United States Patent

Knight et al.

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[54] **HEAT-TRANSFER FERMENTING AND AGING VESSEL**

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[52] **U.S. Cl.**.....**220/13,** 220/71

[51] **Int. Cl.**.....**A47j 27/10**

[58] **Field of Search**.....220/71, 1 B, 13, 10

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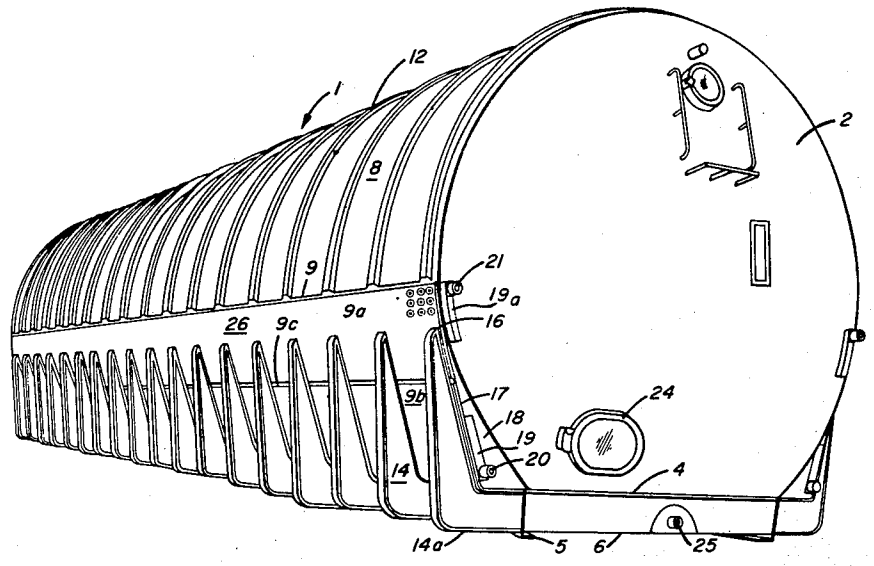
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[57] **ABSTRACT**

A heat-transfer vessel or tank for use in fermenting and aging bear, and like products, is near-cylindrical in configuration and cross-section, the near-cylindrical body being closed at either end by a dished head member in order to form a closed tank. Each side wall of the tank includes a cooling jacket. The tank is mounted on a frame of metal beams, and reinforcing cantilever members are rigidly connected to the frame and are secured to and embrace the cooling jacket. The cooling jacket is preferably of dimpled construction, and each dished head member is in the form of a torisphere.

