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STORAGE TANK FOR COMBUSTIBLE AND INFLAMMABLE MATERIALS

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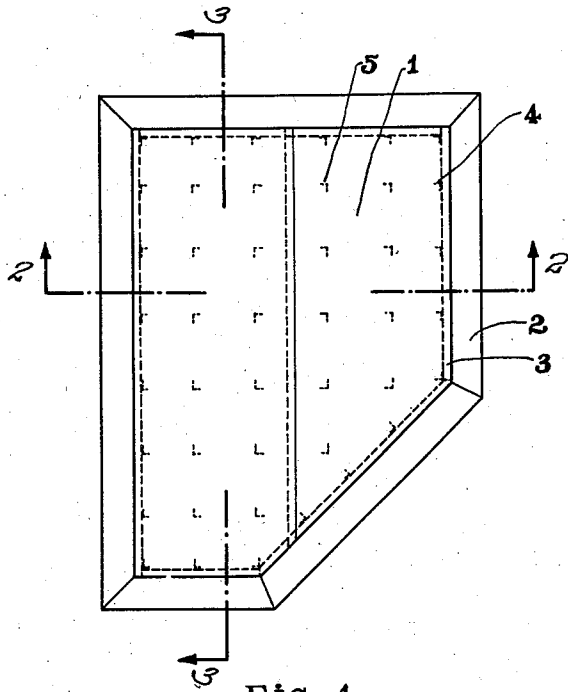


FIG. 1

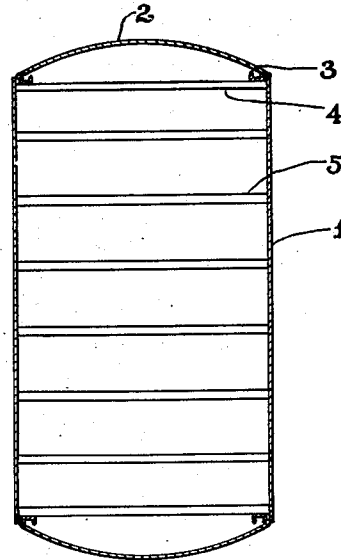


FIG. 3

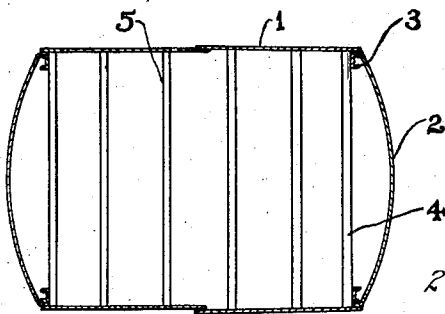
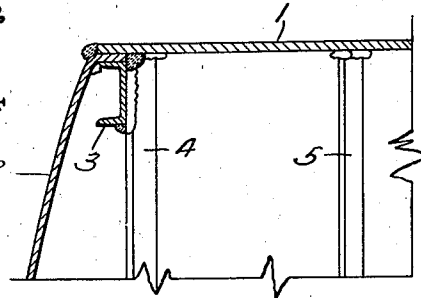


FIG. 2

FIG. 4.



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STORAGE TANK FOR COMBUSTIBLE AND
INFLAMMABLE MATERIALS

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Substitute for abandoned application Serial No.
650,219, January 5, 1933. This application De-
cember 28, 1935, Serial No. 56,466

5 Claims. (Cl. 220-1)

This application is a substitute application to replace my abandoned application Serial No. 650,219, filed January 5, 1933.

In this application the following terms shall be interpreted in accordance with these definitions:

Structural design—The modern engineering method of arranging and proportioning a structure or its elements by means of the application of mathematics and the physical sciences.

Structural member—Any of the elementary shapes listed in any standard steel handbook or a built-up combination of said elementary shapes with or without plates.

Tie—A structural member designed to resist tension.

Brace—A structural member designed to resist compression. The term (tie or brace) designates a single member structurally designed to perform the dual function of resisting tension or compression.

Spring (verb)—(Architecturally) To curve as a structural arch.

(Structurally) To react as a structural arch from the points of application of the induced thrusts.

Springing line—(Architecturally) In a vertical cross section thru an arch structure, the line marking the level from which the structural arch springs.

(Structurally) The line joining the points of application of the thrusts induced by a structural arch.

Springing plane—The locus of the springing line in a structural barrel arch.

Structural arch—A curved structural element spanning an opening and so proportioned to resist the equilibrium curve of forces acting within the arch and also the thrusts produced by the resolution of the superimposed loads or pressures.

Geometric arch—Any part of a curve, an arc.

This invention relates to a tank used for the storage of combustible, inflammable or other hazardous material in which the structural parts are so arranged as to produce an improved type of construction and therefore a more efficient and economic structure than types which are now in public use.

Tanks used for the storage of combustible or inflammable materials are required by standard specifications for tank design to be constructed to resist certain external loads or pressure and also a specified internal pressure. The stand-

ard specifications for tank design also embody the requirement that a specified factor of safety be maintained in the structural part of the tank subjected to strain, that is, no structural material of which the tank is constructed and which carries a load shall be strained beyond the state where the stress in the structural material divided into the stress at which the structural material actually breaks will exceed a specified amount. This specified amount is termed the factor of safety.

