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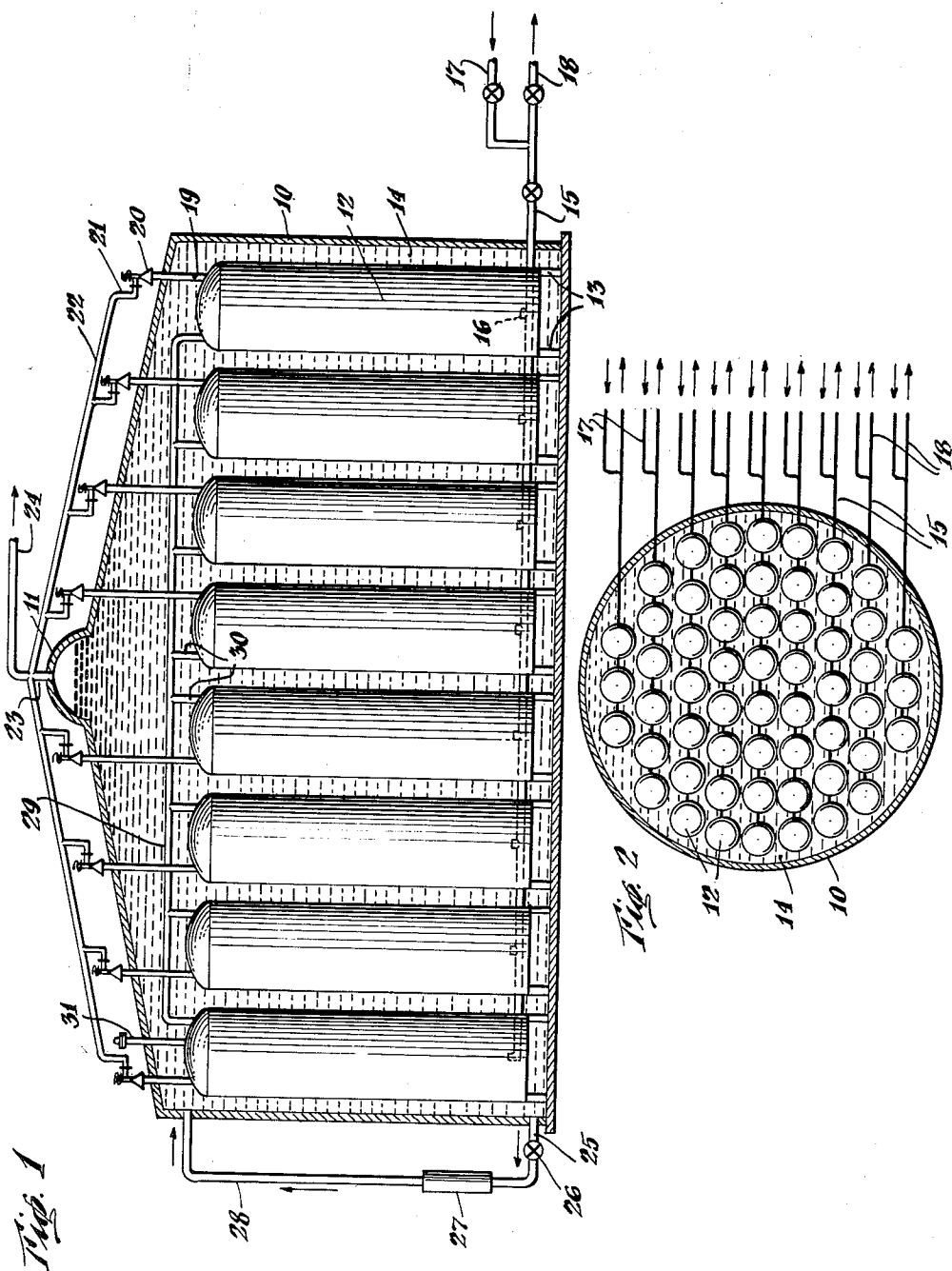
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SAFETY STORAGE SYSTEM FOR LIQUEFIED HYDROCARBONS

