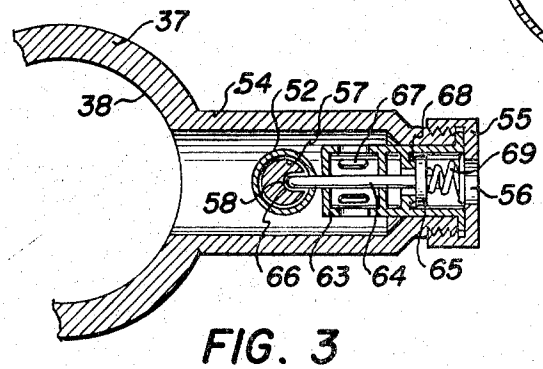


FIG. 3

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SYSTEM FOR STORING PETROLEUM PRODUCTS

BACKGROUND OF THE INVENTION

1. Field of the Invention

The invention relates to petroleum storing systems and, more particularly, to such systems wherein a plurality of storage tanks are located underground and vented to the atmosphere.

2. Description of the Prior Art

Conventionally, storage systems for petroleum products at locations such as service stations involve the use of a plurality of underground storage tanks filled with products of different quality. A fill line is provided in each tank and the fill lines and tanks are so positioned that the fill caps are in close proximity to facilitate simultaneous loading of a plurality of the tanks from a single truck. The products from the tanks are pumped through underground lines to dispenser located on an "island," next to which the customer vehicles are parked.

Each tank is provided with a vent line that runs underground on a rising slope to connect with a riser which extends a substantial distance above the ground. In this manner, the fumes from the product stored in the tank are not expelled in a dangerous location or where they would likely be offensive to persons in the vicinity of the station. Typically, codes require that risers in an open area extend at least 12 feet above the finished grade at its base. Alternately, they are normally required to extend 3 feet above the roof of a building and to be horizontally positioned 5 feet from any opening in the building.

In any event, each tank has its own venting system. A five-tank station has heretofore required the installation of five separate venting systems typically employing 2 inch piping and running a distance of anywhere from 25-feet to as much as 100 feet, with the major portion thereof being installed below grade level. Multiple venting systems have been found necessary in the past to prevent the flow of product from one tank to another. For instance, during filling operations it is not unusual for the operator to load a tank beyond its capacity. Under such circumstances, if the plurality of tanks were vented by an interconnected venting system, the product in the tank being filled could flow through the vent lines into other tanks, thereby contaminating the product contained therein.

Quite obviously, the prior art practice of providing each tank with its own venting system has significantly increased storage system installation costs. This is a major factor to be considered in any highly competitive field, particularly in these times of rapidly rising costs. Additionally, multiple risers detract from the aesthetic quality of the environs.

Another characteristic of these prior art storage systems is that, in an overloading situation, product is pushed into the vent line. Frequently, the slope of the underground portion of the vent line is not true and some of the product will remain in the line as the tank is emptied. The next time a delivery is made, vapors from the tank are expelled with force through the venting system causing the product trapped therein to spray out of the vent riser. This not only presents an unsanitary condition but also one which is potentially dangerous.

An analogous situation of far more serious consequences frequently arises during the tank filling operation. These tanks are filled from a tank truck utilizing a fill hose provided with a visual gauge. The operator watches the gauge and, as the flow rate in the hose decreases, he knows that the tank is almost full. At this time, he should stop the flow in order that the tank will still accommodate the product, typically on the order of 10 to 15 gallons, remaining in the fill hose. However, if for one reason or another, the operator does not stop the flow at the proper time, he finds himself with a full tank and hose. If the delivery is being made when the station is in operation, the tank truck operator can wait until the station operator has sold enough product to drain the hose. Alternately, the product can be dispersed through the service station pump into buckets and dumped into another tank. This is not a safe

operation. Neither is completely ethical when the other tank contains a product of different quality. Obviously, the problem is compounded if such a situation arises at a time when the station is closed. In this instance, a spill is inevitable and a very dangerous and otherwise undesirable situation is created.

These limitations of prior art systems for storing petroleum products are alleviated by the present invention.

It is therefore a primary object of this invention to provide a storage system for petroleum products which is significantly less expensive than systems currently in use.

It is another object of this invention to provide a common venting system for a plurality of underground tanks.

A further object is to prevent petroleum products in a storage tank from entering the tank's venting system.

