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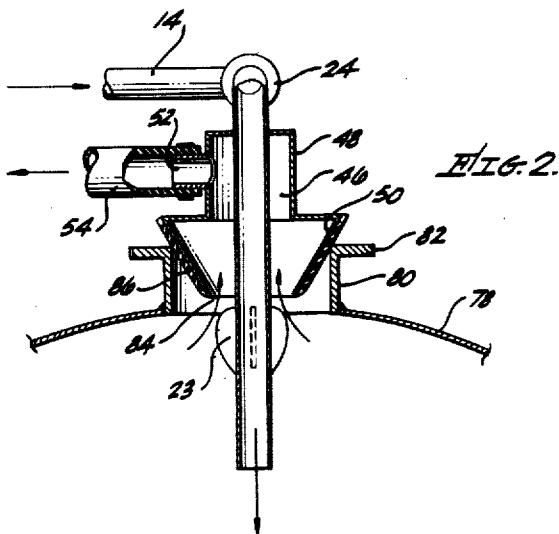
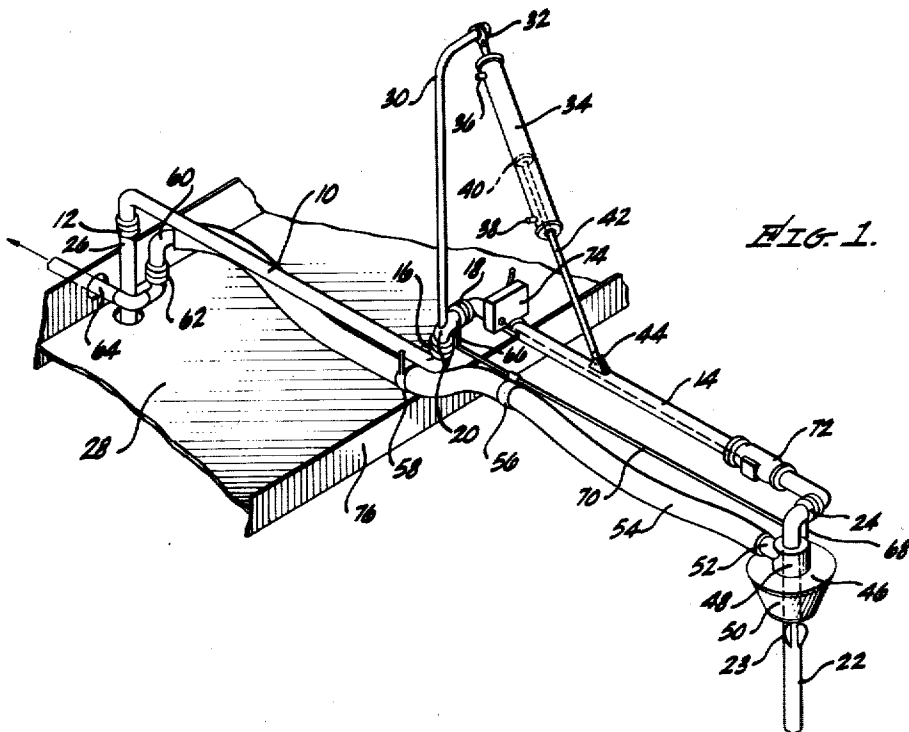
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2,803,269

