Dec. 4, 1934. G. E. ESCHER 1,983,355

STRUCTURAL TANK UNIT AND ASSEMBLY THEREOF

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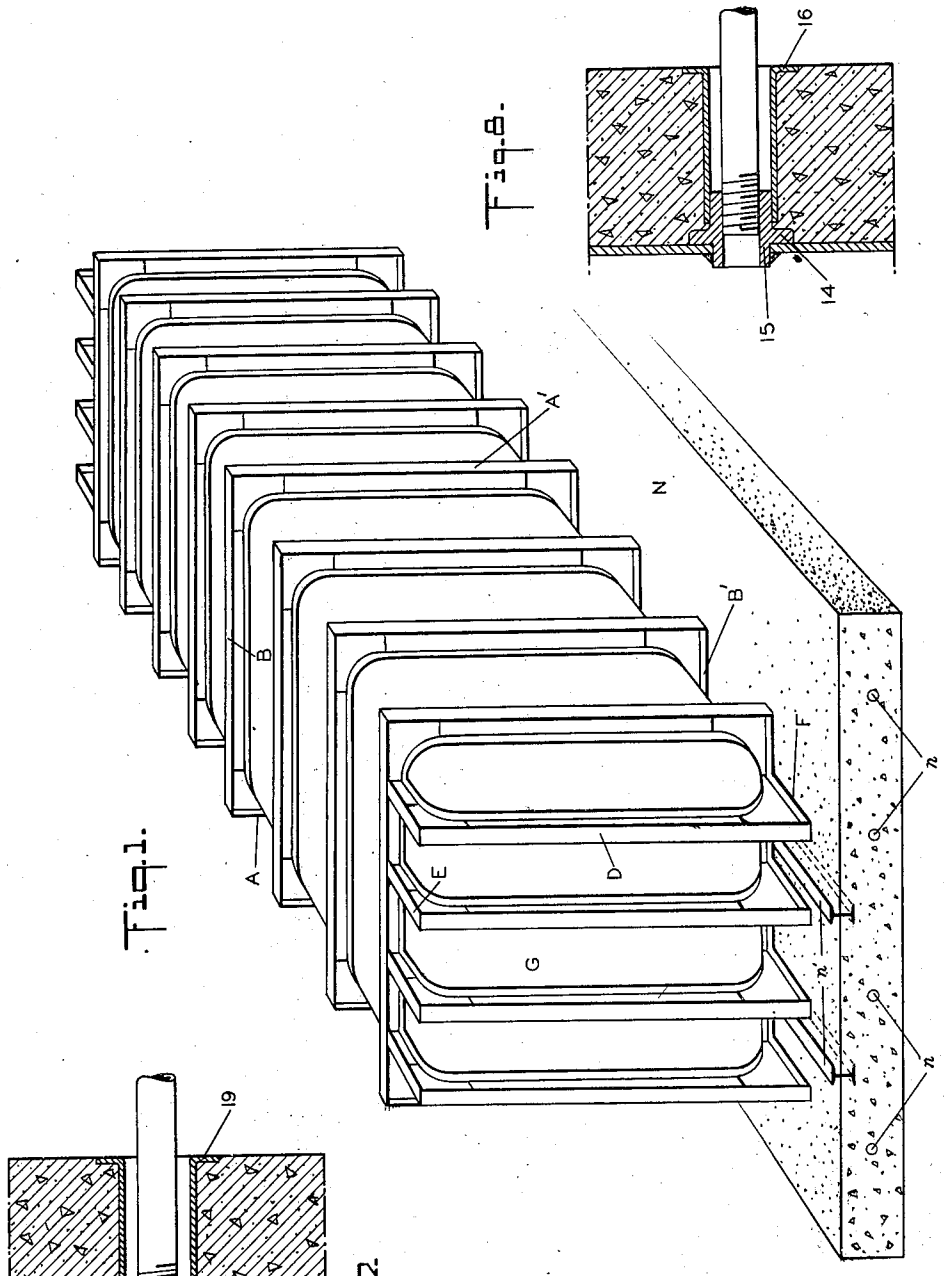


Fig. 1.

Fig. 8.

Fig. 2.