Another object of this invention is to automatically stop the flow of product into a storage tank at a level which will permit product in the fill hose to subsequently be accommodated in that the tank.

An additional object is to prevent spilling of product in service station areas during storage tank filling operations.

Also, one object of this invention is to provide a unique and improved valve which prevents petroleum storage systems from being filled beyond a predetermined volumetric capacity.

A still further object of this invention is to provide a manifolded venting system for a plurality of petroleum product storage tanks, which will preclude the passage of product from one tank into another under any possible conditions.

BRIEF DESCRIPTION OF THE DRAWINGS

The novel features that are considered characteristic of the invention are set forth with particularity in the appended claims. The invention itself, however, both as to its organization and its method of operation, together with additional objects and advantages thereof, will best be understood from the following description of specific embodiments when read in connection with the accompanying drawings, wherein like numbers have been employed in the different figures to denote the same parts and wherein:

FIG. 1 is a perspective view illustrating the improved system of this invention for storing petroleum products;

FIG. 2 is a detail elevation view in section of the preferred embodiment of the unique valve employed in the storage system of FIG. 1;

FIG. 3 is a sectional view taken along line 3–3 of FIG. 2; and

FIG. 4 is a perspective view of the manifold of the storage system of FIG. 1 and the connections thereto.

SUMMARY OF INVENTION

The invention comprises both a system and process for storing petroleum products. Briefly, each of a plurality of underground storage tanks is vented to a common manifold located in their immediate vicinity. A single vent line runs from the manifold to a convenient, above grade, relatively distant location where the vapors can be safely exhausted. A float valve connects each tank to its vent line and is designed to close off the vent line prior to the tank's reaching its full capacity. The flow of product into the tank will cease as soon as the vapor pressure equals the head on the product in the fill hose. Holes in the float permit the float to be gradually flooded, thereby losing its buoyancy. A secondary venting system is manually opened, bypassing the float valve. At this point, the float valve recycles to its original open position and the product remaining in the fill hose will flow into the tank. Product in the float drains through one of the holes provided therein as product is emptied from the storage tank to restore the float's buoyancy.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring first to FIG. 1, three petroleum product storage tanks 10, 11 and 12 are shown buried under the paved surface 13 of a service station. These tanks 10, 11 and 12 are respectively provided with fill pipes 14, 15 and 16 which extend from the paved surface 13 through the top of the tank to the vicinity of the bottom of the tank, and with suction lines 17, 18 and 19, which extend underground to a service station island 20 where they connect to dispensing pumps 21, 22 and 23. Typically, different grade product is stored in each of the tanks 10, 11 and 12 and vehicles being filled with petroleum park next to island 20 and are serviced in the conventional manner through the dispensing pumps 21, 22 and 23. A manifold 24 is installed under the paved surface 13 above the tanks 10, 11 and 12 and in the immediate vicinity thereof. Mounted to the top of each tank 10, 11 and 12 is a unique valve 25 of this invention, the details and operation of which will subsequently be fill fully explained. The mainfold 24 is connected to the valves 25 of the tanks 10, 11 and 12 by pipes 26, 27 and 28, respectively, which are installed on a gradually rising slope between the valve and the manifold. Also connected to the manifold 24 is a vent line 29 which runs a relatively long distance underground on a gradually rising slope from the manifold to a point adjacent a wall 30 of the service station building 31 where it turns vertically upwards to form a riser 32 positioned adjacent the wall and rising above the roof 33.

It will be noted that the fill pipes 14, 15 and 16 are positioned in close proximity. In this manner, they can be filled from a tank truck 34 part parked in one position in the station. Due to the number of tasks which must be performed by the truck operator, it has become the practice to fill no more than two tanks simultaneously from the truck 34. Two fill hoses 35 are seen connected to tanks 10 and 11 and to separate tank compartments (not illustrated) on the truck 34 through unloading valves 36. Tank 12 is subsequently loaded in a similar manner through fill pipe 16 and one of the hoses 35 after delivery is completed to either tank 10 or 11.