9 Claims, 7 Drawing Figures



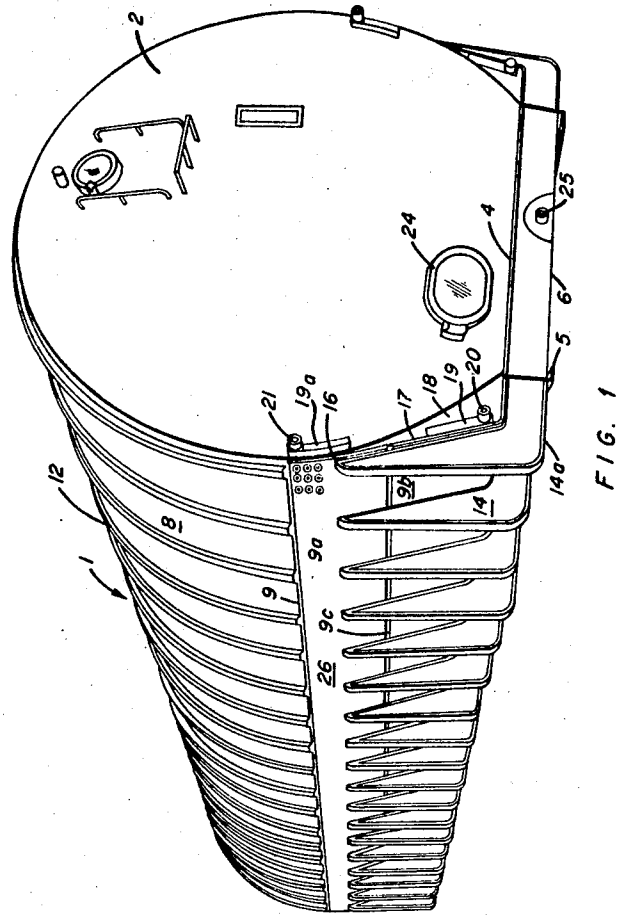


FIG. 1

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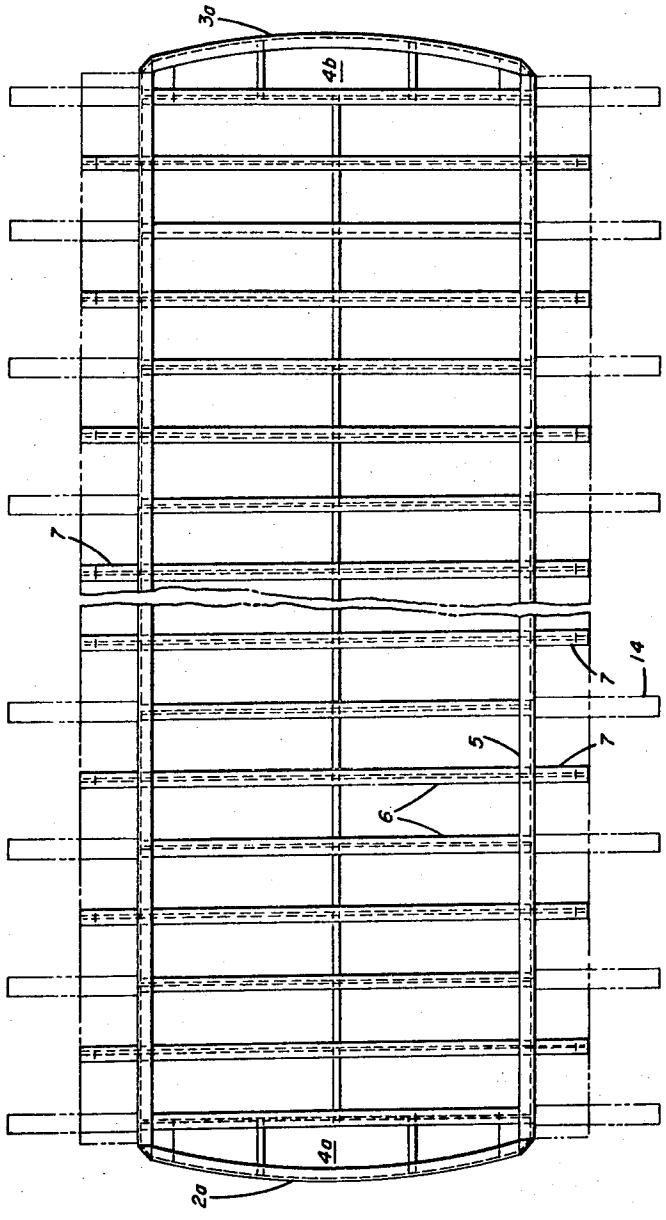


