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METHOD AND APPARATUS FOR LOADING RECEPTACLES WITH VOLATILE LIQUIDS

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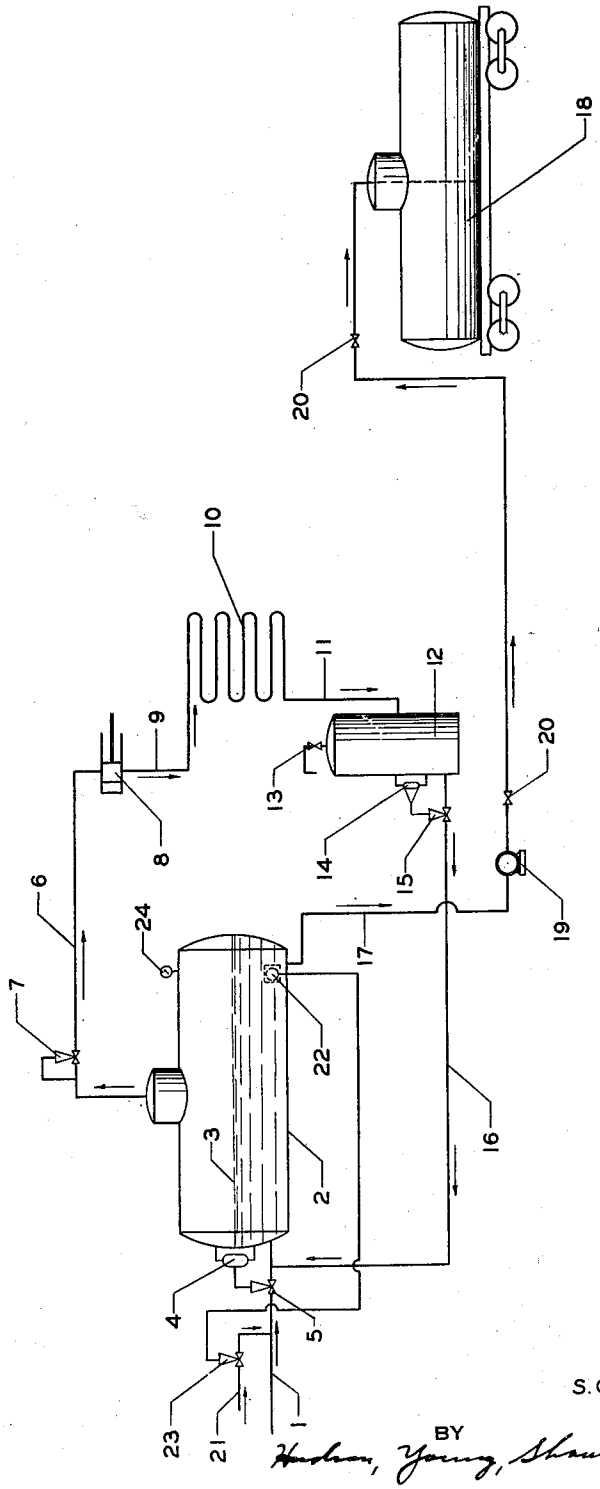

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METHOD AND APPARATUS FOR LOADING RECEPTACLES WITH VOLATILE LIQUIDS

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This invention relates to a method and apparatus for loading receptacles with volatile liquids and is especially adapted to loading tank cars with natural gasoline, liquefied propane, liquefied butane or mixtures thereof, these liquids having been previously stored as a whole, or in their component parts, in suitable storage tanks. While the following description sets forth in detail the manner and apparatus by which my invention may be practiced to load natural gasoline into tank cars, its application to loading receptacles with various other volatile liquids will be readily apparent to those skilled in the art.

There have been a number of developments in the field of loading volatile liquids, such as natural gasoline, into tank cars for the purpose of reducing evaporation losses and eliminating the danger of fire and explosion. These developments may be classified under the following general types of closed systems: (I) Those systems in which the loading procedure is performed under pressures at least as high as, and usually higher than the vapor pressure of the liquid at loading temperature; and (II) those systems which operate at substantially atmospheric pressure, vaporized material being collected and partially recondensed by treatment at the loading rack or returned to absorbers at the producing plant. The first mentioned type of system necessitates the use of special tank car dome covers with suitable provision for loading, gauging and sampling. Since this equipment must be provided for each car, it is evident that the cost of so equipping each car is often prohibitive in view of the small savings effected. Auxiliary dome covers are provided for the second type of system to permit the collection of evolved vapors. These auxiliary covers are replaced by regular dome covers on completion of the loading. The principal obstacle to the complete success of either of these systems is the presence of air in the empty cars. My system, on the other hand, contemplates the collection of all vapors at one point without admixture with air, with the result that these vapors may be recondensed at relatively low pressures by simple compression and cooling. Furthermore, the successful operation of my process does not require any special dome equipment, thus making it possible to use any tank car which is brought to the loading rack. Unlike pressure systems, no pressure exists on the loaded car so that losses in transit are minimized. The practice of my invention also provides a means for disposing of the heat contained in the metal of empty cars which sometimes arrive at loading racks at temperatures as high as 120° F., during the summer months.