The detail structure and operation of the unique valve 25 will be best appreciated by referring to FIGS. 2 and 3. A valve body 37 is provided with a cylindrical bore 38 which extends therethrough with one end provided with internal threads 39 to facilitate connection to one of the pipes 26, 27 or 28. The other end of the cylindrical bore 38 is provided with internal threads 40 to receive the threaded collar 41 which terminates in an outwardly depending flange 42. A float 43 is pivotally connected to the valve body 37 by an arm 44 which carried a disc 45 mounted thereto on a swivel joint 46. As illustrated, in the fully extended position 47 of the float 43, the disc 34 is not in contact with the annular cap 41; however, when in its uppermost position 48, the disc seats against the flange 42 on the collar 41 to close off the entrance 49 to the valve body 37. Any initial misalignment between the flange 42 of collar 41 and disc 45 is accommodated by the swivel joint 46, thereby assuring a gas tight seal between those two members. Collar 41 and disc 45 are formed of closely machined metal parts or of other materials suitable to effect a gas tight seal therebetween, such as neoprene or polyurethane, when the float 43 is in its uppermost position 48. Small apertures 50 and 51 are provided through the upper and lower portions, respectively, of float 43. Their function will subsequently become apparent.

Also provided in the valve body 37 is a second cylindrical bore 52, the lower end of which communicates with the bore 38 through a channel 53 in the valve body. This bore 52 intersects a tubular member 54, communicating with the bore 38, and which tubular member is provided with an end cap 55 having an aperture 56. Positioned within the bore 52 is a piston 57 which has a tapered groove 58 and which is connected to a cable 59 aligned axially with the bore and extending externally thereof through a cap 60 mounted on a threaded extension 61 of the bore formed on the valve body 37. That portion of the cable 59 extending exteriorly of the valve body 37 is provided with a shield 90. A spring 62 within the bore 52 acts against the piston 57 to continuously bias it in the direction of the channel 53.

Mounted within the tubular member 54 is a bearing support structure 63 which slideably carries a pin 64, one end of which carries an annular seal 65 and the other end 66 of which engages the tapered groove 58. The bearing support structure includes apertures 67 spaced around its periphery and an annular seat 68. A spring 69 mounted within the bearing support structure 63 between the end cap 55 and the annular seal 65 urges the annular seal and the pin 64 towards the piston 57. Action of this spring 69 causes the seal 65 to seat against the annular seat 68 when the piston 57 is fully extended within the bore 52. The annular seal 65 may for formed of neoprene or any other suitable material which will effect a gastight connection with the seat 68.

Pulling the cable 59 in an upward direction will cause the tapered surface of the groove 58 to drive the pin 64 against the force of the spring 69, thereby disrupting the gastight connection between the seal 65 and the seat 68. Packing material 70 within the threaded extension 61 acts against the cable 59 to maintain a gastight seal as the cable is moved axially within the bore 52. As illustrated in the drawing, the cylindrical bore 52 is parallel with the bore 38. However, in many instances, it will be desirable to locate the upper ends of the shielded cables 59 in the same fill boxes wherein the fill pipes 14, 15 and 16 terminate. Under such circumstances, easiest operation of the shielded cables 59 will be obtained when the axes of the bores are aligned with their respective fill boxes.

The valve body 37 is connected to the storage tank 10, 11 and 12 utilizing screw threads 71 provided around its periphery. These threads cooperate with threaded ring 72 which is positioned within an opening 73 in the top of the tank 10, 11 or 12 and which is welded to the tank.

Referring now to FIG. 4, the manifold 24 is seen to comprise three tee pipe fittings 74, 75 and 76 joined together by short nipples 77 and 78. An elbow 79 connects the tee 74 to pipe 26. Similarly, elbows 80 and 81 connect tees 75 and 76 to pipes 27 and 28, respectively. Closing one end of the manifold 24 is a plug 82. The other end of the manifold 24 is connected to the vent line 29 by two elbows 83 and 84 joined by a short nipple 85. Typically, the pipes 26, 27 and 28 are 2 inches in diameter, the vent line 29 is 3 inches in diameter and the manifold 24 is formed of 3 inches × 3 inches × 2 inches tees 74, 75 and 76.