LIQUID DISPENSING AND VAPOR RECOVERY SYSTEM

Filed March 15, 1955

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

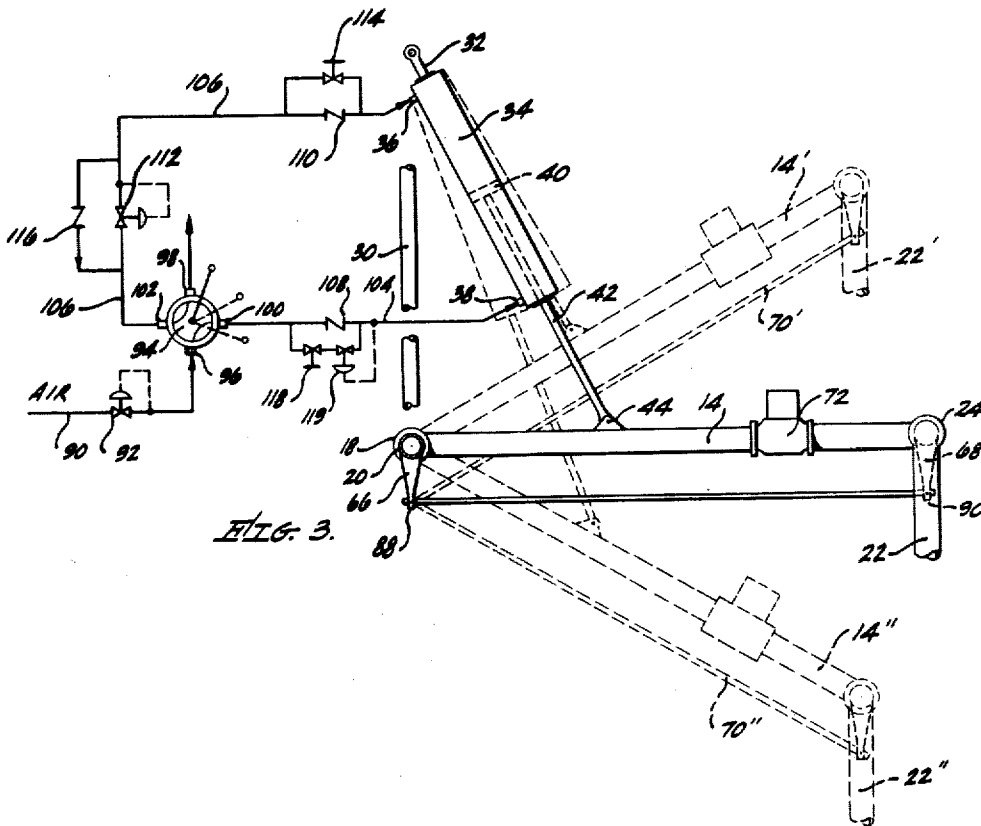
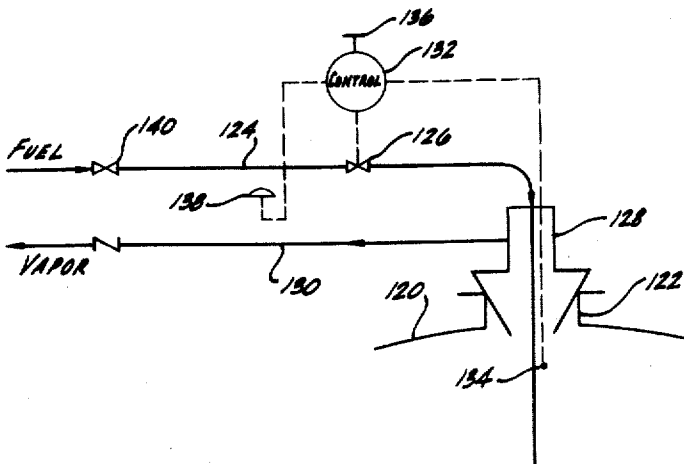


FIG. 4.



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LIQUID DISPENSING AND VAPOR RECOVERY SYSTEM

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17 Claims. (Cl. 141—250)

This invention relates to the dispensing of liquids and particularly to apparatus for liquid dispensing and simultaneous vapor recovery. More particularly this invention relates to an improved apparatus for the transfer of volatile liquids of relatively low boiling point such as in the filling of vessels therewith under circumstances involving the generation and/or displacement from the vessel of relatively large quantities of vapors.

Light, low boiling liquids present considerable problems from air pollution and fire and explosion hazard standpoints during the transfer thereof from one vessel to another. Such liquids comprise solvents including the low molecular weight alcohols, ketones, and esters, and including the light hydrocarbon solvents such as naphtha, and the relatively low boiling internal combustion engine fuels such as gasoline. These liquids have relatively high vapor pressures under normal temperature conditions and evaporate very readily, especially during agitation. The vaporization occurs at substantial rates from vessels open to the atmosphere and occurs at considerably higher rates when the liquid is in motion such as during the introduction of liquid into the vessel. Exceedingly high rates of vaporization occur when the liquid is introduced into the vessel under conditions which cause it to splash either against the bottom or walls of the vessel or against the liquid level therein.

Under these conditions of liquid transfer where vaporization takes place, serious hazards due to possibility of fire and/or explosion, fume generation, and air pollution present themselves. Furthermore, these light solvents are frequently very expensive and any vaporization loss is expensive and wasteful of materials. Often local regulations govern the type and mount of such vaporized materials which can be handled in the open air in order to minimize the possibility of air pollution or the damage from fire or explosion.

One particular application of this invention, which is not to be considered as limiting the invention, is in the loading of gasoline tank trucks and trailers at high volumetric rates. These trucks and trailers have liquid capacities of as high as about 4,000 to 8,000 gallons and will load at rates as high as 1500 to 2000 gallons per minute. In the case of railroad tank cars, these capacities are of the order of 3,000 to 50,000 gallons and the loading rates may be increased if desired to as high as 2000 to 4000 gallons per minute. The quantity of displaced vapor laden air evolved from such operations is at least equal to and frequently greater than the volume of the vessel because of the agitation induced vaporization. It has been found that gasoline losses may range as high as about 35,000 gallons per month at an active gasoline loading station in which about 22 million gallons per month are handled. This amounts to a 0.15% volumetric liquid loss and is economically undesirable as well as involving a fire hazard.

Therefore the present invention is directed to an improved apparatus for the transfer of volatile liquids at high flow rates and in which an exceedingly efficient

mechanism is incorporated for preventing such vapor loss. The apparatus is simple in construction, easier to operate than conventional loading equipment, and has been found capable of substantially complete elimination of danger from fire and explosion, vapor loss, and air pollution.

