

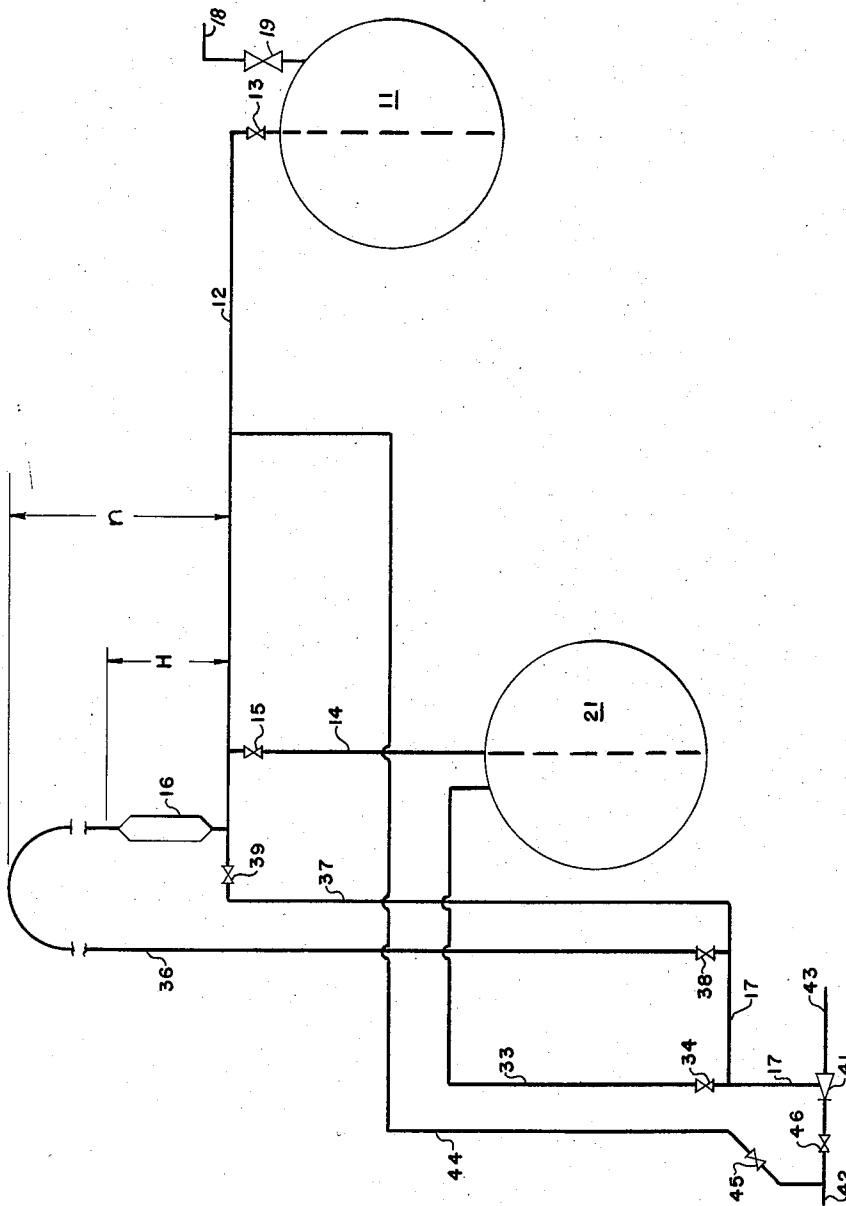
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LIQUID UNLOADING SYSTEM

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LIQUID UNLOADING SYSTEM

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This invention relates to the unloading of certain liquid chemical products from tank cars. More specifically, the invention relates to an improved apparatus for providing highly safe and effective unloading by the application of vacuum to such liquid products.

In the handling of numerous chemical products, it has been the practice of industry to transfer such liquids by the application of vacuum rather than by positive displacement or positive pressure liquid transport equipment. The reason for such a general approach may be one of several. For example, the liquid being transferred from one vessel to another may be toxic, or may be flammable or explosive when exposed to the atmosphere. Examples of such fluids for which vacuum transfer is usually provided are organometallic liquid compounds, the pure alkali metals such as sodium, and various other products. The most customary or frequently encountered situation in which the vacuum transfer of large quantities of such liquids is encountered is in the unloading of tank car shipments of the commodity to storage or weigh tanks. Vacuum transfer, or at least simply gravity transfer is also used in numerous subsequent processing operations, but the degrees of flow then involved are of lower magnitude than in unloading operation.