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2 Sheets-Sheet 1



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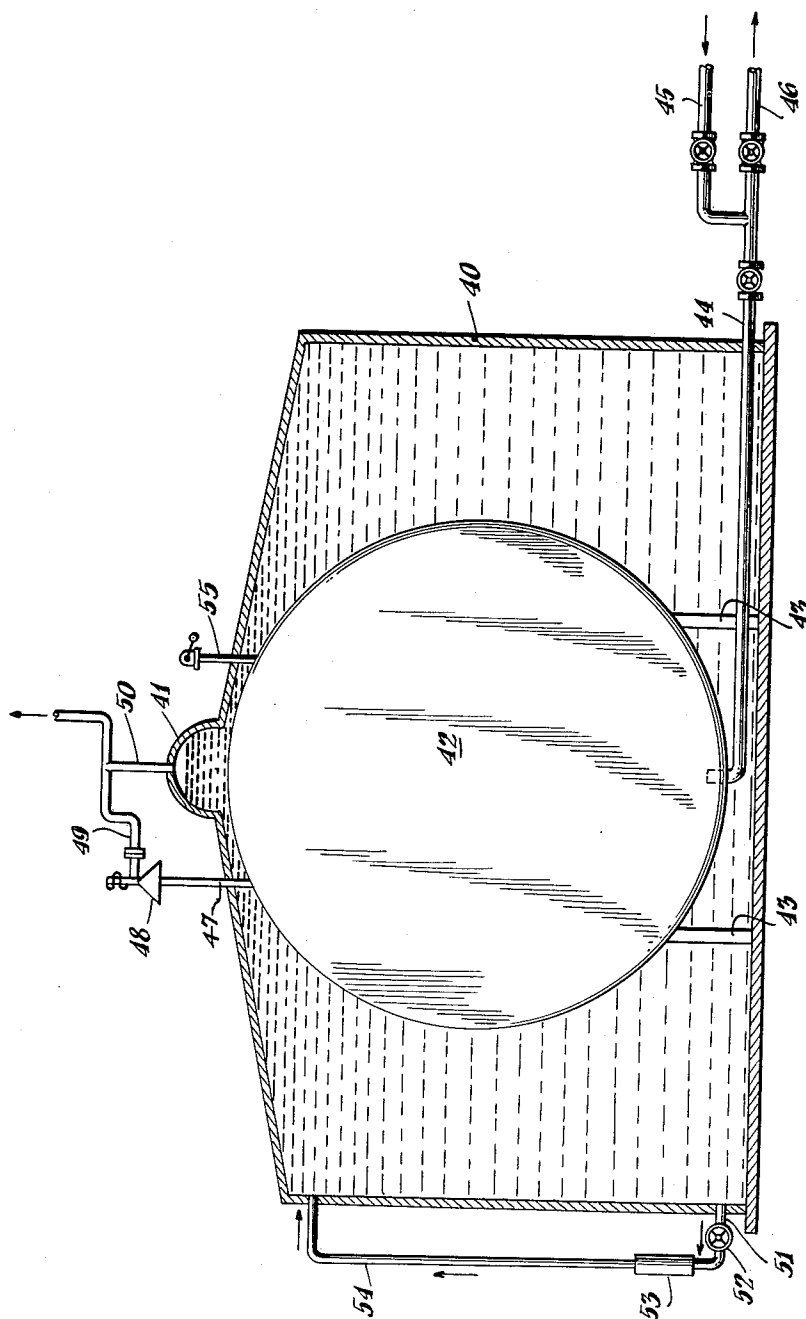
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Fig. 3



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SAFETY STORAGE SYSTEM FOR
LIQUEFIED HYDROCARBONS

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This invention relates to a simple, but highly effective, system for storing liquefied hydrocarbons. More particularly, the present invention is concerned with an apparatus and method for effecting safe storage of liquefied gas fuels such as butane, propane, and various combinations of the lower liquefied hydrocarbons.

