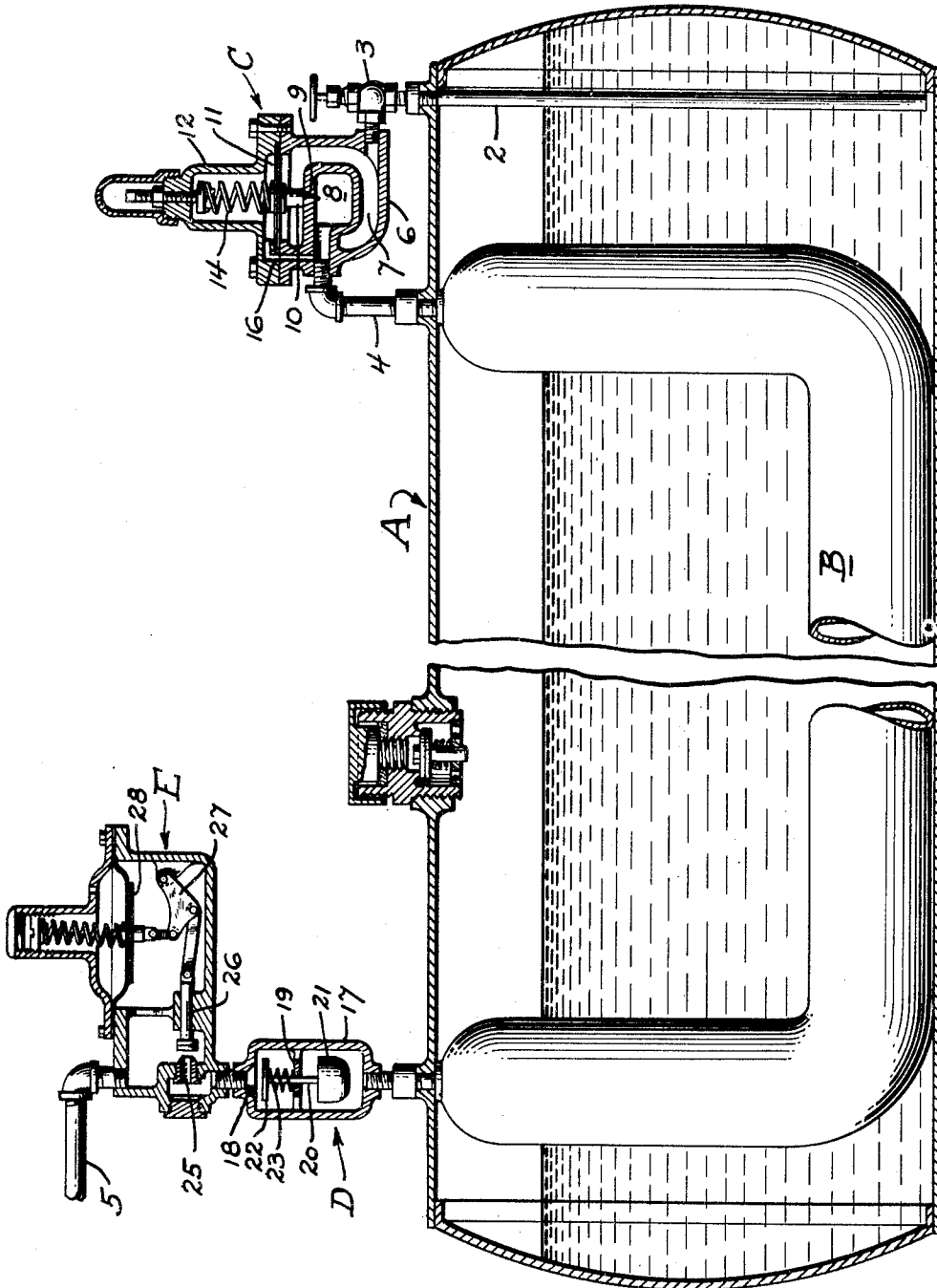


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METHOD AND APPARATUS FOR VAPORIZING AND
DISPENSING LIQUEFIED GASES
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METHOD AND APPARATUS FOR VAPORIZING
AND DISPENSING LIQUEFIED GASESTallent H. Ransome, Berkeley, Calif., assignor, by
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This invention relates to a method and apparatus for vaporizing and dispensing liquefied gases such as a mixture of butane, propane, and similar gases.