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STRUCTURAL TANK UNIT AND ASSEMBLY THEREOF

Filed Sept. 8, 1933 4 Sheets-Sheet 2

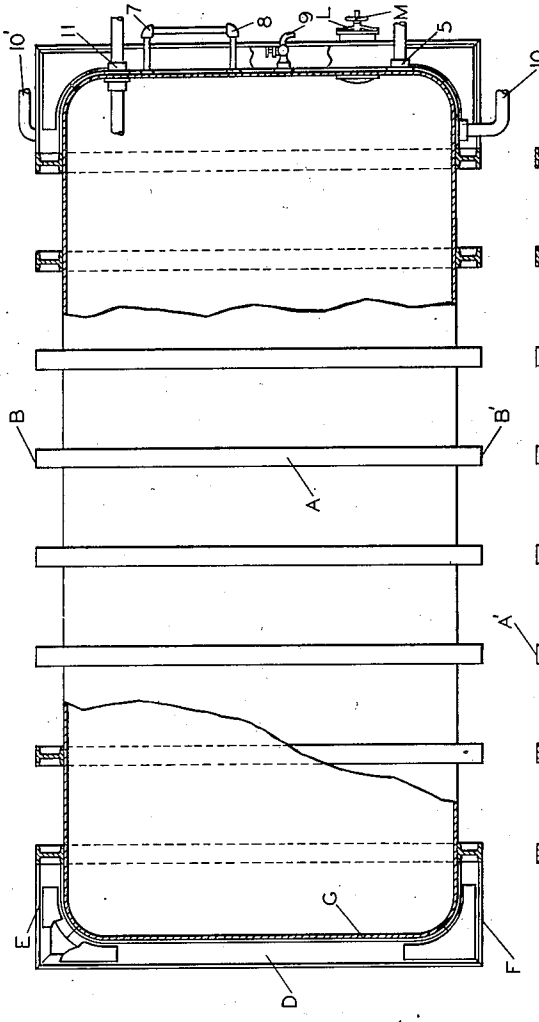


Fig. 3.

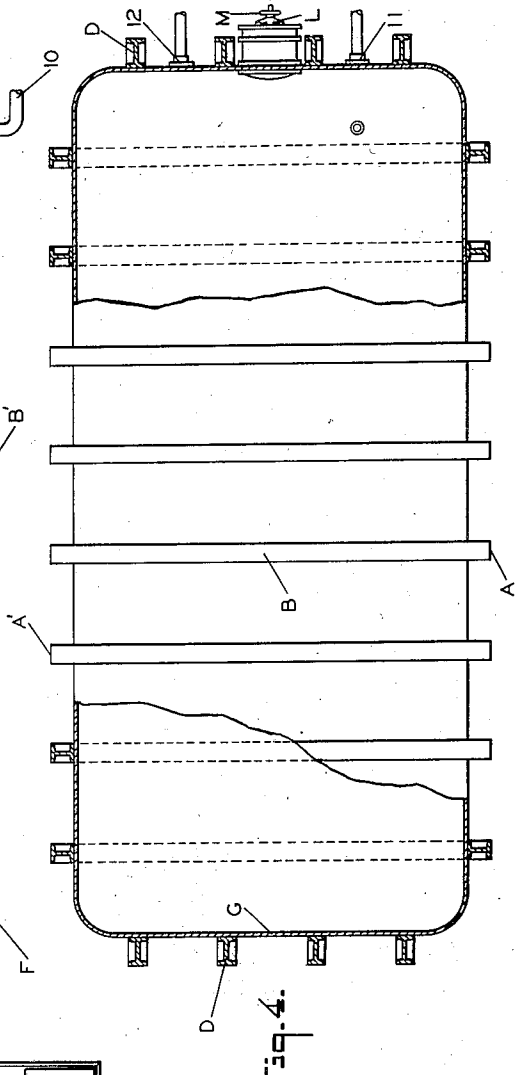


Fig. 4.

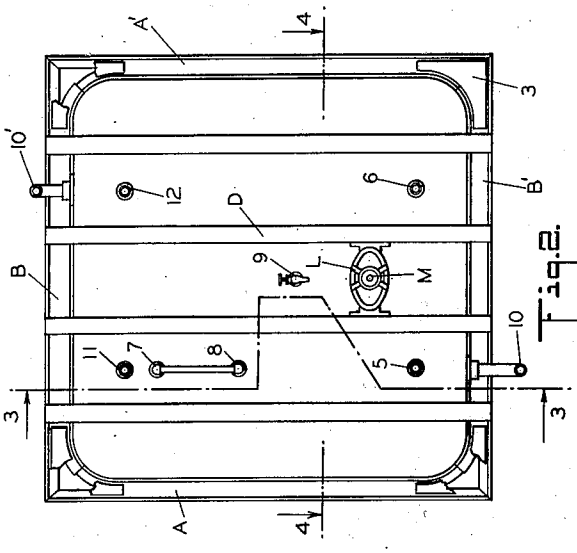


Fig. 2.