Storage of such liquefied combustible gases has heretofore generally been effected in a series of inter-connected containers. These storage systems have been installed both above ground and directly within the ground, depending largely upon the nature of the liquefied gas stored therein. Thus, tanks of propane liquefied gas have ordinarily been located above the ground and atmospheric heat has been relied upon to vaporize or gasify the liquid within the tank. Containers of liquefied butane, on the other hand, have been buried within the ground in order to utilize the heat of the earth since liquid butane inherently requires more heat than propane for vaporization. Liquefied butane has also been stored above ground in relatively large spherical pressure vessels.

Storage systems of the above type have constituted serious fire and explosion hazards, particularly in petroleum refineries where surrounding operations being carried on are directly concerned with treatment of hydrocarbons, both in the liquid and vapor state. As will be realized, the escape of liquefied hydrocarbons from storage is quite dangerous since the escape of a comparatively small quantity of liquid is equivalent to a corresponding large quantity of gas. Such gas, in contact with the proper proportion of air, constitutes a highly combustible mixture which is readily ignited with explosive violence. The escape of liquefied butane is particularly hazardous since the gaseous butane released is heavier than the atmosphere and collects along the surface of the earth, concentrating in low spots such as in wells, cellars, basements, etc., where it may be ignited by a spark from an electric motor or other device and hence cause a serious fire or explosion. Furthermore, in the event of fire, vented liquefied gas will cause rapid spreading of the fire, which may lead to complete destruction of the entire storage installation.

One suggestion heretofore made for minimizing fire and explosion hazards created by the storage of liquefied gases has been to continuously spray water over the containers maintained in open type storage. In this system, a plurality of drums of predetermined capacity, for example, 45,000 gallons, are supported in a horizontal position in a suitable framework and water is sprayed

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over the drums from a series of sprays located immediately above the supported drums. Such proposed system, in addition to entailing the installation of water sprays, has the disadvantage of requiring the need of an excessive amount of cooling water. Thus, for a fifty-drum set-up of the above type, about 5000 gallons per minute of spray water would be required. In addition, a 500 H. P. pump plus a reservoir of about 140,000 barrels capacity for a 24-hour water capacity would be necessary.

It is an object of the present invention to prevent or greatly minimize the fire and explosion hazard created by storage of liquefied normally gaseous hydrocarbons without encountering the difficulties inherent in the prior art practices. A further object is the provision of a process and apparatus for storing liquefied hydrocarbons which are readily largely adaptable from existing petroleum refinery equipment. A still further object is to simplify the servicing or removal and replacement of charged containers. A very important object of the invention is to provide an inexpensive storage system affording safe storage facilities for liquefied hydrocarbons, particularly located within the confines of a petroleum refinery or urban area.

The above and other objects which will be apparent to those skilled in the art are achieved by the process and apparatus of the instant invention. Broadly, the present storage system involves a tank adapted to receive one or more containers or drums containing liquefied gas which, as above noted, is generally butane, propane or a mixture of the two, or a gas having the characteristics of the lower hydrocarbons. The tank is substantially filled with a non-gaseous insulating material, such as water, sand, gravel or the like, which surrounds the container or drums vertically positioned in said tank. A conduit opening into the container or drums is positioned in the lower part of the tank, permitting introduction and withdrawal of the gas from the container or drums. Thus, the storage container or drums may be filled and emptied without opening the same to the atmosphere, thereby preventing the introduction of dirt or other foreign matter into the stored gas and also preventing admixture of air with the stored gas.

The containers are provided with a small relief valve in the top thereof communicating with a discharge vent which is maintained on flare in order that any gas escaping from the storage drums is burned before it becomes mixed with air in appreciable amounts and hence constitutes the aforementioned fire and explosion hazard. Also,

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it is desirable to provide a vent for the tank itself which is maintained on flare in order that any leaking gas from the tank is subject to combustion before escape into the atmosphere.