It is a primary object of the present invention to provide an improved apparatus for dispensing volatile liquids without the uncontrolled evolution of vapors therefrom.

An additional object is to provide an apparatus for the recovery of dangerous and/or valuable vapors displaced during the loading at high rates of flammable or noxious liquids such as solvents or fuels.

It is a more specific object of this invention to provide an improved apparatus according to the foregoing objects and which incorporates novel mechanical developments to prevent the build-up of destructive pressure within the vessel being filled and for maintaining a vapor-tight connection between the loading apparatus and vessel being loaded.

Other objects and advantages of the present invention will become apparent to those skilled in the art as the description thereof proceeds.

Briefly, the present invention comprises an improved apparatus for the transfer of volatile liquids at high rates and incorporates means for receiving and preventing the loss of displaced gases such as air which are laden with evolved vapors of the liquid being handled. The apparatus comprises a jointed tubular loading arm provided with swivels between each section. The loading arm consists of three essential conduit or pipe sections. These include a first or horizontal section which is movable in a horizontal plane and is connected at its upstream end through a vertical swivel to a source of liquid to be loaded, a second or intermediate section connected at its upstream end by means of a horizontal and a vertical swivel to the downstream end of the first section whereby the second section is movable in vertical planes at any angle to the first section, and a third or vertical section connected by means of a horizontal swivel to the downstream end of the second section.

The designation of swivels as being "horizontal" or "vertical" refers to the direction of their longitudinal axis around which the movable parts rotate.

A novel mechanical means hereinafter more fully detailed is provided in conjunction with the second and third conduit sections whereby the third section, constituting the delivery end of the loading arm, is maintained at all times parallel to a given axis. In the loading of gasoline tank trucks for example having hatches which open through their upper surfaces, this mechanical means is adjusted to maintain the third section in a vertical position at all times regardless of the movements of the first and second sections.

The third section is provided with an integrally attached vapor collecting cap or hood which is adapted to seal against the inner edge of the loading hatch and prevent the direct escape therethrough of the vapors displaced when liquid is introduced into the vessel through the serially connected conduit sections of the loading arm. A flexible conduit opens from the cap or hood and extends back along the segmented tubular loading arm whereby the displaced vapors are carried from the loading site. The maintenance of the third conduit section in a vertical position by the means generally indicated is exceedingly important as it permits maintenance of this vapor-tight seal in spite of the settling of the tank truck or car during loading and which normally causes misalignment of the seal.

The equipment briefly described above is physically supported through a rigid connection at the upstream end of the first conduit section and is usually operated in

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conjunction with a loading rack consisting essentially of elevated horizontal walkway or platform which extends along the side of the truck loading driveway at a height of about 8 to 12 feet. The truck and trailer are positioned on the driveway parallel to the loading platform, the hatches are opened, and the loading arm is swung out over the truck. The third section is extended downwardly into each hatchway, and the vapor recovery head is seated in and sealed against the hatch. The introduction of liquid is begun and the displaced vapors flow upwardly through the hatch, into the vapor collecting head which prevents their escape to the atmosphere, and then through the flexible vapor conduit to a suitable recovery system of the general type outlined below.

The usual liquid storage or transportation vessels, here exemplified by gasoline trucks and trailers specifically, are not designed to withstand high operating pressures. The usual maximum pressure for these particular vessels is about 4.0 p. s. i. g. (pounds per square inch gage). To prevent the build-up of undue pressures within the vessels being loaded, a novel apparatus is provided for automatically relieving any excess pressure during the loading and for fixing a desired maximum vessel pressure which cannot be exceeded.

The second and third conduit sections of the loading arm are supported from the downstream end of the first conduit section and are varied in position by means of a pneumatic cylinder which serves to raise and lower these sections of the arm. In accordance with the principles of this invention, the pressure of air maintained on each side of the piston within this pneumatic cylinder is selected from a consideration of the weight of these loading arm sections, the area of the tank loading hatch, the maximum tank pressure, and the area of the piston in the pneumatic cylinder so as to maintain a predetermined downwardly acting weight of the second and third arm sections against the vessel hatch. This net downward weight is controlled, by controlling the cylinder air pressures as described, so that the net downward weight in pounds divided by the area of the hatch opening in square inches does not exceed the maximum allowable pressure in pounds per square inch of the vessel being loaded. For gasoline tank trucks as stated above this pressure is usually about 4.0 p. s. i. g. In such a truck having a 10-inch diameter hatchway the open area thereof is 78.5 square inches. The pneumatic cylinder is therefore loaded so as to leave a net downward weight of the loading arm of no greater than 314 pounds exerted through the vapor collecting head and against the vessel hatchway. In the event of a pressure build-up to 4.0 p. s. i. g. within the vessel, a force of 314 pounds is exerted through the vapor collecting head upwardly against the loading arm causing it to lift. This opens the hatchway to the atmosphere, permits vapors to escape from the vessel, and prevents the pressure from raising to a value greater than the allowable limit. In actual operation with gasoline trucks, this net downward weight is preferably adjusted to about 200 pounds whereby a vessel build-up in pressure to 2.5 p. s. i. g. will lift the vapor collecting head from the hatchway and provide a safety factor with respect to any pressure build-up.