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STRUCTURAL TANK UNIT AND ASSEMBLY THEREOF

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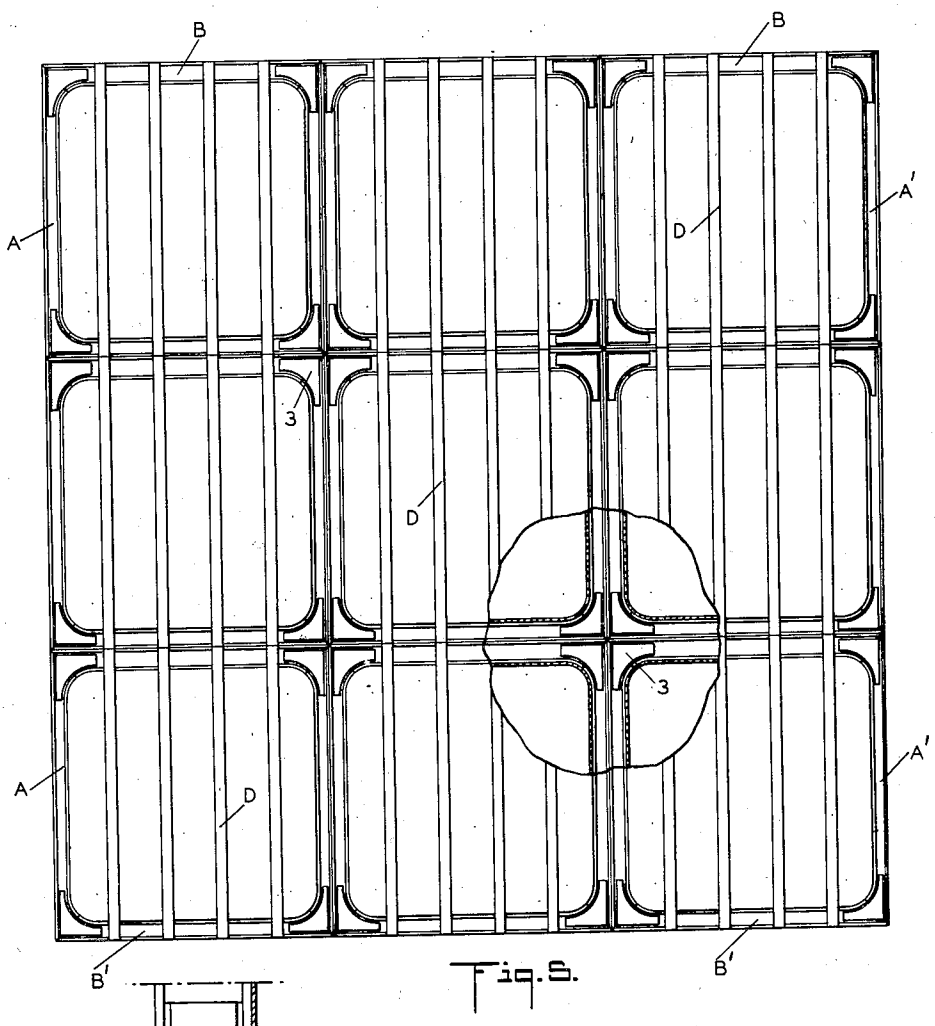


Fig. 5.

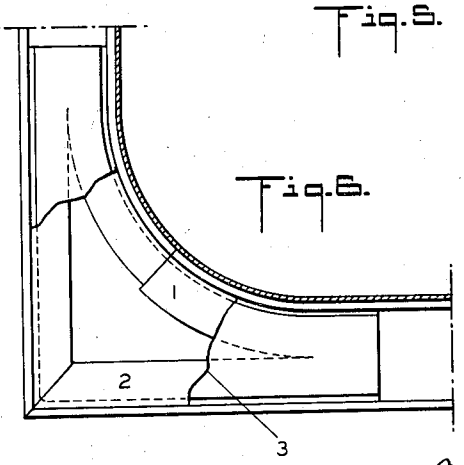


Fig. 6.

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STRUCTURAL TANK UNIT AND ASSEMBLY THEREOF

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Fig. 11.

