

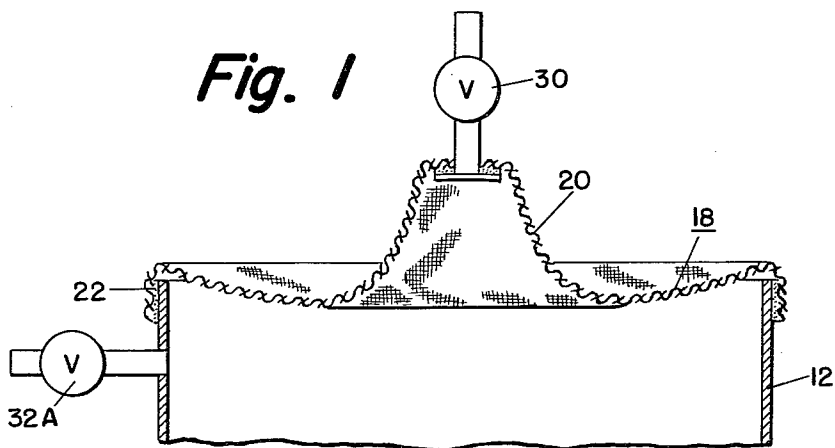
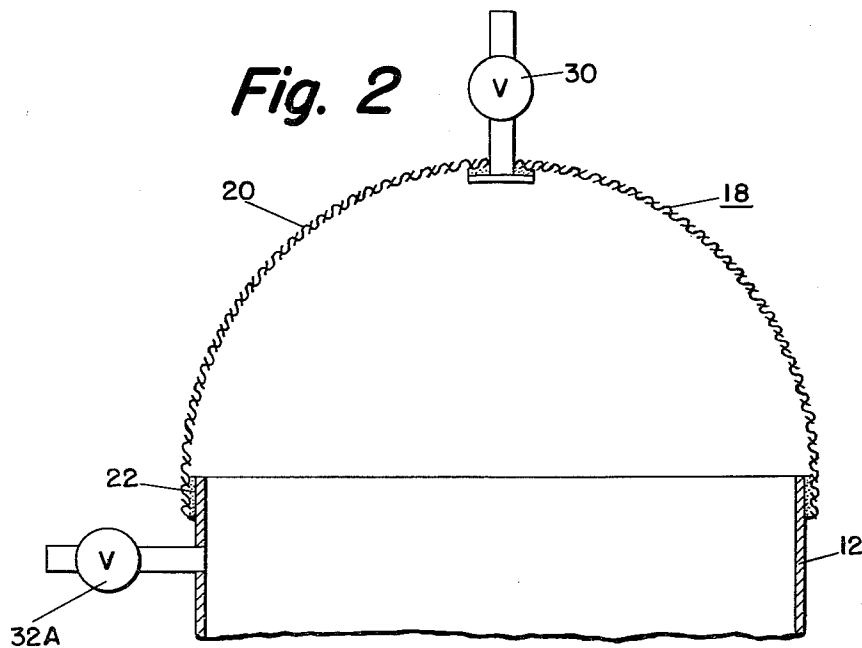
Aug. 21, 1962