OPERATION OF THE PREFERRED EMBODIMENT

In order to fill the storage tanks 10, 11 and 12, the tank truck 34 is first parked in the vicinity of the fill pipes 14, 15 and 16. Fill hoses 35 are connected between the unloading valves 36 and the fill pipes 14 and 15. The respective unloading valve 36 are then opened to permit products in the tank truck 34 to simultaneously flow through fill hoses 35 and the fill pipes 14 and 15 into the tanks 10 and 11. As product flows into each tank, such as tank 10, it will gradually fill the tank and initially come into contact with float 43 in its position 47. This float 43 will then rise with the rising product level within the tank 10 until it reaches its uppermost position 48. Until the float 43 reaches this uppermost position 48, the rising product level in the tank 10 forces vapors in the tank to be exhausted to the atmosphere through the cylindrical bore 38 of the valve body 37, the pipe 26, the manifold 24 and the vent line 29. When the float 43 is in its uppermost position 48, the disc 45 seats against the flange 42 of the collar 41 to preclude further escape of vapors from within the tank 10 through the entrance 49 of the valve body 37 and subsequently through the vent line 29 to the atmosphere. After the disc 45 has seated against the flange 42, a small additional amount of product will flow from the truck 34 into the tank 10 until the pressure of the vapor retained in the tank above the product equals the head pressure of the product within the fill hose 35 of the truck 34. However, when this condition is reached, flow of product into

the tank automatically ceases. It will be noted that the tank is not filled to capacity at this time and the product level will be well below the aperture **56**.

During this phase of the operation, an the annular seal **65** within the tubular member **54** remains in contact with the seat **68** under pressure from spring **69**. Thus, none of the vapors in the tank **10** escape into the venting system through the opening **56** and the tubular member **54**.

Also during this phase of the operation an after the rising product within the tank **10** has initially contacted the float **43**, product very gradually, but continuously, flows into the float through the small aperture **51**. As product flows into the float **43** through aperture **51**, vapors contained therein escape through aperture **50**. These apertures **50** and **51** are sized so that the float **43** does not lose its buoyancy until after the float is in its uppermost position **48** with the disc **45** firmly seated against the flange **42** of the collar **41**. After the disc **45** is seated against the flange **42**, product continues to flow into the float **43** through aperture **51** until the level of the fluid within the float is at the same level as that of the product surrounding the float. The float **43** is configured so that when this condition is reached the float loses its buoyancy.

As indicated, shortly after the disc **45** seats against the flange **42** to preclude further escape of vapors from the tank **10** into the venting system, flow of product in the fill hose automatically ceases and the float **43** loses its buoyancy. However, since the pressure on the bottom of the disc **45** is greater than the atmospheric pressure against its top, the disc and attached float **43** will not return to their original fully extended position **47**.

At this time, when the truck operator notes that product has stopped flowing through the fill hose **35** into the tank **10**, he closes the unloading valve **36**. The operator next pulls the cable **59**, the top of which is accessible at ground level, in an upward direction. This movement of cable **59** raises the piston **57** within the cylindrical bore **52** and the pin **64**, seated in the tapered groove **58**, is displaced in a right-hand direction as viewed in FIG. 2. Seal **65** is thereby moved out of contact with annular seat **68**. Vapors within the tank **10** then escape through aperture **56**, the bearing support structure **63**, the apertures **67**, the tubular member **54** and the cylindrical bore **38** into the venting system. Product within the fill hose **35** will then drain into the tank **10** and, when the vapor pressure within the tank reaches atmospheric, the float **43** returns to its original position **47** with the interior of the tank vented through the entrance **49** of the valve body **37**.

The truck operator releases the cable **59** and the springs **62** and **69** will return the piston **57** and the annular seal **65** to their original positions, respectively. As indicated, this operation is concurrently performed with respect to tank **11**. As soon as the filling operation with respect to the first of these tanks **10** and **11** is completed, its fill hose **35** is connected between the fill pipe **16** of tank **12** and a selected tank compartment (not illustrated) on the truck **34** through a valve **36**. The operation is then repeated with respect to tank **12** to fill it with product. After all tanks **10**, **11** and **12** have been filled, the operator can disconnect his fill hose **35** and make his next delivery.

The valve **25** is configured so that the product within its respective tank **10**, **11** or **12** never rises to the level of aperture **56**. In many instances, it may be desirable to never let the level of the product reach the entrance **49** to the venting system.

As product is dispensed through, for instance, the dispensing pump **21** to a point where the level of the product in the tank **10** is below the float **43**, all of the product in the float will have drained out through aperture **51**, thereby restoring the float to its full buoyancy condition. At this point, the venting system is completely recycled and ready for the next tank filling operation, i.e., the float is fully buoyant and in it fully extended position **47**, the tank **10** is connected to the venting system through the entrance **49** of the valve body **37** and the seal **65** is in contact with the annular seat **68**. For one reason or another, deliveries are often made which only partially fill tanks **10**, **11** or **12**. Naturally, in these instances, the vapors will be vented through the entrance **49** of the valve body **37** to atmosphere, but operation of the valve **25** will otherwise not be affected.