This control of the net weight at the outer or downstream end of the loading arm is controlled within narrow limits by controlling the air pressure which exists within the pneumatic cylinder on each side or both sides of the piston. The upper end of the cylinder is attached to a stanchion or davit which in turn is supported from the downstream end of the first conduit section. The piston is connected through a piston rod by means of a pivot to the second conduit section so that by increasing the air pressure on the lower side of the cylinder will cause the second and third sections to be lifted. Obviously releasing this pressure will permit gravity to move the second and third sections downwardly so as to set the vapor recovery head against the truck hatch. By main-

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taining a predetermined air pressure at all times in the lower part of the pneumatic cylinder with heavy loading arms, all but the desired net weight may be suspended by means of the cylinder. With lighter loading arms, as in the following example, a residual pressure is maintained above the piston to fix the desired net downwardly acting force. In these ways the vapor relief valve provision of this invention is obtained.

The foregoing elements of this apparatus briefly described above will be more readily understood by reference to the accompanying drawings in which:

Figure 1 is an isometric view of the improved loading arm of this invention,

Figure 2 is an elevation view in cross-section showing part of the second and the third conduit sections, the vapor collecting head, the vessel hatchway, and the vapor removal conduit,

Figure 3 is an elevation view showing the second conduit section and the pneumatic cylinder lift means therefore, the mechanical connection providing for the vertical positioning of the third conduit section, and a schematic flow diagram of the lift cylinder air control system permitting the maintenance of a predetermined net weight against the vessel hatch, and

Figure 4 is a simple schematic flow diagram of the fluid flow and the control thereof as are involved in the utilization of the apparatus of this invention.

Referring now to Figure 1, the apparatus of the present invention comprises a loading arm consisting of first conduit section 10 supported by and movable in a horizontal plane around first swivel 12, second conduit section 14 movable in any vertical plane and supported by means of second and third swivels 16 and 18 which are in turn interconnected by elbow 20, and third conduit section 22 connected by means of fourth swivel 24 to the downstream end of second conduit section 14. Supply conduit 26 provides the liquid to be dispensed. Loading platform 28 is shown from which the operators fill tank trucks and trailers, for example, by means of the apparatus described.

A davit 30 extends vertically from elbow 20 and provides an overhead support 32 for pneumatic cylinder 34, which in turn is provided to raise and lower sections 14 and 22 and the equipment associated therewith in a vertical plane. Inlet and outlet conduits 36 and 38 are provided above and below piston 40 within cylinder 34. Piston rod 42 extends from piston 40 downwardly and is pivotally connected at 44 to an intermediate point along the length of second conduit section 14. The operation of pneumatic cylinder 34 and the pneumatic control system adapted for raising and lowering the loading arm are more clearly shown and will be described in connection with Figure 3.

Third section 22 is provided with hatch guides 23 and a vapor collecting head and seal indicated generally as 46. It consists of an upper cylindrical section 48 integrally connected at its upper end to the outer surface of third conduit section 22. Lower inverted truncated conical section 50 also surrounds section 22, is connected at its upper end to the lower periphery of cylindrical section 48, and leaves a lower annular shaped opening surrounding conduit section 22 through which the displaced vapors flow into the vapor collecting head 46. A vapor outlet conduit 52 opens at right angles from upper cylindrical section 48 and continues in the form of a flexible tubing 54 supported by connections 56 and 58 from the loading arm itself. The vapor conduit then continues through elbow 60, swivel 62, and then on through outlet line 64 through a check valve not shown but indicated in Figure 4 to suitable vapor processing facilities not shown.

In order to maintain third conduit section 22 and the vapor collecting head 46 connected thereto at all times in a vertical position so as to seal properly against the vessel hatch, a lever and connecting rod system is pro-

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vided whereby third conduit section 22 is rotated in a vertical plane about fourth swivel 24 through an angle which is equal to the angular deflection of second conduit section 14 relative to a horizontal reference. This means that when conduit second section 14 is horizontal, third conduit section 22 is vertical. When second conduit section 14 is lowered from the horizontal position by an amount of 15° for example, third conduit section is rotated through an angle of 15° about fourth swivel 24 so as to maintain its original vertical position. This action is also more clearly indicated in Figure 3. This angular compensation is obtained by extending a pair of lugs or levers 66 and 68 downwardly from corresponding sides of third and fourth swivels 18 and 24 respectively and pivotably connecting the lower ends of these lugs by means of connecting rod 70. A parallelogram is formed having four pivotable connections so that each pair of opposite sides remain parallel at all times. The opposite sides consist respectively of lugs 66 and 68 as one pair and second conduit section 14 and connection rod 70 as the other pair. Since lug 66 is vertical at all times, lug 68 and the third conduit section 22 to which it is integrally connected also remains vertical at all times.

