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C. L. DAY
CONTAINER

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2 Sheets-Sheet 1

Fig. 1.

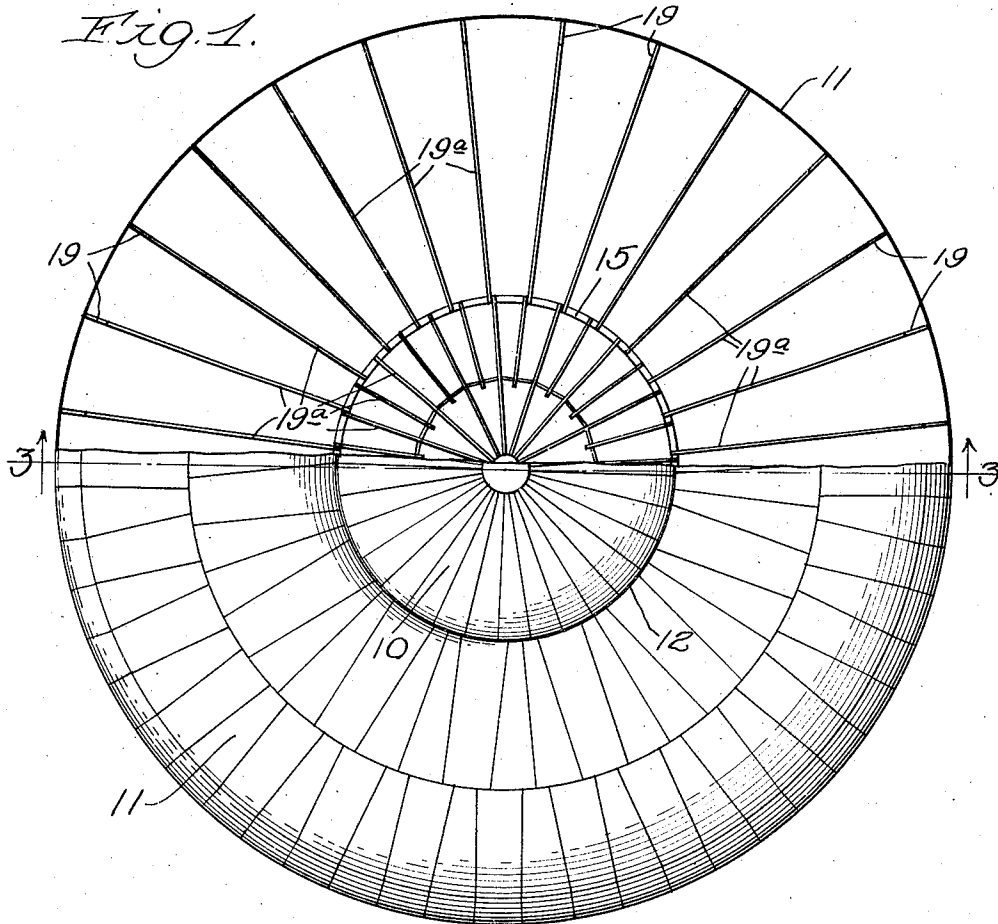
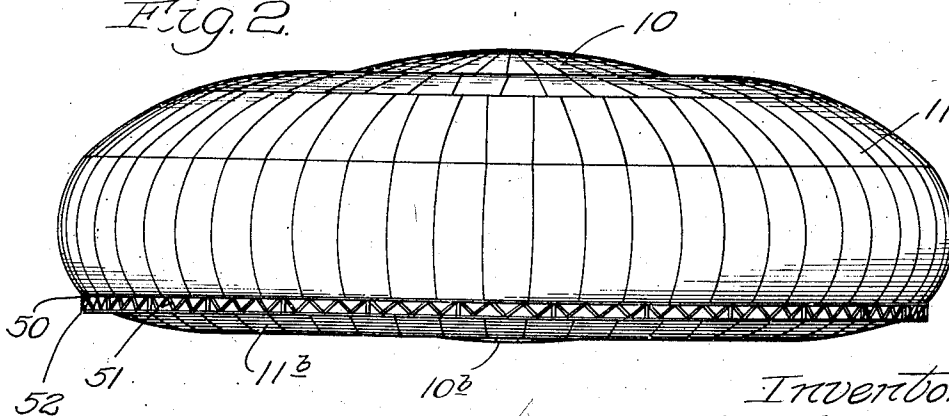


Fig. 2.



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UNITED STATES PATENT OFFICE

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CONTAINER

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2 Claims. (Cl. 220—1)

This invention relates to improvements in containers, and is here shown as embodied in a container especially adapted for holding liquids under pressure.

