United States Patent

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[54] **INSULATED STORAGE TANK OF INCREASED CAPACITY WITH SUSPENDED INSULATED CEILING**

14 Claims, 5 Drawing Figs.

[52]	U.S. Cl.	220/10
[51]	Int. Cl.	B65d 7/22
[50]	Field of Search	220/9 G, 9 F, 10; 62/45

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ABSTRACT: An enclosed insulated tank having an external metal shell with a metal bottom, a metal wall and a sloped metal roof, an internal metal shell having a metal bottom and a metal wall, insulation between the internal and external bottoms and the internal and external walls, a metal canopy member fluid tightly secured to and extending from about an upper part of the inner wall inwardly and upwardly and terminating in spaced relationship from the roof, an insulated fixed-position ceiling suspended from the inside of the roof having its periphery adjacent to, and conforming with, the internal peripheral terminus of the metal canopy, and insulation between the canopy member and the roof.

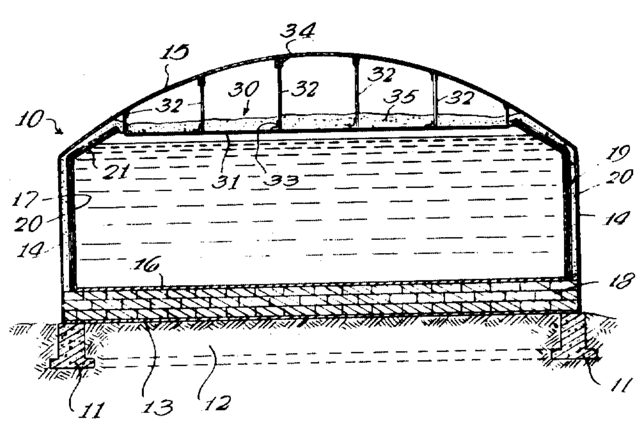

Fig. 1

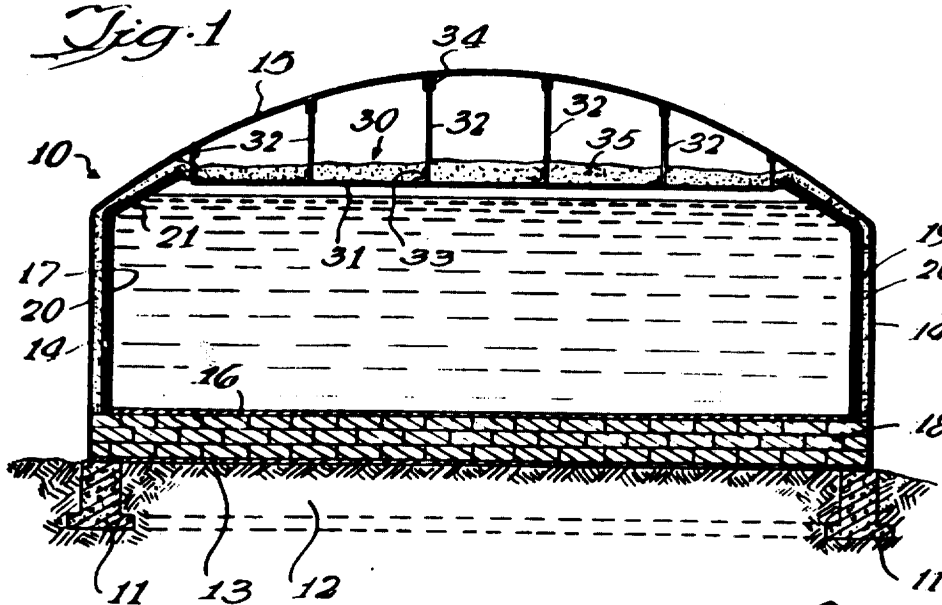

Fig. 2

Fig. 5

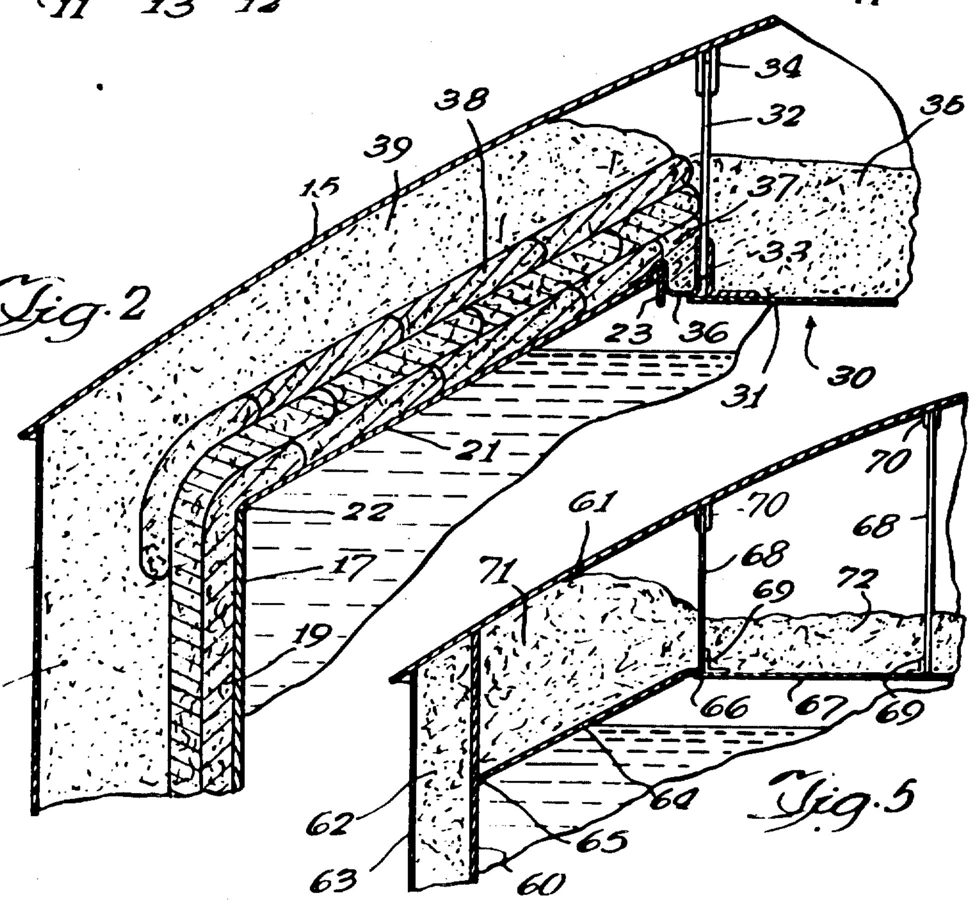

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Fig. 3