Butane in liquid form is at the present time extensively used after vaporization for heating, cooking, refrigeration, etc., both commercially and for household purposes. Commercial liquid butane is usually composed of a mixture of several gases such as ethane, propane, iso-butane, normal butane, etc. These gases have different boiling points, and if allowed to evaporate in a liquid container, fractionation takes place, as the lowest boiling point gas will boil off first, then the next gas, etc. This method, while in common use, is undesirable as it requires frequent adjustment of the burners and furthermore, leaves an accumulation of low-end fuels which will not evaporate under certain cold weather conditions.

The object of the present invention is generally to improve and simplify the construction and operation of apparatus of the character described; to provide a method of evaporation which maintains a constant homogeneous mixture of the fuels both in the liquid and vapor or gaseous phase; to provide a method and apparatus for the vaporization of liquid fuels which requires neither external or internal heaters, burners, etc., to supply the latent heat required for vaporization; to provide a non-freezing expansion valve; to provide a method and apparatus for vaporizing liquid gases in which the expansion valve is jacketed and heated by the liquid gas to be vaporized, and in which the latent heat of vaporization is supplied by the body of liquid gas maintained in the tank or container; to provide a two-stage vaporizing method in which primary vaporization takes place in the expansion valve and secondary or final vaporization takes place in a tank placed within the fuel or feed tank, and the major portion of which is normally in a substantially submerged condition in the liquid fuel so as to be in intimate contact therewith, and to permit free heat exchange between them; and further, to provide safety regulators, pressure reduction valves, and other apparatus whereby a dry gas under any desired reduced pressure is insured at all times at the discharge or dispensing end of the apparatus.

The apparatus employed is shown by way of illustration in the accompanying drawing, which is a diagrammatic sectional view of the apparatus.

Referring to the drawing in detail, A indicates a tank of suitable capacity to contain a liquid

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gas to be vaporized and dispensed. Mounted within the tank is a second tank or container B, the major portion of which will be submerged in the liquid gas and thereby provide a direct heat exchange relationship therewith. Extending into the tank A and to a point adjacent the bottom thereof is a discharge pipe 2 which is connected through a shutoff valve 3 with an expansion valve generally indicated at C. This valve also serves as a pressure reducing valve and it is connected through pipe 4 with one end of the second named tank B. The opposite end of this tank is connected with a float-actuated safety shut-off valve D and this is in turn connected with a final pressure-reducing valve E which connects with a service or dispensing line indicated at 5.

The valve E is of standard construction and requires little if any description, but the valves C and D are of special design and as such will be specially described. Valve C comprises a body member 6 having a jacket space 7 and a central expansion chamber 8. An orifice member 9 connects the jacket space and the central chamber, but the orifice is controlled by a valve 10 movable to and away therefrom. This valve is carried by a diaphragm 11 secured to the body member by a flange head 12. This in turn carries an adjustable spring 14 which normally maintains the valve in closed position when the shutoff valve 3 is closed. If the atmospheric temperature exterior of the tank A is around 70° F., the vapor pressure within the tank will run from 30 to 50 pounds gauge, depending upon the proportion of propane and butane and other gases contained. If the shutoff valve 3 is open, the vapor pressure in tank A will force the liquid up through pipe 2 into the jacket 7 of the valve and the pressure in the jacket space will obviously be the same as that in the tank, for instance 40 pounds. This pressure is exerted against the diaphragm 11 and spring 14 and if the spring is properly adjusted, valve 10 will open and liquid gas will be sprayed through the orifice into the central chamber 8. It will here be partially vaporized and will then flow through pipe 4 into tank B, where vaporization will be completed, as the latent heat required for complete vaporization is supplied from the body of liquid gas in which tank B is substantially submerged, due to the direct heat exchange relationship maintained between the tank and the liquid. Also, the cross-sectional area and the length of the tank B are such that free expansion of the gases will take place. This aids vaporization, insures a dry gas, and materially increases

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the capacity or volume of gas produced by a plant or vaporizer of a given size.

