Oct. 8, 1963 P. R. GREEN ETAL 3,106,071

SYSTEM FOR FILLING CLOSED CONTAINERS WITH VOLATILE LIQUIDS

Filed Aug. 16, 1961

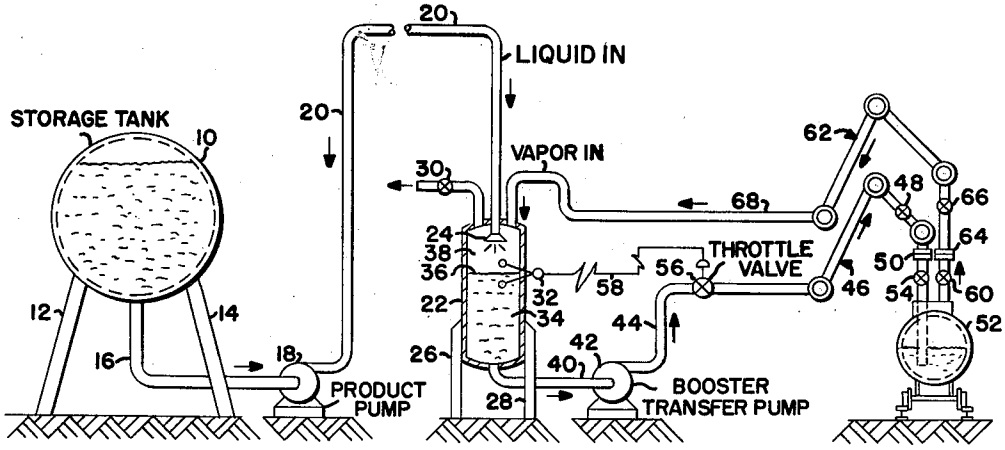

FIG.-1

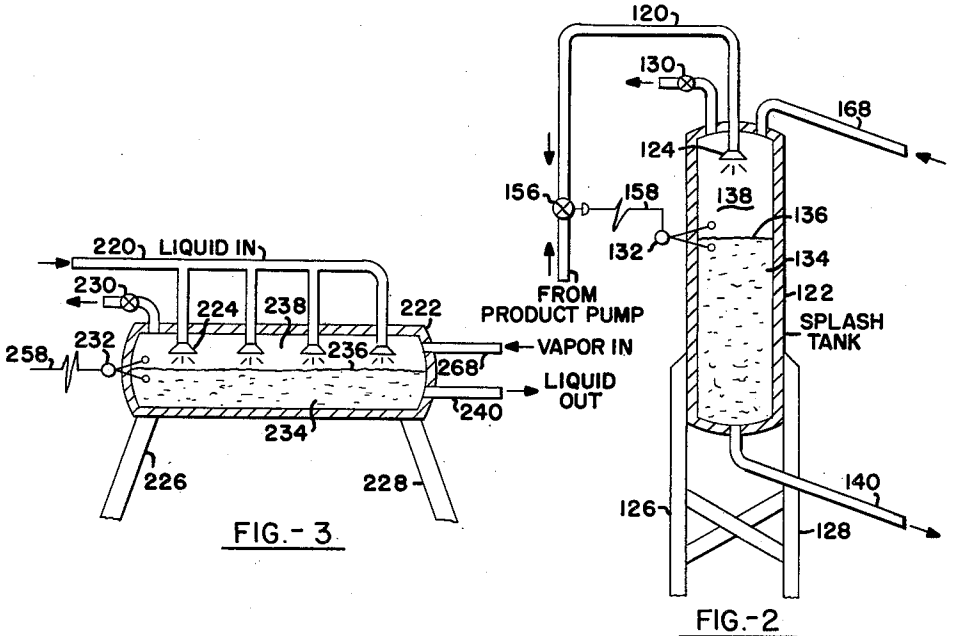

FIG.-3

FIG.-2

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United States Patent Office 3,106,071 Patented Oct. 8, 1963

3,106,071
SYSTEM FOR FILLING CLOSED CONTAINERS WITH VOLATILE LIQUIDS

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Filed Aug. 16, 1961, Ser. No. 131,893
8 Claims. (Cl. 62—55)

This invention relates to a system wherein volatile liquids such as liquid propane or liquid butane may be transferred from one container to another container. It relates particularly to a system of the kind described employing a closed storage container and a closed receiving container; that is, a system wherein the materials being transferred are maintained in the liquid state at substantially atmospheric temperature by the application of pressure.

