March 26, 1968 L. M. HERFF 3,374,916

LIQUID STORAGE TANK

Filed Oct. 10, 1966

FIG. 1.

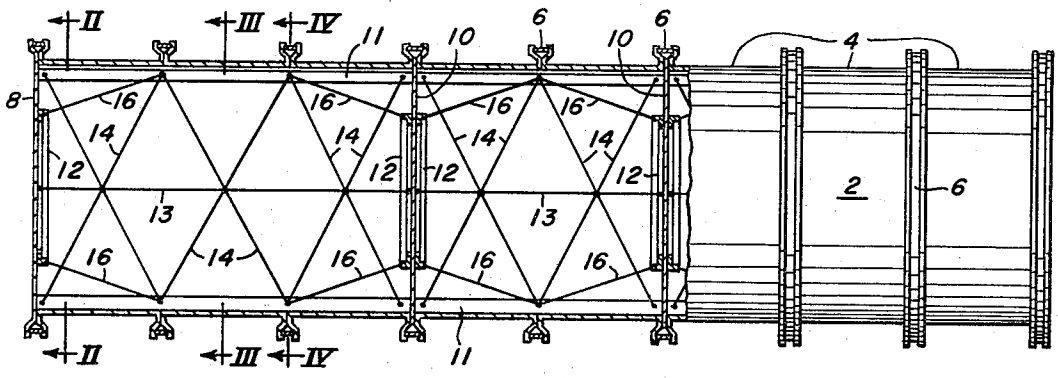


FIG. 2.

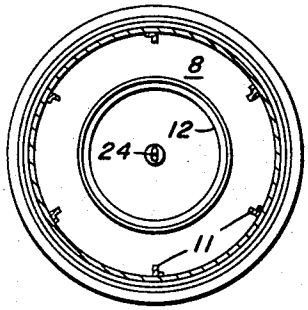


FIG. 3.

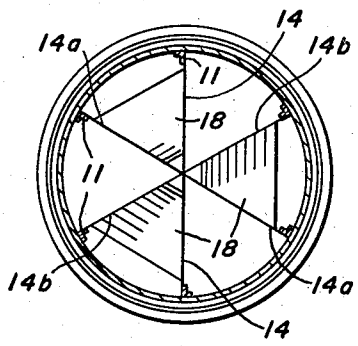


FIG. 4.

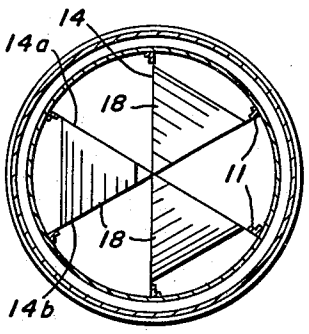
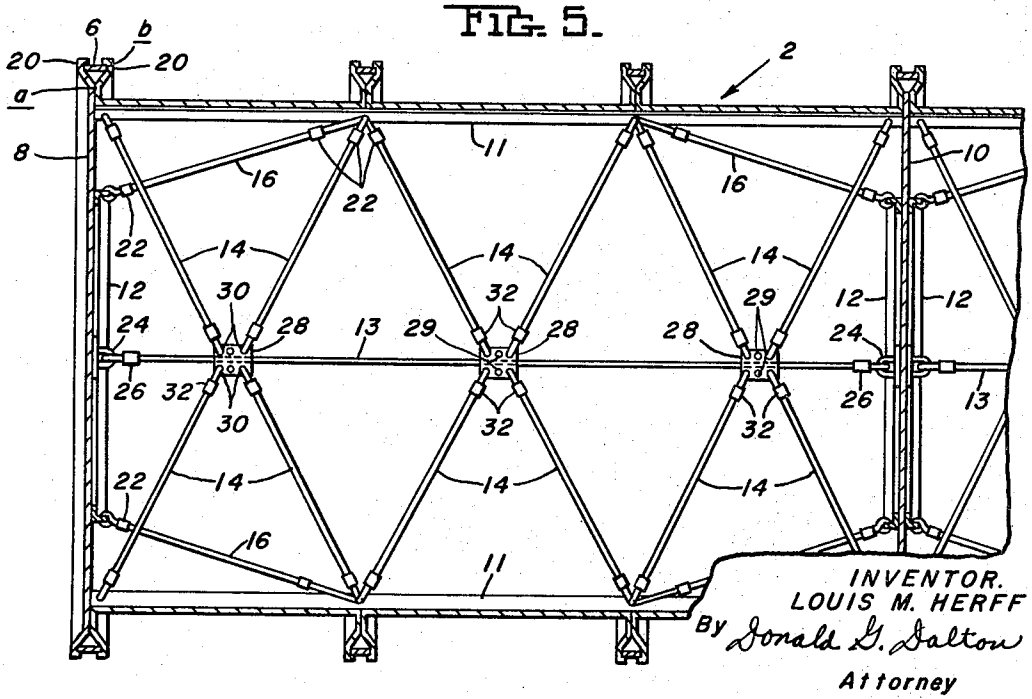


FIG. 5.



