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PROCESS AND APPARATUS FOR STORING AND UTILIZING HIGHLY VOLATILE LIQUIDS

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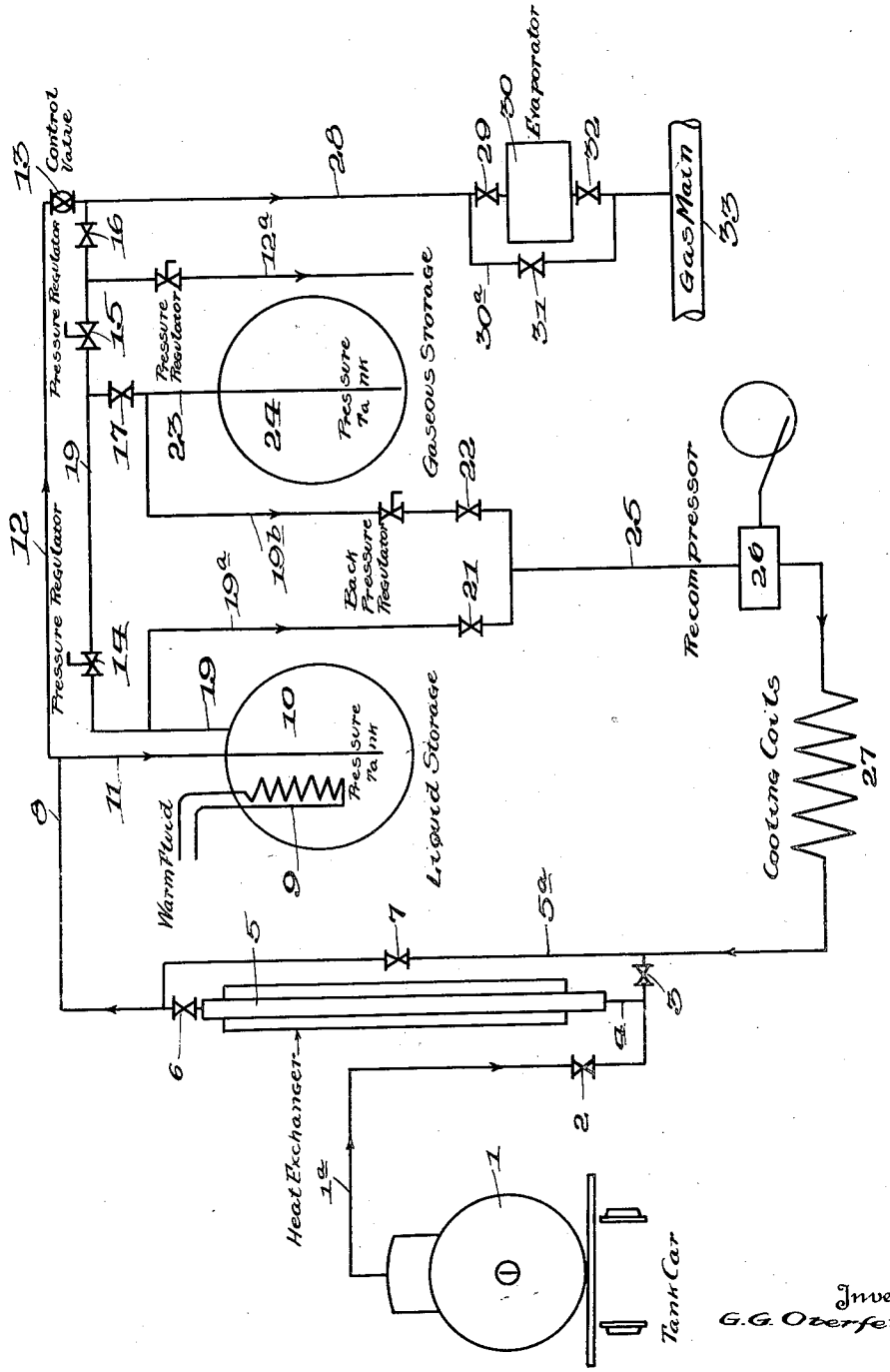

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UNITED STATES PATENT OFFICE

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PROCESS AND APPARATUS FOR STORING AND UTILIZING HIGHLY VOLATILE LIQUIDS

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This invention relates to improvements in the process and apparatus for utilizing highly volatile liquids, such as the lighter combustible components of natural gas gasoline or analogous combustible materials, obtained during the fractional distillation of crude oil, the thermal decomposition of oil, illuminating gas manufacture, and the like.