The present invention is essentially a system for utilizing without loss of material, the autogenous refrigeration which the material, in this case, natural gasoline, has always supplied at loading racks. It recognizes the fact that any grade of natural gasoline is an excellent refrigerant and that by reducing its pressure, both the liquid and the surrounding surface will be cooled with the result that a car of natural gasoline loads out cold. I propose to avail myself of this phenomenon of self-cooling; but, instead having this take place in the tank car as has been the procedure heretofore, I find it advantageous to induce refrigeration of the liquid before it is introduced into the car. By cooling the liquid to about 5° to 25° F., below its equilibrium boiling point at atmospheric pressure prior to loading into the car, the loss of liquid due to evaporation on coming in contact with the interior of the car and the air therein is reduced to the extent that it is negligible for all practical purposes.

The primary object of this invention is to minimize evaporation losses during the loading of volatile liquids into receptacles.

Another object of my invention is to eliminate the dangers of fire and explosion while loading receptacles, such as tank cars, with inflammable volatile liquids.

A further object of this invention is to provide a method and apparatus for continuously blending and loading volatile liquids into suitable receptacles. The practice of this invention permits proper blending of separately stored liquids, such as butane, which has been stored under pressure, and 12-pound Reid vapor pressure natural gasoline, to obtain 26-pound Reid vapor pressure natural gasoline. I thus avoid the use of conventional types of blending tanks with their cost and the losses usually incurred in their use.

These and additional objects and advantages will be apparent from the following description and annexed drawing which is a diagrammatic representation in elevation of a preferred embodiment of the apparatus employed for practicing the invention.

Referring to the drawing, I have denoted therein a pipe 1 through which a stream of natural gasoline, for example 26-pound Reid vapor pressure natural gasoline, is passed from a source of supply, not shown, into a closed and thermally insulated processing tank or container 2. The liquid in this tank is maintained at a prede-

termined level, as indicated by reference numeral 3, by means of a liquid level controller 4 which operates to open or close valve 5 in pipe 1, depending upon the quantity of liquid in the tank. A conduit 6, which is provided with a back pressure regulator 7, establishes communication between the top of the tank and the suction side of a compressor 8. The compressor serves two functions, namely, to maintain the pressure in the processing tank lower than the pressure of the liquid admitted thereto and also to compress the vapors evolved from the liquid in the tank. The compressed vapors flow through a discharge pipe 9 into a condenser 10 which is preferably water cooled in the usual manner. The condensate or reliquefied vapors pass through a pipe 11 and into an accumulator or chamber 12 wherein the pressure is governed by a relief valve 13. The accumulator is equipped with a liquid level controller 14 for operating a valve 15 in a pipe 16 through which the reliquefied vapors are returned to pipe 1 downstream from valve 5 and thence back into the processing tank. The liquid having been autogenously cooled in the tank by partial evaporation is conducted through an outlet in the end of the tank opposite pipe 1 and thence by a thermally insulated line 17 into the lower portion of a tank car 18. A pump 19 may be installed in line 17 to pump the cooled liquid into the tank car, while one or more manually operated valves 20 may be provided to control the flow of liquid into the car.

The above described apparatus, augmented by equipment which I shall now describe, is utilized for the purpose of blending two volatile liquids, such as liquefied butane and 12-pound Reid vapor pressure natural gasoline to make a 26-pound Reid vapor pressure blend. One of the liquids is supplied through pipe 1 and the other liquid is admitted as shown through a separate pipe 21. A thermostatically controlled device 22 is arranged near the liquid outlet in the tank so that if the temperature in tank 2 falls below a predetermined point, it will throttle or close a valve 23 in pipe 21. Also, if the temperature in tank 2 rises above the predetermined value, valve 23 will be opened to admit more liquid to the tank. Back pressure regulator 7 and thermostatically controlled device 22 are both adjusted to admit a sufficient amount of liquid through valve 23 so that the controlled equilibrium boiling temperature at the controlled pressure shall be the temperature characteristic of the desired blend, in this case 26-pound Reid vapor pressure natural gasoline. A suitable gauge 24 is installed on the tank to indicate the pressure therein. It is to be understood that the proportion of each liquid admitted through its corresponding pipe may be controlled by manually operating valve 23 instead of controlling the same thermostatically as indicated above.