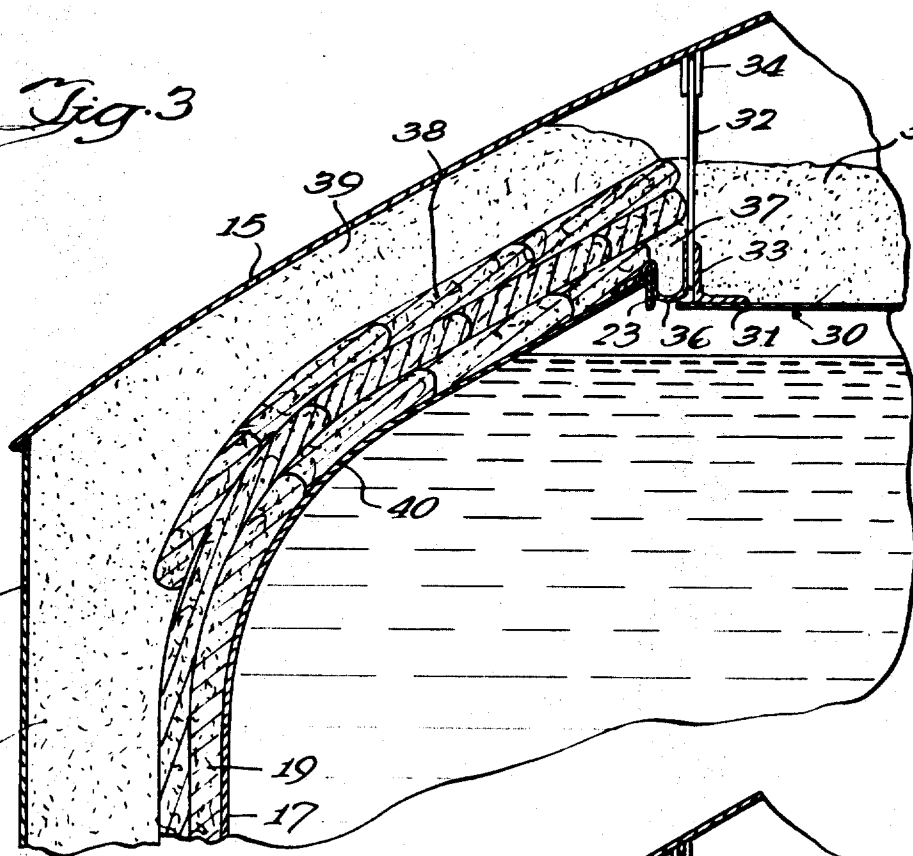
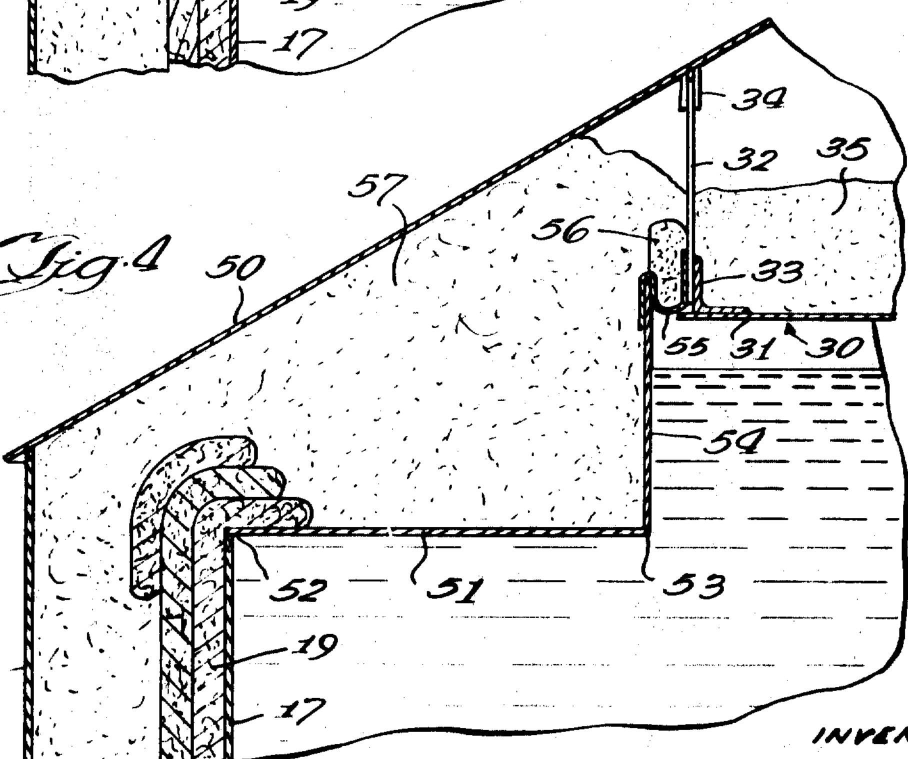


Fig. 4



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INSULATED STORAGE TANK OF INCREASED CAPACITY WITH SUSPENDED INSULATED CEILING

This invention relates to storage tanks where heat gain or loss is to be avoided and cost is reduced. More particularly, this invention is concerned with means of increasing the storage capacity, without increasing the size, of an insulated storage tank for storing liquids at low temperatures, such as liquefied gases stored at about atmospheric pressure or slightly above atmospheric pressure.