Channel **53** facilitates the removal of any foreign matter which may collect in the cylindrical bore **52**.

It will be appreciated by those familiar with this art that this system precludes, under all condition, product from entering the venting system. One of the more significant advantages of this aspect of the invention is the substantial cost savings which can be realized utilizing an underground manifold connected to each of a plurality of tanks and which is vented to the atmosphere by a single line. This system also advantageously automatically cuts off the flow of product from the tank truck while there is still sufficient capacity in the tanks to accommodate the amount of product in the fill hoses.

I claim:

1. A venting system for a plurality of underground liquid storage tanks each having fill and outlet connections comprising:
- an underground manifold;
- a pipe connecting each said tank to said manifold;
- a single vent line having one end thereof connected to said manifold and its other end opening to the atmosphere;
- first means carried by each said tank for automatically closing off its respective said pipe when said fluid in said tank reaches a predetermined level below the full capacity of said tank; and
- second means for subsequently opening said respective pipe while said fluid in said tank is at least at said predetermined level.

2. The system of claim **1** wherein said first means includes:
- a valve body including communicating open ends interposed between said tank and its respective said pipe; and
- a float moveably attached to said valve body for closing off one said open end of said valve body when said float is in its uppermost position.

3. The system of claim **2** wherein said second means includes means for removing the buoyancy of said float.

4. The system of claim **3** wherein said second means additionally includes means connected to said valve body for venting the interior of said tank to said respective pipe independently of said first means.

5. The system of claim **2** wherein said second means includes means for restoring said float to a valve-open position with the interior of said tank communicating with said respective pipe.

6. A valve assembly for use in venting a fluid storage tank having a fill pipe and a vent line comprising:
- a valve body connected between said vent line and the upper interior of said tank;
- first means connected to said valve body responsive to the level of fluid within said tank for automatically closing said valve when said fluid read reaches a predetermined level within said tank below the full capacity of said tank; and
- second means for subsequently restoring said first means to a valve-open position while said fluid is at least at said predetermined level.

7. The valve assembly of claim **6** wherein said first means comprises:
- a float moveably attached to said valve body; and
- closure means carried by said float to seat against the bottom of said valve body and thereby close said valve when said fluid reaches said predetermined level in said tank.

8. The valve assembly of claim **7** wherein said second means includes means for removing the buoyancy of said float.

9. The valve assembly of claim **8** wherein said second means additionally includes means connected to said valve body for venting the interior of said tank to said vent line independently of said first means.

10. The valve assembly of claim **8** wherein said means for removing the buoyancy of said float includes at least two apertures in said float.

11. A system for venting vapor from a plurality of underground liquid storage tanks each having liquid fill and liquid outlet connections comprising:

an underground manifold;

a single vent line having one end thereof connected to said manifold and the other end thereof opening to the atmosphere;

a plurality of vent pipes corresponding in one-to-one relation to the storage tanks with a separate one of said vent pipes connecting the interior of its corresponding storage tank to said manifold;

first means acting in conjunction with each said vent pipe and its corresponding tank for sharply decreasing the rate at which vapor can be vented from the interior of each tank to its corresponding vent pipe when liquid in the storage tank reaches a predetermined level; and

second means for subsequently increasing the rate at which vapor can be so vented while the liquid in the storage tank is at least at its predetermined level.

12. The system of claim 11 in which the means for sharply decreasing the rate at which vapor may be vented from the interior of each tank to its corresponding vent pipe includes float actuated means for blocking at least the largest portion of the vapor flow from the interior of the storage tank to its corresponding vent pipe when liquid in the tank reaches a predetermined level.

13. The system of claim 12 in which said second means comprises means for removing the buoyancy of said float actuated means.

14. The system of claim 11 in which said means for sharply decreasing the rate at which vapor can be vented from a tank to its corresponding vent pipe includes:

first and second orifices connecting the interior of the tank with its corresponding vent pipe, said first orifice being substantially larger than said second orifice; and

float actuated means for closing said first orifice when liquid in the tank reaches a predetermined level.

15. The system of claim 14 in which said second means comprises means for removing the buoyancy of said float actuated means.