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STORAGE VESSEL

3,050,208

Filed Sept. 25, 1959

2 Sheets-Sheet 1



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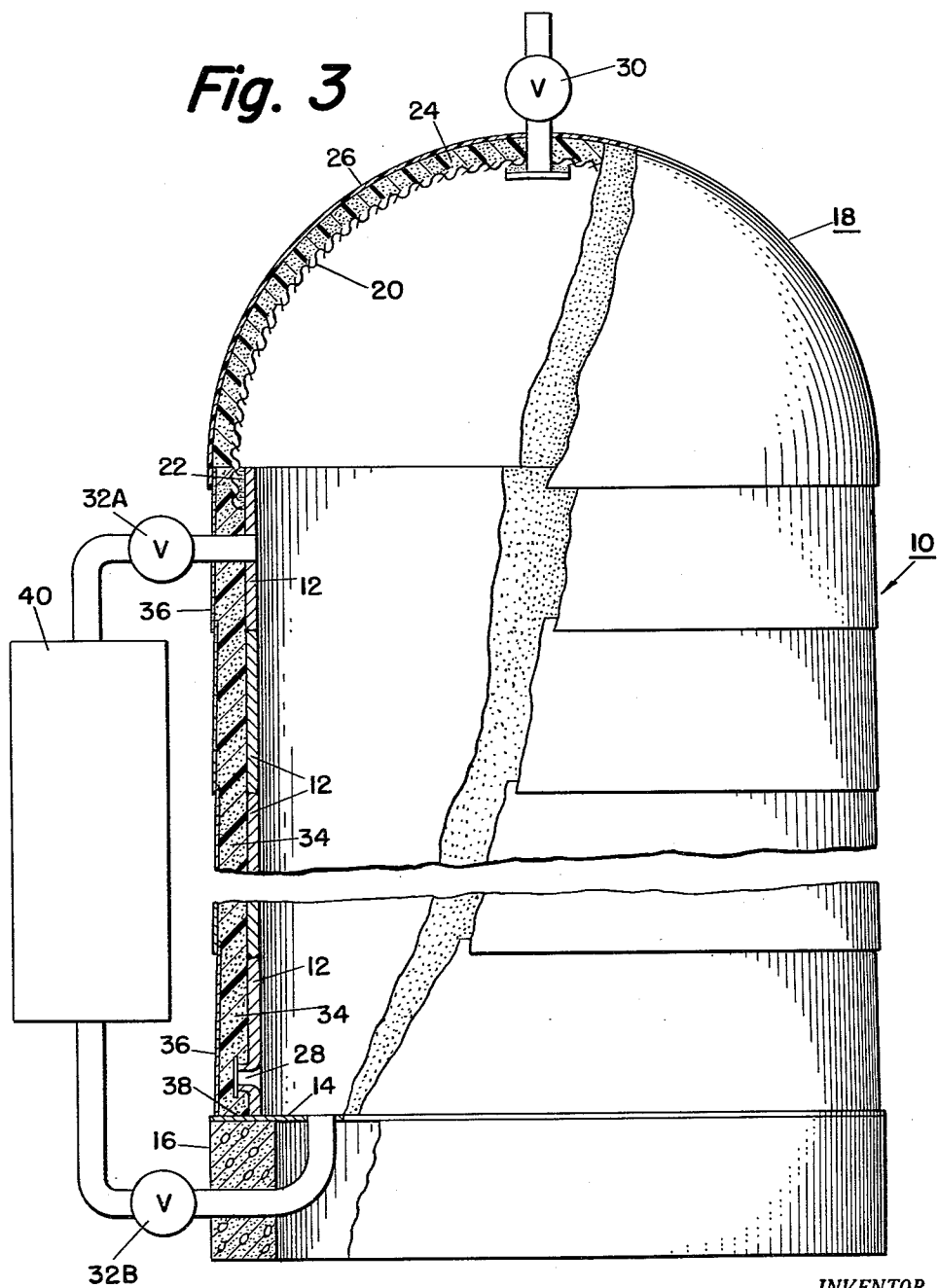
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1

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STORAGE VESSEL

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Filed Sept. 25, 1959, Ser. No. 842,324
8 Claims. (Cl. 220—9)

The present invention relates to a storage vessel, and more particularly to a storage vessel for storing large quantities of volatile liquids that have a normal boiling point below prevailing atmospheric temperatures, such as ammonia, butane, butadiene, chlorine, ethylene, liquefied petroleum gases (L.P.G.), propylene, and sulphur dioxide.

L.P.G. comprises principally either propane or butane, or mixtures thereof, and is widely used both industrially and by the general public for a vast number of uses. The storage of L.P.G., particularly commercial propane, has long presented a problem, since when the same is used for urban heating, the amount consumed per unit of time is apt to be enormous.