Part of the latent heat required for vaporization is also supplied to the central chamber 8 of the expansion valve, as the chamber is surrounded by the jacket space 7 through which the liquid fuel flows before discharging through the orifice 9 into the central chamber. Thus partial vaporization takes place in the chamber 8 and final vaporization is insured in the tank or inner container B.

The valve C functions not only as an expansion valve but also as a pressure reducing valve, as chamber 8 is connected with the upper side of the diaphragm through means of a by-pass passage 16. Gas entering through this passage functions as a counter-pressure to the higher pressure liquid fuel to which the other side of the diaphragm is exposed, and substantially any desired pressure reduction may thus be obtained by proper adjustment of the spring 14. In actual practice, the pressure is reduced to 2 to 3 pounds gauge, and this pressure or any other desired pressure is maintained up to the final reduction valve E which may step it down to 10 inches of water pressure, more or less, before entering the service line 5.

The main features of the present invention may be listed as follows: first, the provision of a method of vaporizing liquid fuel of the character described which will insure a continuous homogeneous mixture of the liquid fuel in the tank and in the gas delivered to the service line; second, to provide a method of the character described which eliminates the necessity of employing water heaters, burners, or in fact any type of heater to supply the latent heat of vaporization; and third, to provide an apparatus which is simple and foolproof in operation and in which freezing or sticking of the expansion valve is substantially eliminated.

On the Pacific coast and in many parts of the West, also in the tropics and other places, the atmospheric temperature seldom drops much below 32° F., or which is commonly known as the freezing point. Under such climatic conditions tank A may be mounted in the open and exposed to atmospheric temperatures the year round. The tank and the liquid within it will naturally assume the same temperatures as the surrounding atmosphere when the apparatus is not in operation. However, when the shutoff valve 3 is open and gas begins to flow, the temperatures of the liquid within the tank will slowly drop as the B. t. u.'s required to supply the latent heat of vaporization are absorbed from the liquid within the tank. For instance, part of the latent heat is absorbed from the liquid circulating through the jacket space 7 of the expansion valve, and the remaining heat required for complete vaporization is supplied from the main body of liquid within the tank A, and it is for this reason that the liquid fuel will tend to become cooler and cooler. If the tank A and the body of liquid maintained therein are large enough, continuous operation day in and day out is possible, as the large surface of the tank will absorb heat both by radiation and by contact with the surrounding atmosphere and will convey it to the body of liquid contained therein in sufficient quantity to replace the latent heat absorbed from the liquid fuel. In most instances, however, an apparatus of this character is in intermittent service only; for instance, for household use the apparatus will be in operation during the preparation of break-

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fast, luncheon and supper, and at other times it is, practically speaking, out of operation. Hence, while the tank A and the body of liquid contained therein would not be large enough for continuous use, it may be more than sufficient for intermittent operation, as ample time between periods of operation is provided for re-absorption of heat.