FIG. 2

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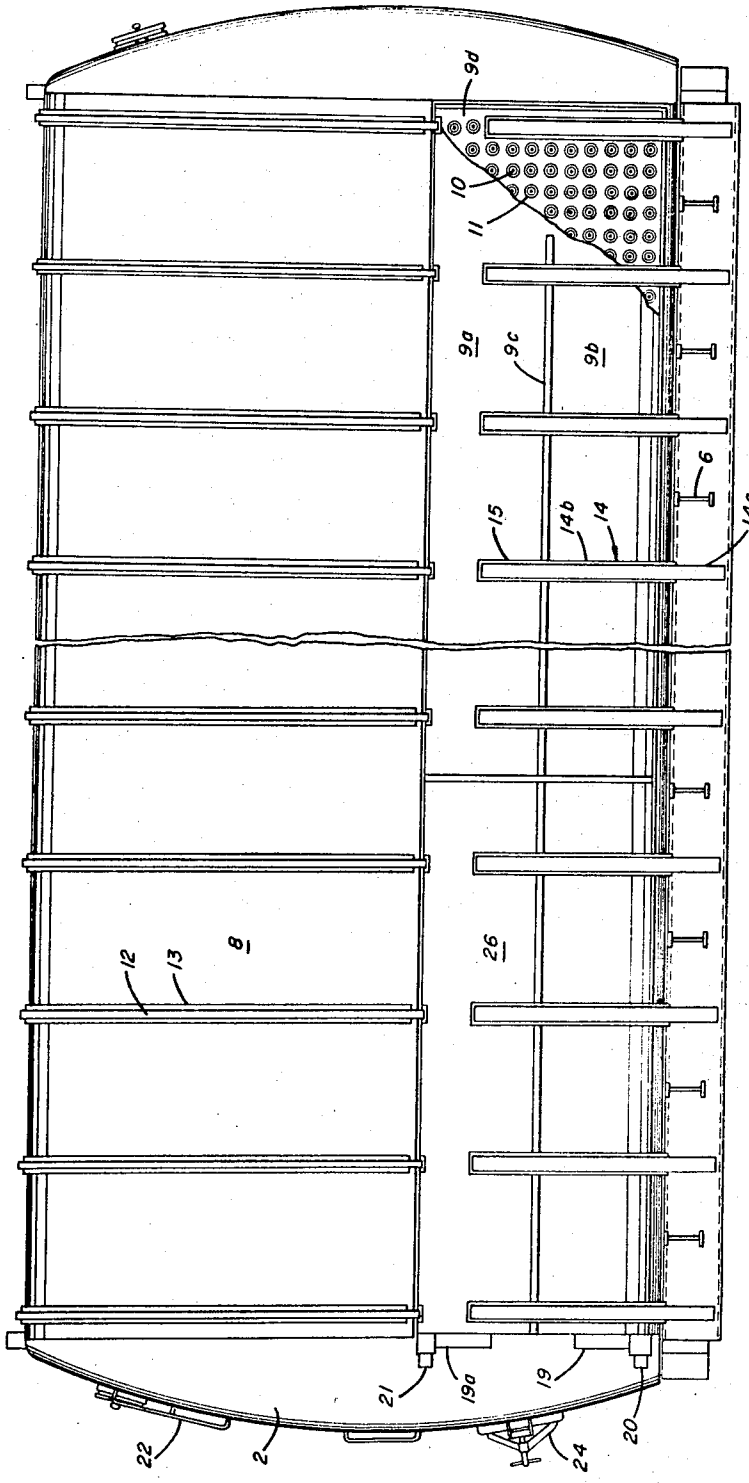


FIG. 3

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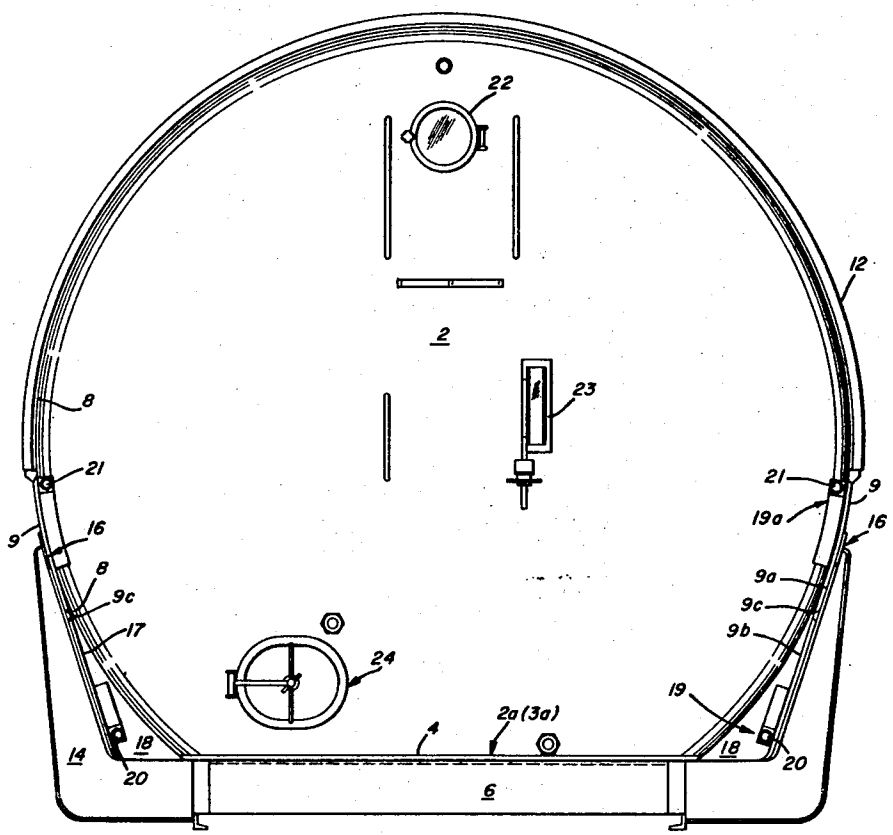