In describing the invention, reference may be made to the following United States Patents, namely: 1,622,787, Horton, March 29, 1927; 1,778,944, Horton, October 21, 1930; 1,885,601, Horton, November 1, 1932; 1,928,640, Boardman, October 3, 1933. In a sense, the present invention may be considered as a combination of one or more of the inventions disclosed in one or more of said prior patents.

Among the features of my invention is the provision of a container in the form of a solid of revolution about a central vertical axis comprising a central portion with an upwardly curved top and a downwardly curved bottom, having its periphery closed by one or more peripheral portions each in the shape of a flattened torus, and the provision of tension members joining the top and bottom where the separate portions join, that is, the tension members unite the node circles.

Another feature of my invention is the formation of the central portion with a substantially spherical curvature at the top and bottom. If desired, however, such central portion may have a curvature more or less conforming to the curvature of the central portion of any of the containers shown in any of the three Horton patents above mentioned. I prefer, however, to curve the bottom of the central portion downwardly so that it will conform more to the curvatures shown in Horton Patents 1,778,944 and 1,885,601 than to the flat bottom shown in Horton Patent 1,622,787. The peripheral portion in the general shape of a flattened torus may have a curvature conforming generally to the curvature shown in Figs. 3, 4 and 5 of Boardman Patent 1,928,640. Of these three forms I prefer that shown in Fig. 4 with the downwardly curved bottom rather than the flat bottoms. If more than one peripheral portion is employed each may be in the general shape of a flattened torus, for example, as shown in Fig. 4 of Boardman Patent 1,928,640.

Other features and advantages of my invention will appear more fully as I proceed with my specification.

In those forms of devices embodying the features of my invention shown in the accompanying drawings, Fig. 1 is a top plan view partly in section, Fig. 2 is a view in side elevation, Fig. 3 is a view taken as indicated by line 3 in Fig. 1,

and Fig. 4 is a view similar to Fig. 3 showing a modified form.

As shown in the drawings, the closed container of Figs. 1, 2 and 3 is in the form of a solid of revolution about a vertical central axis. This container includes a central portion 10 with an upwardly spherically curved top 10^a and a downwardly curved bottom 10^b. The periphery of the central portion is closed by a peripheral portion 11 in the general shape of a flattened torus. The central portion joins the peripheral portion at the top on the circle 12 which may be called the upper node circle. The central portion joins the peripheral portion at the bottom on the circle 13 which may be called the lower node circle. The curvature of the peripheral portion 11 may resemble in general the curvature of one of the containers in Figs. 3, 4 or 5 of Boardman Patent 1,928,640. As here shown it resembles most closely the form shown in Fig. 4 of said Boardman patent having a downwardly rounded bottom. That is, the bottom 11^b of the peripheral portion 11 may be substantially cylindrically curved the same as the bottom 212 of the container in Fig. 4 of Boardman Patent 1,928,640.

15 indicates a circular girder at top of the container adjacent the upper node circle and 16 indicates a similar girder at the bottom of the container at the lower node circle. The circular girders 15 and 16 are joined by a plurality of tension members 17, 17. These members may also serve, at times, as compression members.

18 may indicate a vertical central post which may serve both as a compression and tension member or either.

Inside of the container I provide means for bracing the shell against distortion which might otherwise be caused by undue pressures negative or positive. As here shown, this bracing is in the form of vertical trusses 19 at the sides of the container and radial trusses 19^a at the top. This trussing is shown more or less diagrammatically as the details of same are not of great importance in connection with the present invention. It will suffice to say that sufficient trussing is employed to suitably stiffen and strengthen the container against any stresses or strains to which it may be subjected.

The form of container shown in Fig. 4 is similar to that above described except that two peripheral portions are used. As here shown the central portion is indicated by 110 and the same may have a spherically curved top 110^a and a spherically curved bottom 110^b. Around the central portion 110 is the inner peripheral portion 111.

This portion may have a curvature resembling generally, for example, in Fig. 4 of Boardman Patent 1,928,640. Outside of this portion there is an outer peripheral portion 111^a which may also have a curvature resembling the curvature shown in Fig. 4 of Boardman Patent 1,928,640. In other words, in the container in Fig. 4 there is a central portion with an upwardly curved top and a downwardly curved bottom. Outside of this lies an inner or intermediate peripheral portion with both its inner edges and outer edges open. The outer open edge of this inner or intermediate peripheral portion is closed by an outer peripheral portion 111^a. In a device of this kind there will be two node circles at the top, namely, 112 and 112^a and two node circles at the bottom, namely, 113 and 113^a. 115 and 115^a indicate upper circular girders just under the upper node circles, and 116 and 116^a indicate circular girders just above the lower node circles. The inner and outer pairs of girders are connected by the vertical posts or tension members 117 and 117^a. 118 indicates a central vertical post.

50 indicates an external ring girder at the junction of the bottom and sides. This ring girder may be supported by diagonal and vertical members 51 resting on a lower ring 52 which may rest on the ground 53. 54 may indicate horizontal members joining the ring 52 with the container to assist in holding the former in place.