It should be noted that the discharge pipe 2 extends substantially to the bottom of the tank A. This is important as one of the features of the invention is to maintain a homogeneous mixture of liquid gas in the tank and, similarly, a homogeneous mixture of fuel in the service line 5. This is insured by extending the pipe 2 to the bottom of the tank, as this prevents boiling off from the surface or fractionation which would occur if the supply of gas were drawn from the surface of the liquid. Circulation and continuous mixing of the liquid gas within the tank A are maintained also due to the U shape of tank B. For instance, when the vaporizer is in operation, the gases leaving chamber 8 and flowing through pipe 4 are only partially vaporized and expanded, but the moment they enter the upper end of tank B they will immediately be fully expanded and further vaporized, thus setting up a refrigerating action which has its greatest intensity in the upper or entrance end of the tank. This portion of the tank will accordingly become very cold, and will thus chill or cool the liquid surrounding it. This cold liquid settles toward the bottom and warmer liquid rises to take its place, thereby causing a continuous thermosiphon circulation which further aids in maintaining a homogeneous liquid mixture within the tank.

Another important feature is the provision of an expansion valve which shall be non-freezing. That is desirable because a refrigerating effect takes place around the expansion valve or the orifice 9 due to the expansion of the liquid gas into a vapor or gaseous state in chamber 8 and the pressure reduction which simultaneously takes place. While ice and frost may gather on the exterior of the body 6 and the head 12, such frosting will not interfere with the operation of the diaphragm and the valve 9, as these are always flooded, or in contact with the liquid fuel in the jacket space 7. Furthermore, as the liquid fuel itself requires extremely low temperatures before freezing, the chance of valve 10 freezing or sticking is substantially eliminated. However, be that as it may, valves do stick at certain times; for instance, a small piece of scale or other foreign matter might lodge between the valve and the spring orifice; and if valve 10 should stick open, tank B would soon be flooded with liquid fuel and this would flow through the reduction valve E and into the service line with results that might be disastrous. To avoid this, the float-actuated safety valve D is employed. This is interposed between the outlet of the tank B and the intake of the reduction valve E. It consists of a housing 17 having a valve seat 18 formed in its upper end. A bearing 19 is formed midway of the housing and in the bearing is slidably mounted a valve stem 20 on the lower end of which is mounted a float 21 and on the upper end a valve 22. Normally there will be a flow of dry gas through the housing 17 past the float 21 and the valve 22. Hence, there is the weight of the float 21, the valve 22 and the stem 20 to maintain the valve in open position. On the other hand, if tank B should fill with liquid fuel and that gas in liquid state should enter the housing 17, the float would

rise and the valve would close. It however happens that the specific gravity of a liquid gas of this character is very low, the average specific gravity of a mixture of gases such as here described being 0.58. The buoyancy of the float 21 in a liquid of such low specific gravity would not be great, as the float should be made of metal due to the high pressures that may be encountered if liquid fuel enters. To overcome the excess weight of the metal float, a spring 23 is interposed between the valve and the bearing 19. This counteracts the greater proportion of float weight, thereby rendering the float active or at least sufficiently active to positively rise and close the valve if liquid gas enters. If a dry gas is flowing through the housing 17, it enters the main chamber of valve E through an orifice 25. A valve 26 actuated through linkage 27 and a diaphragm 28 regulates the pressure, and any pressure drop may be obtained and maintained in the line 5.

While the apparatus has been particularly described for use in climates where the temperature seldom drops below the freezing point, it should be remembered that the minimum boiling point of a gaseous mixture such as here described is around -10° F. Hence there is a wide operating range between the freezing point, 32° F. and -10° F. Even at that, an apparatus such as here shown may be used in cold climates where temperatures as low as 40° or 50° F. below zero are encountered, as it is obviously possible to bury the tank A in the ground below the frost line so that the tank may absorb heat from the surrounding ground. Again, if it is not practical, or for any reason undesirable, to bury the tank, an auxiliary heater may be installed.

While certain features of the invention have been more or less specifically described and illustrated, I wish it understood that various changes may be resorted to within the scope of the appended claims.

Having thus described my invention, what I claim and desire to secure by Letters Patent is:

1. In an apparatus of the character described an expansion valve comprising a jacketed casing having an inlet in communication with the jacket and connected with a source of liquid gas under pressure, said casing having an expansion chamber formed therein surrounded by the jacket so as to be in heat exchange contact with the liquid in the jacket, and an adjustable valve controlling spray of liquid gas from the jacket into the expansion chamber to promote vaporization of the liquid in said chamber.