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LIQUID STORAGE TANK

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6 Claims. (Cl. 220—5)

This invention relates to the construction of large tanks that are used for storing liquids, such as oil, milk, or water, during their transport over highways or railroads.

An object of my invention is to provide a transport tank construction that has improved strength, yet is lightweight and easy to assemble. In addition, my invention also solves a particularly troublesome problem caused by the inertia of a large mass of liquid inside a transport tank that is decelerating. During deceleration of the tank, the liquid inside is thrown against the front end plate of the tank, causing great stress on this plate and the weld which secures the plate to the other walls of the tank.

One method of reducing the stress on the end plate of the tank during deceleration has been to install intermediate plates or bulkheads inside the tank to divide the mass of liquid into smaller parts. Thus, each bulkhead or end plate receives only a part of the total force which the end plate would receive were it not for the bulkheads. While intermediate bulkheads do help to solve this stress problem, they alone are not satisfactory where a large mass of liquid is to be carried. This is due to the large number of bulkheads that are needed to withstand adequately the inertial force of the liquid, and the weight of these bulkheads themselves causes a problem. The total weight of the tank with the bulkheads is extremely heavy in proportion to the load that it is able to carry.

With my invention, the number of bulkheads needed for a transport tank is reduced by the employment of a series of lightweight baffle elements, which are placed to create turbulence in the liquid cargo and absorb the inertial force of the liquid in the tank. In addition, these baffle elements are part of a novel, lightweight structure which greatly strengthens the entire tank without a substantial increase in weight.

Other objects and advantages of my invention will appear more readily from the following description of my invention and the attached drawings in which:

FIGURE 1 is a side elevation of a transport storage tank for liquids, with a portion thereof broken away in longitudinal section;

FIGURE 2 is a cross-sectional view of the tank of FIGURE 1, taken along line II—II of FIGURE 1;

FIGURE 3 is a cross-sectional view of the tank of FIGURE 1, taken along line III—III of FIGURE 2;

FIGURE 4 is a cross-sectional view of the tank of FIGURE 1, taken along line IV—IV of FIGURE 2; and

FIGURE 5 is an enlarged longitudinal section of part of the tank of FIGURE 1.

Referring to FIGURE 1, a storage tank **2** is made of a number of cylindrical shell sections **4** that are welded together and reinforced by stiffening rings **6**. The tank is closed on either end by end plates **8**, and bulkheads **10** divide the tank into several compartments. Preferably all of the foregoing parts of the tank **2** are of stainless steel, because it is a high strength, relatively lightweight material, and has excellent weldability by the resistance welding process. Six longitudinal stiffeners **11** in the form of steel angles are spaced equally around the inner wall of the tank **2** to increase lengthwise rigidity of the tank. The end plates **8** and bulkheads **10** are made more rigid by circular stiffeners **12**, welded to the inside surfaces of the end plates and to both sides of the bulkheads. The circular shape of one of the stiffeners **12** may be seen in FIGURE 2.

As shown in the broken away part of FIGURE 1, there is a network of cables within the tank **2**. The cables shown in this figure are only the ones which are located in one plane extending diametrically through the tank **2**. They comprise primary cables **13** extending along the axis of the tank and attached to the centers of the end plates and bulkheads. Also, secondary cables **14** are connected between the longitudinal stiffeners **11** and primary cables **13**. The secondary cables **14** are at an angle with the primary cables **13**, being attached to the stiffeners **11** at points adjacent where the cylindrical sections **4** are joined, and to the cables **13** at nodes midway between the junctions of the sections **4**. Other secondary cables **16** are connected between each longitudinal stiffener **11** and the circular stiffeners **12** on the end plates **8** and bulkheads **10**.

The tank **2** actually has three times as many cables **14** and **16** as are shown in FIGURE 1, since there are additional sets of these cables, like the one shown in FIGURE 1, in two planes located 60° to either side of the plane in which the section of FIGURE 1 is taken. Some of the cables **14***a* and **14***b* in these two planes may be seen in the cross-sectional views of tank **2** in FIGURES 3 and 4.

The cables **13**, **14** and **16** are all fastened so that they are held taut, and thus they serve to add rigidity to the walls and bulkheads of the tank **2**. The primary cables **13** and the secondary cables **16** keep the bulkheads **10** and end plates **8** from bulging in their central areas, and thus increase the ability of these members to withstand the forward and rearward inertial forces of the liquid cargo during acceleration or deceleration of the tank.

In addition to increasing the rigidity of the walls of the tank **2**, the secondary cables **14** also support a number of triangular-shaped baffle elements **18**, shown in FIGURES 3 and 4. The elements **18** are connected across alternating spaces between the cables **14**, and are preferably made of lightweight, high-strength stainless steel sheets having an approximate thickness of .020 inch. The edges of the sheets are wrapped around the cables **14** to hold them in place.