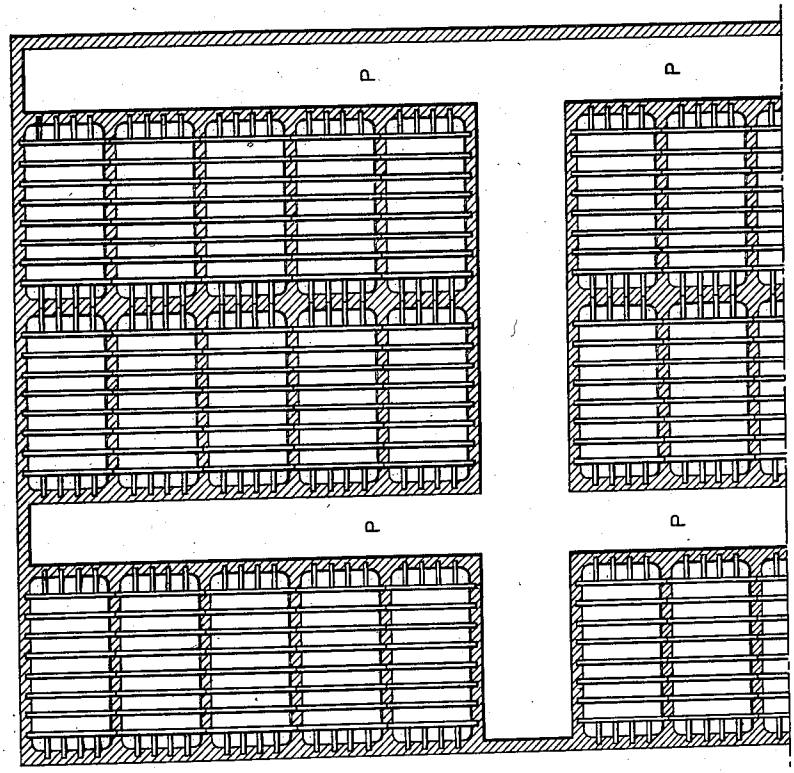


Fig. 9.

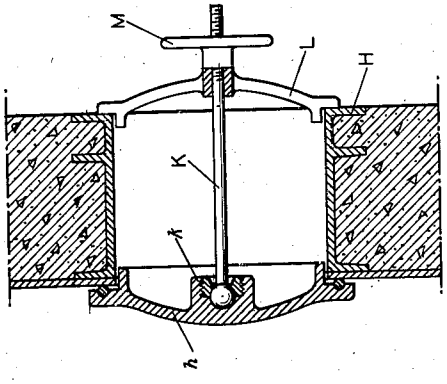
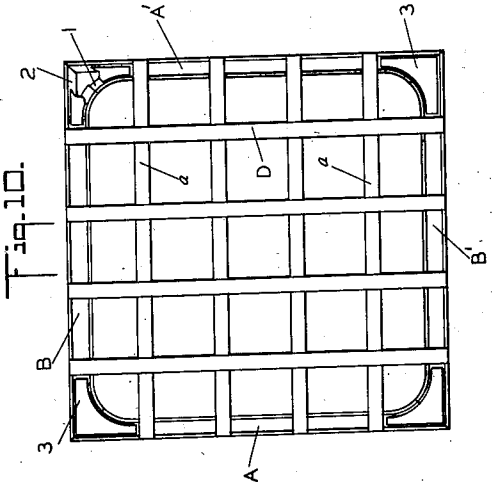


Fig. 10.



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Patented Dec. 4, 1934 1,983,355

UNITED STATES PATENT OFFICE

1,983,355

STRUCTURAL TANK UNIT AND ASSEMBLY THEREOF

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Application September 8, 1933, Serial No. 683,576

6 Claims. (Cl. 72—1)

This invention relates to structural tank-units and assemblies thereof, particularly suitable for use in constructing storage buildings having built-in tanks.

It has been common in the art heretofore to construct cellular reinforced concrete buildings having the individual cells lined with sheet metal to serve as tanks for liquids, for example, as fermenting tanks in breweries. In these prior constructions the strength of the concrete and of the metallic reinforcements, the position of any seams in the concrete due to different times of pouring, and cracks due to shrinkage or settlement were determinative of the success or failure of such a type of construction, and the necessary expense involved in caring for these features materially added to the cost of such buildings. Also, the construction was such that bracing was necessary inside the tanks when pouring the concrete, with resultant danger of marring the inner surfaces of the tanks.

The object of the present invention is to avoid the disadvantages of the reinforced concrete constructions and with this object in view it consists in providing a structural unit of such a type that a plurality of such units can be assembled to form a cellular structure in which the structural units will comprise post or column sections and girder sections of structural steel capable of withstanding and transmitting the principal stresses of the building, the post or column sections and girder sections of each unit being spaced apart and held in position by a metallic plate wall secured on the inside of the column sections and girder sections to form a continuous wall enclosing a space to form a chamber, the structural units in ordinary use being arranged in layers, or tiers or both, the column sections of one unit being arranged to be in contacting alignment with the columns of the adjacent sections in the tier and the girders being arranged to be placed in contacting alignment with the girders of the adjacent units in the layer. The spaces between the girders and columns of a unit, and also between the wall plates of adjacent units, are filled with a suitable filling material capable of transmitting distributing stresses from the wall of a unit to the adjacent frames of the same unit, and of locking together the frames of adjacent units. For such filling material concrete is particularly suitable, and on account of the construction of the units the walls of the latter serve as forms for pouring the concrete without requiring bracing inside such walls of the respective chambers.