In a preferred embodiment of the invention, a conventional oil storage tank, such as a 100-foot diameter tank generally found in a petroleum refinery, is employed as the above-mentioned tank and water is used as the insulating medium. With the use of water or other liquid insulator, the temperature thereof is suitably controlled by withdrawing a stream of the liquid, passing the same through a heater and recycling the warmed liquid to the tank. The temperature of the container or drums may thus be maintained at a predetermined figure, depending on the nature of the liquefied gas stored therein and on the existing atmospheric conditions. For example, with liquefied propane, butane, or mixtures thereof, withdrawal, heating, and recycling a stream of water or other insulating liquid will generally be effected in cold weather to maintain the temperature of the water or other insulating liquid at a temperature of at least about 50° F.

The invention may be further understood by reference to the attached drawing wherein:

Figure 1 is an elevational view, partly in section, showing a storage system of this invention.

Figure 2 is a plan view of the storage system shown in Figure 1.

Figure 3 is an elevational view, partly in section, showing an alternate storage system of this invention.

Referring now to the drawing, wherein like figures indicate like parts, and particularly to Figure 1, 10 designates a tank which may be a conventional oil storage tank, for example, a 100-foot diameter tank commonly used for storage in petroleum refineries. This tank is suitably modified with provision of dome 11 on the top thereof. Positioned within tank 10, in relatively compact, side-by-side relationship, is a plurality of vertical containers or drums 12 which are of substantially the same size and shape. The vertical containers 12 are suitably slightly elevated above the floor of tank 10 and rest on supports 13 in order that the temperature of the containers may be maintained with greater uniformity by having the insulating medium 14 contained within tank 10 substantially completely surrounding each of the vertical containers. A conduit 15 pierces the wall of tank 10 near the bottom thereof and passes as a manifold through each of the vertical containers 12. Conduit 15 is provided with a plurality of openings 16, one of which extends into each of said containers. Liquefied gas is thus introduced and withdrawn from containers 12 through conduit 15, the flow rate being suitably regulated by control valves. Liquefied gas is introduced to conduit 15 through pipe 17 and withdrawn therefrom through outlet pipe 18.

The containers 12 are each furnished with an outlet pipe 19 in the top thereof, provided with a relief valve 20, through which any excess liquefied gas is permitted to escape. A conduit 21 extends from relief valve 20 to a common manifold 22 into which gas escaping from each of the depicted containers is conducted. Likewise, a discharge vent 23 in dome 11 of tank 10 is provided for the release of gas which may escape from the upper portion of tank 10. The gas passing through manifold 22 is suitably connected to discharge vent 23 and the total discharged gas

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stream exits through pipe 24 and is maintained on flare so that gas escaping from the containers or tank is burned before it has an opportunity to mix with air in appreciable amount and to thus present a fire and/or explosion hazard.

As set forth hereinabove, the preferred insulating material contained in tank 10 is a liquid and, in particular, water. The provision of dome 11 permits the tank to be kept full of water or other insulating liquid clear into the dome portion of the tank. This is highly advantageous since a substantial void space in the top of the tank in which explosive vapors could accumulate is thereby eliminated. In order to adjust the temperature of the water or other liquid to a desired figure, a stream thereof is suitably withdrawn from tank 10 through conduit 25, the rate of flow being controlled by valve 26. The withdrawn stream is then forced through heater 27 which is maintained at the desired temperature with steam or by other heating means. The warmed stream of liquid is then recycled to the upper portion of tank 10 through conduit 28.

The amount of liquid and gas in each of the vertical containers 12 is suitably maintained at the same level. In this regard, conduit 15 which passes as a manifold through each of the containers serves as a liquid balancing line. A manifold line 29 connected to each of the vertical containers by conduits 30 which pass through the top of said containers constitutes a vapor balancing line. The amount of liquefied gas in the containers at any given time may be measured by a liquid level indicating device 31 which is inserted into one of the containers. Since the level of liquid will be identical in each series of interconnected containers due to the aforementioned liquid and vapor balancing lines, the measurement of liquid in a single container of each series will also indicate the amount of liquid present in the other interconnected containers of the series.

