This invention relates to evaporators. In one of its more specific aspects it relates to an evaporator for use in transforming liquefied petroleum gases to their normally gaseous states in which condition the gases are in condition for use as fuel.

Liquefiable petroleum gases are transported and stored under pressure as liquids because of the relatively small volume occupied by a liquid in comparison to its gaseous volume. Such fuels must be in the form of gas in order to be mixed with air for combustion. The apparatus of my invention is particularly useful in serving as an evaporator for transforming liquefied petroleum gases to their gaseous forms.

An object of my invention is to provide an evaporator apparatus suitable for use in evaporating liquefied normally gaseous materials.

Another object of my invention is to provide an evaporator suitable for use in evaporating liquefied petroleum gases.

Still other objects and advantages of my invention will be apparent to those skilled in the art from a careful study of the following description which, taken in conjunction with the attached drawing, respectively describes and illustrates a preferred embodiment of my invention.

The drawing shows, in section, one form of my evaporator.

Referring to the drawing, the evaporator is composed of several main parts, viz., an outer shell 1 of a generally cylindrical form and an inner shell 2, also of cylindrical form, which inner shell is obviously smaller in both length and diameter than the outer shell 1. The outer shell has a closed head end 3, a closed lower end 4 and a base supporting member 5. The inner shell 2 is also closed at its upper end by closure 6 and likewise the bottom by closure 7. Bottom closure 7 is spaced a short distance from the lower end of and within the lower portion of inner shell 2. The inner shell extends upwardly from the bottom of the outer chamber, substantially coaxially therewith, so as to form an annular space between the walls of the inner and outer shells and a cylindrical space within the outer shell and above the inner shell.

The generally cylindrical inner shell 2, with its two ends closed, forms a steam chamber 8 into which steam is admitted into the upper portion of the steam chamber through fluid inlet means, such as steam inlet pipe 9. The bottom end 7 of this inner chamber 8 serves as support for the steam pipe 9, the latter being welded or otherwise rigidly attached in a gas-tight manner with the end member 7. A web or plate member 10 is welded or otherwise attached to the upper end of the steam pipe 9 and to the inner wall of the steam chamber 8 as shown, for support of the steam pipe 9. The bottom closure member 7 of the steam chamber 8 is an inwardly curved member so as to provide a sump for drainage of condensate through a drain pipe 11.

The head end closure member 3 of the outer shell 1 has vapor outlet means, such as flanged opening 15, adapted to take a flanged pipe for conveyance of vaporized material from the evaporator. A liquid inlet means, such as tube 16, extends through the side wall of the outer shell near the head end and terminates in a short section of pipe 17 at right angles to the inlet tube 16 in such a manner as to discharge in a downward direction any material entering the pipe 17. The upper end of this pipe is of course closed. The inlet tube 16 may be welded in place or may be threadedly attached to a collar member 18 which may be welded or otherwise rigidly attached to the shell 3.

To the head end of the inner steam chamber 2 is attached a small circular plate 19 as shown and arranged in such a manner as to be in the path of flow of liquid exiting from the inlet pipe section 11. Around this plate 19 and somewhat greater in diameter is a retainer means, such as collar 20, which is welded to the head end member 8 of the steam chamber. This collar member is intended to retain liquid to be evaporated which enters through the inlet tubes 16 and 17 in the form of a lake. As long as only a very small volume of volatile liquid is added it is for the most part completely retained within the limits of this ring member 20. Under these conditions evaporation of small amounts of liquefied gases can be accomplished without raising the temperature of the vapors formed to a great extent. However, when a larger volume of liquid is to be evaporated, the liquid overflows from the ring 20 and runs down the sides of the steam chamber 2.

Since most such liquids do contain at least traces of higher boiling materials, a sump 21 having fluid outlet means, such as drain 22, is provided for their removal.

The water condensate outlet 11, similar to the steam inlet pipe 9, is not welded nor otherwise attached to the base end member 4 because of thermal expansion considerations.

An auxiliary inlet means, such as liquid inlet 23, is provided near the base of the evaporator for use under heavy load conditions.

An opening 24 is provided in the outer shell
for inserting a relief valve, not shown, for safety purposes. An exterior steam jacket 25 is provided for use under heavy load conditions especially in cold weather. This exterior jacket is formed by an outer cylindrical shell 26, end closure means, such as members 30, and the outer shell 1 of the evaporator proper. Two or more steam inlet openings 28 are provided at the upper end of the jacket as shown, while a condensed steam or water outlet opening 29 is provided at the lower end thereof.

For installing such an evaporator for use in vaporizing such materials as liquefied petroleum gases, the base 5 of the evaporator may be fixed to any desired foundation or other support as desired, and it should preferably be rigidly attached to such a support.

A pipe or tube from a source of liquefied petroleum gas, as an underground tank, etc., not shown, branches, and the main branch is attached to inlet member 18, while the secondary branch is connected with the inlet opening 23. These branch lines are not shown, for reasons of simplicity. A popoff or other type of relief or safety valve is fitted to opening 24.

Steam connections are made to openings 28 and to steam pipe 8. Sump drain 22 is attached to such disposal as desired for removal of heavy hydrocarbon ends. Pipe 11 and opening 29 are connected to pipes for water or condensed steam disposal.

Outlet 15 from the evaporator space is attached to a gas main for transfer of vaporized gas to points of disposal.

Liquefied petroleum gases are usually transported and stored under considerable pressure. Accordingly, a pressure reducing valve should be installed in the liquid feed line just outside the inlet connection 18. In like manner a pressure reducer should be installed so as to control pressure of liquid entering the vaporizing chamber through opening 23. If desired, a pressure reducing valve may be installed in the main feed line prior to its branching to points 18 and 23.