When a volatile liquid is admitted into a closed container, the space within the container for vapor originally present therein and vapor resulting from evaporation of the admitted volatile liquid inside the container will decrease progressively as the quantity of liquid within the container increases; consequently, the vapor will be compressed, resulting in a temperature rise in the vapor. A part of this vapor is condensed upon coming into contact with the surface of the liquid within the container, and as the heat of condensation resulting therefrom cannot be distributed extremely rapidly throughout the entire liquid mass by natural heat flow the temperature prevailing at the liquid surface is higher than the temperature of the liquid below the surface. This compression of vapor and the resulting non-uniform temperature distribution in the liquid tend to cause the pressure of the vapor within the container to exceed the vapor pressure of the liquid corresponding to the mean liquid temperature.

Various techniques have been proposed to reduce if not eliminate the afore-described pressure rise in the vapor space of a closed container being filled with a volatile liquid, that is, techniques other than that of simply permitting the vapor to escape to the atmosphere through a suitably adjusted relief or safety valve. Such escape is usually undesirable not only because the vapors involved are often hazardous due to their flammability as in the cases of propane and butane, but also because of the attendant loss of valuable materials.

One transfer and/or filling technique known to the prior art comprises the step of spray loading of volatile liquid directly into a receiving container from the top thereof, so as to obtain contact and heat transfer between the liquid being introduced and the vapor already present in the container. This results in some degree of cooling of the latter owing to the falling of the introduced liquid through the vapor and onto the liquid surface. There is then also a slight improvement in the distribution of the heat of condensation to the lower, colder layers of the liquid within the container because of greater turbulence. It has been found in practice, however, that this technique does not achieve a sufficient cooling of the vapor to substantially prevent a rise of pressure within the container, especially in the course of an extended filling operation.

Another technique makes use of a gas compression system wherein the vapors generated during transfer are withdrawn from the receiving container, compressed, cooled, and condensed, and the condensate returned to the receiving container. This technique, while effective, is obviously one which requires at least some additional and expensive equipment.

Still another technique makes use of a vapor balance system wherein a vapor line is employed to equalize pressures between the receiving container and the storage container wherefrom the receiving container is filled. This technique, although simple, may be costly due to the length of vapor line required in some installations.

Even still another technique makes use of a condensing system wherein a heat exchanger and a condensate collector are employed. This technique, like that making use of a gas compression system, requires at least some additional and expensive equipment.

An object of the present invention is to improve upon existing techniques for transferring volatile liquids from one closed container to another by simplifying the equipment needed to effect such transfer efficiently, reducing the cost of this equipment, or achieving both a simplification and a cost reduction.

According to the present invention, a container filling or volatile liquid transfer system is provided which includes a relatively small drum, tank, or container known generally as a splash tank. Volatile liquid intended for ultimate loading into a receiving container is transferred to this tank from a storage container or other source, entering the splash tank at the top to flow downwardly as a spray through the vapor space thereof rather than entering at or near the bottom to have to mix initially with any liquid already in the tank. This form of entry furnishes at least some cooling and condensation of vapors in the spash tank.