2. In an apparatus of the character described an expansion valve comprising a jacketed casing having an inlet in communication with the jacket and connected with a source of liquid gas under pressure, said casing having an expansion chamber formed therein surrounded by the jacket so as to be in heat exchange contact with the liquid in the jacket, an orificed spray member forming communication between the jacket space and the expansion chamber, and an adjustable valve to control the flow of liquid gas through the spray orifice into the expansion chamber.

3. In an apparatus of the character described an expansion valve comprising a jacketed casing having an inlet in communication with the jacket and connected with a source of liquid gas under pressure, said casing having an expansion chamber formed therein surrounded by the jacket so as to be in heat exchange contact with the liquid in the jacket, an orificed spray member forming communication between the jacket space and

the expansion chamber, and an adjustable valve to control the flow of liquid gas through the spray orifice into the expansion chamber, said valve extending through the jacket space and being at all times surrounded by the liquid gas to be vaporized.

4. In an apparatus of the character described an expansion valve comprising a jacketed casing having an inlet in communication with the jacket and connected with a source of liquified fuel under pressure, said casing having an expansion chamber formed therein surrounded by the jacket so as to be in heat exchange contact with the liquid in the jacket, an orificed spray member forming communication between the jacket space and the expansion chamber, and a diaphragm actuated adjustable valve controlling flow of liquefied fuel through the spray orifice into the expansion chamber, said orificed spray member being at all times substantially submerged in the liquefied fuel to be vaporized.

5. An apparatus of the character described comprising a liquefied fuel container, a second container mounted interior thereof and substantially submerged in the liquefied fuel, an expansion valve, a discharge connection connected at one end to one side of the expansion valve and extending to the other end at a point adjacent the bottom of the first named container to deliver liquefied fuel from the bottom of the first container to the expansion valve, a connection between the other side of the expansion valve and the second named container to deliver gas at a reduced pressure thereto, a discharge connection on the second named container to deliver gas therefrom, a pressure reducing valve on said discharge connection to further reduce the pressure of the gas, and a float actuated valve in the discharge connection to close the same if liquefied fuel enters the discharge connection.

6. An apparatus of the character described comprising a liquid gas container, a second container mounted interior thereof and substantially submerged in the liquid gas, an expansion valve, a jacket surrounding said valve, means for delivering liquid gas from the bottom of the first named container to circulate it through the jacket and then through the expansion valve, means for conveying gas under reduced pressure from the expansion valve to the second named container, a discharge connection on the second named container, and a pressure reducing valve on said connection to further reduce the pressure of the gas.

7. In a liquefied petroleum storage and dispensing system, a main storage tank, said tank being buried, a take-off connection joined to said tank and in communication with its interior, members defining a fluid conduit from said take-off connection to a point of use, a pressure regulator positioned adjacent the tank in communication with said conduit, a portion of said conduit lying within said tank and comprising a vaporizing unit.

8. A fuel supply apparatus comprising a tank adapted to contain a liquid under pressure, means to withdraw liquid from a point adjacent the bottom of said tank, means to reduce the pressure of said withdrawn liquid to cause vaporization thereof, a pipe line including inlet and outlet end portions and an intermediate portion immersed in the liquid in said tank, means to pass the vaporized liquid to said pipe line, and means to direct the vapors from said pipe line.

9. Apparatus for supplying fuel at a low pressure from a mixture of liquefied hydrocarbons,

said apparatus comprising a pressure storage tank buried in the ground below the frost line to absorb vaporizing heat from the surrounding earth to maintain the tank under a substantially constant vapor pressure, means extending from the tank to a place where the fuel is consumed, and means controlling the flow of fuel through said extending means, said extending means including a liquid eduction tube, a vaporizer unit including a conduit connected at one end with the liquid eduction tube and having the lowest point thereof in direct contact with a convectively circulated fluid which transfers the heat of the earth to the walls of the unit, and a service line connected at the opposite end of the conduit and terminating near the place of fuel consumption, said control means including a pressure reducing device between the tube and unit, and a pressure reducing device between the unit and the service line.