In the manufacture of natural gas gasoline or "natural gasoline", as it is generally called, the processes have in recent years developed to such an extent that there is frequently produced a liquid too volatile to comply with specifications of purchasers of the product, when it is used for blending with refinery products for the purpose of increasing the volatility of the resulting motor fuel blend. This condition makes it necessary for the natural gasoline manufacturer to reduce the volatility of his initial product by separating therefrom the lighter fractions in the proportion required to produce a natural gasoline of a desired volatility specification. The lighter fraction removed from the initial product is composed primarily of propane, iso-butane, normal butane and relatively small proportions of ethane and the pentanes. This invention pertains primarily to the improvements in the process of storing and utilizing these lighter combustible constituents of natural gasoline, but it is to be understood that the invention is also applicable to similar and analogous substances and processes. I, therefore, do not limit myself to the application of these improvements to combustible gases since it is evident that the improvements are also useful in processes employing material of similar volatility.

The object of this invention is the elimination of difficulties which have hitherto mitigated against the large scale utilization of the lighter combustible components of natural gasoline for domestic and industrial purposes. The improvements obtained by my invention are manifested by some of the objects and advantages as herewith presented:

1. Economy in storing and utilizing of the product.

2. Economy in installation of equipment required for storing and utilizing the product.

3. Reduction of pressures required for storage.

4. To provide a storage and a means which may be applied for either a continuous or intermittent utilization of the product.

5. To utilize the latent heat of vaporization of the product for cooling purposes.

6. To utilize as far as possible the heat of the atmosphere for evaporation of the product.

7. Minimization of hazards in storage and utilization of the product.

The invention as herein described relates more particularly to the utilization of the lighter combustible fractions of natural gasoline for gas enrichment purposes, but it is to be understood that the invention is not limited to the particular product and utilization as described. Particular reference is made to the use of the lighter fractions of natural gasoline as applied to gas enrichment for the purpose of affording an explanation as to the general procedure that may be followed in adapting my invention for similar and analogous processes utilizing products of similar and analogous characteristics.

Any kind of gas which may be used for industrial purposes can be enriched by the gas enrichment gasoline. The only essential characteristic of the gas flowing through the gas main is that it shall have a heat value lower than that of the gas enrichment gasoline. Consequently, air itself may be used, producer gas, flue gases, artificial gases, natural gases, cracked gases, water gas, and the like.

In utilizing the lighter fractions of natural gasoline for fuel purposes, economy in the manufacture, shipment and storage will generally require a product having a minimum amount of constituents either more volatile or less volatile than the propane or the butanes. If substantial quantities of constituents more volatile than propane are present, the volatility of the material causes difficulties in handling. If large quantities of constituents less volatile than the butanes are present, advantages in utilization are some-

what decreased, and besides the pentanes and heavier products could at present be sold at a greater profit and to much better advantage to the motor fuel industry. Substantially pure butane for gas enrichment purposes offers the advantage of greater ease in handling, storing and utilizing the product, but the increased yield obtainable by incorporating propane and iso-butane, tends toward economy in that the natural gasoline manufacturer can thereby supply the trade with a product at a lower market price.

With the foregoing objects outlined and with other objects in view which will appear as the description proceeds, the invention consists in the novel features hereinafter described in detail, illustrated in the accompanying drawing, and more particularly pointed out in the appended claims.

The figure shown in the drawing is a diagrammatic view of an apparatus by which my method may be carried out when using propane and butanes for gas enrichment purposes.

Hereinafter the term "gas enrichment gasoline" will refer to substantially equal proportions of propane, iso-butane and butane. This terminology, however, is only used for the purpose of explanation, since it is evident that any desired proportion of the volatile hydrocarbon compounds may be used for gas enrichment gasoline.