A liquid line leads away from the bottom of the splash tank, and by means of suitable fittings may be placed in filling connection with a receiving container. Also leading away from the splash tank is a line where-through vapors may be returned from a receiving container. It is contemplated that the storage container and the splash tank will be separated by a considerable distance while the splash tank itself will be so located that a receiving container may be brought up quite close to it. Receiving containers are contemplated to be in a variety of forms such as tanks of substantial size mounted upon highway vehicles, railway cars, marine barges, and even aircraft, as well as being the customary small pressure cylinders.

One advantage of this invention in its apparatus embodiment is that it can be fabricated of readily available materials. Another advantage is that it can be fabricated relatively inexpensively in the field for economical operation. Still another advantage is that it does not require long vapor balance lines. Even still another advantage is that it does not require compression or heat exchange equipment, or any particular supply of cooling water.

These and other advantages of the present invention as well as its nature and substance will be more clearly perceived and fully understood by referring to the following description and claims taken in connection with the accompanying drawing in which:

FIG. 1 represents a partially pictorial, partially schematic view of a container filling system according to this invention in which the splash tank is disposed substantially vertically, and liquid is delivered from this tank to a receiving container by means of a pump;

FIG. 2 represents a vertical splash tank and connections made thereto for use in a system according to this invention in which liquid is delivered from this tank to a receiving container by means of gravity, and

FIG. 3 represents a horizontally disposed splash tank and connections made thereto.

Referring now to the drawing in detail, especially to FIG. 1 thereof, a bulk storage tank or container for volatile liquid materials under pressure such as liquefied propane or liquefied butane is designated **10**. This container will have suitable fittings for filling and venting.

It may be elevated on legs or stanchions 12 and 14 as shown, or it may be seated directly on earth formation. Particular details of construction and installation of storage container 10 do not, however, constitute any part of the present invention. Leading out of the bottom of the interior region of storage container 10 is a liquid discharge line 16 which extends to and connects with the inlet side of product pump 18 which may be of any suitable kind. Liquid discharge line 20 extends from the outlet side of pump 18 to and through the top of splash tank 22, and terminates within the top of the interior region of this tank in spray head or spray nozzle 24.

Splash tank 22 which is considerably smaller than storage container 10 may be elevated on legs or stanchions 26 and 28 as shown, or it may be seated directly on earth formation. It is provided with a safety or relief valve 30, and with a liquid level sensing and signal generating device 32 which may be of any suitable kind. Within the splash tank there is a body of liquid 34 in the process of transfer having a surface 36, the level of which is intended to be maintained between predetermined upper and lower limits according to the setting of sensing device 32. Above liquid surface 36 is vapor region 38 down through which passes liquid from storage tank 10 issuing out of spray head 24.

Leading out of the bottom of the interior region of splash tank 22 is a liquid discharge line 40 which extends to and connects with the inlet side of booster transfer pump 42 which may be of any suitable kind. Liquid discharge line 44 extends from the outlet side of pump 42 to the inlet side of articulated pipe structure 46 which is appropriately supported and actuated for raising and lowering by means not shown. Near its outlet side, this structure contains a stop valve 48, and at its outlet side it is connected through flanged joint 50 with the inlet or liquid filling fitting of receiving container 52 which is shown as the liquid-holding element of a railway tank car. This filling fitting includes a stop valve 54 closely below flanged joint 50, and it extends into the lower region of receiving container 52. The receiving container itself is considerably smaller than storage container 10, but it may be larger than splash tank 22.

Discharge line 44 contains a power-operated throttle valve 56 which receives actuating signals from sensing device 32 through connection 58. This connection may be of an electrical nature as indicated, but it may also be a pneumatic, hydraulic, mechanical linkage, or any other appropriate connection depending upon the choice of liquid level sensing and signal generating device, and the power means selected for operating valve 56.