FIG. 4

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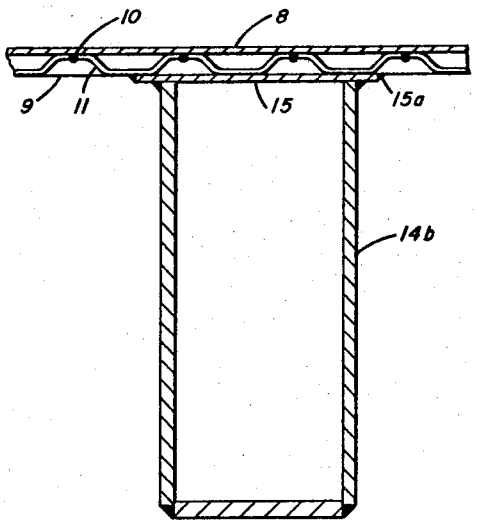


FIG. 7

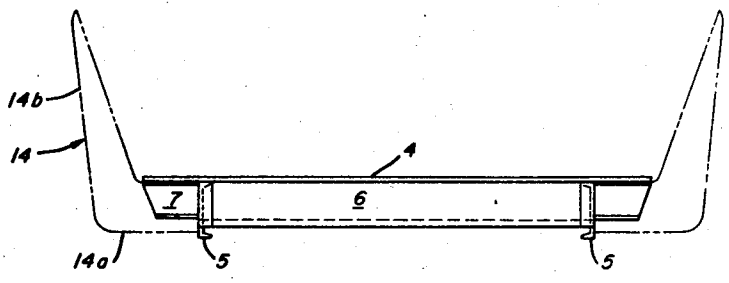


FIG. 5

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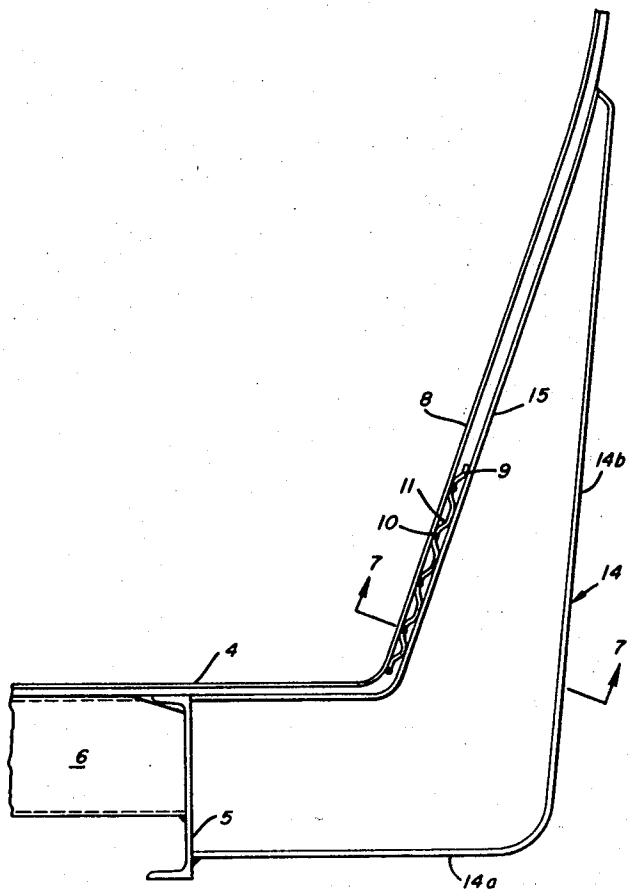


FIG. 6

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HEAT-TRANSFER FERMENTING AND AGING VESSEL

The present invention relates to a large enclosed container of novel structure particularly designed to be used as a fermenting and aging vessel in the brewing of beer and like products.