Before pointing out the novelties in the construction of my tank I will first describe and use as a comparative example a type of tank for the storage of inflammable or combustible material which is at present often designed. The type of tank referred to has the shape of a rectangular parallelepiped. When a tank of such form or shape is subjected to an internal pressure all sides including the top and bottom are subjected to flexure outward and tend to blow out. This tendency is resisted by tying each side to the side opposite, including the top and bottom by means of steel bars acting as tension members and structurally designed as such. It is therefore necessary to have a set of ties for every side surface including the top and bottom sides and in this case three sets of ties.

When this type of tank is subjected to an external pressure the sides, including the top and bottom, are subjected to flexure inward and tend to collapse; the tie members now act as braces since they are now in compression and therefore must be structurally designed as compression members.

A tank of the type just described is often used in practice even though it has many disadvantages of which some may be listed as follows:

(a) A set of ties for every two opposite sides (including the top and bottom) is required.

(b) These ties must also be able to resist compression which requires that their (L/R) ratio (the ratio of their length to their radius of gyration) must be so proportioned that they can effectively function as compression members. This may necessitate an increase in the amount of material used in them or other costly methods of construction for the purpose of decreasing this (L/R) ratio.

(c) Due to the great number of ties the construction is laborious, cumbersome and expensive.

(d) The plane figure of the tank is practically restricted to the shape of a quadrilateral because of the obvious expense and difficulty involved in

tying or bracing the sides together if the shape were other than a quadrilateral.

It has been my object in the design of my tank to invent a type of tank which is of an improved type of construction and a more efficient and economic structure than tanks now in public use. On comparing the construction of my tank to the construction of the tank previously described, it can be seen that the undesirable features (c) and (d) pointed out above, are eliminated and the undesirable features as pointed out in (a) and (b) are reduced, thus producing a more efficient and economical structure.

This is done by curving the vertical sides 2 of my tank therefore causing the curved vertical sides 2 to become the major carriers of the load; acting as arches which are subjected to tension when the tank is subjected to an internal pressure and compression when it is subjected to an external pressure. Any thrust produced by the arch action is carried by a beam 3 placed substantially in the springing plane of the arch which in turn distributes it to members capable of resisting tension or compression 4 which are connected to the beams and the curved vertical sides. This last mentioned arrangement of the structural beam and tension or compression members in conjunction with the curved vertical side makes the curved side capable of resisting stress independently of any other part of the tank and so the top and bottom flat surfaces may have the plane figure of any polygon and the same principle of curved vertical sides connected as described be applied. The arrangement as described also eliminates the sets of ties running from one vertical side to the vertical side opposite leaving only the ties or braces running from the top to the bottom of the tank and therefore the amount of material and labor in the construction is greatly reduced. Again it is emphasized that the arched side construction which comprises the curved plate 2 the structural beam 3 and the structural members 4 is a new structural unit, the nearest analogy being a structural truss. It can therefore be used in a single unit or compounded in a series of units in place of any or all flat sides of tanks now in public use.

I will now describe in greater detail how my tank is constructed and refer to the drawing herewith submitted.

Figure 1 is a plan drawing showing the outline of the tank and the location of the steel therein. The outline of the tank is any polygon which is herein shown as an irregular polygon.

Figure 2 and Figure 3 are sectional elevations taken along the dot and dash lines designated as 2-2 and 3-3 respectively, and looking in the direction of the arrowheads.

Fig. 4 is an enlarged detail of Fig. 2.

The top and bottom sides of this tank are horizontal flat surfaces shown in the plan drawing Figure 1 and designated by the number 1 and hereafter referred to by this number. The vertical sides of this tank are curved surfaces having the outline of an arch as shown on the section drawings Figure 2 and Figure 3 and designated by the number 2 and hereafter referred to by this number. All the sides are constructed of open hearth tank steel plate which overlap or abut each other, the seams being welded.

The sides 2 are bent at their ends to form a lap with which they are joined to the sides 1. At the juncture formed where sides 1 meet the sides 2 a structural beam is placed either inside or outside of the tank, since its purpose

and function is the same in either position. This beam is connected at the juncture of the sides 1 and 2 by means of rivets or welds. These structural beams will hereafter be designated as 3.

The beams 3 are tied together by structural steel members acting as ties or braces which are welded or riveted where they join or connect with the beam 3. These ties or braces will be hereafter designated as 4.

The sides 1 are tied or braced together by means of structural steel members which are connected where they join the sides by means of welds. These ties or braces will hereafter be designated by 5.

Having described the construction of my tank I will now describe the purpose and function of each detail mentioned.