Along the length of second conduit section 14 is provided a flow control valve 72 and an operating and control instrument 74 adapted to actuate it. The preferred type of valve and controller is one in which the instrument is adapted to be set so as to remain open until a determined quantity of fluid has passed therethrough at which time it closes. At high liquid loading rates, so as to avoid excessive pressure build-up due to the momentum of liquid flowing in the line, controller 74 cuts off liquid flow in two stages rather than by an abrupt shut-off. Preferably the liquid rate is reduced from full flow to a value of about 20% of full flow over a period of about one second, followed by a subsequent reduction of the remaining 20% of the flow rate over a period of about one additional second. The shut-off automatically takes place during delivery of the final 30-100 gallons of the predetermined volume to be loaded.

The apparatus of Figure 1 is also provided with suitable flow control devices such as the four-way valve indicated in Figure 3, and the dead-man shut-off valve and the high liquid level shut-off valve indicated in Figure 4 at positions along the length of second conduit section 14. These elements are conveniently located at control instrument 74.

Although the loading arm is shown in Figure 1 in its extended position at a 90° angle with respect to the loading platform 28, this position was employed for purposes of clarity of illustration. During actual operation the loading arm is in a position such that first section 10 extends across loading platform 28 at an angle of about 45° and second section 14 makes with first section 10 an angle of about 90° so as to bring loading head 46 closer to the outboard edge 76 of loading platform 78. In this position the control instruments located at controller 74 are within easy reach of the operators who stand on loading platform 28.

Referring now to Figure 2, the upper part of a tank 78 is shown provided with filling hatch 80 and flange 82. The cover is not shown. Second conduit section 14, fourth swivel 24, third conduit section 22, hatch guides 23, and vapor collecting head 46 are shown and are indicated by the same numbers as in Figure 1. Vapor collecting head 46 consists of upper cylindrical section 48, lower inverted truncated conical section 50, and is provided with vapor outlet conduit 52 to which flexible hose 54 is connected. The lower conical section 50 provides a lower annular opening 84 through which the displaced vapors pass. The conical element 50 is designed with an upper diameter of about 12 inches and a lower diameter of about 6 inches so that it will set in and seal the 8-inch and 10-inch diameter hatches customarily used in gasoline tank trucks. Obviously these dimensions may

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be changed to meet the requirements of the particular apparatus being filled. The outer surface of conical section 50 is provided with a layer 86 of resilient material such as gasoline resistant rubber, neoprene, etc., by means of which a vapor-tight seal is provided against the inner edge of hatch 80. The escape of vapors through the hatchway is thus prevented and they are forced upwardly through collecting head 46 and outwardly through line 54.

Referring now more particularly to Figure 3, a combination schematic flow diagram of the loading arm activating system is shown. Herein pneumatic cylinder 34, support 32, piston 40, connecting rod 42, pivot connector 44, second conduit section 14, third conduit section 22, fourth swivel 24, flow control valve 72, davit 30, first and second lugs 66 and 68, and connecting rod 70 are all shown as in Figure 1. In Figure 3, is clearly shown the mechanism by means of which third conduit section 22 is maintained vertical regardless of the attitude of the other conduit sections. First lug 66 remains vertical at all times since it is integrally connected in that position to elbow 20 shown in Figure 1 and a portion of which is shown in Figure 3. Elbow 20 revolves only in a horizontal plane about vertical swivel 16 shown in Figure 1. Connection rod 70 is pivotably connected at 88 and 90 to lugs 66 and 68. Elements 66, 14, 68, and 70 constitute the parallelogram previously referred to so that when second conduit section 14 is raised into the position indicated generally at 14', third conduit section 22' remains in its vertical position. The same effect is achieved when second conduit section is in the position indicated as 14'', third conduit section 22'' is vertical.

Pneumatic cylinder 34, employed to raise and lower the second and third conduit sections of the loading arm, is operated by means of air or other fluid under pressure. In the case of gasoline tank truck loading in which pressures not greater than about 2.5 p. s. i. g. are to be allowed in the vessel being filled, the apparatus according to the present invention may be constructed and operated as follows to obtain these results. Operating air under pressure is supplied at 125 p. s. i. g. through line 90. Pressure control valve 92 is provided to maintain the supply pressure at 100 p. s. i. g. at all times. Four-way control valve 94 is provided having inlet port 96, vent port 98, and two additional ports 100 and 102 connected respectively through lines 104 and 106 to connections 38 and 36 respectively at the ends of pneumatic cylinder 34. If desired, a valve having separate vent ports for the ports 100 and 102 may be substituted. The valve is shown in Figure 3 in the "raise" position so that air at 100 p. s. i. g. flows through line 104 into the space below piston 40 lifting it and the loading arm while venting air from above piston 40 through line 106, through valve 94 to atmospheric pressure vent. In this particular case, a bottom piston pressure of 80 p. s. i. g. was needed to balance the suspended weight of the loading arm. The 100 p. s. i. g. air and venting the upper cylinder permits immediate upward motion of the arm when the control valve is placed at "raise."