A conventional tank for storing liquefied gases at about atmospheric pressure or slightly thereabove consists of a metal shell having an essentially flat metal bottom, an essentially vertical wall, usually cylindrical, and a metal roof, generally sloped in the form of a conical section or in the form of a domed roof, supported by the wall. The bottom rests on an insulated base and the wall is externally insulated. The roof is also usually insulated externally.

Insulating the roof is costly since it is difficult to shape the insulation to the roof contour and to make it weathertight. This problem was considered and met by an improved insulated tank as shown in Sattelberg et al. U.S. Pat. 3,352,443 which eliminates the insulation from the roof and adds an insulated ceiling suspended from the inside of the noninsulated roof. The suspended insulated ceiling hangs from the sloped metal roof and extends to approximate contact with the metal wall to thereby provide a totally insulated storage space.

Although the suspended insulated ceiling type of storage tank provides certain economies in construction, there is considerable space between the suspended ceiling and the roof which is not utilized. If a tank could be constructed with a suspended internal insulated ceiling of increased storage capacity, without increasing the external dimensions of the tank, a considerable economic advantage would be realized.

According to the present invention, there is provided an improved enclosed and/or insulated storage tank which comprises a metal shell having an insulated metal bottom, an insulated metal wall, a sloped metal roof, a metal canopy member extending from near the top of the wall inwardly and upwardly and terminating in spaced relationship from the roof, and an insulated ceiling suspended from the inside of the roof having its periphery adjacent to, and conforming with, the internal peripheral terminus of the metal canopy, and insulation between the canopy member and the roof.

The metal canopy member comprises an upwardly and inwardly directed extension of the metal wall and raises the height to which a liquid can be stored in the tank significantly above the level to which it could be raised if the metal wall lacked such an internal extension. The metal canopy member in some respects might be considered a partial internal roof since it more or less follows the general contour described by the roof to thereby provide space between it and the roof for holding and securing insulation material in place. However, the suspended insulated ceiling still occupies a substantial part of the area across the upper part of the tank which must be insulated against heat leak in order that the temperature of a stored liquid can be controlled. A tank built using the combination metal canopy member and suspended insulating ceiling will have 10 to 15 percent more usable storage capacity than a similar tank having the same metal shell, but without the metal canopy member, and having the periphery of the suspended ceiling in contact with the wall.

The canopy member as employed in the tank can have any suitable shape and can be fabricated of one or more pieces. It is advisably made of metal plate of sufficient strength to withstand the stresses to which it will be subjected.

As used herein in describing the invention, the term "sloping roof" is intended to include roofs having surfaces such as generated by rotating a line, curved or straight, about a vertical axis. The roofs thus can be conical, semispherical, elliptical or otherwise curved with the highest point being at the axis and the lowest point at the periphery or circumference of the roof.

The invention will now be described further in conjunction with the attached drawings in which:

FIG. 1 is a vertical sectional view through a double-bottomed double-walled single roofed tank having a canopy member to increase storage capacity;

FIG. 2 is an enlarged vertical sectional view of that portion of the tank of FIG. 1 showing the wall and roof juncture area and a frustoconical section canopy extension which permits increased storage capacity in the tank;

FIG. 3 is a vertical sectional view similar to FIG. 2, but showing an arcuate canopy member;

FIG. 4 is a vertical sectional view, similar to FIG. 2, showing a canopy structure having a horizontally inwardly directed element from which a vertical wall extends upwardly to thereby increase the capacity of the tank; and

FIG. 5 shows a canopy member used on a single shell tank to increase the liquid storage capacity thereof.

