Fig. 1

Fig. 2

Fig. 3

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My invention relates to improvements in tanks for holding liquids and especially such liquids as liquefied hydrocarbons, the liquid temperature or boiling point of which at atmospheric pressure is exceedingly low.

One object of the invention is to provide a tank which will hold with a minimum of evaporation such a liquefied hydrocarbon as methane which at atmospheric pressure boils at —238° F.

I propose a metal tank of such strength as to support the hydrostatic pressure of the liquid contained therein, the tank being designed to support only the hydrostatic pressure and being not designed to support gas pressure above atmospheric more than just enough to permit the vapor as the liquid changes from liquid to gaseous stage to discharge from the tank.

I propose to line the metal tank with an insulating mass which will protect the metal tank from the cold of the liquid hydrocarbon so that little if any condensation of moisture from the air on the outside of the tank will occur and so that the tank from a metallurgical point of view may be designed from the point of view of normal atmospheric temperatures rather than the low temperature characteristic of the methane in liquid phase.

I propose to place inside of the insulating lining a liquid and gas impervious lining or bag which will be loosely contained within the insulating lining and will effectively prevent penetration of liquid into the insulating lining. Preferably also it will prevent penetration of gas into the insulating lining though this is not as important as penetration of the liquid into and through the lining so that the metal shell will at all times be protected against the cold of the liquid.

The impervious lining or bag will be so arranged that it approximately fits the inside of the insulating lining. It will be loosely suspended therein so that expansion and contraction of the insulating lining and of the metal shell will have no effect on the bag itself. The bag will be suspended at the top around the outer periphery of the shell or intermediate the outer periphery and center of the shell, will hang down along the inner boundary of the insulating lining and will rest on the insulating floor of the shell or tank. When the tank is empty this bag will hang free. When the tank is filled with liquid, the hydrostatic pressure of the liquid will hold the bag or impervious lining against the insulating lining.

As heat enters through the outer shell, the insulating lining and the impervious lining, vaporization of the gas will occur and develop sufficient pressure in the order of an inch or so of water to cause the gas to escape from the tank through an open discharge aperture to a point of use of other treatment. This may cause slight inflation of the bag at its top where it is not in contact actually with the liquid. It is important that no substantial pressure be developed in the tank because as above indicated, the tank shell is not designed to support such a pressure.

I propose to make the impervious lining out of an inert material, for example, glass fiber cloth and to coat this cloth or impregnate this cloth with a plastic chemically inert to liquid or gaseous methane and having such physical characteristics as will leave it sufficiently flexible under the very low temperatures involved so that the impervious lining may be displaced by the liquid and be forced outwardly against the inner periphery of the insulating lining without breakage or rupture of the bag.

I have illustrated in detail only the bag itself, the tank and the insulating lining and other features form no part of the present invention. My invention is illustrated more or less diagrammatically in the accompanying drawings, wherein:

FIGURE 1 is a part vertical section through the tank containing the liquid;
FIGURE 2 is a part vertical section through the tank when empty; and
FIGURE 3 is a horizontal section along the line 2—2 of FIGURES 1 and 2.

Like parts are indicated by like characters throughout the specification and drawings.

The cylindrical steel tank has a generally plane steel floor 1, a vertically disposed generally cylindrical wall 2, and a horizontal roof 3. The horizontal roof is apertured centrally at 4. 5 is an insulating floor lining which may well be of balsa wood. 6 is an insulating wall lining and 7 an insulating roof lining, all of them contained within the steel tank and furnishing adequate insulating inside the steel walls. 8 is a sleeve concentric with the aperture 4 extending downwardly through the insulating roof 7 and flanged at 9 to engage and underlie the insulation 10. 11 is a collar encircling the sleeve 8 and resting on the steel roof 3.