In the manufacture of beer on a commercial scale, large quantities of wort, including fermentable carbohydrate and yeast foods are inoculated with yeast and fermented for a time sufficient to convert the carbohydrate into alcohol and carbon dioxide. During fermentation the heat that is produced must be dissipated in order that the fermentation temperature may be controlled, because otherwise the quality of the beer will be impaired. When brewing is completed, the brew must be cooled and aged.

Brewing and aging vessels are necessarily of large capacity, 60,000 imperial gallons for example, and should at the same time be of convenient design and relatively light in weight. It will be obvious that structural strength is of primary importance.

Prior art containers are generally rectangular or loaf-shaped in cross-section; and in order to provide the necessary structural strength, relatively large amounts of floor space must be provided to accommodate the bracing and strengthening members. Many prior art tanks have elaborate stiffening and bracing structures, particularly at the cooling area, which are difficult to construct and assemble. In a number of instances their cooling assemblies comprise pluralities of fins that must be welded into place, thus adding materially to the costs and complications of manufacture.

According to the present invention, an efficient and adequate cooling area is provided by the mounting of dimpled plate means on the lower extremities of the tank wall structure. With that kind of novel structure, welding with respect to the cooling assembly is reduced to a minimum, cooling efficiency is improved and construction costs are considerably reduced by comparison with those for conventional tanks.

From the standpoint of maximum vessel strength for a given size, the ideal container would be cylindrical in shape; and it is a particular object of the present invention to provide a fermentation vessel of appropriate strength and of light weight, having a near — or quasi - cylindrical shape, and being approximately circular in cross-section and having a smooth, unobstructed interior.

It is a further object of the invention to provide a tank equipped with an efficient cooling system that is of simple and practical construction.

The tank of the invention is constructed of stainless sheet steel and is provided preferably with torispherical front and rear head members welded to a tubular body section of welded plate construction reinforced by means of lightweight hollow members or cantilever side beams. The entire structure is supported on a plurality of transverse beams mounted on spaced longitudinal beams.

The invention will be described with reference to the accompanying drawings in which:

FIG. 1 is a perspective view of tank according to the invention and displaying the head end;

FIG. 2 is a plan view of the tank floor structure;

FIG. 3 is a side elevation;

FIG. 4 is a head end elevation;

FIG. 5 is an end view of the bottom supporting structure and the cantilever reinforcing members;

FIG. 6 is a side elevation showing one of the cantilever members and a section of the cooling jacket; and

FIG. 7 is a section on line 7—7 of FIG. 6.

The tank designated generally at 1 is of quasi-cylindrical shape and has convexly dished front and rear head members of discs 2 and 3 that are circular in outline and that have a chordal section removed, designated at 2*a* and 3*a*, (FIG. 4) in order to be registrable with the bottom 4 of the tank which is flat and which is made of stainless steel. The preferable configuration of head members 2 and 3 may be defined as ellipsoidal or torispherical and is known in the art, specifications therefor being set out in the Boiler and Pressure Vessel Code published by the American Society of Mechanical Engineers (A.S.M.E.).

The stainless steel tank bottom 4 (FIG. 6) is secured to and supported by a web of steel beams comprising longitudinal beams 5, and a plurality of transverse beams 6 the ends of which are welded to and terminate at the inner surfaces of beams 5. The bottom 4 of the tank extends laterally beyond the beams 5 in order to meet the tank walls, and the outer lateral extremities of the bottom are supported on extension members 7 that are butt-welded to the outer surfaces of longitudinal beams 5 and that alternate with the cantilever members to be described below. The ends of the tank bottom4 are suitably shaped as shown at 4*a* and 4*b* to conform to the curvature of the chordal sections 2*a* and 3*a* of head members 2 and 3.