So far as is practical, the same or similar elements which appear in the various drawings will be identified by the same number.

With reference to FIG. 1, the tank 10 is mounted on ring wall foundation 11. Within ring wall foundation 11 is placed compacted support material 12. The tank 10 has an outer shell comprised of a bottom 13, cylindrical wall 14 and a domed roof 15. In addition, tank 10 has an inner shell composed of bottom 16 and sidewall 17. Insulation 18 is laced between outer bottom 13 and inner bottom 16. This insulation is capable of withstanding the pressure applied when the tank is fully loaded. The space between outer wall 14 and inner wall 17 is insulated in part by glass fiber blankets 19 placed against the outer surface of inner wall 17 and by filling up the remainder of the space with granular insulation 20. As shown more clearly in FIG. 2, one or more insulating blankets 19 are placed against inner wall 17.

Extending inwardly and upwardly from inner wall 17 is canopy member 21, which is generally frustoconical. It is thus straight in vertical radial cross section. It can be readily formed of metal plate and joined at its lower end 22 to the top edge of inner wall 17 or at some other appropriate location along the upper portion of the inner wall. A stiffening vertical ring 23 is placed around the upper edge of canopy member 21 to make it more rigid. Other supports can be used as may be advisable.

A suspended ceiling 30 is supported by domed roof 15. The suspended ceiling has a substantially flat horizontal deck 31 suspended by elongated members 32 from domed roof 15. Elongated members 32 connect to the deck 31 and roof 15 by either brackets 33 and 34 or by direct welding to structural members on deck 31 and roof 15. Granular or other insulation 35 is placed on top of deck 31 to provide an insulated surface over the entire area between the upper terminal edge of canopy member 21 and ring 23 to thereby completely insulate the upper horizontal area of the tank.

A gap is provided between ring member 23 and the edge of deck 31 so that contraction and expansion of each can take place freely. The gap is spanned by an appropriate device such as a flexible membrane 36 in which a glass fiber blanket 37 is placed. Glass fiber blankets 38, a continuation of blankets 19, are placed in layers on top of canopy member 21 and then granular insulation 39 is placed thereon up to the bottom surface of domed roof 15.

The tank structure of FIG. 3 is very similar to that described in conjunction with FIGS. 1 and 2, except that, in FIG. 3, the canopy member 40 in vertical radial cross section is arcuate and smoothly joins inner wall 17. The other elements shown in FIG. 3 are the same as those described with reference to FIGS. 1 and 2.

The tank structure illustrated by FIG. 4 is also similar to that shown in FIG. 2 and the same elements have been identified with the same numbers as those which appear in FIG. 2. The tank of FIG. 4 has a conical or domed roof 50 supported by outer wall 14. Extending inwardly in a horizontal direction is plate member 51 which is joined at its outer edge 52 to the top edge of wall 17. From the inner edge 53 of horizontal plate member 51, a vertical cylindrical plate member 54 extends upwardly to a position adjacent deck member 31 of suspended roof 30. Membrane 55 spans the gap between the outer edge of deck 31 and the upper edge of cylindrical member 54 and supports a glass fiber insulating blanket 56. Granular insulation 57 is piled on top of plate 51 until it reaches the roof 50 and to a height which corresponds approximately with the level of grandular insulation 35 placed on deck 31.

