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2,568,111

CORROSION RESISTANT STORAGE TANK

Filed April 19, 1946

2 Sheets-Sheet 1

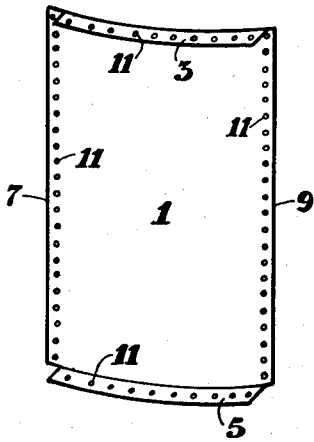


Fig. 1

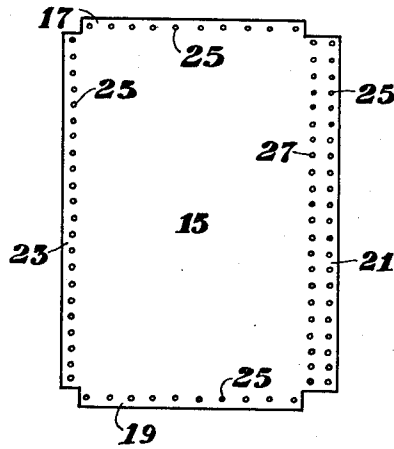


Fig. 2

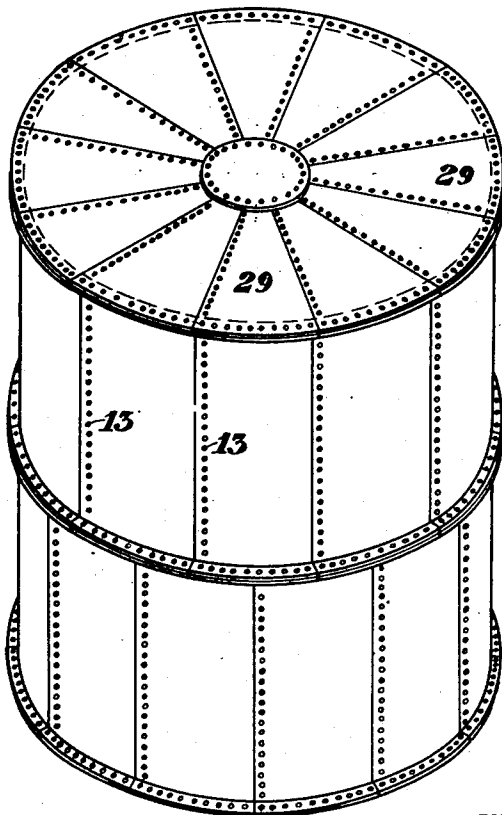


Fig. 3

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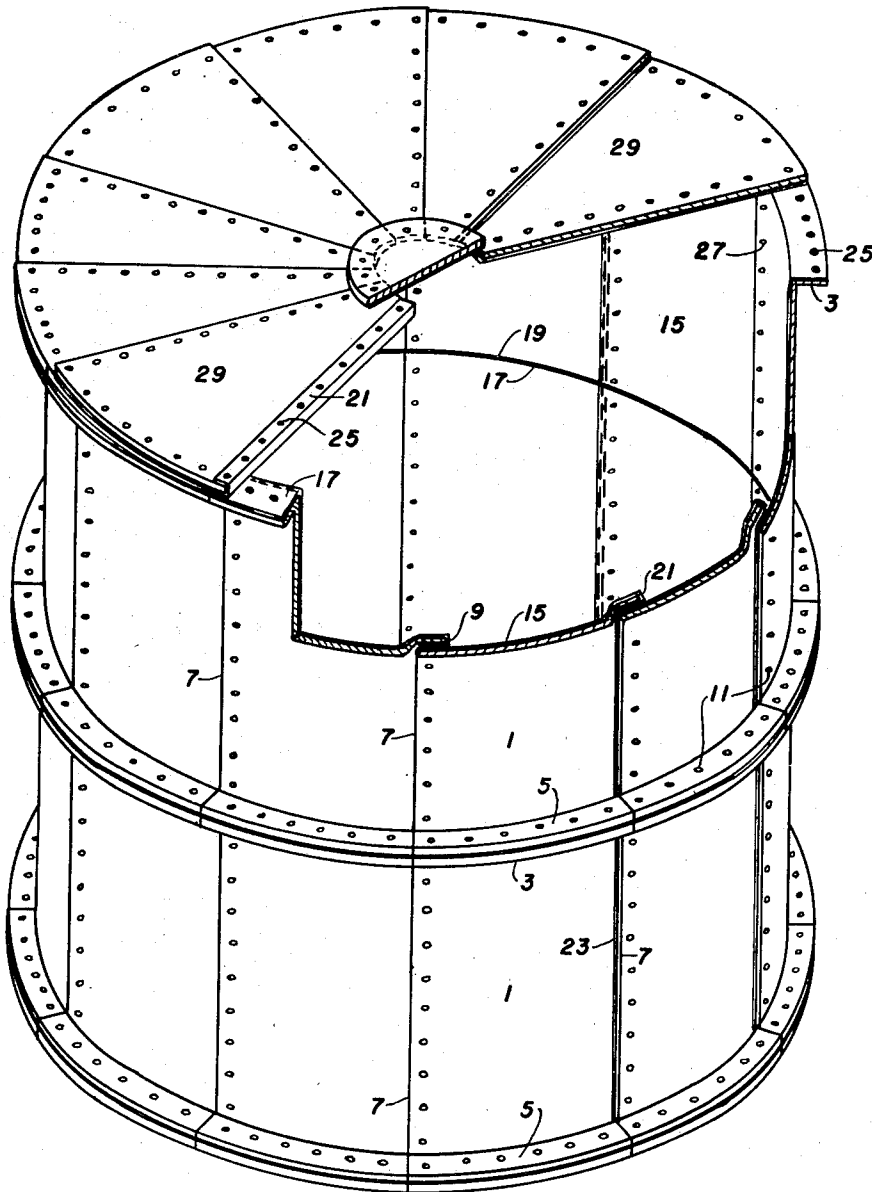


FIG. 4

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CORROSION-RESISTANT STORAGE TANK

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3 Claims. (Cl. 220-63)

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This invention relates to corrosion-resistant containers and to a method for rendering steel containers non-corrosive to mineral oils, brine and gases containing corrosive reagents, such as hydrogen sulfide.

Considerable difficulty is experienced in the storage of crude petroleum oil due to the fact that such oils contain brine in admixture therewith, and contain dissolved or include therein gases containing a small amount of hydrogen sulfide. The brine and the hydrogen sulfide exert a corrosive action on the steel walls of the containers, eventually eating through the walls and causing leakage and necessitating replacement of the container or storage vessel.

Attempts have been made to coat the inside walls of steel storage vessels with corrosion-resistant coatings, but in general, such coatings have not been satisfactory for the reason that they either peel or crack off, thereby exposing the walls of the container to the corrosive action of the brine, hydrogen sulfide and other corrosive agents.