Heretofore, it has been the practice to apply vacuum to the weigh or receiving tank which is to receive the liquid commodity being discharged from the incoming tank car, rather than to the tank car itself. In this manner, a weigh tank served as a trap to render it impossible for the liquid product to be sucked into the vacuum system, and also made it possible to utilize the same vacuum source for unloading from the weigh tank proper and transferring to subsequent processing operations. However, in previous installations, a particular difficulty was that in order to accomplish the latter objective (applying the vacuum to the contents of the weigh tank for delivery to processing) it was necessary that the line to the weigh tank extend to the bottom portion thereof so it in turn could be unloaded. The result of this situation, as will be evident from the later description of the figure, was that the effective vacuum applicable to the tank car tank being unloaded was reduced by the build-up of liquid head as the weigh tank was filled. In addition, it frequently happened that despite the customary precautions, that the liquid being unloaded would spill over into the vacuum source line and be responsible for certain operating difficulties. If the vacuum was generated by a vacuum pump, a pump designed only for gaseous handling would be fouled or filled with the liquid product and would require disassembly and clean out. In many cases a liquid hydrocarbon eductor system is employed to establish vacuum, particularly in petroleum refineries, and in such instances the carry over of the liquid being transferred would contaminate or dilute the hydrocarbon liquid in the eductor system.

Accordingly, an object of the present invention is to provide new and improved apparatus for the transfer from one vessel to another under vacuum of chemical

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liquid products. More specifically, the object of the invention is to provide apparatus for transfer of such liquids under vacuum wherein a constant vacuum can be maintained upon the discharging tank regardless of the level of liquid transferred in the receiving tank or vessel. A further object is to provide the constant vacuum on the discharging tank but also provide for application at will of the same vacuum to the receiving tank when it is to be discharged. An additional object is to provide positive preventive means which negate the misdirection of the liquid being transferred into the vacuum generating system. Other more specific objects will appear herein-after.

The details of the invention and the preferred embodiment thereof will be more readily understood from the following discussion and the accompanying figure, the figure being a schematic elevation of a typical embodiment, the vessels involved being shown in section.

Generally, the invention comprises, in combination, a transfer line for receiving liquid from a tank to be discharged, a receiving tank, a vacuum generating means, a dip line or discharge line from the transfer line into the receiving tank, and a vertically extended loop line connecting the vacuum source and the transfer line. The vertical loop line joins the transfer line at a point at least as far removed from the discharging tank as the discharge or dip line. In addition the loop line extends vertically to an elevation such that a column of the liquid equal to such elevation would exceed the vacuum available, expressed as head of liquid being transferred.

A by-pass line is also generally provided, joining the transfer line and the vacuum source. This line does not have an elevated portion therein, and joins the transfer line at a point generally adjacent the loop line. A direct vacuum line is also provided, connecting the upper portion of the receiving tank space with the vacuum source.

Both the transfer line and discharge lines communicate with the interiors of the discharging and receiving tanks, at points near the bottoms, respectively. Valves are provided in the transfer line, the loop line, the discharge line, and the by-pass and direct vacuum lines. Generally, in operation, vacuum is initially applied through the loop leg line to the transfer line with the valves in the discharge line and the direct vacuum line closed. The valve in the discharge line is then opened, and the liquid pulled into the transfer line siphons automatically through the discharge line into the receiving tank. The valve in the loop line can then be closed and the valve in the direct vacuum line opened. The vacuum applied to the discharging tank builds up to the vacuum generated by the source. If the siphon is lost, the vacuum can be promptly reestablished in the transfer line by opening the valve in the loop line, and flow will be readily restarted. The inter-relation of the components of the apparatus and the method of operation will be more clearly understood from the accompanying figure.