The aperture thus formed furnishes access to the interior of the tank and may be used for introduction of liquid or gas by any suitable means not herein shown. 11 is a bag or lining impervious to the liquid, preferably of woven glass fiber and is impregnated with and coated with any of the suitable impervious plasmas now on the market which remain flexible under such low temperatures as —238° F. This bag provides an effective barrier to penetration of liquid methane and methane toward and into the insulating lining. The glass fibers, of very small diameter, of which the cloth is woven also remain flexible even at such low temperatures and both the glass fibers and the coating are inert to liquid and to gaseous methane at the low temperatures of the liquid in the tank.

I have not illustrated the means whereby the cloth is assembled into a bag and whereby the separate sections are cemented together so as to make a continuous impervious bag as they form no part of the present invention.

The bag is generally cylindrical. It has a flat bottom as indicated and a generally flat top. At the center of the top, the bag is apertured to conform to the aperture through the sleeve 8 and an annular ring 12 is held against the flange 9 by cap screws or other suitable means 13, so that the bag is held in place and access may be had through the interior of the bag through the sleeve 8. 14 indicates a plurality of flexible suspensions or hangers attached to the bag by any suitable means around the periphery of the top of the cylindrical portion of the bag. These hangers are supported on anchorages 15 which may be, as indicated, carried by the insulating lining so that the anchorages do not extend clear through the lining and L-shaped brackets or framing for heat condition from the shell 2 to the interior of the tank. When the tank is empty, it tends to hang loose as indicated in FIGURE 2. When the tank is filled, it tends to expand into contact with the floor and wall of the lining and the pressure of evaporation may raise the bag from the position shown at 16 in FIGURE 2 to a position such as that shown at 17 in FIGURE 1 and may even hold it up against the roof 7 depending on the weight of the top of the bag and the pressure
generated by evaporation of the liquid hydrocarbon. If found necessary, intermediate hangers may be interposed at other points. As a general proposition such flexible support as indicated in FIGURES 1, 2 and 3 will be entirely sufficient to hold the bag in place so that when the liquid is introduced, there will be a minimum of movement of the bag and a minimum of strain on the bag. The bag itself does not support the hydrostatic or gaseous pressure in so far as it is backed up by the insulating lining, which in turn is backed up by the metal shell.

The insulating lining must, of course, be assembled in the shell at ordinary room temperatures and the usual tight lining will be installed. However, when the cold liquid is introduced into the tank, the contraction of the insulating lining as a result of cooling by the liquid may well be greater than the contraction of the shell which is to a very large extent insulated by the insulating lining and there is the possibility that cracks or voids might appear in the insulating lining and if a liquid impervious bag or other means were not interposed between the insulating lining and the liquid, shrinkage of the lining might result in such cracks and voids being developed as would permit penetration of the liquid through the insulating lining into excessive cooling contact with the shell. The bag or flexible lining, however it is supported or formed, prevents such penetration of liquid even if such voids or gaps should develop.

I claim:

1. A storage tank of large capacity for housing a liquefied hydrocarbon composed mostly of methane whereby storage is limited to about atmospheric pressure and at a temperature of about −258° F. comprising an outer fluid and vapor impervious metal shell capable of supporting the liquid load, an inner container of a fluid impervious material capable of standing up with the liquefied hydrocarbon gas at about −258° F. in the interior thereof and directly in contact therewith, and a thick layer of balsa wood completely separating the outer shell and inner container with the balsa wood insulation arranged as an internal lining about the walls of the outer shell and having structural strength and integrity capable of supporting the inner container when filled with a liquefied hydrocarbon gas to maintain the desired separated relationship between the outer shell and inner container.

2. A storage tank of large capacity for housing liquefied methane at about atmospheric pressure and at a temperature of about −258° F. comprising an outer steel shell, an inner shell of a vapor and fluid impervious material capable of maintaining strength and integrity under the temperature conditions existing when the liquefied methane is directly in contact therewith, and a thick layer of balsa wood panels lining the inner face of the steel shell to maintain a separated relationship between the inner container and the steel shell and to minimize heat transfer therebetween, said thick layer of balsa wood lining having rigidity and structural strength capable of maintaining the desired spaced relationship between the inner container and the metal shell when the inner container is filled with the liquefied methane.

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