When the level of liquid surface 36 approaches its predetermined lower limit, sensing device 32 generates a signal causing valve 56 to become more nearly closed, and thus restrict the delivery from pump 42 to allow the liquid level in tank 22 to rise. Correspondingly, when the level of liquid surface 36 approaches its predetermined upper limit, sensing device 32 generates a signal causing valve 56 to become wider open, and thus permit greater delivery from pump 42 to cause the liquid level in the splash tank to fall. The liquid level sensing and signal generating device may, of course, be designed and installed cooperatively with throttle valve 56 to control or maintain liquid surface 36 at or very closely around a single predetermined level in splash tank 22. This would be in place of exercising liquid level control across a range of levels between predetermined upper and lower limits as described hereinbefore.

Receiving container 52 is provided with a vapor outlet fitting for use during filling operations. This fitting extends outwardly from the upper region of this container, and includes a stop valve 60. A second articulated pipe structure 62, appropriately supported and actuated for raising and lowering by means not shown, makes connection at its inlet side through flanged joint 64 with the vapor outlet fitting of container 52. Near its inlet side pipe structure 62 contains a stop valve 66, and from its outlet side a vapor return or vapor balance line 68 extends, as illustrated, to the top of splash tank 22, and makes connection therethrough to the interior of this tank in its vapor region 38. It is also within the contemplation of this invention that vapor return line 68 make connection to the interior of the splash tank below the predetermined lower limit of the level of liquid surface 36.

In the operation of the container filling system of FIG. 1, flanged joints 50 and 64 having been made up tight and stop valves 48, 54, 60 and 66 having been opened, pump 18 withdraws volatile liquid material under pressure from storage container 10, and discharges it into splash tank 22 through spray head 24. The liquid streams descending from the spray head have at least a tendency to cool and condense vaporous material in upper region 38 of the splash tank, and of course they act to replenish liquid body 34 in the tank as pump 42 withdraws liquid therefrom. Maintenance of the level of liquid surface 36 within splash tank 22 is effected by cooperative action of sensing device 32 and throttle valve 56 as already described.

Liquid material discharged by pump 42 through line 44 and pipe structure 46 flows into receiving container 52 near the bottom thereof through its filling fitting. Any vapor initially in the receiving container and also any vapor in this container evolved from liquid filling thereinto may flow back to vapor region 38 of the splash tank through pipe structure 62 and line 68 upon the pressure in the vapor region of the receiving container tending to become at all elevated above that in the vapor region of the splash tank. Vapor entering the splash tank from the receiving container through the connections shown will be spray and splash cooled and at least reduced in pressure if not fully condensed by liquid flowing into tank 22 through spray head 24. Vapor bubbled into the splash tank from the receiving container by an alternate connection below liquid surface 36 will likewise be cooled and at least partly condensed. At any rate, with some open path for flow of vapor back from the receiving container to the splash tank, there will be an orderly filling of the receiving container without either an undesirable loss of valuable vaporized formerly liquid material from the system, or an undue rise of pressure in the receiving container.

When the filling operation is completed as indicated by appropriate gaging means associated with receiving container 52, pumps 18 and 42 may be shut down, and stop valves 48, 54, 60, and 66 closed to isolate the filling system from the receiving container, and maintain both tight against the escape of either liquid or vaporous material. With the four stop valves closed, flanged joints 50 and 64 may be broken; the filled receiving container rolled away from filling location; an empty receiving container brought into this location; flanged joints 50 and 64 made up to it; the four stop valves opened, and pumps 18 and 42 started to commence another filling operation.

Referring next to FIG. 2, it is contemplated that the splash tank of a container filling system according to this invention may be mounted sufficiently high with respect to the loading location of receiving containers that liquid material can be delivered from it into a receiving container simply by gravity. In an example of such an arrangement, splash tank 122 is elevated on cross-braced legs or stanchions 126 and 128. Liquid material is delivered to the splash tank through line 120 from a storage container and by a product pump not shown, actually entering the tank in its upper or vapor region through a spray head or spray nozzle 124.