Liquefied petroleum gas at either storage tank or reduced pressure is introduced through inlet tube 16 into my evaporator, and during periods of small supply all the liquid may be vaporized on top of the internal steam chamber. At slightly higher rates of flow, some liquid may overflow the wall 20 and run down the side of the steam chamber. Such liquid is then vaporized by heat from the sides of the steam chamber or by contact with superheated vapor which is rising from the bottom of the vaporizing chamber. This intimate contact of liquid and vapor in the vaporization chamber results in the overall vaporization of the liquid petroleum gas at substantially the boiling point of the material at the pressure at which it is being vaporized. The annular space comprising the vaporization chamber is intended to be sufficiently large as to permit gas to rise to the exit point of the chamber without entraining liquid.

The outer steam jacket 25 may be supplied steam independently from the inner chamber 8 so that it may be used or not used as desired. During the summer season or periods of moderate gas consumption it may not be necessary to use this outer jacket and therefore heat loss by radiation to the atmosphere can be reduced and also this will permit additional control of the superheat of the vaporized gas.

The pipe section 17 at the discharge end of the liquid inlet pipe 15 is intended to reduce the velocity of the liquid to be vaporized. In the event the liquid has experienced a pressure reduction and volume increase due to vaporization at the point of pressure reduction. The pipe 17 points downward so as to direct the flow of inlet material toward the vaporization chamber 8. The other liquid inlet 23 is provided near the bottom of the vaporizing chamber for use in the event there is any tendency for the vaporized gas to prevent downflowing liquid from within ring 20 from reaching the bottom of the heat exchanger. A perforate annular ring 31, at a level not higher than closure 1, provides an annular space in the bottom of the vaporizing chamber which space is not heated by steam from either the steam chamber 8 or the steam jacket 25. This annular space forms a sump to serve as a collecting space for unevaporated heavy hydrocarbon ends which may then be withdrawn through pipe 22 for disposal.

It is especially important that these heavy ends not be heated, especially during periods of very low gas consumption, for it allows them to be separated and withdrawn from the system. If heated, they vaporize and are withdrawn with the other gases and may ultimately condense and accumulate at undesirable points along the gas distribution system.

The materials of construction of my evaporator as herein disclosed may be selected from among those commercially available, but I have found that ordinary steel plate stock serves well. Fittings such as the threaded openings should preferably be welded into the evaporator body as illustrated.

The particular dimensions and relative size of the constituent parts of the evaporator may be varied by those skilled in such art to solve the particular evaporation problem at hand. I have described my invention as being particularly adapted for the evaporation of liquefied petroleum gases, its use is not necessarily limited to this application since it operates equally as well for the quantity evaporation of any liquefied gases.

It will be obvious to those skilled in the art that many modifications and alterations of my evaporator may be made and yet remain within the intended spirit and scope of my invention.

Having disclosed my invention, I claim:

1. An evaporator comprising in combination a closed outer shell; a closed inner shell, being shorter and smaller than said outer shell, extending from the bottom of and substantially coaxially with said outer shell; heat exchange medium inlet means extending into said inner shell to a point in the upper portion thereof; heat exchange medium outlet means communicating between said inner shell and the exterior of said outer shell; liquid inlet means in the upper portion of said outer shell and extending downwardly to a point spaced above the top central portion of said inner shell; and means for attaching the ends of said further cylindrical shell to said outer shell in substantially a fluid tight manner; and inlet and outlet openings in said further cylindrical shell for inlet and outlet of a heating medium.

2. The apparatus of claim 1 wherein said outer cylindrical shell is surrounded by a further cylindrical shell forming an annular space therebetween, said further cylindrical shell being shorter in length than said outer shell and said means attaching the ends of said further cylindrical shell to said outer shell in substantially a fluid tight manner; and inlet and outlet openings in said further cylindrical shell for inlet and outlet of a heating medium.
3. An evaporator comprising in combination a substantially vertically disposed closed outer shell; a closed inner shell, being shorter and smaller in diameter than said outer shell, extending from the bottom of and substantially coaxially with said outer shell so as to form a substantially annular space between the walls of said inner and outer shells; liquid inlet means adapted so as to convey liquid downwardly against the upper end of said inner shell and into said liquid retainer means; and vapor outlet means in the upper portion of said outer shell.

4. An evaporator comprising in combination an upright closed cylindrical outer shell; a closed cylindrical inner shell, being shorter and smaller in diameter than said outer shell, extending from the bottom of and substantially coaxially with said outer shell so as to form a substantially annular space within said outer shell and above said inner shell, the bottom closure in said inner shell being spaced a short distance from the lower end of said shell; liquid retainer means comprising a collar member affixed to the outside of the top of said inner shell; fluid inlet means adapted so as to convey hot fluid heat exchange medium upwardly through said inner shell into and against its upper portion; fluid outlet means adapted so as to convey said heat exchange medium from the lower portion of said inner shell to the exterior of said outer shell; a first liquid inlet means in the upper portion of said outer shell, adapted so as to convey liquid against the upper portion of said inner shell and into said liquid retainer means; a second liquid inlet means in the lower portion of said outer shell; perforate closure means in the annular space between said first and second shells, positioned on a level at least as low as said bottom closure in said inner shell and below the level of said second liquid inlet means; liquid outlet means in the lower end portion of said outer shell below said perforate closure means; and vapor outlet means in the upper portion of said outer shell.

6. The evaporator of claim 1 wherein the outlet end of said heat exchange medium inlet means in the upper portion of said inner shell opens toward the upper end of said inner shell.

Owen L. Garretson.

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