Because of the structural features of the units embodying the present invention, the location of the joints between the respective pourings of the concrete, or the presence of cracks in the concrete, or the location of the same becomes unimportant, because the concrete is never called on to transmit anything more than thrusts from the wall of one unit to its adjacent framework members or by friction to prevent sliding of one member of a frame on its contacting adjacent member of another frame.

The invention will first be described in connection with the accompanying drawings and then more particularly pointed out.

In the drawings, Fig. 1 is a perspective view looking from the back of a structural unit embodying the invention, the chamber within the unit being intended to serve as a tank, as for example, a pressure tank in a brewery, the plate wall being liquid tight.

Fig. 2 is an elevation of the front end of the unit shown in Fig. 1.

Fig. 3 a vertical section on the line 3—3, Fig. 2.

Fig. 4 a horizontal section of the structural unit.

Fig. 5 a detail rear elevation, partly in section, on a reduced scale, showing three units side by side in a layer and three layers high to form three tiers of three units each.

Fig. 6 a detail view of the corner construction of each unit.

Figs. 7, 8 and 9 are detail views referred to hereinafter.

Fig. 10 a detail of a modification of the structural unit.

Fig. 11 is a diagram in the nature of a plan of part of a building, illustrating different ways of utilizing the structural units.

Referring to the drawings, and more particularly to Figs. 1 to 4, A, A^1 are sectional side posts or columns of any suitable structural metal cross-section suitable for columns, as for example, I-bars, as shown. To the upper ends of each pair of sectional side posts is connected an upper girder B of any desirable girder construction, as, for example, an I-beam. To the lower ends of each pair of sectional side posts is connected a lower girder, B^1, which, also, may be an I-beam. The side posts or columns A, A^1 with the upper girder B and the lower girder B^1 constitute a transverse frame, which is braced to form a rigid connection at each corner by a special construction that will give an arched surface of a width equal to the maximum width of the girders and posts, to form a good bearing surface for the wall plate at this point, such plate being correspondingly rounded to fit snugly against the said arched

surface. One way of making such a rigid connection between a girder and post is as shown in Fig. 6. The ends of the I-beams of the girder and post have the webs slit for a short distance back from the ends to form an inner branch 1 and an outer branch 2, the inner branch being bent inward away from the outer branch and curved as shown. The extreme ends of each branch are mitered as shown. The branches at the upper end of a post are brought into alignment with the branches at the corresponding end of its girder, and may be suitably united, for example, by oxy-acetylene or electric welding. A reinforcing corner-plate or gusset-plate 3 of suitable conformation to fit against the webs and up to the flanges of the post and girder is suitably secured in place, most advantageously by welding to the webs and flanges of the post and girder respectively. While one corner plate 3 may suffice in some cases, it is advantageous to employ two corner plates, one on each side of the web at each joint in order to give great strength against the heavy shear stress at the corners and to make the corner portions of the frames as rigid as possible.

A plurality of frames made as above-described are provided for each structural unit, these frames being arranged as transverse frames, that is to say, occupying positions transverse to the longitudinal axis of the chamber enclosed by the plate wall. The two transverse frames of a unit nearest the ends of the unit may be termed end-frames for purpose of reference hereinafter.

Each unit also comprises a plurality of end post or column sections, as indicated at D, Fig. 1, each post section being connected at its upper end to a short normal upper girder E by a joint similar to that used in connecting the corners of the frame, and also being connected at its lower end to a short normal lower girder F, by a similar joint. The other ends of the short normal girders E and F are connected to the adjacent end frame in any suitable way, as for example by welding, each of said girders extending in a direction normal to the plane of said end frame.

The transverse frames, the end post sections and the short normal girders constitute the framework of the unit. These are secured in their positions by a plate wall G in close contact with the inner surfaces of the framework and rigidly secured thereto as by electric welding which is entirely on the outside of the plate wall.