I have discovered that the inside walls of steel and other metal containers can be protected against corrosion by lining such containers with flexible sheeted fibrous material or woven fabric which has been impregnated and/or coated with a corrosion-resistant substance. Any suitable sheeted fibrous material, such as heavy wrapping paper, canvas, roofing felt, woven glass fibers, nylon or other synthetic resin material may be used. As corrosion-resistant substances with which the fibrous or woven sheets are impregnated and/or coated may be mentioned Amercoat 23, a vinyl resin, Uclon, a vinyl resin, or various resins and thermoplastics, such as phenol-formaldehyde, phenol-paraformaldehyde and thiourea-furfural resins and coal tar pitch.

My invention is particularly applicable to the protection of storage tanks made up of a plurality of staves or sections bolted together. However, the invention is not limited to storage tanks of this type.

In order to more fully explain the invention reference is made to the drawings, of which Figure 1 is a perspective view of a stave or section of a bolted tank, viewing the stave from a point to the right and above the top thereof; Figure 2 is a plan view of a section of corrosion-resistant fibrous material or fabric adapted to be applied to the stave or section shown in Figure 1; Figure 3 is a perspective view of a bolted storage tank made up of staves or sections corresponding to the stave shown in Figure 1; and Figure 4 is an

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enlarged perspective view partly in section, of the tank shown in Figure 3.