When control valve 94 is placed in the "lower" position, port 96 is connected to port 102 and port 98 is connected to port 100. The 100 pound air then flows through line 106 provided with pressure reducer 112 by means of which the maximum operating pressure above piston 40 may be controlled. Under these circumstances the rate at which the loading arm is lowered depends upon the net weight of the loading arm and the pressure difference between each side of piston 40. The lower end of the cylinder is vented through vent 98 to the atmosphere and a minimum of 20 p. s. i. g. above piston 40 is required to cause immediate lowering of the arm when the control is placed at "lower," e. g. the 100 p. s. i. g. less 80 p. s. i. g. required to balance the arm.

In order to limit and control the rate at which the outer two conduit sections 14 and 22 are raised and lowered, lines 104 and 106 opening to and from the pneu-

matic cylinder are each provided with a control valve and a check valve connected in parallel. The check valve 108 permits full flow of 100 pound air into pneumatic cylinder 34 below piston 40 so as to lift it when valve 94 is in the "raise" position. In this case the air vented from above piston 40 is vented to atmospheric pressure through control valve 114 at a rate which may be varied so as to control the rate of lift. This vented air passes through line 106 and around valve 112 through check valve 116 to vent port 98.

To lower the loading arm, control valve 94 is shifted into the "lower" position, 100 pound air is applied to the upstream side of pressure reducing valve 112, and 20 pound air flows on through check valve 110 into the upper end of cylinder 34. The 20 pound air pressure and the weight of the loading arm causes it immediately to move downwardly, displacing air from below piston 40 through line 104 and through limiting valve 118 to the atmosphere through vent port 98. The relative adjustment of control valves 114 and 118 determine the rate at which the loading arm raises or falls when control valve 94 is respective in the "raise" and "lower" positions. To hold the loading arm in any given position, control valve 94 is moved into the "hold" position at which all ports thereof are isolated from one another and no air flows into or out of pneumatic cylinder 34. When loading arms which are heavier than necessary to provide the relief valve effect, then a residual pressure must be maintained below piston 40 to support the excess weight. This is controlled by pressure controller 119 which serves to maintain a minimum back pressure in line 104.

The control of the pressure at which the lighter than necessary loading arm will lift and relieve accumulated pressures within the tank being filled is regulated by the adjustment control valve 112 which maintains the operating air pressure in cylinder 34 above piston 40 at a value sufficient in addition to the net arm weight to make up the required downward force to seat the vapor collecting head 46 into the tank hatch. This "relief valve" attribute of the apparatus of this invention has been described above by way of example involving a 10-inch filling hatch.

Thus, in the present invention the loading arm is adaptable to independent variation of the raising and lowering rates, to be held at any intermediate position without motion, and to apply a predetermined load against the filling hatch of the vessel which will automatically relieve against pressures building up beyond any predetermined value. Additionally, the third conduit section and the vapor collecting head are at all times maintained in a vertical position permitting easy alignment and a complete vapor sealing against the tank hatch.

The pressures necessary for immediate response, i. e. upward or downward movement of the loading arm, are determined as follows, depending upon whether the net unsupported weight of the second and third conduit sections of the arm is less or more than the force required to resist the tank pressure.

For arms lighter than necessary to provide the requisite downward force involved in the relief valve service, some top cylinder pressure such as 20 p. s. i. g. is required in the "lower" position to maintain this force. The pressure is set by adjustment of valve 112 shown in Figure 3. Some lower cylinder pressure will be required to just balance the weight of the arm, for example, 80 p. s. i. g. After changing the control from the "lower" to the "raise" position, the maximum pressure to lift immediately will be 20 plus 80 or 100 p. s. i. g.

With heavier than necessary arms, some lower cylinder pressure such as 10 p. s. i. g. will be necessary to leave acting downwardly the required force for the relief valve service. This is controlled by adjustment of back pressure controller 119 in Figure 3. Some net lower cylinder pressure will be required to just balance the arm, 110 p. s. i. g. for example. To lift the arm, air

pressure in the lower end of the cylinder must be slightly above 110 p. s. i. g., say 120 p. s. i. g. Thus valve 92 is set to supply 120 p. s. i. g. lift air to the bottom of the cylinder through line 104. Valve 112 may be closed (for gravity lowering) but preferably is set for 120 minus 110 p. s. i. g. or 10 p. s. i. g. to effect immediate lowering. The rates of movement are again set by valves 114 and 118.

The above pressures are of course merely illustrative, and obviously will be different for different sized loading arms and tanks being filled.