Where natural facilities for underground storage are lacking, resort must be had to above-surface storage facilities. Also, underground storage offers problems with regard to the contamination of the liquid being stored. The construction of suitable above-surface storage vessels constitutes an economic problem. Refrigerated storage offers merit for storage of large quantities of the liquids by reducing the internal pressure which must be contained through reducing the vapor pressure of the fluid being stored. If the internal pressure to be contained in the vessel is reduced to slightly above atmospheric, a cylindrical form of the vessel offers economic merit as this form is easily constructed. However, the cost of manufacture for above-surface roofs (which must be gas-tight in respect to the remainder of the tank), is apt to be considerable.

This invention has an object the provision of a novel storage vessel.

This invention has as another object the provision of a novel storage vessel of relatively low cost for the above-surface storage of volatile fluids such as L.P.G.

This invention has as yet another object the provision of a novel storage vessel having a roof of low cost construction.

Other objects will appear hereinafter.

For the purpose of illustrating the invention there is shown in the drawings a form which is presently preferred; it being understood, however, that this invention is not limited to the precise arrangements and instrumentalities shown.

Referring to the drawings wherein like character references refer to like parts:

FIGURE 1 is a fragmentary view of the upper portion of the storage vessel of the present invention before the fabric portion of the roof thereof has been expanded.

FIGURE 2 is a view similar to that of FIGURE 1 but showing the fabric portion of the roof of the storage vessel in expanded disposition.

FIGURE 3 is fragmentary vertical sectional view revealing the finished storage vessel construction of the present invention.

Referring to the drawings, the storage vessel of the present invention shown in FIGURE 3 is designated generally as 10.

The storage vessel 10 comprises a steel cylindrical tank

2

12 to which a flat tank bottom 14 may be welded. The specific construction of the tank bottom forms no part of the present invention, although a suitable form of tank bottom may be produced by butt welding steel plates. The flat tank bottom 14 and the cylindrical tank 12 are supported on a concrete ring 16.

The mode of construction for the cylindrical tank 12 likewise forms no part of the present invention. However, such cylindrical tank 12 is preferably formed by butt welding successive courses of steel plates. When the successive courses are vertically welded and horizontally girth welded, it is advisable to fill the cylindrical tank 12 with treated water. This will help preserve the desired roundness of the cylindrical tank 12 and provide stability against wind forces.

When the desired height for the cylindrical tank 12 has been attained, construction of the roof of the storage vessel is begun.

The roof of the storage vessel designated generally as 18 comprises three layers which are sandwiched together (see FIGURE 3). The innermost layer 20 comprises a woven flexible fabric of either metal fibers, fiberglass fibers, or synthetic fibers, such as nylon, which has been thoroughly impregnated with a flexible coating of low permeability, such as neoprene. The roof 18 is formed in the shape of a hemisphere, with the bottom annular margin of the innermost layer 20 being securely joined to either the inner or outer wall surface of the cylindrical tank 12 through an adhesive joint 22.

While a wide variety of strong fabrics impregnated with elastomeric materials may be utilized to form the innermost layer 20 of the roof 18, where, as in the illustrated embodiment, such innermost layer 20 comprises a neoprene impregnated nylon, it is desirable that the innermost layer 20 be cemented to the cylindrical tank 12 by an epoxy resin adhesive. Such epoxy resin adhesives present the required high strength adhesive characteristics, and durability, required for fixedly securing the innermost layer 20 to either the inner or outer wall surface of the cylindrical tank 12. While epoxy resin adhesives are to be preferred, it is of course, to be understood that other adhesives may be utilized.

The degree of overlap of the annular margin of the innermost layer 20 to the upper wall surface of the cylindrical tank 12 should be sufficient to provide the required anchorage strength characteristics for the roof 18. By providing the annular margin for the adhesive joint 22 with a vertical height equal to one foot, sufficient overlap is provided for anchoring an innermost layer 20 formed of neoprene impregnated nylon to steel using an epoxy resin adhesive for most sizes of construction.