Referring more particularly to the drawings, the numeral 1 indicates generally a stave or section of a bolted cylindrical storage tank. Section 1 is a rectangular, arcuate shaped plate formed with the tabs or flanges 3 and 5 along the upper and lower edges thereof. The tabs or flanges 3 and 5 are bent outwardly at substantially right angles to the face of the stave. The lateral edges 7 and 9 of the stave are crimped or tapered in accordance with standard practice. The flanges and lateral edges have holes 11 punched therein at spaced intervals in order to permit bolts 13 to pass therethrough and hold the staves together, as well as to fasten the top and bottom of the tank to the staves. As shown in Figure 3 the roof is also made of wedge-shaped sections with holes punched along the edges thereof. The tank is of conventional construction generally used in the oil producing industry.

A sheet of fibrous material or woven fabric 15 is cut and shaped to fit against the inner surface of the stave 1. The sheet 15 is also formed with tabs 17, 19 and 21 along the edges thereof, which tabs as well as the edge 23 are punched with holes 25. The tabs 17 and 19 are adapted to be folded back over the tabs or flanges 3 and 5 of the stave 1 with the holes of the sheet tabs in alignment with the holes of the stave tabs or flanges. The tab 21 is adapted to be folded back over the lateral edge of the stave inside the tank and to be bolted between the overlapping edges of two adjacent staves. As will be seen from Figure 2 an extra row of holes 27 is punched along the right edge of the sheet 15 in order to accommodate bolts when the sheet is bent around the edge of the stave. The rows of holes 25 and 27 along the right edge of the sheet are in alignment with each other. The sheets 15 may or may not be fastened to the stave 1 by suitable adhesive, although we prefer to adhere the sheets to the staves in order to cause the sheets to lie snug against the surface of the stave. Any suitable adhesive may be used to cause the sheet to adhere to the stave. In general, I prefer to use as adhesive a material similar to that which is used to impregnate and/or coat the sheet.

The roof and bottom will be lined with protective sheets in the same manner as the side walls of the tank. Sheets will be cut of the same size and shape as the roof and bottom section 29 except that an extra tab corresponding to tab 21 of sheet 15 will be provided along one edge to be bent over the inside edge of the stave and be

bolted between overlapping edges of adjacent staves. The sheet sections will be punched with holes, as described in connection with sheet 15, to align with the holes of the roof and bottom sections.

Sheets of fibrous material or fabric may be impregnated with the corrosion resistant material by running the material through a bath of the corrosion-resistant material either in heated liquid form or dissolved in a suitable solvent, and thereafter allowing the sheet to dry before cutting it into proper sizes for application to the staves or sections. Such operations are well known in the roofing industry where cheap felt in roll form is run through a molten bath of tar or asphalt in order to impregnate the felt, and

very rapidly to 300° F. over a period of 20 minutes. The material to be impregnated and/or coated is dipped in the resin while it is liquid. The resin becomes hard and transparent after one hour and is insoluble in ordinary organic solvent.

Strips of wrapping paper and of canvas were impregnated with resins prepared as aforesaid and tested by immersing the strips in a bath containing brine and sour crude mineral oil, so that the lower third of the strip was covered by brine, the middle third was covered by oil, and the upper third was exposed to the crude oil vapors. The bath was covered and connected to a reflux condenser and placed in a water bath maintained at the desired testing temperature. The results of the tests are given in the following table.

Table

Type of Resin	Material Impregnated	Solvent	g. Resin, cc. Solvent	Test in brine and crude oil		
				Temp. of Test, °F.	Days	Effect on Resin
Phenol-Formaldehyde (NH ₄ OH catalyst).....	Wrapping Paper..	Alcohol, Toluene..	1.9	140	31	None
Thiourea-furfural (HCl catalyst).....	do.....	None.....		140	31	None
Styrene (SnCl ₄ catalyst).....	do.....	None.....		75	25	None
Phenol-formaldehyde (NH ₄ OH catalyst).....	Canvas.....	Alcohol, Toluene..	1.9	140	43	None
Thiourea-furfural (HCl catalyst).....	do.....	None.....		140	43	None

thereafter run between hot rolls to which asphalt is applied in order to coat the sheet, after which the sheet is cut into desired shapes in a continuous operation.