Referring to the figure, a discharge vessel or tank 11 and a receiving tank or vessel 21 are shown in customary relationship. Normally, the discharge tank is of course the tank of a tank car, and the receiving tank 21 is usually slightly below the level of the discharge tank 11. The top of the discharge tank 11 communicates with atmospheric pressure by conventional vent means. The vent means customarily includes a vent line 18 and a valve 19 which is opened during operation. A line 12 extends into the discharging tank to a point at about the bottom thereof for complete emptying and is preferably equipped with a valve 13. A discharge line 14 joins the line 12 and extends to the bottom of the receiving tank 21, a valve 15 being provided in this line. Additional lines, including a loop line 36, and a by-pass line 37, connect to the line 12, preferably spaced apart from the connec-

tion of the discharge line 14, and further away from the discharge tank 11. These two lines have common termini, but differ in that the loop line 36 forms an overhead loop, the highest point thereof being at an elevation of "n" feet above the junction of the transfer line 12 and the discharge line 14. As explained hereafter, this elevation contributes very materially to the effectiveness of all embodiments of the invention. In preferred embodiments, an enlarged segment 16 is provided in the loop line 36, located generally between the highest point of the line and the point of connection with the discharge line 14. Both the loop line 36 and the by-pass line 37 are provided with valve means 38, 39. The loop line 36 and bypass line 37 are manifolded in a vacuum header 17, to which is also connected a direct vacuum line 33. The direct vacuum line 33, having a valve 34 therein, connects directly to the top portion of the receiving tank 21.

A vacuum inducing means maintains in operation a vacuum in the vacuum header 17. A variety of vacuum inducing means may be employed, but a particularly effective apparatus is a liquid eductor 41 as indicated in this embodiment. The eductor 41 in typical operation receives a flowing hydrocarbon or inert liquid stream through line 42 and by converting pressure head to velocity head, establishes a vacuum in the header 17. The inert liquid discharged from the eductor is discharged through a line 43.

A supplemental feature found in the most preferred embodiments of this invention employing a liquid actuated eductor means as described is a wash liquid line 44, provided with a valve 45, which can receive a wash liquid from line 42, the wash liquid being the hydrocarbon fluid (or other inert liquid) employed to operate the eductor system.

In preferred forms of the invention, the loop line 36 has therein, as already disclosed, an enlarged segment 16 removed from the connection of the loop line and the transfer line 12. It is preferred that the volumetric capacity of this enlarged segment 16 be equal to the entire volume of the transfer line 12. The significance of this segment is that automatic disengaging is provided for occasional presence of gas or vapor bubbles. Thus, occasionally leaks can occur in the valve or connecting means 13 joining the portion of the transfer line 12 which is between the portion inside the discharging tank 11 and the connection with the loop line 36. The presence of a substantial quantity of gas originating in this part of course decreases the average density of the fluid in the transfer line and the enlarged zone 16 assures that such gas or vapor will be disengaged without carry over of liquid through the loop line 36. This desirable effect of a specifically enlarged zone can also be achieved by providing a loop line sized sufficiently large to provide more volume in the branch extending to the highest point from the transfer line, at least as large as the transfer line volume.

The operative relationship of the various components of the apparatus will be further understood by the following description of an unloading cycle. At the start of operation, the liquid level in the discharging tank 11 is near the top of the tank, and the receiving tank 21 is substantially empty or having only a minor quantity of charge already therein. Vacuum is established on the system as follows: the valve 38 to the loop line 36 is opened, with the valve 15 to the discharge leg 14 to the receiving tank 21 closed, and the valve 13 in the transfer line 12 open. In addition the valve 34 to the vapor space in the receiving tank 21 is closed. Vacuum is rapidly established in the loop line 36 and transfer line 12, to the degree of vacuum provided by the eductor vacuum system. Flow of liquid starts through the transfer line 12 and continues through a portion of the leg of the loop line 36 but does not carry over but rises to a height "H" corresponding to the head provided by the vacuum. Discharge line 14 is concurrently or thereafter opened by

opening the valve therein 15, and liquid flow immediately starts through discharge line 14 under the influence of the elevation head. Desirably, the loop line 36 valve 38 is then closed and the direct vacuum line 33 valve 34 is opened. The pressure in the receiving tank 21 is thus steadily decreased, and flow continues under siphoning action and the increasing vacuum in the receiving tank. Because flow is established so rapidly, the start up period is appreciably reduced because flow does not need to await the removal of copious quantities of gas from the empty receiving tank space.