The tank structure of FIG. 5 differs from those described with regard to FIGS. 1 to 4. The tank structure of FIG. 5 has a single shell composed of bottom 16 (FIG. 1), a cylindrical wall 60 and roof 61 supported on the upper edge of wall 60. Any external shell insulation such as foamed-in-place polyurethane insulation 62 is placed around the outer surface of wall 60 and is covered by a vapor barrier such as sheet aluminum 63. Canopy member 64 is joined at its lower edge 65 to wall 60. The canopy member 64 extends inwardly and upwardly at an angle and terminates adjacent inner upper edge 66 of deck 67 of an insulated suspended ceiling. The insulated ceiling has deck 67 suspended from roof 61 by elongated members 68 which can be joined such as by brackets 69 to deck 67 and by brackets 70 to roof 61 or such other means as is suitable. Granular or any other insulation 71 is placed on top of canopy member 64 to a height sufficient to provide the necessary insulation. Insulation 72 of the granular type is also placed on top of deck 67 to thereby insulate the area between the upper edge 66 of canopy member 64. It should be understood regarding the tank structure of FIG. 5 that wall 60 is joined at its bottom edge to an essentially flat bottom plate 16 and that the bottom is duly insulated thereby providing a fully insulated single shell tank for storing liquefied gases or other material. Further details concerning the bottom structure of such a tank are to be found in Sattelberg et al. U.S. Pat. 3,352,443.

The provision of the canopy members as shown in the FIGS. of the drawings permits storage in the tank of from 10 to 15 percent more material than would be possible if no such canopy was provided and the suspended ceiling lowered and brought into contact at its periphery with the upper edge or portion of the shell wall which contacts the material stored in the tank such as inner wall 17 as shown in FIG. 2 and the sidewall 60 of FIG. 5. Material stored in the tank can be raised until the upper level of stored material is brought to just below the upper inner edge of the canopy member. Thus, neither the height of the tank wall nor the deck of an insulated ceiling in contact with the wall restrict or limit the storage capacity of the tank as was the case in previous tanks. The use of a canopy member allows liquid to rise into what normally was vapor space and thus makes more effective cost and thermal use of a tank which does not have to change in shape or amount of insulation used, to obtain increased storage capacity. There is practically no change in area of tank exposed to heat leak and an actual decrease in percent heat leak while obtaining from 10–15 percent increase in usable storage in the percent increase

What is claimed is:

1. An insulated tank comprising:
- a metal shell having an insulated metal bottom, an insulated metal sidewall and a metal roof which slopes upwardly and inwardly from adjacent the top of said sidewall and forms a downwardly opening cavity within said roof above the top of said sidewall,
- a metal canopy member fluid tightly secured to and extending inwardly and upwardly from the upper peripheral part of the sidewall generally paralleling said shell metal roof and terminating within said cavity in spaced relationship below the roof,
- an insulated ceiling suspended from the inside of the roof having its periphery adjacent to, and conforming with, the internal peripheral terminus of the metal canopy, and
- insulation between the canopy member and the roof.

2. An insulated tank according to claim 1 in which the vertical radial cross section of the metal canopy member is straight.

3. An insulated tank according to claim 1 in which the vertical radial cross section of the metal canopy member is arced.

4. An insulated tank according to claim 1 in which the bottom is circular and the sidewall is cylindrical.

5. An insulated tank according to claim 4 in which the metal canopy member is frustoconical.

6. An enclosed tank comprising:
- an external metal shell having a metal bottom, a metal sidewall and a metal roof which slopes upwardly and inwardly from the top edge of said sidewall and forms a downwardly opening cavity within said roof above the top of said sidewall,
- an internal metal shell having a metal bottom and a metal sidewall spaced respectively from said external shell bottom and sidewall,
- insulation between the bottoms and the sidewalls of said external and internal shells.
- a metal canopy member fluid tightly secured to and extending inwardly and upwardly from the upper peripheral part of the sidewall of the inner shell and terminating within said cavity in spaced relationship below the roof,
- an insulated ceiling suspended from the inside of the roof having its periphery adjacent to, and conforming with, the internal peripheral terminus of the metal canopy, and
- insulation between the canopy member and the roof.

7. An enclosed tank according to claim 6 in which the vertical radial cross section of the metal canopy member is straight.