After the fabric layer 20 is inflated to the position shown in FIGURE 2 in the manner as will be described, an insulating layer 24 of a rigid foam polymer is adhered to the outer surface of the fabric layer 20. A preferred rigid foam polymer insulation layer 24 is one formed from polyurethane, although other foamed plastics may be utilized. The thickness of the rigid foam polymer insulation layer 24 required is governed by the thermal insulation desired since a three inch thickness is more than adequate to be self-supporting and to withstand the wind and other forces prevailing on the roof 18.

The innermost fabric layer 20 of the roof 18 provides bulk of desired tensile properties and the adhering insulation layer 24 provides the desirable compressive proper-

3

ties. The insulation layer 24 also serves to protect the inner fabric layer 20 from weather exposure and ultraviolet rays which may adversely affect the fabric layer 20.

A vapor barrier layer 26 is provided over the rigid foam polymer layer 24. The vapor barrier layer 26 may comprise an application of one or more coatings of a low permeability material, such as aluminum pigmented vinyl chloride acetate resin. A long lasting impervious coating which also adds to the composite strength of the roof 18 is a fiberglass reinforced epoxy layer applied to the outer surface of the rigid foam polymer 24.

The cylindrical shell 12 is insulated by courses of thin flat metal sheathing 36, such as aluminum sheathing, which are coiled around and spaced from the outer surface of the cylindrical shell 12. The bottommost course of the sheathing 36 is seated on the flat tank bottom 14, and is adhered to the flat tank bottom 14 by an epoxy adhesive joint 38. The remaining courses of sheathing 36 are in overlapped relation and are joined together by an epoxy adhesive. The space between the courses of sheathing 36 and the cylindrical shell 12 is filled with a rigid foam polymer 34. It is desirable that the vapor barrier layer 26 of the roof 18 be continuous with or overlap the sheathing 36.

The storage vessel 10 preferably includes at least one suitably sealed porthole 28, which may serve as a manhole for gaining access to the interior of the vessel. A vapor outlet fitting 30 is provided at the top of the roof 18 and may be of a size so as to also serve as a manhole.

A plurality of valved ducts 32a and 32b provided at the top and bottom of the storage vessel 10 permit controlled introduction and removal of the liquid stored in the vessel 10. It is preferred that the incoming liquid be introduced through the top duct 32a and the liquid be withdrawn from the vessel 10 through the bottom duct 32b.

The storage vessel 10 also includes a refrigerating unit 40 for maintaining the fluid at a temperature whereby the vapor pressure of the fluid is within the design range of the interior pressure of the vessel 10. By using a refrigerating unit 40 of the regenerative refrigeration type, the liquid within the vessel 10 can be maintained at its proper temperature, and at the same time the liquid be stored within the vessel 10 can be used as a refrigerant.

The roof 18 of the present invention may be formed both rapidly and cheaply. Thus, the first stage of the formation of the roof 18 is shown in FIGURE 1. In this stage, the prefabricated innermost layer 20 is adhesively secured to the cylindrical tank 12. This is accomplished by adhesively joining the inner face of the annular margin of the innermost layer 20 to the outer face of the cylindrical tank 12 as has heretofore been indicated by an adhesive joint 22. The innermost layer 20 is readily prefabricated, and is light in weight (approximately 20-22 ounces per yard for 1500 ASTM grab material) so as to enable the entire innermost layer 20 to be suspended by the same erection equipment used for the cylindrical shell 12. The prefabricated layer 20 is also easily transported from the prefabricator in a rolled up condition. By joining the fabric layer 20 to the outer face of the cylindrical tank 12, the adhesive joint 22 can be accomplished readily from the outside of the cylindrical tank 12, and is therefore preferred.