The storage system described above, as will be noted from Fig. 2, is composed of a plurality of vertical containers which are connected in a number of series extending horizontally across the tank. It is contemplated that any feasible number of containers or series of containers may be stored in accordance with the present system. In a typical set-up, utilizing a tank of about 100 feet in diameter, approximately fifty vertical containers, 12 feet in diameter, are capable of being stored.

In Figure 3, a system for safely storing liquefied, normally gaseous hydrocarbons in a large spherical pressure vessel is shown. Such spherical vessels exposed to the atmosphere have commonly heretofore been employed for the storage of liquefied butane. Since the same fire hazards exist with these spherical vessels, which may be as large as 60 feet in diameter, as are present with the smaller containers described above, the same fire protection means are required. Referring more particularly to this figure, 40 designates a tank which may be of any desired shape, but which conveniently is a conventional cylindrical oil storage tank provided with a dome 41. A large spherical vessel or container 42 is positioned within tank 40, resting on supports 43. A conduit 44 passes through tank 40 and enters the bottom of vessel 42. Liquefied gas may thus be introduced and withdrawn from vessel 42 through conduit 44, the flow rate being suitably regulated by control valves. Liquefied butane or other gas is introduced to conduit 44 through pipe 45 and withdrawn therefrom through outlet pipe 46.

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A vapor outlet pipe 47 is connected to the top of vessel 42. Pipe 47 is provided with a relief valve 48 through which excess liquefied gas may escape. A conduit 49 serves to conduct the escaping gas to flare. Likewise, a discharge vent 50 serves to remove gas from the upper part of dome 41 and to conduct such escaping gas to flare. Tank 40 is filled with a non-gaseous insulating medium, such as water, which is contained in the tank clear up into dome 41, thereby eliminating excessive void space in the tank where explosive vapors might accumulate. The temperature of the water or other insulating liquid in tank 40 is suitably adjusted by withdrawing a stream thereof through conduit 51, the rate of flow being controlled by valve 52. The withdrawn stream passes through heater 53, maintained at the desired temperature. The warmed liquid stream is then recycled to the upper portion of tank 40 via conduit 54. The amount of liquid present in vessel 42 is conveniently measured by liquid level indicating device 55.

The storage system of this invention represents a compact, inexpensive means for safely storing liquefied, normally gaseous hydrocarbons, eliminating, for all practical purposes, the fire and explosion hazard which has heretofore been prevalent in the storage of such liquefied gases. The present system is particularly convenient in that it may be readily adapted for protection of existing liquefied gas storage facilities by the construction of a tank surrounding said facilities, which tank may then be filled with a non-gaseous insulating medium as described hereinabove.

It is accordingly to be understood that the above description is merely illustrative of preferred embodiments of the invention, of which many variations may be made within the scope of the following claims by those skilled in the art without departing from the spirit thereof.

I claim:

1. An apparatus for the storage of liquefied, normally gaseous hydrocarbons, comprising a tank adapted for the reception of a non-gaseous insulating medium, a plurality of uniform, vertical containers arranged in relatively compact, side-by-side relationship within said tank, each of said containers being substantially surrounded by said insulating medium, conduits interconnecting the lower portions of said containers and adapted for the introduction and withdrawal of liquefied gas to and from the interior of said containers, outlet pipes positioned in the top of each of said containers and piercing the roof of said tank, relief valves, one being affixed to each of said outlet pipes exterior of said tank, permitting release of escaping liquefied gas, conduits for conducting said gas escaping through said relief valves to a manifold, whereby said containers are maintained in a fixed, rigid position within said tank while the escaping individual streams of gas from said containers are combined in a common stream, a vent positioned in the roof of said tank, permitting release of escaping liquefied gas therefrom, and means for conducting the gas escaping from said containers and said tank to flare.