10. Apparatus for supplying fuel at a low pressure from a mixture of liquefied hydrocarbons, said apparatus comprising a pressure storage tank buried in the ground below the frost line to absorb vaporizing heat from the surrounding earth to maintain the tank under a substantially constant vapor pressure, means extending from the tank to a place where the fuel is consumed, and means controlling the flow of fuel through said extending means, said extending means including a liquid eduction tube, a vaporizer unit including a conduit connected at one end with the liquid eduction tube and surrounded by and in contact with a convectively circulated fluid which transfers the heat of the earth to the walls of the unit, and a service line connected at the opposite end of the conduit and terminating near the place of fuel consumption, said control means including a pressure reducing device between the tube and unit and a pressure reducing device between the unit and the service line.

11. A method of dispensing liquefied petroleum gas as a dry gas comprising storing a quantity of liquefied gas under pressure in a storage member, withdrawing said liquefied gas from said storage member, vaporizing said withdrawn gas by reducing the pressure thereof and by confining same to flow along a path at the lowest point of which said gas is in heat exchange contact with a liquid warmed directly and solely by earth heat without mixture with said liquid, and reducing the pressure of said vaporized gas to a service pressure.

12. A method of dispensing liquefied petroleum gas as a dry gas comprising storing a quantity of liquefied gas under pressure in a storage member buried underground, withdrawing liquefied gas from said storage member, vaporizing the said withdrawn gas by reducing the pressure thereof and by directing same to flow along a path through said storage member in heat exchange relationship at its lowest point with the liquefied gas in said storage member and without mixture therewith, and reducing the pressure of said vaporized gas to a service pressure.

13. Apparatus for supplying fuel at a low pressure from a mixture of liquefied hydrocarbons, said apparatus comprising a pressure storage

tank, means extending from the tank adapted to conduct the fuel therefrom, and means controlling the flow of fuel through said extending means, said extending means including a liquid eduction tube, a vaporizer unit including a conduit connected at one end with the liquid eduction tube and having the lowest point thereof in direct contact with a convectively circulated fluid, and a service line connected at the opposite end of the conduit, said control means including a pressure reducing device between the tube and unit.

14. Apparatus for supplying fuel at a low pressure from a mixture of liquefied hydrocarbons, said apparatus comprising a pressure storage tank, means extending from the tank adapted to conduct the fuel therefrom, and means controlling the flow of fuel through said extending means, said extending means including a liquid eduction tube, a vaporizer unit including a conduit connected at one end with the liquid eduction tube and surrounded by and in contact with a convectively circulated fluid, and a service line connected at the opposite end of the conduit, said control means including a pressure reducing device between the tube and unit.

15. In combination in a liquefied gas storage and dispensing system, a tank, and a take-off connection comprising conduit forming means in communication with the interior of said tank, a pressure reducing regulator mounted in communication with said conduit, a vaporizing tubular chamber mounted within the tank in a position to be immersed in liquid therein, a connection from said regulator to one end of said tubular container and a second connection from the opposite end of said tubular container adapted to be connected with a point of use.

16. In combination in a liquefied gas storage and dispensing system, a tank, and a take-off connection comprising conduit forming means in communication with the interior of said tank, a dip tube extending relatively close to the bottom of the tank and being in communication with said conduit forming means, a pressure reducing regulator connected in communication with said conduit forming means, a tubular vaporizing container mounted within the tank in a position to be immersed in liquid therein, a connection from said regulator to one end portion of said tubular container, and a connection from the opposite end portion of said tubular container adapted to be connected with a point of use.

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