In the practice of the present invention the liquid is admitted by pipe 1 near the bottom of the tank to induce turbulence. The pressure on tank 2 is maintained below that of the incoming liquid and should be controlled at a value below atmospheric pressure. The sole purpose of this reduced pressure in the processing tank is to permit the liquid autogenously to cool itself by partial evaporation to a temperature below its equilibrium boiling point at atmospheric pressure. The proper pressure in tank 2 to induce autogenous cooling of particular liquids may be obtained by adjusting back pressure regulator 7 and by the operation of compressor 8. I find that by sub-cooling the liquid in this manner to a temperature ranging from about 5° to 25° F., below its equilibrium boiling point at atmospheric pressure, the cooled liquid will be able to absorb the heat transmitted to it through the walls of pipe 17, as well as the heat contained in the tank car shell without loss of the liquid by evaporation. The practice of this invention does not completely eliminate loss of liquid due to contact with the warmer air in the car. However, by delivering the cooled liquid to the lower portion of the tank car by the use of the well known down pipe indicated in the drawing, the air in the car will be displaced with a minimum loss of material. It will be evident to those skilled in the art that this loss is negligible compared to the extensive losses experienced heretofore, due to evaporation of the liquid and the mixing of the evolved vapors with air in the car during the loading operations. I have provided a definite place for evaporation and cooling to occur, namely, in processing tank 2 which is free from air. The unadulterated evolved vapors are readily reliquefied in an economical manner by compressor 8 and condenser 10 and are then returned to the processing tank.

In practicing my invention to blend and load two liquids continuously into the tank car, it is immaterial which liquid is admitted through pipe 21. I prefer to admit the more volatile liquid therethrough, but find that equally satisfactory results may be obtained by using pipe 1 for the lighter liquid and pipe 21 for the heavier liquid. Although not essential to the successful operation of the invention, baffles or other suitable means not shown may be installed in the lower portion of the tank for the purpose of increasing turbulency therein to more completely mix the liquids and to promote evaporation of the mixture.

From the foregoing it is believed that the method and apparatus for practicing my instant invention will be readily comprehended by persons skilled in the art. It is to be clearly understood, however, that various changes in the apparatus herewith shown and described and in the modes of operation outlined above may be resorted to without departing from the spirit of the invention as defined by the appended claims.

I claim:

1. The method of blending two normally gaseous liquids differing in volatility preparatory to loading into a suitable receptacle comprising the steps of simultaneously admitting both liquids to a closed zone of reduced pressure wherein the mixture of the liquids is cooled by partial evaporation, controlling the proportion of each liquid admitted to the closed zone, reliquefying the vapors evolved from the mixture in the closed zone, and returning the reliquefied vapors to the closed zone.

2. The method of blending two normally gaseous liquids differing in volatility preparatory to loading into a suitable receptacle comprising the steps of autogenously cooling a mixture of the liquids in a closed zone of reduced pressure to a temperature below the equilibrium boiling point of the desired blend at atmospheric pressure, controlling the proportion of each liquid in the closed zone, reliquefying the vapors evolved from the mixture in the closed zone, and returning the reliquefied vapors to the closed zone.

3. The method of blending two normally gaseous liquids differing in volatility preparatory

to loading into a suitable receptacle comprising the steps of autogenously cooling a mixture of the liquids in a closed zone of reduced pressure to a temperature ranging from 5° to 25° F., below the equilibrium boiling point of the desired blend at atmospheric pressure, controlling the proportion of each liquid admitted to the closed zone, compressing and condensing the vapors evolved from the mixture in the closed zone to reliquefy the same, and returning the reliquefied vapors to the closed zone.

4. The method of blending two normally gaseous liquids differing in volatility preparatory to loading into a suitable receptacle comprising the steps of autogenously cooling a mixture of the liquids in a closed zone of reduced pressure, thermostatically controlling the amount of one of the liquids admitted to the closed zone to produce a mixture which will have the equilibrium boiling point characteristic of the desired blend at the reduced pressure, compressing and condensing the vapors evolved from the mixture in the closed zone to reliquefy the same, and returning the reliquefied vapors to the closed zone.