8. An enclosed tank according to claim 6 in which the vertical radial cross section of the metal canopy member is arced.

9. An enclosed tank according to claim 6 in which the bottoms are circular and the sidewalls are cylindrical.

10. An enclosed tank according to claim 9 in which the metal canopy member is frustoconical.

11. An insulated tank comprising:
- a metal shell having an insulated metal bottom, an insulated metal sidewall and a metal roof which slopes upwardly and inwardly from adjacent the top of said sidewall,
- an open top liquid impervious vessel disposed within said metal shell and having a bottom and a sidewall, said vessel bottom being spaced above said shell metal bottom and said vessel sidewall being spaced radially inwardly from said shell metal sidewall,
- a metal canopy member extending inwardly and upwardly from the upper peripheral part of the vessel sidewall and terminating in spaced relationship below the roof,
- the metal canopy member having a substantially horizontal annular element fluid tightly joined to the vessel wall about its upper part and a substantially cylindrical vertical element fluid tightly joined to, and extending upward from the inner edge of the horizontal annular element,
- an insulated ceiling suspended from the inside of the roof having its periphery adjacent to, and conforming with, the internal peripheral terminus of the metal canopy, and
- insulation between the canopy member and the roof.

12. An insulated tank comprising:
- a metal shell having an insulated circular metal bottom, an insulated metal cylindrical sidewall and a metal roof which slopes upwardly and inwardly from adjacent the top of said sidewall,
- an open top liquid impervious vessel disposed within said metal shell and having a bottom and a sidewall, said vessel bottom being spaced above said shell metal bottom and said vessel sidewall being spaced radially inwardly from said shell metal sidewall,
- a metal canopy member extending inwardly and upwardly from the upper peripheral part of the vessel sidewall and terminating in spaced relationship below the roof,
- the metal canopy member having a horizontal annular element fluid tightly joined to the top portion of the vessel sidewall and a vertical cylindrical element fluid tightly joined to the inner edge of the annular element and extending upwardly therefrom,
- an insulated ceiling suspended from the inside of the roof having its periphery adjacent to, and conforming with, the internal peripheral terminus of the metal canopy, and

insulation between the canopy member and the roof.

13. An enclosed tank comprising:

an external metal shell having a metal bottom, a metal sidewall and a metal roof which slopes upwardly and inwardly from the top edge of said sidewall,

an internal metal shell having a metal bottom and a metal sidewall spaced respectively from said external shell bottom and sidewall,

insulation between the bottoms and sidewalls of said external and internal shells,

a metal canopy member extending inwardly and upwardly from the upper peripheral part of the sidewall of the inner shell and terminating in spaced relationship below the roof.

the metal canopy member having a substantially horizontal annular element fluid tightly joined to the inner shell sidewall about its upper part and a substantially cylindrical vertical element fluid tightly joined to, and extending upward from the inner edge of the horizontal element,

an insulated ceiling suspended from the inside of the roof having its periphery adjacent to, and conforming with, the internal peripheral terminus of the metal canopy, and

insulation between the canopy member and the roof.

14. An enclosed tank comprising:

an external metal shell having a circular metal bottom, a metal cylindrical sidewall and a metal roof which slopes upwardly and inwardly from the top edge of said sidewall,

an internal metal shell having a circular metal bottom and a metal bottom and a cylindrical sidewall spaced respectively from said external shell bottom and sidewall,

insulation between the bottoms and the sidewalls of said external and internal shells,

a metal canopy member extending inwardly and upwardly from the upper peripheral part of the sidewall of the inner shell and terminating in spaced relationship below the roof,

the metal canopy member having a horizontal annular element fluid tightly joined to the top portion of the sidewall of the internal shell and a vertical cylindrical element fluid tightly joined to the inner edge of the annular element and extending upwardly therefrom,

an insulated ceiling suspended from the inside of the roof having its periphery adjacent to, and conforming with, the internal peripheral terminus of the metal canopy, and

insulation between the canopy member and the roof.