As stated above, I have shown in Fig. 3 the use of a single flattened torus around the central portion. In Fig. 4, I have shown the use of two such flattened tori around the central portion. It is obvious that any number of such portions may be used. In general, for a given diameter, the higher the gas pressure the greater will be the number of flattened tori portions which can be advantageously used. One of the principal features is to transmit a large portion of the upward gas pressure on the roof plates to the bottom through the columns or ties 17, 117, and 117^a connecting the ring girders on the upper and lower node circles. If this were not done the entire upward gas pressure would be carried by the side sheets and when the container held little or no liquid would tend to raise the bottom plates off of the foundation and induce excessive ring compression stresses in the ring girder and adjacent bottom and side sheets.

The container is especially adapted for holding liquids under pressure, for example, volatile liquids like gasoline and light oils where the evaporation causes an internal gas pressure. By holding such pressure up to a certain point evaporation may be lessened or eliminated.

In a sense, the invention may be considered as a combination of the inventions disclosed, for example, in Horton Patent 1,778,944 and Boardman Patent 1,928,640. The internal vertical trusses 19 of Fig. 3 and 119 of Fig. 4, may be used as a framework for assisting in holding any overhanging plates during erection and are used after completion to assist in carrying the overhanging liquid load to the external ring girder 50 (or 150 of Fig. 4). The radial trusses 19^a and 119^a serve as a framework for the roof plates and may serve as a support for scaffolding during erection. They help to hold the roof in shape when the container is not subjected to its normal liquid and gas loads. The ring girders 15, 115 and 115^a connected to the ring girders under them by the posts 17, 117 and 117^a also assist in supporting the roof when the container is

not subjected to its normal liquid loads and these vertical posts also serve as tension members to counteract internal pressure in the container.

An important feature of the invention is the provision of the nodes in the roof and bottom plates with girders inside adjacent said nodes connected by ties to enable the roof and bottom plates to transmit the upward gas pressures over predetermined areas. The bottom rests in one or more annular troughs and one spherical segment scooped out of the ground. The normal upward liquid level is the plane of the uppermost node circle. The upper central spherical segment is not normally filled with liquid because its storage volume is not sufficient to offset the cost of providing for the stresses which would be caused if it were filled. The nominal liquid capacity is normally between the plane of the uppermost roof node circle and the plane of the uppermost bottom node circle, the space in the trough normally being dead or unused space.

The trough radii of curvature are so chosen as to as nearly as possible balance the horizontal radial components of the stresses in the plates meeting at a ring girder. The trusses may be welded to the shell. A concrete ring wall 70 may be employed under the ring 52, and a ring wall 170 under the ring 152.

Although the formula

$$r_2 = \frac{T}{P - \frac{T}{r_1}} \text{ or } T = \left(\frac{1}{\frac{1}{r_1} - \frac{1}{r_2}} \right)$$

referred to in Horton Patent 1,622,787 and Boardman Patent 1,928,640 is theoretically used in developing the shell curves for the flattened toroidal segments, practically no strict adherence to this ideal form is necessary when the internal trussing and framing construction shown in the drawings is used. In actual use the loading conditions are frequently not normal, for example, when there is gas pressure but no liquid present. Since internal trussing, framing, tension and compression members and the like are necessary to take care of the stresses when the load conditions are not normal, it is not necessary that the ideal curvature be employed.

It will be seen that in the structure of Fig. 3, for example, the central portion 10 may be called a central portion with a dome-like top. The periphery of this is closed by the peripheral portion 11 in the general shape of a torus with a roof-like top. The dome-like top of the central portion and the roof-like top of the peripheral portion meet at the upper node circle 12 at an angle less than 180°. In the form of Fig. 4 there are a plurality of concentric peripheral portions.

While I have shown and described certain embodiments of my invention, it is to be understood that it is capable of many modifications. Changes, therefore, in the construction and arrangement may be made without departing from the spirit and scope of the invention as disclosed in the appended claims, in which it is my intention to claim all novelty in my invention as broadly as permissible, in view of the prior art.

What I claim as new, and desire to secure by Letters Patent, is:

1. A closed container in the form of a solid of revolution about a vertical central axis, including, a central portion with a dome-like top and a bottom, and a peripheral portion in the general shape of a torus including a roof-like top, the

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dome-like top of the central portion and the roof-like top of the peripheral portion meeting at an angle of less than 180° .

5 2. A closed container in the form of a solid of revolution about a vertical central axis, including, a central portion with a dome-like top and a bottom, and a plurality of concentric peripheral

portions each in the general shape of a torus including a roof-like top, the dome-like top of the central portion and the roof-like top of the inner peripheral portion meeting at an angle of less than 180° .

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