Flow thus established is continued in this manner, the level of contents in the discharging tank 11 dropping, and rising in the receiving tank 21. If any leaks are encountered in the piping system so that air is entrained with the moving liquid in sufficient quantity to break the siphon leg, the flow of liquid may be interrupted. In such event, any liquid height in the loop line 36 automatically feeds back to the discharge line 14 into the receiving tank 21, and then the full vacuum of the vacuum system is immediately re-established on the discharging tank 11 by reopening the loop line 36 and flow is re-initiated. In some operations, this period of the discharging cycle will assume an intermittent pulsing effect, that is, slugs of liquid are alternately aspirated out of the discharging tank 11 when the full effect of the vacuum source is applied through the loop line 36, and is terminated when the loop line head is again established as before and the effect of the vacuum thus applied for flow is temporarily eliminated. Upon completion of the unloading cycle, it is necessary to flush out the system by the liquid employed in the vacuum establishing device. Thence, the loop line 36 is closed by closing the valve therein 38, but the transfer line valve 13 and the discharge to the discharge line 14 are kept open. A washing liquid such as a low density hydrocarbon, is fed to the system by opening the valve 45 in the wash liquid line 44 and closing the valve 46 controlling operation of the eductor 41. Upon completion of filling with this wash liquid, the system is again emptied. However, in this case, since the washing liquid is of appreciably lower density than the liquid normally handled in the tanks, the flow of liquid is through the transfer line 12 and through the entire loop line 36 during an initial portion of the washing operation. This washes out the loop line 36 as well as the discharging tank 11. The washing operation is concluded by closing the valve 38 in the loop line 36 and opening the valve 39 in the bypass line 37.

Having fully described the apparatus of the invention, it will be understood that numerous minor variations can be incorporated without departing from the scope of the invention as defined in the following claims.

I claim:

1. A safety transfer system for the transfer of a liquid from a discharge tank maintained at atmospheric pressure to a receiving tank, said receiving tank having an elevation not greater than the discharge tank, comprising: a transfer line, a vertically extended loop line, a discharge line, a direct vacuum line, valves in said loop, discharge, and direct vacuum lines, and a vacuum source; said transfer line communicating with the interior of the discharge tank near the bottom thereof, said discharge line being connected to the transfer line and communicating with the interior of the receiving tank near the bottom thereof, said loop line connecting to the transfer line at a point at least as remote from the discharge tank as the discharge line, and connecting to said vacuum source, the elevation of the highest point in said loop line being greater, in head of liquid being transferred, than the head corresponding to the vacuum generated by the vacuum source, and said direct vacuum line communicating with the upper portion of the interior of the receiving tank and the vacuum source.

2. The apparatus of claim 1 further defined in that

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the loop line has an enlarged segment therein, said segment being between the highest point in the loop line and the connection with the transfer line, and having a volumetric capacity at least equal to the volume of the transfer line.

3. The apparatus of claim 1 further defined in that the volume of the portion of the loop line, from the connection to the discharge line to the highest point of the loop line, is greater than the volume of the transfer line.

4. A safety transfer system for the transfer of a liquid from a discharge tank to a receiving tank, and for cleaning said discharge tank, including a transfer line, a vertically extending loop line, a discharge line, a direct vacuum line, a wash liquid line, valves in each of said lines and a vacuum source, said source including an eductor system for generating vacuum by flow of an inert liquid, and a vacuum manifold, the transfer line extending from within the discharge tank near the bottom thereof to a point generally above the receiving tank,

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the discharge line connecting to the transfer line and extending to a point within the receiving tank and adjacent to the bottom thereof. the loop line connecting to the transfer line at a point at least as remote from the discharge tank as the discharge line and connecting to the vacuum manifold, the highest point in said loop line being greater, in head of liquid being transferred, than the head corresponding to the vacuum generated by the vacuum source, the direct vacuum line communicating with the upper portion of the interior of the receiving tank and the vacuum manifold, and the wash liquid line extending from the eductor system to the transfer line and connecting thereto at a point closer to the discharge tank than the connection with the discharge line.

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