This exterior welding has the advantage that the inner surface of the plate wall may be continuous throughout and will be less marred than if other methods of securing the plate wall to the framework were employed. This is particularly advantageous in the present case, because it becomes possible to use a plate or sheet metal made of two layers or plies united into one sheet by heating and rolling, the inner ply or layer being of suitable stainless steel, that is chromium-nickel-iron alloy metal, while the outer ply is of another kind of steel which can be selected for its greater economy or other advantageous property. It will be noted that the plate wall encloses a space forming a chamber which if the wall be made liquid-tight will serve as a tank. In practice the plate-wall is made of sheets butt-welded to form a continuous wall, excepting for the manhead and pipe connections, hereinafter referred to. The frames, on account of their great strength due to their members being dimensioned to resist considerable pressures in the tank may readily be used also as part of the building framework, thereby materially reducing the cost of the same. The end posts with their short normal girders united to the end frames serve to retain the ends of the tank against any internal pressure and thereby prevent them from bulging outward. All the post or column sections act not only as columns to support compressive loads, but also as beams to carry any transverse loads, as for example, those due to unbalanced pressures where one tank is filled and an adjacent one empty. The spacing of the members of the framework is such that a plate-wall of normal sheet or plate thickness can be used to sustain any stresses either inward or outward on the plate-wall spanning the space between any two adjacent framework members and transmit such stresses to the said members. In the extreme case where one tank has its maximum pressure and an adjacent tank has no pressure, the pressure tending to bulge the wall of the loaded tank outward is resisted, not only by the frames of the loaded tank, but also by the contacting frames of adjacent tanks.

Each structural unit is provided at its front end with a man-hole thimble H located between a pair of end post sections and suitably secured thereto, the plate-wall being suitably fitted to the inner end of the thimble and welded thereto. A lid or cover *h* may be provided for the man-hole thimble, this usually being on the inside of the thimble and held in place in any suitable way as, for example, by a rod K connected to the center of the cover as, for example, by a ball and socket connection indicated at *k*, Fig. 9. The rod K extends outward through a removable yoke or spider L spanning the front end of the thimble, the rod being screw-threaded at the front end and being engaged by a hand-wheel M threaded to fit the threaded portion of the rod. In practice, the man-hole and head are elliptical, so the head when loosened may be withdrawn readily in the usual manner.

It is generally desirable to provide an inlet and outlet for pipe connections whereby the liquid may be admitted to or withdrawn from the tank. These are indicated at 5 and 6 respectively. At 7 and 8 are indicated connections for a liquid level gage, and at 9 a connection for a pipe for withdrawing samples from time to time. At 10 is shown a drain pipe. A vent pipe connection may be provided as indicated at 10^1, Fig. 1.

Where a refrigerator coil is to be placed in the tank, an inlet and an outlet connection for the brine pipes must be provided. These are indicated at 11 and 12 respectively.

In Fig. 8 is illustrated a form of construction suitable for the connections 5, 6, 7, 8, 9, 10 and 10^1 which are of non-corrodible metal such as stainless steel or the like at all parts which would come into contact with the liquid going to or escaping from the tank. As shown in Fig. 8, a threaded hub 14 of stainless steel or the like is arranged on the outside of the plate wall, and welded thereto. It has a thimble portion, indicated at 15, which fits through a hole in the plate wall, and is welded to the wall on the inside. Into the threaded portion of the hub may be screwed a pipe of stainless steel or the like extending outside the structural unit. The hub may also be provided with a sheath or thimble 16, extending to the outer face of the front wall and flanged to be flush with said outer face. This sheath or thimble may be welded to the hub 14.

The connections for the brine pipes of the refrigerator coils, if such are used, may be made

as shown in Fig. 7. This comprises a hub 17 of stainless steel in the inside of the tank wall and welded thereto, this hub being threaded to receive the end of the pipe of the refrigerator coil. A hub 18 is welded to the outside of the wall and is threaded to receive the threaded end of the exterior brine pipe. The hub 18 also is provided with a sheath or thimble 19 which extends to the outer face of the front wall and is flanged to be flush therewith.

The structural tank units may be constructed complete in the shop and transported to the site of the building, or the parts may be prepared and the units completed by welding adjacent the site for the building and then put in place as completed units.

With the structural units thus far described it is understood that when completed they will rest on a concrete foundation, and that the spaces between the frames, girders and end posts will be filled with a suitable filling material. While this filling material may be of various kinds, in practice concrete is advantageous.

An assemblage of structural units will now be described where concrete is used as the filling material and some of the posts and girders of the structural units form parts of the outer and inner building walls.

In the construction of a storage building having a plurality of tanks, a concrete foundation slab N, suitably reinforced with metallic reinforcements as for example, rods n and bars n^1, in the upper face of the slab, is laid down, in the usual way. Upon this slab a series of completed structural units, each made as hereinbefore described, is placed, in such order as may be desired. Usually the front ends of the tanks, which have the manholes, abut on a corridor indicated at P, Fig. 11. One row of structural units may have its rear ends against and forming part of an adjacent wall of the building, so that the sets of end post or column sections at the rear will serve to form the columns for such outer wall of the building. The inner row of structural units are arranged with their rear ends abutting against each other, the post or column sections of one unit being in close contact with the corresponding post or column sections of the structural unit to the rear of it. In this arrangement the side post or column sections of two units form parts of the outer building wall, as shown in Fig. 11. The inner walls are made by erecting forms and pouring concrete where desired.