2. An apparatus for the storage of liquefied, normally gaseous hydrocarbons, comprising a tank adapted for the reception of an insulating liquid, a plurality of uniform, vertical containers arranged in relatively compact, side-by-side relationship within said tank, each of said containers being substantially surrounded by said insulating liquid, conduits interconnecting the

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lower portions of said containers and adapted for the introduction and withdrawal of liquefied gas to and from the interior of said containers, outlet pipes positioned in the top of each of said containers and piercing the roof of said tank, relief valves, one being affixed to each of said outlet pipes exterior of said tank, permitting release of escaping liquefied gas, conduits for conducting said gas escaping through said relief valves to a manifold, whereby said containers are maintained in a fixed, rigid position within said tank while the escaping individual streams of gas from said containers are combined in a common stream, a vent positioned in the roof of said tank, permitting release of escaping liquefied gas therefrom, means for maintaining the gas escaping from said containers and said tank on flare, an outlet conduit piercing the bottom wall of said tank through which a stream of said insulating liquid is withdrawn, heating means through which said withdrawn liquid stream is passed and a conduit for recycling said heated liquid stream to the interior of said tank, whereby the temperature of said insulating liquid is maintained at a controlled level.

3. An apparatus for the storage of liquefied, normally gaseous hydrocarbons, comprising a tank adapted for the reception of a non-gaseous insulating medium, a vessel rigidly supported within said tank, said vessel being substantially surrounded by said insulating medium, a conduit adapted for the introduction and withdrawal of liquefied gas to and from the interior of said vessel, an outlet pipe positioned in the top of said vessel and piercing the roof of said tank, a relief valve affixed to said outlet pipe exterior of said tank, permitting release of escaping liquefied gas, a conduit for conducting said gas escaping through said relief valve to flare, a vent positioned in the roof of said tank, permitting release of escaping liquefied gas therefrom, and means for conducting said escaping gas to flare.

4. An apparatus for the storage of liquefied, normally gaseous hydrocarbons, comprising a tank adapted for the reception of an insulating liquid, a vessel rigidly supported within said tank, said vessel being substantially surrounded by said insulating liquid, a conduit in the lower portion of said vessel adapted for the introduction and withdrawal of liquefied gas to and from the interior of said vessel, an outlet pipe positioned in the top of said vessel and piercing the roof of said tank, a relief valve affixed to said outlet pipe exterior of said tank, permitting release of escaping liquefied gas, a conduit for conducting said gas escaping through said relief valve to flare, a vent positioned in the roof of said tank, permitting release of escaping liquefied gas therefrom, means for maintaining said escaping gas on flare, an outlet conduit piercing the bottom wall of said tank through which a stream of said insulating liquid is withdrawn, heating means through which said withdrawn liquid stream is passed and a conduit for recycling said heated liquid stream to the interior of said tank, whereby the temperature of said insulating liquid is maintained at a controlled level.

5. An apparatus for the storage of liquefied, normally gaseous hydrocarbons, comprising a dome-capped tank adapted for the reception of an insulating liquid, a vessel rigidly supported within said tank, said vessel being surrounded by said insulating liquid, which substantially fills said tank, extending up into the dome cap thereof, a conduit piercing the lower wall of said tank

and extending into the interior of said vessel, said conduit being adapted for the introduction and withdrawal of liquefied gas to and from the interior of said vessel, an outlet pipe in the top of said vessel extending vertically upward and piercing the roof of said tank, a relief valve affixed to said outlet pipe exterior of said tank, permitting release of liquefied gas escaping from the interior of said vessel, means for indicating the level of liquid contained within said vessel, a vent in the dome of said tank, permitting release of escaping liquefied gas therefrom, and means for conducting the gas escaping through said relief valve and from said tank to flare.