Referring now in particular to Figure 4, a schematic flow diagram of the present invention is shown including tank 120 and filling hatch 122. The loading arm is schematically indicated as line 124 provided with flow control valve 126 corresponding to valve 72 in Figures 1 and 3. The vapor collecting head is indicated schematically as 128 provided with vapor outlet line 130. Control instrument 132 is connected to control valve 126 and is adapted to be actuated by the independent variables indicated below. To provide for complete safety in operation of this device a high level liquid detector 134 is provided and connected to control instrument 132. Adjustment means 136 is likewise connected to preset the desired volume of liquid after which valve 126 will close. A "dead-man valve" actuator 138 is also connected to controller 132. With master fuel valve 140 open, liquid will enter through loading arm 124 only when controller 136 is preset to the desired volume of liquid to be loaded, high level indicator 134 does not detect a high liquid level, "dead-man valve" actuator is depressed by the operator, and valve 126 is manually opened and held open by a suitable catch. The concurrence of all four of these events is required to maintain liquid flow. The liquid flow is automatically terminated by release of the "catch" and causing the closure of valve 126 as actuated by controller 132, either when dead-man valve actuator 138 is released, or element 134 indicates a high liquid level, or the preset flow of liquid has been delivered into tank 120. In this system volatile liquids may be loaded at high flow rates with complete safety and without loss of valuable or dangerous vapors.

In an experimental model of the device of this invention, the loading arm was approximately ten feet in total length. The first conduit section was of 4-inch schedule 40 pipe while the second section was schedule 20. The first and second sections were each five feet long. The vapor conduit was 4-inch diameter rubber hose reinforced with steel and the pneumatic cylinder was about ten feet long by six inches in diameter. The device was found capable of delivering high volatility premium gasoline into trucks and trailers at rates of 1200 gallons per minute without any measurable escape of vapors from the truck.

A particular embodiment of the present invention has been hereinabove described in considerable detail by way of illustration. It should be understood that various other modifications and adaptations thereof may be made by those skilled in this particular art without departing from the spirit and scope of the invention as set forth in the appended claims.

I claim:

1. An apparatus for transferring volatile liquids into a container and collecting evolved vapor therefrom without loss to the atmosphere which comprises a segmented loading arm conduit including a first, a second, and a third conduit section serially connected by means of conduit swivels, means for raising and lowering said second and third conduit sections in a vertical plane, a vapor collecting head surrounding said third conduit section, a flexible vapor conduit opening therefrom and extending along the length of said segmented loading arm, said collecting head being adapted to be seated against the loading hatch, and means for controlling the force with which said vapor collecting head is pressed against said loading hatch so that said force in pounds divided by the hatch

area in square inches does not exceed the pressure in pounds per square inch allowable in said container.

2. An apparatus according to claim 1 wherein said vapor collecting head comprises inverted truncated conical section integrally and concentrically attached at its upper end to the outer surface of said third conduit section leaving an annular space between its lower end and said conduit section, and a layer of liquid-resistant resilient material supported around the outer surface of said conical section and adapted to provide a vapor-tight seal against the periphery of said loading hatch.

3. An apparatus according to claim 1 in combination with means for maintaining said third section in a vertical position regardless of the attitude of said first and second conduit sections.

4. An apparatus according to claim 3 wherein said means comprises in combination a vertical lug extending downwardly from integral attachment at its upper end to the downstream end of said first conduit section, a connecting rod pivotably attached at one end to said lug and pivotably attached at the other end to said third conduit section forming with said swivels at the ends of said second conduit section a pivoted parallelogram the opposite sides of which remain parallel.

5. An apparatus according to claim 1 in combination with a valve disposed along the length of said segmented loading arm, and a remote control means connected thereto adapted to open and close said valve.

6. An apparatus according to claim 5 wherein said remote control means is provided with manually operated means to open said valve, a high liquid level detecting means extending downwardly parallel to said third conduit section, a biased normally released manually operated valve actuator disposed adjacent said remote control means, said liquid level detector and said manually operated valve actuator being connected and adapted to actuate said valve.

7. An apparatus according to claim 1 wherein said means for raising and lowering the second and third conduit sections relative to said first conduit section comprises in combination a stanchion rising from near the downstream end of said first conduit section, a pneumatic cylinder and a piston therein, means for connecting the cylinder to the upper end of said stanchion, a connecting rod connecting said piston through a pivotable connection at an intermediate point along said second conduit section, and a pneumatic cylinder control means for controlling the introduction and removal of a fluid under pressure to and from said cylinder.

8. An apparatus according to claim 7 wherein said pneumatic cylinder control means comprises in combination a four-way valve connected at its inlet port with a supply of fluid under pressure, a first and a second control conduit connecting a first and second control port of said valve respectively with the pneumatic cylinder above and below said piston, a check valve in each of said control conduits to prevent fluid out flow from said cylinder, a control valve connected in parallel with each of said check valves and adapted to control the rate of piston movement in each direction, and at least one vent conduit opening from said four-way valve, said four-way valve being adapted to connect said inlet port with one of said control ports and connect the other control port with a vent conduit so as to actuate said pneumatic cylinder and to raise and lower said second and third conduit sections.

9. An apparatus according to claim 8 in combination with another check valve connected in said first control conduit to prevent fluid flow therethrough into said cylinder, and a back pressure control valve connected in parallel with said check valve and adapted to limit the maximum fluid pressure applied above said piston to lower said loading arm and maintain a predetermined downward force sealing said vapor collecting head against the hatch of the container being filled.