When the structural units forming a complete layer are in position, suitable outside forms may be placed for the building walls and the concrete poured not only to form the outer walls of the building but to fill the respective channels which exist between the frames and between the end posts of the structural units. It is one of the advantages of the invention, that the forms may be clamped to the framework of the units, and thus avoid the necessity for outside shoring or inside forms.

It is to be particularly noted that the horizontal spaces between the lower girders connect with the vertical spaces between the corresponding side post or column sections, to form conduit-like channels, so that a proper concrete mixture filled into the upper end of the said channels will flow down the vertical portions of the channel and then horizontally through the horizontal portion of the respective channels. On account of the relatively large radius of the curve at the rounded corners of the tanks the concrete may flow freely into the horizontal portion, particularly as a gravity head will build up in the vertical portion of the channels as they fill up. By employing any suitable means for agitating the concrete while still soft, as is customary in practice, the concrete flows readily into the horizontal portions of the channels and, under the gravity head due to the gradual filling up of the vertical portions of the corresponding channels, the concrete in the horizontal portions is put under pressure and thereby completely and solidly fills its spaces, a result which is obtainable only because of the formation of close conduit-like channels by the girder sections and column sections. In practice the concrete is poured down the vertical portion of the channel and allowed to run through the horizontal portion until it fills the entire horizontal portion, whereupon concrete is poured in the next vertical portion of a channel. In this way all trapping of air in the horizontal portion is avoided. The outer wall of the building is completed to a level just below that of the underside of the upper girders, that is, to the beginning of the corner curves, and the vertical channels are filled to the same level. Then the next layer of units is put in place and the concrete is poured as before, running into the spaces between the upper girders of the lower layer as well as into the spaces between the lower girders of the upper layer, the upper ends of the vertical channels of said lower layer being filled at the same time. The outer wall forms may be lifted up for the additional height of wall and the further pouring of concrete proceeded with as before.

It is particularly to be noted that in the completed structure the concrete is in sections of a width equal to the distance between frames or between end post sections. This is an important advantage because the spaces due to shrinkage widthwise of the channels are reduced to a minimum. It is true there may be some shrinkage lengthwise in the horizontal portions of the channels, but as these portions are cast under pressure the shrinkage will be reduced so as not to be injurious.

Under, some circumstances, as for example, where the tanks may have to be removed, or where the building is already erected, it may be desirable to employ an assemblage of structural units without concrete in the spaces.

In this case the plate-wall portions between the frames and between the end post sections may require some support as a part of the framework. This may be provided by supplying intermediate stiffeners consisting of short lengths of structural steel of any suitable cross-section extending between the frames and end posts and contacting with the outside of the plate-wall. Such a modification is illustrated in the detail view Fig. 10, where the stiffeners are indicated at a. These may be welded to the respective members of the framework, either posts or girders and, most advantageously to the plate-wall.

In the absence of the concrete the abutting members of two adjacent units may be secured in any suitable way as for example by welding after erection to cause such abutting members, either posts, or girders, to act as one member.

It will be noted that as a result of the construction described the plate-wall has a smooth unobstructed inner face, that is to say, a face free from cavities in which sediment or residues could be trapped in such a way as to require special care in cleaning the tank to remove it, and also

a face free from projections or protuberances of such a nature as would shade portions of the surface from the direct action of a stream of water thrown by a hose in cleaning the tank, as for example, from the open man-hole in the customary way. It has long been recognized in the brewing art that tanks for beer, and particularly beer-fermenting tanks, must have sanitary linings which can be cleaned readily, that is, cleaned without resorting to special precautions and treatment, to free the tank from residues, as these are likely to serve as culture spots for microbes which injuriously affect the stored liquid. Such a sanitary inner surface for the tank is provided by the present invention and is correlative to the formation of the plate-wall in the way most favorable mechanically to transmit tensile stresses from one member to another of the building structure members, that is, the post sections and girder sections which carry the plate wall.

