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METHOD FOR FILLING CLOSED CONTAINERS WITH VOLATILE LIQUIDS

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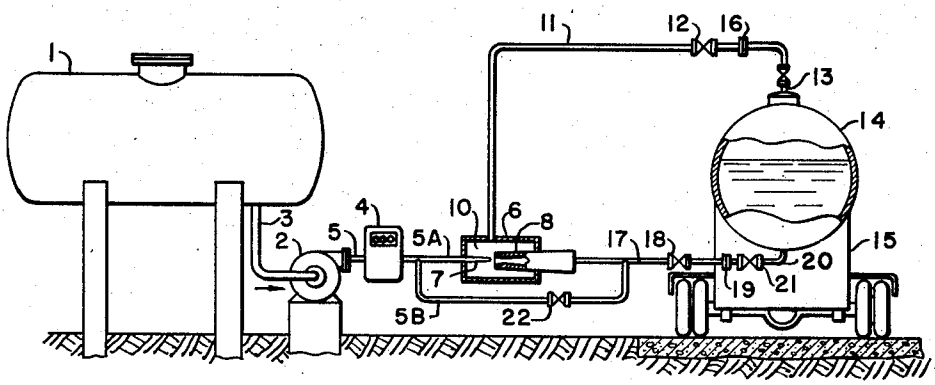

FIG. 1

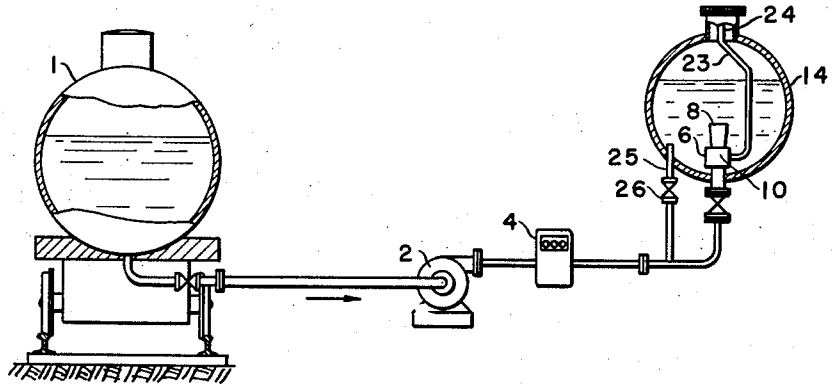

FIG. 2

INVENTORS:
C. L. COLDREN
D. R. HAWKINSON

BY: H. D. Burks
THEIR ATTORNEY

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METHOD FOR FILLING CLOSED CONTAINERS WITH VOLATILE LIQUIDS

Clarke L. Coldren, Lafayette, and Donald R. Hawkinson, Berkeley, Calif., assignors to Shell Development Company, New York, N.Y., a corporation of Delaware

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2 Claims. (Cl. 62—50)

This invention relates to the art of dispensing volatile liquids into closed containers. More particularly, the invention relates to an improved method and apparatus for filling such closed containers with volatile readily evaporatable liquids such as liquefied hydrocarbons of which propane and butane are examples and other liquefied materials of which anhydrous ammonia, vinyl chloride and sulfur dioxide are examples.

When volatile liquid is admitted into a closed container the space available within the container for vapor originally present and vapor resulting from evaporation of the admitted volatile liquid within the container will be reduced progressively as the quantity of liquid in the container increases. As a result the vapor will be compressed resulting in a rise in temperature of the vapor. Part of the vapor is condensed upon coming into contact with the surface of the liquid within the container and as the heat of condensation resulting cannot be distributed rapidly enough throughout the liquid mass, the temperature prevailing at the liquid surface is higher than the temperature of the liquid below the surface. This compression of the vapor and non-uniform temperature distribution causes the pressure of the vapor within a closed container to exceed the vapor pressure of the liquid corresponding to the mean liquid temperature.

Various systems have been heretofore proposed to obviate or reduce this pressure rise in the vapor space. In some cases the vapor is permitted to escape to the atmosphere. However, this is usually undesirable not only because the vapors are often hazardous due to their combustibility or toxicity but also because of the loss of the valuable material. Quite often the vapor space of the container to be filled is connected to the vapor space of the reservoir from which the liquid is withdrawn during the filling operation. If the distance separating the reservoir and the container is considerable this expedient can create difficulties owing to the great length of the connecting vapor conduit as the long vapor conduit brings about changes in temperature and presents resistance to the passage of the vapor. Furthermore, it is a common practice to install a fluid meter between the supply reservoir and the container to be filled for registering the quantity of product dispensed to the container. When vapor is vented to the atmosphere or returned to the reservoir there results a loss to the party receiving the material in the closed container of vapors which have already been metered as liquid. This makes it necessary to make an estimate allowance for the loss. Such estimates are difficult to make accurately.