10. An apparatus according to claim 8 in combination with a back pressure control valve connected in said second conduit and adapted to limit the minimum fluid pressure below said piston when the loading arm is lowered into discharge position so as to support thereby a portion of the weight of said second and third conduit sections leaving the remaining portion of said weight acting downwardly as a predetermined force sealing said vapor collecting head against the hatch of the container being filled.

11. An apparatus for loading volatile liquids into and collecting evolved vapors from a container which comprises a segmented loading arm having a first conduit section connected through a vertical first swivel at its inlet end to a vertical supply conduit thereby being movable in a horizontal plane and provided with a vertical second swivel at its outlet end, a second conduit section connected through a horizontal third swivel to said second conduit swivel thereby being movable in a vertical plane and provided at its outlet with a horizontal fourth swivel, and a third conduit section connected at its inlet end to said fourth swivel, connecting means connecting the upstream end of said third swivel with the downstream end of said fourth swivel to maintain said third conduit section vertical in spite of changes in altitude of said first and second conduit sections, a stanchion extending upwardly from the upstream end of said third swivel, a pneumatic cylinder and piston assembly supported from said stanchion, a piston rod connecting said piston at one end with a pivot on said second conduit section, a four-way control valve, a conduit for fluid under pressure connected to the inlet port of said valve, first and second control conduits connecting the upper and lower ends of said cylinder with first and second control ports of said valve respectively, at least one vent conduit opening from said valve, a check valve adapted to prevent outflow from said cylinder in each of said control conduits, a control valve connected in parallel with each check valve to control the rate of movement of said piston in said cylinder, said four-way valve adapted to connect simultaneously said inlet port with one control port and connect the other control port with a vent conduit to raise and lower said second and third conduit sections, a vapor collecting head having a lower inverted truncated conical portion integrally sealed concentrically at its upper end around said third conduit section, a layer of resilient material disposed on the outer surface of said conical section to seal against the hatch of a container being filled, a flexible conduit for vapor opening from said vapor collecting head and extending along the length of said segmented loading arm, and a vertical swivel at the outlet of said vapor conduit and adjacent said vertical first conduit swivel connecting said vapor conduit to a vapor disposal conduit.

12. An apparatus according to claim 11 in combination with a liquid control valve disposed in said second conduit section, a volume controller connected to said control valve, a "dead-man" actuator connected to said controller, a liquid level detector disposed adjacent said third conduit section and connected to said controller, said controller being thus adapted to be manually actuated to initiate delivery of a preset desired volume and adapted to be actuated to keep said control valve open while the preset volume is being delivered and said "dead-man" actuator remains actuated and the liquid level is below said level detector.

13. An apparatus according to claim 11 in combination with another check valve connected in said first control conduit to prevent fluid flow therethrough into said cylinder, and a back pressure control valve connected in parallel with said check valve and adapted to limit the maximum fluid pressure applied above said piston to lower said loading arm and maintain a predetermined downward force sealing said vapor collecting head against the hatch of the container being filled.

14. An apparatus according to claim 11 in combination

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with a back pressure control valve connected in said second conduit and adapted to maintain at least a minimum fluid pressure below said piston when the loading arm is lowered into discharge position so as to support thereby a portion of the weight of said second and third conduit sections leaving the remaining portion of said weight acting downwardly as a predetermined force sealing said vapor collecting head against the hatch of the container being filled.

15. An apparatus for controllably lifting and lowering a vertically movable element so as to maintain a predetermined force acting downwardly through said movable element against another relatively stationary element which comprises a pneumatic cylinder and piston assembly supported from an elevated point, a piston rod means connecting said piston at one end with said vertically movable element, a four-way control valve, a conduit for fluid under pressure connected to the inlet port of said valve, first and second control conduits connecting the upper and lower ends of said cylinder with first and second control ports of said valve respectively, at least one vent conduit opening from said valve, a check valve adapted to prevent outflow from said cylinder in each of said control conduits, a control valve connected in parallel with each check valve to control the rate of movement of said piston in said cylinder, said four-way valve adapted to bring into simultaneous communication said inlet port with one control port and the other control port with a vent conduit to raise and lower said vertically movable element, and a back pressure controller valve connected in one of said control conduits to maintain

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the pressure in the associated part of said cylinder at a predetermined value to control the force with which said vertically movable element supported by said pneumatic cylinder presses against said relatively stationary element.

16. An apparatus according to claim 15 wherein the weight of said vertically movable element is less than said predetermined force, and wherein said back pressure control valve is connected in said first control conduit and adjusted to maintain a sufficient pressure above said piston in said cylinder to supplement said weight and obtain said predetermined force, and a check valve connected in parallel with said back pressure control valve to permit outflow of fluid from said cylinder around said back pressure control valve.

17. An apparatus according to claim 15 wherein the weight of said vertically movable element exceeds said predetermined force, and wherein said back pressure control valve is connected in said second control conduit and adjusted to maintain below said piston in said cylinder a minimum preset pressure sufficient to support said first movable element and leave it unsupported by an amount equal to said predetermined force.

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