Referring to the drawing, 1 designates a tank car, preferably of the insulted type and capable of holding fluids under pressure. The gas enrichment gasoline is shipped in such car to the point of utilization, and the approximate pressure prevailing in the tank car will depend upon the nature of the volatile fluid therein, and upon the temperature of the liquid within the car. The temperature of the liquid will, of course, depend upon the atmospheric temperature conditions to which the car is subjected. When used for the transportation of gas enrichment gasoline, the pressure within the car will be approximately 60 pounds at 70° F.

At the point of utilization, the tank car containing gas enrichment gasoline is connected to a pipe 1*a* through which such gasoline may travel to the utilization plant. A valve 2 is arranged in the pipe to control the flow of the gasoline, which may pass by way of pipe 4 through a heat exchanger 5, when the valve 3 is closed. In this way the liquid mixture under pressure is unloaded and cooled. The function of the heat interchanger is to chill the liquid coming from the tank car, and by thus reducing the sensible heat of the liquid, the amount of material vaporized during transfer of liquid from the tank car will be minimized.

When the heat exchanger is employed, the temperature of the refrigerant should be below the boiling point of the gas enrichment gasoline at the pressure existing on said gasoline within the heat exchanger. If this pressure is 15 pounds gauge, the temperature should preferably be below 20° F.

If it is not desired to chill the liquid from the tank car during transfer from the car to a liquid storage tank 10, the liquid may be by-passed through pipe 5*a*. The outlet of the heat exchanger and pipe 5*a* are provided respectively with valves 6 and 7 for controlling the passage of the liquid through either the heat exchanger or the by-pass. Whether the liquid flows through the liquid heat exchanger or by-pass pipe, it enters a pipe 8 which conveys the same to a pipe 11 that extends into the storage tank 10 and discharges the liquid near the bottom of said tank.

During the transfer of the contents of the tank car into the storage tank 10, if the liquid is passed through the heat exchanger, the latter may be cooled by any suitable refrigerant, but I prefer to cool the liquid by introducing chilled similar liquid into the same in a manner hereinafter described.

The liquid is held in the tank 10 under super-atmospheric pressure, and when it is utilized for gas enrichment purposes or the like, vapors from the same are permitted to pass through the pipe 19, pressure regulators 14, 15 and valve 16 to the line 28. From the line 28, the vapors may pass through an evaporator or heater 30, or by-pass through the pipe 30*a* and enter the gas main 33 to enrich the gas passing therethrough. Suitable valves 29, 31 and 32 are provided for controlling the passage of the vapors to the gas main.

Any pressure above atmospheric, and below about 5 atmospheres may be employed in the tank 10, and the temperature of the liquid in that tank will be approximately 18° F. at 15 pounds gauge pressure, when the tank is used for the storage of gas enrichment gasoline. Of course, this pressure will enable the vapors to automatically flow through the pipes 19 and 28 and into the gas main as the pressure in the latter is generally held slightly above atmospheric.

In case the vapors are temporarily not utilized for gas enrichment purposes, due to shutdowns and the like, the vapors evolved in the tank 10 can be passed into the pressure tank 24 for gaseous storage. Ordinarily, the gaseous storage tank is held under a pressure considerably lower than that of the liquid storage tank 10, in order to take care of vapors evolved during evaporation when the material is not being utilized for gas enrichment.

It may be stated that it is immaterial what temperature and pressure exist within the tank 24, so long as the pressure in that tank is not higher than that in the tank 10. The temperature in the tank 24 will naturally be somewhat higher than in the tank 10, owing to radiation losses encountered on the vapors

in passing from tank 10 to tank 24. Of course, the pressure in the tank 24 must be sufficient to deliver the gas from that tank to the gas main 33. Any pressure above atmospheric and below the pressure in the tank 10 will, therefore, be satisfactory.