It has also been proposed to feed the volatile liquid into the vapor space at the top of the container to be filled instead of into the liquid space at the lower part of the container so as to insure a better contact and heat transfer between the liquid being introduced and the vapor in the container resulting in a better cooling of the vapor owing to the falling of the introduced liquid through the vapor and on to the surface of the liquid. There is also a slight improvement in the distribution of the heat

of condensation to the lower colder layers of the liquid because of the increased turbulence. Unless adequate spray nozzles are fitted in the vapor space of receiver or container, a sufficient cooling of the vapor does not take place and excessive pressure results. To install such spray nozzles in all existing containers for the volatile liquids would be a prohibitive expense.

Another known system involves the withdrawal of the vapor out of the vapor space within the container by means of an eductor inserted in the liquid supply conduit. Such a system is the subject of U.S. Patent 2,764,873 issued upon an application of W. E. Mooyaart.

It has been found that the efficiency of the eductor system there described can be increased by means of our invention. More particularly it is an object of our invention to provide a method and apparatus of the type described in which part of the liquid passing from the reservoir to the container is passed through an eductor to the throat of which is connected a vapor line from the vapor space of the closed container and the remainder of the liquid stream passed directly into the container.

It is a further object of our invention to provide a system for filling closed containers by means of an eductor so arranged that the amount of liquid passed through the eductor and directly into the container may be varied to suit existing operation conditions.

Another object of our invention is to provide an eductor loading system having optimum performance. Another object of our invention is to provide a volatile liquid transfer system having increased capacity.

According to the system of U.S. Patent 2,764,873, an eductor, also known as an ejector, is inserted in the liquid supply conduit, preferably downstream from the meter if such is provided, and the suction side of the eductor is connected to the vapor space of the container to be filled. The volatile liquid is supplied from a source outside of the container at a suitable pressure, for example, by a liquid pump, or from an elevated or pressurized reservoir and is flowed through the eductor as a moving column of liquid of substantial velocity in lateral communication with the low pressure zone of the eductor. Vapors from the upper part of the closed container or receiver are thereby drawn into the moving column of liquid passing to the container and intimately mixed therewith resulting in direct heat exchange. As a result, the vapor condenses and/or dissolves in the fresh liquid passing to the container.

The volume of vapor to be withdrawn and the flow rate of liquid to the container will vary with different sizes of containers and with different temperature conditions. As a consequence, with a given eductor using the known system, the pumping efficiency will fluctuate. By the use of our invention such fluctuations may be minimized.

The further objects and advantages of the invention will be readily apparent from the following detailed description of a specific embodiment of our invention throughout which reference is made to the accompanying drawing of which:

Figure 1 is a diagrammatic elevation view of an installation for filling a vehicle-borne container from a stationary reservoir.

Figure 2 is a similar view of a modified installation for filling a stationary container from a railroad tank car.

Referring to Figure 1, a pressure reservoir **1** for liquefied petroleum gas, commonly referred to as LPG, is connected to a delivery pump **2** by means of a suitable conduit **3**. A liquid meter **4** is connected in the discharge line **5** of the pump. On the downstream side of the meter, the discharge line branches into two arms **5***a* and **5***b*. In the arm **5***a* an eductor or ejector device **6** is connected.

The eductor comprises a high pressure nozzle 7 which is in axial alignment with a converging discharge piece 8 but in spaced relationship thereto. An annular casing surrounds the end of the nozzle 7 and the end of the discharge piece 8 to form a chamber 10. The chamber 10 is connected by a conduit 11 provided with a valve 12 to the valved vapor outlet 13 of a tank 14 which is mounted on a wheeled chassis 15. A suitable coupling device, such as a flanged connection 16, may be provided to effect ready connection of the conduit 11 to the outlet 13 of the tank 14. The discharge piece 8 is connected to liquid conduit 17 having a valve 18, which leads to a flanged connection 19, the other side of which is connected by piping 20 to the bottom of the tank 14. A shut-off valve 21 is provided in the piping 20. The arm 5*b* from the discharge side of the meter 4 is provided with a valve 22 and, by-passing the eductor 6, is joined to the conduit 17 by a suitable connector. When all connections have been made, loading is started by opening all line valves except the valve 22 in the line 5*b* which is preferably initially kept closed but is soon adjusted to optimized eductor performance. In this case volatile liquid from the reservoir will flow at a substantial velocity from the nozzle 7 causing a reduced pressure in the chamber 10 and drawing vapors from the vapor space of the tank through the outlet 13 of the tank 14 and by way of conduit 11 into the chamber 10. Here the vapors will become mixed with the liquid and become dissolved or condensed and pass through the discharge piece 8 and associated piping into the tank 14. As a result, direct heat exchange between the gas and liquid takes place and the temperature of the liquid stream passing into the tank 14 is rendered substantially uniform. The mixing of the incoming volatile liquid with liquid already in the tank is effected by turbulence and eddy currents caused by the velocity of the discharge into the tank 14.