6. An apparatus for the storage of liquefied, normally gaseous hydrocarbons, comprising a tank adapted for the reception of a non-gaseous insulating medium, a plurality of uniform, vertical containers arranged in relatively compact, side-by-side relationship within said tank, each of said containers being substantially surrounded by said insulating medium, a liquid balancing line interconnecting the lower portions of said containers and adapted for the introduction and withdrawal of liquefied gas to and from the interior of said containers, a vapor balancing line interconnecting the upper portions of said containers, outlet pipes positioned in the top of each of said containers and extending vertically upward, piercing the roof of said tank, relief valves, one being affixed to each of said outlet pipes exterior of said tank, permitting release of escaping liquefied gas, means for conducting said gas escaping through said relief valves to flare, a vent positioned in the roof of said tank, permitting release of escaping liquefied gas therefrom, and means for conducting said escaping gas to flare.

7. An apparatus for the storage of liquefied, normally gaseous hydrocarbons, comprising a tank adapted for the reception of a non-gaseous insulating medium, a spherical pressure vessel rigidly supported within said tank, said vessel being substantially surrounded by said insulating medium, a conduit piercing the lower wall of said tank and extending into the interior of said supported spherical vessel, said conduit being adapted for the introduction and withdrawal of liquefied gas to and from the interior of said vessel, an outlet pipe positioned in the top of said vessel, said pipe extending vertically upward piercing the roof of said tank, a relief valve affixed to the exterior end of said outlet pipe, a conduit for conducting said gas escaping through said relief valve to flare, a vent positioned in the roof of said tank, permitting release of escaping liquefied gas therefrom, and means for conducting said escaping gas to flare.

8. A process for storing liquefied, normally gaseous hydrocarbons, comprising introducing said hydrocarbons into a vessel rigidly supported within a dome-capped tank, surrounding said vessel in said tank with a non-gaseous insulating medium, maintaining the upper level of said medium within the dome of said tank, withdrawing escaping liquefied gas from the top of said vessel and from the top of said tank and maintaining said escaping gas on flare.

9. A process for storing liquefied normally gaseous hydrocarbons, comprising introducing said hydrocarbons into a plurality of uniform, vertical containers rigidly affixed in a dome-capped tank, surrounding said containers in said tank with an insulating liquid, maintaining the upper level of said liquid within the dome of said tank, withdrawing escaping liquefied gas from the top of said containers and from the top of said tank and maintaining said escaping gas on flare.

10. A process for storing liquefied, normally gaseous hydrocarbons, comprising introducing said hydrocarbons into a vessel rigidly supported within a tank, surrounding said vessel with an insulating liquid, withdrawing escaping liquefied gas from the top of said vessel and from the top of said tank, burning the gas escaping from said vessel and said tank in the atmosphere, withdrawing a stream of said insulating liquid from said tank, passing said withdrawn stream through a heater and recycling the heated liquid stream to said tank, whereby the temperature of said insulating liquid is maintained at a predetermined level.

11. A process for storing and dispensing liquefied, normally gaseous hydrocarbons, which comprises simultaneously introducing liquefied hydrocarbon gas into a plurality of uniform, vertical containers positioned within a tank and surrounded by an insulating liquid, withdrawing streams of escaping liquefied gas from the top of each of said containers, combining said streams in a common stream, withdrawing escaping liquefied gas from the top of said tank, burning the gas escaping from said containers and said tank in the atmosphere, withdrawing a stream of said insulating liquid from said tank, passing said withdrawn stream through a heater and recycling the heated liquid stream to said tank, whereby the temperature of said insulating liquid is maintained at a predetermined level.

12. A process for storing and dispensing liquefied, normally gaseous hydrocarbons, which comprises simultaneously introducing liquefied hydrocarbon gas into a plurality of uniform, vertical containers positioned within a dome-capped tank, surrounding said containers in said tank with an insulating liquid, maintaining the upper level of said insulating liquid within the dome of said tank, adjusting the amount of liquefied hydrocarbon gas in each of said containers to substantially the same level, withdrawing streams of liquefied gas from the top of each of said containers, withdrawing escaping liquefied gas from the top of said tank and maintaining the gas escaping from said containers and said tank on flare.

References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
1,007,828	Webb	Nov. 7, 1911
1,047,075	Kessler	Dec. 10, 1912
1,140,250	Cabot	May 18, 1915
2,558,694	Speig	June 26, 1951