What is claimed is:

1. A structural unit for storage buildings, comprising a plurality of transverse closed frames, each frame consisting of side post sections, upper girder sections rigidly connected to the upper ends of the side post sections, and lower girder sections rigidly connected to the lower ends of the side post sections, two of the frames constituting end frames of the structural unit, said unit also comprising end post sections carrying upper and lower short normal girders rigidly connected to the respective end posts and also secured to the respective end frames, said frames and end-post sections being spaced apart and held in position by a plate-wall secured to the inside of said frames and end post sections to enclose the space within the same, and distribute stresses from frame to frame and from the end post sections to the frames, said plate-wall being liquid-tight and formed to provide a smooth, unobstructed, readily cleaned, sanitary inner face for the tank.

2. A structural unit for storage buildings comprising a framework consisting of a plurality of transverse closed frames, each frame consisting of side post sections, upper girder sections rigidly connected to the upper ends of the side post sections, and lower girder sections rigidly connected to the lower ends of the side post sections, two of the frames constituting end frames, said framework also comprising end post sections carrying upper and lower short normal girders rigidly connected to the respective end posts and also connected to the respective end frames, the connections of the girders and posts forming rounded corners, with relatively large radius of curvature, on the inside of the frame, said structural unit also comprising a substantially continuous plate-wall, fitting the inside of the framework and in close contact therewith and rounded at the corners, said wall being welded to the framework outside the wall and formed to provide a smooth, unobstructed, readily cleaned, sanitary inner face for the tank.

3. A structural unit for storage buildings comprising a framework consisting of a plurality of transverse closed frames, each frame consisting of side post sections, upper girder sections rigidly connected to the upper ends of the side post sections, and lower girder sections rigidly connected to the lower end of the side post sections, two of the frames constituting end frames, said framework also comprising end post sections carrying upper and lower normal girders rigidly connected to the respective end posts and also connected to the respective end frames, the connections of the girders and posts forming rounded corners, with relatively large radius of curvature, on the inside of the frame and comprising reinforcing plates, said structural unit also comprising a substantially continuous plate-wall, fitting the inside of the framework and in close contact therewith and rounded at the corners, said wall being welded to the framework outside the wall and formed to provide a smooth, unobstructed, readily cleaned, sanitary inner face for the tank.

4. A structural unit for storage buildings comprising a framework consisting of a plurality of transverse closed frames, each frame consisting of side post sections, upper girder sections rigidly connected to the upper ends of the side post sections and lower girder sections rigidly connected to the lower ends of the side post sections, two of the frames constituting end frames, said framework also comprising end post sections carrying upper and lower short normal girders rigidly connected to the respective end posts and also connected to the respective end frames, the connections of the girders and posts forming rounded corners, with relatively large radius of curvature, on the inside of the frame, said structural unit also comprising a plate-wall fitting the inside of the framework and in close contact therewith and rounded at the corners, said wall being welded to the framework outside the wall, said structural unit also comprising a man-hole thimble secured to a pair of end post sections at the front end of the unit, the plate-wall having an opening in alignment with the thimble and being secured to the thimble by welding, the plate-wall being continuous at all places except the man-hole to form a liquid-tight pressure tank when the man-hole is closed by a cover, said plate-wall being formed to provide a smooth, unobstructed, readily cleaned, sanitary inner face for the tank.

5. An assembly of structural units, each unit comprising a plurality of transverse closed frames, each frame consisting of side post sections, upper girder sections rigidly connected to the upper ends of the side post sections, and lower girder sections rigidly connected to the lower ends of the side post sections, two of the frames constituting end frames of the structural unit, said unit also comprising end post sections having short normal girders rigidly connected to the respective end post sections and also secured to the respective end frames, said frames and end post sections being spaced apart and held in position by a plate wall secured to the inside of said frames and end post sections to enclose the space within the same, and distribute stresses from frame to frame and from the end post sections to the frames, the frames of each unit being spaced to align with the frames of the other sections, said units being arranged in layers and tiers with their respective girders aligned in the layers and their respective posts aligned in the tiers, and thrust-transmitting filler material filling the spaces between the plate walls of the different units and also between the individual frames and end posts of the units.

6. An assembly of structural units, each unit comprising a plurality of transverse closed frames, each frame consisting of side post sections, upper girder sections rigidly connected to the upper ends of the side post sections, and lower girder sections rigidly connected to the lower ends of the side post sections, two of the frames constituting

end frames of the structural unit, said unit also comprising end post sections having short normal girders rigidly connected to the respective end post sections and also secured to the respective end frames, said frames and end post sections being spaced apart and held in position by a plate wall secured to the inside of said frames and end post sections to enclose the space within the same, and distribute stresses from frame to frame and from the end post sections to the frames, the frames of each unit being spaced to align with the frames of the other sections, said units being arranged in layers and tiers with their respective girders aligned in the layers and their respective posts aligned in the tiers, and concrete filling the spaces between the plate walls of the different units and also between the individual frames and end posts of the units.

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