After filling has progressed for some time, the temperature conditions become somewhat stabilized and the pressure in the vapor space of the tank reduced. When such a condition is reached, continued rapid withdrawal of vapor from the vapor space of the tank can result in the flashing off of additional amounts of vapor from the surface of the liquid in the tank 14. As the temperature of the vapor and liquid in the tank 14 is, at this time, more or less uniform, it serves no useful purpose to flash off vapor, mix it with incoming liquid in the eductor, and re-introduce the vapor (now condensed or dissolved in the inflowing liquid) into the tank. Also it must be borne in mind that for a given amount of vapor to be withdrawn per unit of time, there is an optimum pressure and quantity of liquid that should be applied to the nozzle 7 of the eductor to provide a desired velocity of jet therefrom. Below and above such values the efficiency of the eductor falls off.

Besides the above, the eductor device 6 in performing the work of creating a reduced pressure in the chamber 10 consumes energy. Hence, the less the eductor device is used (other things being equal) the more efficient the pumping operation. To the above ends the arm 5*b* and valve 22 are provided whereby amounts of liquid can by-pass the eductor and be fed directly into the bottom of the tank 14.

The percentage of liquid that can thus be directly pumped into the tank and the percentage of liquid which should be passed into the tank by way of the eductor will vary depending upon several factors such as material being pumped, temperatures of the liquid and vapor, atmospheric temperature, pressure in the top of the receiver, size of the receiver, size of the eductor, and capacity of the pump. Other factors of course may be involved depending upon the particular filling situation.

As will be appreciated our invention can be applied to the filling of stationary tanks from mobile reservoirs, filling mobile tanks from stationary reservoirs, filling mobile tanks from mobile reservoirs and filling stationary tanks from stationary reservoirs.

It will further be understood that the eductor and by-pass may form part of the piping associated permanently with the receiver tank rather than forming part of the piping associated with the reservoir.

While we have shown the by-pass valve 22 as a manually operated valve, we may use an automatic by-pass valve responsive to one or more of the factors determining the amount of by-pass desirable for the operating conditions existing.

If desired, the eductor may be mounted entirely within the receiver-tank 14 as shown in Figure 2 at any desired level, for example, near the bottom. The eductor in such case may be connected to a vapor line 23 entirely within the tank 14 having vapor intake openings 24 near the top end for communication with the vapor space at the top of the tank. The lower end of the vapor line 23 is in communication with the chamber 10 of the eductor 6. The discharge piece 8 of the eductor terminates directly in the tank promoting turbulence in the contents. A by-pass line 25, having a control valve 26, leads from the conduit 17 directly into the tank. By suitably directing and locating the discharge piece 8 a combined spray-loading and eductor-loading can be achieved.

The invention as already stated can be used for the filling of containers with liquids other than LPG, for example, ammonia, sulfur dioxide, and the like.

We claim as our invention:

1. In a method of filling a closed container with volatile liquid in which volatile liquid from a source outside said container and prior to discharge into the container is flowed at a substantial velocity through an eductor generating a low pressure therein and vapors of substantially the same composition as said liquid are withdrawn from said container solely by the action of said generated low pressure and mixed with the liquid supplied to the eductor and said liquid and vapors introduced into the container to progressively increase the contents thereof, the steps of: flowing part of the volatile liquid from the source directly into the container without initially contacting the vapor in said eductor.

2. In a method of filling a closed container with volatile liquid in which volatile liquid from a source outside said container and prior to discharge into the container is flowed at a substantial velocity through an eductor generating a low pressure therein and vapors of substantially the same composition as said liquid are withdrawn from said container solely by the action of said generated low pressure and mixed with the liquid supplied to the eductor and said liquid and vapors introduced into the container to progressively increase the contents thereof, the steps of: reducing the velocity of the flow through the eductor when the pressure in the top of the closed container is reduced to the vapor pressure of the tank contents at tank temperature, and passing amounts of the volatile liquid directly to the closed container by other conduit means so that the volume of liquid passing to the container is not reduced.

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