FIGURES 3 and 4 are cross sections of tank **2** showing adjacent conical arrays of cables **14** that are respectively convex and concave. It should be noted that the baffle elements **18** in FIGURE 4 are directly behind spaces between the baffle elements **18** of FIGURE 3.

With the baffle elements **18** arranged throughout the length of tank **2** as shown in FIGURES 3 and 4, a great amount of turbulence is created in the liquid cargo when the tank is accelerating or decelerating. Thus, the liquid does not act as one solid body moving backward or forward between the bulkheads and end plates. Instead, each small mass of liquid behind each baffle element **18** is deflected by that element in a direction away from its original forward or rearward motion. Part of the inertial force of each of these small masses of liquid is absorbed by the resilient baffle element from which it is deflected, and the remander of its inertial force is in most cases either absorbed by the walls of the tank or counteracted by the inertial force of another mass of liquid colliding with it after being deflected in an opposite direction by another baffle element. Thus, the end plates **8** and bulkheads **10** receive very little of the total inertial force of the liquid in the tank while the tank is accelerating or decelerating.

The enlarged view of a portion of tank **2** in FIGURE 5 shows in detail how the various parts of the tank are secured to each other.

Each cylindrical shell section **4** has a flange **20** that is seam-welded at *a* to an adjacent flange **20** of another shell section, or an end plate **8** or bulkhead **10**. A stiffening ring **6** is lodged between two adjacent flanges **20** and is seam-welded to each flange at *b*.

The longitudinal stiffening members **11** and circular stiffening members **12** are spot welded to the inner walls

of the tank **2**. Holes are provided in these stiffening members at appropriate places for insertion of the ends of secondary cables **14** and **16**. The ends of the cables are looped through the holes and are secured in a closed loop by sleeves **22**. The connections of the primary cables **13** to the end plates **8** and bulkheads **10** are accomplished by eyelets **24** welded to the centers of the end plates and bulkheads, and the ends of the cables **13** are looped through these eyelets and secured by sleeves **26**.

The attachments of secondary cables **14** to primary cables **13** are accomplished by pairs of clamp members **28** that are bolted to opposite sides of the primary cable **13** by bolts **29**. Holes **30** in each pair of clamp members **28** accommodate the ends of all the secondary cables **14**, **14***a* and **14***b* to be attached to the primary cable **13** at one node. One end of each secondary cable is looped through the more convenient hole **30** and secured in a closed loop by a sleeve **32**.

While one embodiment of my invention has been shown and described herein, other adaptations and modifications will be apparent within the scope of the appended claims.

I claim:

1. A tank for storing liquids comprising

an elongated metal shell,

end plates secured to the ends of said metal shell,

a primary cable secured to said end plates and extending lengthwise through said tank,

a plurality of secondary cables connected between the inner walls of said shell and said primary cable, a group of at least two of said secondary cables connected to said primary cable at a common node, and each oriented at an acute angle to said primary cable,

and baffle elements connected across alternating spaces between said secondary cables of said group to inhibit the lengthwise flow of liquid in said tank.

2. The tank of claim **1** including groups of said secondary cables arranged in conical arrays about said primary cable, the cables of one of said groups extending from a common connection with said primary cable toward one end of said tank, and the cables of another of said groups extending from a common connection with said primary cable toward the other end of said end, and

baffle elements connected between the secondary cables of each of said groups, said baffle elements connected to one of said groups of cables being placed in areas not in alignment with the baffle elements connected to said other group of cables, as viewed from the end of said tank.

3. The tank of claim **2** wherein each of said groups of secondary cables is composed of six cables, and

three of said baffle elements are connected across alternating spaces between the cables of each of said groups.

4. The tank of claim **1** including circular stiffeners mounted around the outside of said metal shell, said secondary cables being connected to said outer shell at places where said stiffening members are located.

5. The tank of claim **4** wherein

said metal shell is divided into sections, said shell sections having outwardly projecting flanges on their ends, each of said flanges on a shell section being seam welded to the end flange of an adjacent shell section and each pair of flanges so joined having parallel portions spaced from one another,

and said circular stiffeners being placed in the spaces between said spaced apart portions of said flanges and seam welded to the flanges.

6. A tank for storing liquids in transport comprising

an elongated metal shell,

end plates secured to the ends of said metal shell,

at least one bulkhead mounted within said metal shell substantially parallel to said end plates, each bulkhead forming a liquid storage chamber with said shell and the adjacent bulkhead or end plate,

a primary cable extending lengthwise through each of said liquid storage chambers and secured to each bulkhead and end plate,

a plurality of secondary cables connected between the inner walls of said shell and said central cable, a group of at least two of said secondary cables located within each of said liquid storage chambers and connected to said primary cable at a common node, each of said secondary cables being oriented at an acute angle with said primary cable,

and baffle elements connected across alternating spaces between said secondary cables to inhibit the lengthwise flow of liquid in each of said liquid storage chambers.

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