Suitable resins for impregnating and/or coating the fibrous material or fabric for use in lining storage tanks may be made in the following manner: 2 mols of phenol and 2.2 mols of a 35% aqueous formaldehyde solution are placed in a three necked flask equipped with a mechanical stirrer, thermometer, and reflux condenser. The reaction mixture is heated to 176° F. and 15 grams of concentrated ammonium hydroxide solution added. The mixture is raised to 248° F. and the reaction allowed to continue under reflux for 40 minutes. The resulting resin is cooled by immersing the flask in a bath of cold water and then immediately dehydrated by distilling off the water under reduced pressure. When the temperature of the resin undergoing distillation reaches 176° F. the flask is removed from the oil bath which is used to heat the flask during the dehydrating operation, and 1.2 grams of stearic acid is added with stirring. The resulting phenol-formaldehyde resin is dissolved in 125 cc. of a mixture containing 9 volumes of ethyl alcohol and one volume of toluene.

The phenol-paraformaldehyde resin may be made in the same manner as the phenol-formaldehyde resin except that the dehydrating step is omitted.

A thiourea-furfural resin may be made by mixing 100 parts by weight of water with 100 parts by weight of thiourea and 197 parts by weight of furfural. The mixture is heated to 95° F. and stirred until the thiourea is dissolved. The mixture is cooled to 80° F. and 32 cc. of concentrated hydrochloric acid is added slowly with stirring. The temperature is not allowed to exceed 110° F. When the viscosity of the resin reaches that of glycerine the fabric or fibrous sheets are dipped into the resin in order to impregnate and/or coat them, and allowed to drain. The resin becomes hard after one hour.

Styrene resin may be prepared by mixing 66 cc. of styrene with 16 drops of stannic chloride and raising the temperature slowly at first, and then

From the table it is apparent that the coated strips were unaffected by the crude oil, brine or vapors liberated from the crude.

As previously said, I prefer to fasten the corrosion-resistant sheets to the inner walls of the tank, and this may be done by coating the walls of the tank with an adhesive to which the sheets are applied, or by applying heat and pressure to the sheets as they are applied to the staves, causing the plastic, resin or other coating material to adhere to the metal.

Instead of impregnating and/or coating the corrosion-resistant sheets prior to applying them to the inner walls of the tank the uncoated sheets of fibrous material or fabric may be applied to the tank and painted or coated with the corrosion-resistant paint or plastic material after the tank has been completely assembled.

The joints between the sections of lining material may be sealed with thermoplastic or resinous material of the same nature as that used to coat the sheets.

When using impregnated and/or coated felt to line the inner walls of the tank it will be unnecessary to provide gaskets between the flanges, since the sheet sections will serve as gaskets to prevent leakage. However, gaskets may be used if desired.

Instead of using impregnated and/or coated sheets of fibrous material or fabric as a protective lining for the tank, sheets made of flexible or elastic synthetic rubber such as Thiokol which are resistant to attack by the corrosive agents encountered and to the materials to be stored may be used.

By applying sheets to the staves and/or sections of the tank in the manner shown in the drawings and described herein, every portion of the tank will be protected against corrosion. Furthermore, if any portion of the lining becomes damaged it can be readily removed and replaced.

It will be seen, therefore, that I have provided an economical means for protecting steel and other metal storage tanks against corrosion.

It is claimed:

1. A liquid storage tank comprising, a plurality

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of sections provided with out-turned flanges along the upper and lower edges of said sections and overlapping each other along the side edges of said sections, the edges of the sections being provided with holes for fastening the flanges and edges of separate sections together to form the tank, and a corrosion resistant lining in said tank composed of a plurality of sections of corrosion resistant flexible sheet material, each of said sections being adhered to and covering a corresponding section of said tank and the ends of said material being fastened between the flanges of said tank sections.

2. A storage tank in accordance with claim 1 in which said sheets are plastic impregnated and adhered to the inner wall of said tank sections.

3. A tank for holding corrosive hydrocarbon liquids and accompanying vapors, brine and hydrogen sulfide as they occur in crude petroleum hydrocarbons, comprising a shell made up of a plurality of iron sections bolted together to form a unitary structure, a similar plurality of sections of flexible plastic coated and impregnated fibrous material, resistant to deterioration by

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said hydrocarbons and accompanying materials, conformed to the shape of said iron sections and being closely adhered to said iron sections with a thermoplastic material, whereby the fibrous sections form a substantially continuous protective inner lining protecting the iron sections of said tank against corrosion by the hydrocarbons and accompanying material contained therein.

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