The next stage of the formation of the roof 18 for the storage vessel 10 of the present invention is shown in FIGURE 2. In this stage the innermost layer 20 is expanded upwardly to its full height so that it presents a hemisphere. This is preferably accomplished by first substantially filling the cylindrical tank 12 with treated water, and then introducing an inert pressurized gas, such as nitrogen, as through the valved duct 32a located in the upper portion of the cylindrical tank 12. Such pressurized gas serves to inflate the innermost layer 20, namely it distends the innermost layer 20 to the disposition shown in FIGURE 2 from the collapsed disposition shown in FIGURE 1.

When the innermost layer 20 has been distended as

4

seen in FIGURE 2, the rigid foam polymer layer 24 is applied to the innermost layer 20. Such rigid foam polymer layer 24 not only serves as an insulation for the storage vessel 10, but since it is a continuous layer of a permanently set shape, and since it adheres to the innermost layer 20, it serves as a structural skeleton for fixing the innermost layer 20 in its distended disposition.

When the rigid foam polymer layer 24 has been applied, the vapor barrier layer 26 is then applied to the tank, as by means of a spray gun or the like, in order to prevent water vapors entering the rigid foam polymer layer 24 from low temperature service.

The insulation is applied around the cylindrical tank 12 by first placing the bottommost course of sheathing 36 around the tank 12 and then filling the space between the bottommost course of the sheathing 36 and the tank 12 with the foam polymer insulation 34. The next course of the sheathing 36 is placed around the tank 12 overlapping the outer and upper surface of the bottommost course of the sheathing 36, and again the space between the sheathing 36 and the tank 12 is filled with the foam polymer 34. The procedure is followed until the entire height of the tank 12 is covered by the sheathing 36 and the foam polymer 34.

The apparatus and method of the present invention enables a storage vessel having a hemispherical dome or roof to be constructed at a relatively low cost. The combination of the innermost layer and the rigid foam polymer layer insures gas-tightness, while the adhesion of an annular margin of appreciable height further insures gas-tightness between the roof 18 and the cylindrical tank 12.

The present invention may be embodied in other specific forms without departing from the spirit or essential attributes thereof and, accordingly, reference should be made to the appended claims, rather than to the foregoing specification as indicating the scope of the invention.

I claim:

1. A storage vessel for volatile liquids comprising a metal cylindrical tank having a hemispherical roof, with said hemispherical roof comprising an innermost layer of a fabric impregnated with an elastomer, said elastomer impregnated fabric being adhesively secured to the wall surface of said cylindrical tank about an annular margin at the top end of said cylindrical tank, and an outer insulation layer of a foam polymer secured to the outer surface of said innermost layer.

2. A storage vessel in accordance with claim 1 in which the foam polymer is coated with a vapor barrier layer of a low permeable material.

3. A storage vessel in accordance with claim 2 wherein said vapor barrier layer is an aluminum pigmented vinyl fluoride acetate resin.

4. A storage vessel in accordance with claim 2 in which the fabric impregnated with an elastomer is nylon impregnated with a synthetic rubber and the foam polymer is polyurethane foam.

5. A storage vessel in accordance with claim 4 in which the elastomeric impregnated fabric is adhesively secured to the outer surface of the cylindrical tank.

6. A storage vessel for volatile liquids comprising a metal cylindrical tank having a hemispherical roof, said hemispherical roof comprising an innermost layer of fabric impregnated with an elastomer, said elastomer impregnated fabric being adhesively secured to the wall surface of said cylindrical tank about an annular margin at the top end of said cylindrical tank, and with said cylindrical tank and the innermost layer of said hemispherical roof each being covered with a continuous insulation layer of a foam polymer secured to the outer surface of the metal cylindrical tank and to the outer surface of the innermost layer of said hemispherical roof.

7. A storage vessel in accordance with claim 6 including a vapor barrier coated on said foam polymer and thin

5

metal sheathing surrounding the foam polymer around said tank.

8. A storage vessel in accordance with claim 6 including a thin metal overlapped sheathing surrounding the insulation layer of foam polymer around the cylindrical tank.

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