The walls or shell 8 of tank 1 are formed of sheets of stainless steel welded together according to conventional methods and shaped to quasi-cylindrical form in order to be registrable with head members 2 and 3. The lower areas of the walls 8 are exteriorly clad with dimpled steel plate to form a cooling jacket 9, the dimpled plate being spot-welded to the tank walls at 10 through the bases of the dimples 11. (FIGS. 3 and 7).

The jacket 9 is of known construction composed of a double layer of steel sheet, the inner layer being smooth and the outer layer dimpled, the two sheets in the layer being secured together but spaced apart by the depth of the dimples 11. It is to be understood that the peripheral edges of the dimpled sheets are flanged toward the smooth inner sheet, where they are welded together to form a liquid-tight seal.

The upper section of tank 1 carries spaced-apart reinforcing hoops 12 which extend from the top of cooling jacket 9 on one side of the tank to the top of the jacket on the opposite side. The hoops 12 are of channel structure and have flanges 13 (FIG. 3) through which the hoops are welded to the tank.

The lower section of tank 1 is reinforced and additionally supported by means of hollow L-shaped cantilever members 14 (FIG. 6) which alternate with extension members 7 are mentioned above. The short, horizontal portion or leg 14*a* of each member 14 is butt-welded to the longitudinal beam 5. The vertically-extending portion 14*b* of each member 14 is welded to a plate 15, the plate 15 in turn being welded at 15*a* to the exterior of the dimpled cooling jacket 9, each of the plates 15 being of sufficient width to cover approximately three of the dimples 11.

Certain elements in the tank structure are preferably subject to specific basic design requirements or specifications as follows:

SHELL, OR LINER, THICKNESS

$$t = k_1 R^{1/3} \quad \text{(I)}$$

Where — t = Shell thickness (inches)

R = Outside radius of upper half of vessel cross section (inches)

k_1 = Constant of proportion which is no greater than 0.028, and no smaller than 0.020.

LENGTH OF SIDE BEAMS

Cantilever side beams **14** are to be supported by integration with the steel frame or stiffening structure which supports the flat bottom of the vessel. The side beams extend to an elevation below the maximum width of the vessel cross-section, given by the following formula:

$$J = k_2 t^{0.75} \quad \text{(II)}$$

Where -

J = the difference in elevation, or vertical distance of separation, between the height of the vessel at its maximum width, and the height of the top of the side beams (inches).

t = Shell, or liner, selected material thickness within limits imposed by formula I (inches).

k_2 = Constant of proportion which is no greater than 160 and no smaller than 100.

Concerning the bearing, or contact, between side beams and dimpled jacket — the following conditions must be satisfied simultaneously:

a. The width of that surface of the side beams which is in contact with the dimpled jacket, and is called the bearing surface, is no more than one inch wider than the minimum width defined below:

$$W = k_3 L - (C/RL) \quad \text{(III)}$$

Where

W = Minimum width of the bearing, or contact, surface of side beams (inches).

L = Center to center spacing of adjacent side beams (inches)

R = Outside radius of upper vessel shell section (inches)

k_3 = Constant of proportion which is no greater than 0.21 and no smaller than 0.15.

C = Material constant which, for stainless steels lies between 10,000 and 15,000, and is determined by multiplying the flexural working stress of the head transfer jacket material by 0.346. This factor (0.346) corrects for differences from theoretical bending moment calculations on the jacket sections, between supports, resulting from the width of the supports themselves.

b. Based on the calculated average inside circumference of a jacket dimple, there must be a minimum of 2.9 inches combined average inside dimple circumference acting in direct compression between the vessel liner and each side beam, in every 2.25 inches of beam length.