5. The method of blending two normally gaseous liquids differing in volatility preparatory to loading into a suitable receptacle comprising the steps of autogenously cooling a mixture of the liquids in a closed zone of reduced pressure to a temperature ranging from 5° to 25° F., below the equilibrium boiling point of the desired blend at atmospheric pressure, thermostatically controlling the amount of one of the liquids admitted to the closed zone, controlling the level of the mixture in the closed zone, compressing and condensing the vapors evolved from the mixture in the closed zone to reliquefy the same, and returning the reliquefied vapors to the closed zone.

6. Apparatus for loading a volatile liquid into a suitable receptacle comprising a closed container, a liquid inlet and a liquid outlet in the container, means associated with the container for controlling the level of the liquid admitted thereto, a compressor connected to the container for maintaining the pressure therein below the equilibrium boiling point of the liquid at atmospheric pressure and for compressing vapors evolved from the liquid while in the container, a condenser communicating with the compressor and cooperating therewith for reliquefying said vapors, a chamber connected to the condenser, means for controlling the level of the reliquefied vapors admitted to the chamber from the condenser, a conduit for conducting the reliquefied vapors from the chamber to the container, and a conduit for passing liquid from the container outlet to the receptacle.

7. Apparatus for loading a normally gaseous hydrocarbon liquid into a tank car comprising a closed container, a liquid inlet and a liquid outlet in the container, means associated with the container for controlling the level of the liquid admitted thereto, a compressor, a conduit connecting the container to the compressor, a back pressure regulator associated with the conduit intermediate the container and the compressor, which compressor maintains the pressure in the container below the equilibrium boiling point of the liquid at atmospheric pressure and compresses vapors evolved from the liquid while in the container, a condenser communicating with the compressor and cooperating therewith to reliquefy said vapors, a chamber connected to the condenser, means for controlling the level of the reliquefied vapors admitted to the chamber from the condenser, a conduit for conducting the reliquefied vapors from the chamber to the container, and a conduit for passing liquid from the container outlet to the tank car.

8. Apparatus for blending two normally gaseous liquids differing in volatility preparatory to loading into a suitable receptacle comprising a closed container adapted to receive a supply of the liquids, a liquid outlet in the container, means associated with the container for controlling the level of the liquids admitted thereto, means for controlling the proportion of each liquid admitted to the container, a compressor connected to the container for maintaining the pressure therein below the equilibrium boiling point of the desired blend at atmospheric pressure and for compressing vapors evolved from the liquid mixture while in the container, a condenser communicating with the compressor and cooperating therewith for reliquefying said vapors, and a conduit for conducting reliquefied vapors from the condenser to the container.

9. Apparatus for blending two normally gaseous liquids differing in volatility preparatory to loading into a suitable receptacle comprising a closed container adapted to receive a supply of the liquids, a liquid outlet in the container, means associated with the container for controlling the level of the liquids admitted thereto, thermostatic means associated with the container for controlling the amount of one of the liquids admitted thereto, a compressor connected to the container for maintaining the pressure therein below the equilibrium boiling point of the desired blend at atmospheric pressure and for compressing vapors evolved from the liquid mixture while in the container, a condenser communicating with the compressor and cooperating therewith for reliquefying said vapors, a chamber connected to the condenser, means for controlling the level of the reliquefied vapors admitted to the chamber from the condenser, and a conduit for conducting the reliquefied vapors from the chamber to the container.

10. Apparatus for blending two normally gaseous hydrocarbon liquids differing in volatility preparatory to loading into a suitable receptacle comprising a closed container adapted to receive a supply of the liquids, a liquid outlet in the container, means associated with the container for controlling the level of the liquids admitted thereto, thermostatic means associated with the container for controlling the amount of one of the liquids admitted thereto, a compressor, a conduit connecting the container to the compressor, a back pressure regulator associated with the conduit intermediate the container and the compressor, which compressor maintains the pressure in the container below the equilibrium boiling point of the desired blend at atmospheric pressure and compresses vapors evolved from the liquid mixture while in the container, a condenser communicating with the compressor and cooperating therewith for reliquefying said vapors, a chamber connected to the condenser, means for controlling the level of the reliquefied vapors admitted to the chamber from the condenser, and a conduit for conducting the reliquefied vapors from the chamber to the container.

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