Splash tank 122 is provided with a relief or safety valve 130, and with a liquid level sensing and signal generating device 132. Within the splash tank there is a body of liquid 134 in the process of transfer having a surface 136, the level of which is intended to be maintained between

predetermined upper and lower limits according to the setting of sensing device 132. Above liquid surface 136 is vapor region 138, down through which passes liquid issuing out of spray head 124. Leading out of the bottom of splash tank 122 is a liquid discharge line 140 which inclines downwardly toward a receiving container, not shown, at a level lower than the splash tank. Leading into the top of splash tank 122 is a vapor return or vapor balance line 168 inclining upwardly from the receiving container.

Liquid line 120 contains a power-operated throttle valve which receives actuating signals from sensing device 132 through connection 158. When the level of liquid surface 136 approaches its predetermined upper limit, sensing device 132 generates a signal causing valve 156 to become more nearly closed, and thus restrict delivery from the product pump to allow the liquid level in tank 122 to fall. Correspondingly, when the level of liquid surface 136 approaches its predetermined lower limit, sensing device 132 generates a signal causing valve 156 to become wider open, and thus permit greater delivery from the product pump to cause the liquid level in the splash tank to rise.

Referring finally to FIG. 3, it is contemplated that the splash tank of a container filling system according to this invention may be mounted substantially horizontally. In an example of such an arrangement, horizontal tank 222 is elevated on legs or stanchions 226 and 228. Liquid material is delivered to the splash tank through line 220 from a storage container and by a product pump not shown, actually entering the tank through a plurality of spray heads or spray nozzles 224 in the upper or vapor region 238 of the tank above surface 236 of liquid body 234. Splash tank 222 is provided with a relief or safety valve 230, and with a liquid level sensing and signal generating device 232. Leading out of the bottom of the splash tank is a liquid discharge line 240, and leading into the top of the tank is a vapor return or vapor balance line 268.

It is possible to use splash tank 222 in either the system of tank 22 or that of tank 122. Said in other words, liquid line 240 may either go to the inlet side of a booster transfer pump such as 42 with sensing device 232 providing signals through connection 258 to a throttle valve such as 56 on the outlet side of this pump, or else go directly to a receiving container at a loading location lower than splash tank 222 with sensing device 232 being connected to a throttle valve such as 156 in liquid line 220 on the outlet side of the product pump. Within tank 222 itself, the plural number of sprays and the splashing off of the extended surface 236 of the liquid body makes up for the shortness of the sprays to give good contacting of vapor with liquid and consequent reasonable degree of cooling of vapor in upper region 238 of the splash tank.

It is intended to secure protection by Letters Patent of the foregoing-described invention in all its aspects to the broadest extent that the prior art allows.

What is claimed is:

1. A system for filling closed containers with volatile liquids, said system comprising (1) a closed storage container for liquefied product materials under pressure such as liquefied propane or liquefied butane, said storage container having a bottom interior region, (2) a product pump having an inlet side and an outlet side, (3) a liquid discharge line extending from the bottom interior region of said storage container to the inlet side of said product pump, (4) a closed splash tank having an interior region including a top and a bottom, (5) a liquid discharge line extending from the outlet side of said product pump to the top interior region of said splash tank, (6) a liquid discharge line extending from the bottom interior region of said splash tank, said line having an outlet end removed from said splash tank which is adapted to be connected to a closed receiving container, and said line including valve means closely adjacent its outlet end whereby the flow of liquid through said line may be stopped, and (7) a vapor return line extending to the interior region of said splash tank, said line having an inlet end removed from said splash tank which is adapted to be connected to a closed receiving container, and said line including valve means closely adjacent its inlet end whereby the flow of vapor through said line may be stopped.

2. A system according to claim 1 in which said splash tank is disposed substantially vertically.

3. A system according to claim 1 in which said splash tank is disposed substantially horizontally.

4. A system according to claim 1 in which said liquid discharge line extending from the outlet side of said product pump to the top interior region of said splash tank terminates within this region in at least one spray head.