When the tank is subject to an internal pressure the sides 2 are caused to act as arches in tension inducing a thrust produced at the juncture formed where the sides 1 meet the sides 2. This thrust acts inward and tends to collapse the tank at this point. The structural beams 3 were placed at the junctures of the sides 1 and 2 in order to carry and distribute this thrust to the braces 4. The braces 4 are subjected to compression transmitted by the beam 3 and are structurally designed as compression members. In this manner the collapsing tendency at this point is resisted.

While the action as just described is taking place in the sides 2 beams 3 and braces 4; the sides 1 are subjected to flexure outward and tend to blow outward. This is resisted by the ties 5 which are structurally designed as tension members.

All structural steel members are designed in accordance with standard structural design specifications to resist the stresses to which they are subjected to and maintain the factor of safety specified by the specifications.

When the tank is subjected to an external pressure the sides 2 are caused to act as arches in compression inducing a thrust at the juncture formed where the sides 1 meet the sides 2. This thrust acts outward and tends to push out the sides 1 at this point. The beams 3 carry and distribute this outward thrust to the braces 4 which now act as ties subjected to tension and are structurally designed to resist this tension. In this manner the tendency at this point for the sides 1 to be pushed out is resisted.

While the action as just described is taking place in the sides 2 the beam 3 and the ties or braces 4, the sides 1 are subjected to flexure inward and tend to collapse. This is resisted by the ties 5 which now act as braces and are therefore structurally designed to take compression.

Having described the construction of my tank and the function and object of each structural unit, I make the following claims:

1. A storage tank for combustible and inflammable materials comprising; opposed substantially horizontal top and bottom polygonal sides of steel plates; angular sidewalls of steel plates which are arcuated from the perimeter of the top side to the perimeter of the bottom side and springing from said sides; means for connecting the arcuated sides to the opposed top and bottom sides; means for joining the adjacent arcuated sides to each other at their corner junctures; structural members, anchoring the ends of the arcuated sides, cooperatively disposed and connected substantially between the opposed junctures of the arcuated sides and the top and bot-

tom sides; and substantially vertical structural members, connected at points spaced throughout the areas of the opposed top and bottom sides thus securing said sides against relative displacement.

2. A storage tank for combustible and inflammable materials comprising; opposed substantially horizontal top and bottom polygonal sides of steel plates; angular sidewalls of steel plates which are arcuated from the perimeter of the top side to the perimeter of the bottom side and springing from said sides; means for connecting the arcuated sides to the opposed top and bottom sides; means for joining the adjacent arcuated sides to each other at their corner junctures; structural members resisting the inward or outward thrusts produced at the ends of the arcuate sides, cooperatively disposed and connected substantially between the opposed junctures formed by the arcuated sides with the top and bottom sides; and substantially vertical structural members connected at points spaced throughout the opposed areas of the opposed top and bottom sides thus securing said sides against displacement.

3. A storage tank for combustible and inflammable materials comprising; opposed substantially horizontal top and bottom polygonal sides of steel plates; angular sidewalls of steel plates which are arcuated and springing from the perimeter of the top side to the perimeter of the bottom side and connected to said sides; the adjacent arcuated sides being connected to each other at their corner junctures; structural members, resisting tension or compression, are horizontally disposed and connected substantially along the junctures formed by the arcuated sides with the opposed horizontal polygonal sides; substantially vertical structural members, capable of resisting tension or compression, are secured at points spaced horizontally along said opposed horizontal structural members thus anchoring the junctures against displacement inward or outward; and substantially vertical structural members, resisting tension or compression, are secured at points spaced throughout the opposed horizontal areas of the opposed horizontal sides, resisting their displacement inward or outward.

4. A storage tank for combustible and inflammable materials comprising; opposed substantially horizontal top and bottom polygonal sides of steel plates; angular sidewalls of steel plates which are arcuated and spring from the perimeter of the top side to the perimeter of the bottom side and connected to said sides; the adjacent arcuated sides being joined to each other at their corner junctures; substantially vertical structural members, resisting tension or compression, are secured at points spaced horizontally along the junctures of the opposed horizontal sides and the arcuated sides, anchoring said junctures against displacement; and substantially vertical structural members, capable of resisting tension or compression, are secured at points spaced throughout the horizontal areas of the opposed horizontal polygonal sides resisting their displacement inward or outward.

5. A storage tank for combustible and inflammable materials comprising; opposed substantially horizontal top and bottom polygonal sides of steel plates, said top and bottom sides being similar polygons with similar sides disposed symmetrically opposite each other; angular sidewalls of steel plates which are arcuated and springing from the perimeter of the top side to the perimeter of the bottom side and joined to said sides by means of welded connections; angular corner junctures formed by adjacent arcuated sides are joined to each other by means of welds; opposed horizontal channel members of steel are joined by means of welds, substantially at the perimeters of the opposed top and bottom sides, as coincident as is practicable with the junctures formed by the arcuated sides and the opposed top and bottom sides; substantially vertical angle members of steel are disposed at intervals along the said opposed horizontal channel members and joined to said members by means of welds; and substantially vertical angle members of steel are disposed at intervals throughout the horizontal areas of the opposed horizontal sides and joined to said horizontal sides by means of welds.

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