In the event that the storage tank 24 is insufficient to provide for the volume of gas passing from tank 10 during a temporary shut down, a recompressor 26 may be utilized for compressing the overflow. To permit this, pipes 19*a* and 19*b* are connected respectively to the pipes 19 and 23, and they communicate with the pipe 25 leading to the recompressor. When the valve 17 in the pipe 23, and the valve 16 in the pipe 19 are closed, vapors or gases may be drawn from the tanks 10 and 24 by way of pipe 25 into the recompressor, which forces the same through the cooling coils 27, and thus reliquefies such gases or vapors. Thus, the material in reduced volume, and liquefied form may be returned to the tank 10 by way of pipes 5*a*, 8 and 11, or if a tank car is being unloaded, the cooled liquid from the coil 27 may be fed through the heat exchanger and mixed directly with the incoming gas enrichment gasoline for cooling the latter.

By compressing and condensing the vapors from the tanks 10 and 24, and returning the condensate to the tank 10, the refrigerative effect will thereby lower the temperature and pressure of the material stored in the tanks 10 and 24.

If it is desired to use material from the tank 10 more rapidly than the natural evaporation will provide, this may be accomplished by removing liquid from the tank 10 by way of lines 11, 12 and the control valve 13. The valve 13 may be controlled automatically in any desired way. By this means, the excess material required for gas enrichment is accomplished without appreciably lowering the pressure on the tank 10. In addition, there is accomplished the refrigerative effect of the liquid for the purpose of cooling the gas or for other cooling purposes. If it happens that the material stored in the tank 10 has insufficient vapor pressure to permit its utilization by allowing the pressure to force the liquid from the tank 10 through lines 11 and 12, as above described, the vapor pressure of the liquid in the tank may be raised by causing a warm fluid to pass through the coil 9, which is arranged in the tank 10. The temperature used in the coil 9 is determined by the temperature which must exist on the gas enrichment gasoline in order that the pressure in the tank 10 may be sufficient to overcome the pressure head existing by the way of lines 11 and 12, whereby the gasoline may be delivered through those lines to the gas main. The temperature of the coil 9 must, therefore, be higher than that temperature which must exist on the fluid within the tank 10 for the purposes above stated.

The temperature maintained in the evaporator 30 must be higher than the temperature of the boiling point for complete evaporation of the liquid flowing through the evaporator. Warm water, warm gas or any other fluid may be used for effecting vaporization of the volatile fluid passing through valve 29. The cooling effect produced on the evaporator medium may be used, therefore, for economical reasons, for cooling gas or water, or to any other economical advantages. The boiling point of the liquid passing through the valve 29 will depend, of course, upon the pressure existing in the evaporator, which pressure is determined by the pressure in the gas main 33. It is necessary to have sufficient pressure to deliver the fluid into the gas main.

During the period in which the vapors are not used for gas enrichment, and in which the recompressor 26 is not in operation, an excess pressure in the tanks 10 and 24 can be prevented by allowing the vapors to discharge through valved pipe 12*a* to any point of disposal.

From the foregoing, it is believed that those skilled in the art may readily understand the purposes of the invention, the details of the apparatus employed, and the manner of working the process, and it is obvious that changes may be made in the details disclosed without departing from the spirit of the invention.

What I claim and desire to secure by Letters Patent is:

1. A method of transferring gas enrichment gasoline and the like from one receptacle to another receptacle, including passing such gasoline under self-induced super-atmospheric pressure from the first mentioned receptacle into a zone maintained at a temperature lower than the temperature of the gasoline in the receptacle from which the gasoline is being withdrawn, permitting some of the gasoline in the second mentioned receptacle to vaporize, withdrawing the vapors and mechanically compressing the same, cooling such compressed vapors and thus liquefying the same, and adding such cooled liquefied vapors to the gasoline in the zone of lower temperature.

2. An apparatus for transferring gas enrichment gasoline and the like, comprising first and second receptacles, a conduit placing said receptacles in communication, a pipe for leading gases from the second receptacle, a compressor connected to said pipe, a second pipe into which the compressor discharges, means for cooling material passing through the second pipe, and valved means connecting the second pipe to said conduit.

3. An apparatus for transferring gas enrichment gasoline and the like, comprising

first and second receptacles, a conduit leading from the first receptacle into the lower portion of the second receptacle, a pipe leading from the upper portion of the second receptacle, a compressor connected to the last mentioned pipe, a second pipe placing said compressor in communication with the conduit, and a cooling coil interposed in the second pipe.

In testimony whereof I affix my signature.

GEORGE G. OBERFELL.