5. A system according to claim 1 in which said vapor return line extending to the interior region of said splash tank terminates within the top interior region thereof.

6. A system according to claim 1 in which said liquid discharge line extending from the bottom interior region of said storage container to the inlet side of said product pump and said liquid discharge line extending from the outlet side of said product pump to the top interior region of said splash tank taken together are substantially longer than said liquid discharge line extending from the bottom interior region of said splash tank.

7. A system for filling closed containers with volatile liquids, said system comprising (1) a closed storage container for liquefied product materials under pressure such as liquefied propane or liquefied butane, said storage container having a bottom interior region, (2) a product pump having an inlet side and an outlet side, (3) a liquid discharge line extending from the bottom interior region of said storage container to the inlet side of said product pump, (4) a closed splash tank having an interior region including a top and a bottom, (5) liquid level sensing and signal generating means operatively associated with said splash tank in its interior region, (6) a liquid discharge line extending from the outlet side of said product pump to the top interior region of said splash tank, (7) a booster transfer pump having an inlet side and an outlet side, (8) a liquid discharge line extending from the bottom interior region of said splash tank to the inlet side of said booster transfer pump, (9) a liquid discharge line extending from the outlet side of said booster transfer pump, said line having an outlet end removed from said booster transfer pump which is adapted to be connected to a closed receiving container, and said line including valve means closely adjacent its outlet end whereby the flow of liquid through said line may be stopped, (10) a power-operated throttle valve in said liquid discharge line extending from the outlet side of said booster transfer pump, said throttle valve being located in said line between the outlet side of said booster transfer pump and said afore-mentioned valve means, (11) a connection between said liquid level sensing and signal generating means and said throttle valve whereby actuating signals are received by said throttle valve from said liquid level sensing and signal generating means, said throttle valve and said liquid level sensing and signal generating means being so connected that a rising level of liquid within said splash tank causes said throttle valve to become wider open and a falling level of liquid within said splash tank causes said throttle valve to become more nearly closed, and (12) a vapor return line extending to the interior region of said splash tank, said line having an inlet end removed from said splash tank which is adapted to be connected to said closed receiving container, and said line including valve means closely adjacent its inlet end whereby the flow of vapor through said line may be stopped.

8. A system for filling closed containers with volatile liquids, said system comprising (1) a closed storage container for liquefied product materials under pressure such as liquefied propane or liquefied butane, said storage con-

tainer having a bottom interior region, (2) a product pump having an inlet side and an outlet side. (3) a liquid discharge line extending from the bottom interior region of said storage container to the inlet side of said product pump, (4) a closed splash tank having an interior region including a top and a bottom, (5) liquid level sensing and signal generating means operatively associated with said splash tank in its interior region, (6) a liquid discharge line extending from the outlet side of said product pump to the top interior region of said splash tank, (7) a power-operated throttle valve in said liquid discharge line extending from the outlet side of said product pump to the top interior region of said splash tank, (8) a connection between said liquid level sensing and signal generating means and said throttle valve therethrough actuating signals are received by said throttle valve from said liquid level sensing and signal generating means, said throttle valve and said liquid level sensing and signal generating means being so connected that a rising level of liquid within said splash tank causes said throttle valve to become more nearly closed and a falling level of liquid within said splash

tank causes said throttle valve to become wider open, (9) a liquid discharge line extending from the bottom interior region of said splash tank, said line having an outlet end removed from said splash tank and at a lower level than the bottom interior region thereof which outlet end is adapted to be connected to a closed receiving container, and said line including valve means closely adjacent its outlet end whereby the flow of liquid through said line may be stopped, and (10) a vapor return line extending to the interior region of said splash tank, said line having an inlet end removed from said splash tank and at a lower level than the top interior region thereof which inlet end is adapted to be connected to said closed receiving container, and said line including valve means closely adjacent its inlet end whereby the flow of vapor through said line may be stopped.

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