It will be noted that at the point designated at **16** (FIG. 4) in the tank wall the general curvature of the wall flows into a straightened or non-curved section **17** that extends to the tank bottom **4**. That is to say, at point **16** the tank wall abandons the curvature of the head members **2** and **3** and diverges outwardly in relation to the periphery of the head members in order to conform to the configuration of the vertical portion **14b** of the cantilever members **14**. Due to the divergence of the lower portion of tank wall and cooling jacket a triangularly shaped opening is formed between the lower peripheries of head members **2** and **3** and section **17** of the tank wall. That opening is enclosed by means of a triangular box **18**, there being two such boxes at either end of the tank. Each of the four boxes **18** extends a short distance into the tank and the exposed face of each of the two boxes **18** at the front end of the tank serves as a support means for an influent header assembly **19** enclosing the open ends of the lower or in-flow section of dimpled cooling jacket **9**, the header assembly including influent conduits **20**. The upper or out-flow sections **19a** of the cooling jacket **9** are mounted endwise of the cooling jacket in the head **2** and include effluent conduits **21**. A coolant such as ethylene glycol enters and leaves the cooling system by way of conduits **20** and **21** respectively.

The ends of the tank walls and the boxes **18** are welded to the peripheries of the heads **2** and **3**, and the boxes **18** are welded to the cooling jacket **10**.

In order to facilitate flow of the coolant, the cooling jacket **9** is constructed of upper and lower horizontal sections **9*a*** and **9*b***, the side edges of the sections being welded together along horizontal line **9*c***, each section being separated from the other at the weld line, the dimpled plates forming each section being mounted in horizontal position with the exception of the end plates **9*d*** in the jacket (see FIG. 3) located adjacent head member **3**, those plates being mounted in vertical position in order to permit return flow of the coolant.

The head members **2** and **3** are provided with sight glass assemblies **22** and **23** and head member **2** includes a man-hole assembly **24** whereby a cleaning crew may have access to the tank.

The bottom of the tank slopes gently toward the tank end adjacent heam member **2** where a sump is provided in the tank bottom. The sump is emptied by means of pipe **25**.

The top of the tank may be provided with suitable openings to 1) accept an automatic device to facilitate pressure control within the tank and/or 2) provide a further man-hole means in addition to man-hole **24** whereby access to the interior of the tank may be had.

The exterior of the dimpled cooling jacket **9** is coated with "lagging" **26** which may take the form of any suitable insulating material and which may be applied with a towel or in the form of a spray. In FIG. 3 the lagging is broken away at one end of the tank to display a portion of the dimpled jacket.

We claim:

1. A quasi-cylindrical tank of substantially circular cross-section having a smooth, unobstructed interior and comprising, in combination, dished front and rear head members, unitary bottom, top and side wall sections secured to said head members to form a closed tank, a cooling jacket integral with the side wall sections, a plurality of interconnected metal beam members forming a frame mounted beneath and supporting said tank, and a plurality of angular reinforcing cantilever members rigidly interconnecting said frame and said cooling jacket independently of said side wall sections and embracing said cooling jacket.

2. A tank as claimed in claim 1, the bottom wall section being flat and wherein said dished front and rear head members are torispherical and have a chordal portion removed adjacent their lower peripheries, said chordal portions being in registration with the ends of said bottom wall.

3. A tank as claimed in claim 1, said frame including a plurality of extension members alternating with said angular reinforcing cantilever members, the said extension members extending outwardly from and being secured to the frame.

4. A tank as claimed in claim 1, said cooling jacket being formed of dimpled steel plate welded to the sidewall sections through the bases of the dimples.

5. A tank as claimed in claim 1, the top wall thereof including a plurality of reinforcing hoops.

6. A tank as claimed in claim 1, comprising also a plurality of metal plates, each of said angular reinforcing members being of hollow construction and each being welded to one of said metal plates, the plates in turn being welded to said cooling jackets.

7. A tank as claimed in claim 1, said tank top walls and the upper portion of said cooling jacket conforming to the circular configuration of said front and rear head members, the lower portion of said cooling jacket diverging from said circular configuration, the lower edge of said jacket on either side of the tank meeting the tank bottom at a point spaced from said head members.

8. The tank as claimed in claim 7, the divergence of said jacket defining a triangularly shaped opening between a portion of the periphery of each of said head members and said jacket, and a triangular box enclosing each said opening.

9. A tank as claimed in claim 8, comprising also an influent-effluent assembly arranged endwise of said cooling jacket thereby facilitating flow of a coolant, one of said assemblies being mounted on an exposed face of a said triangular box.

* * * * *