Jan. 9, 1934. W. SCHWEMLEIN 1,943,191

FABRICATED TANK

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Fig. 1.

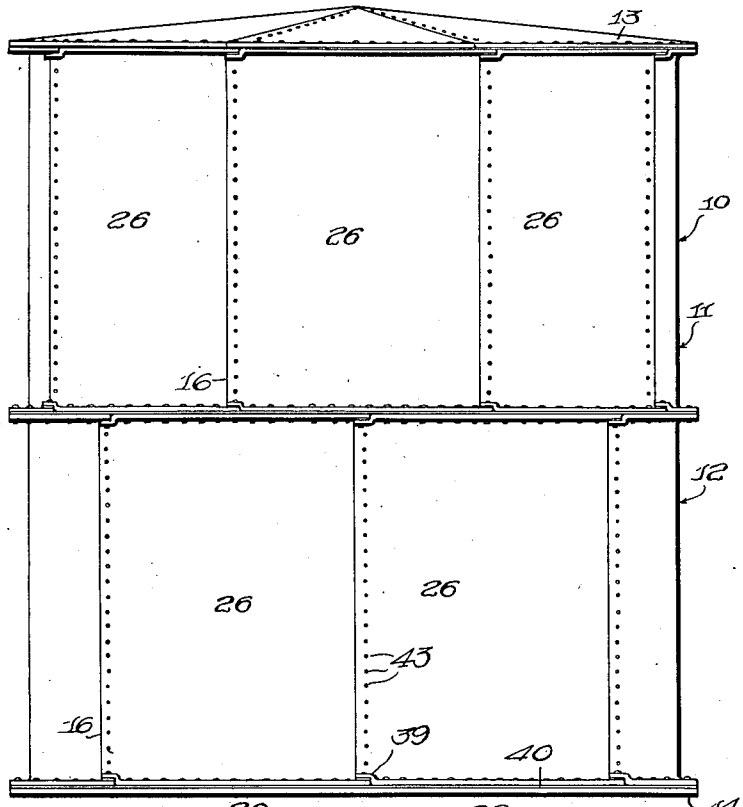

Fig. 2.

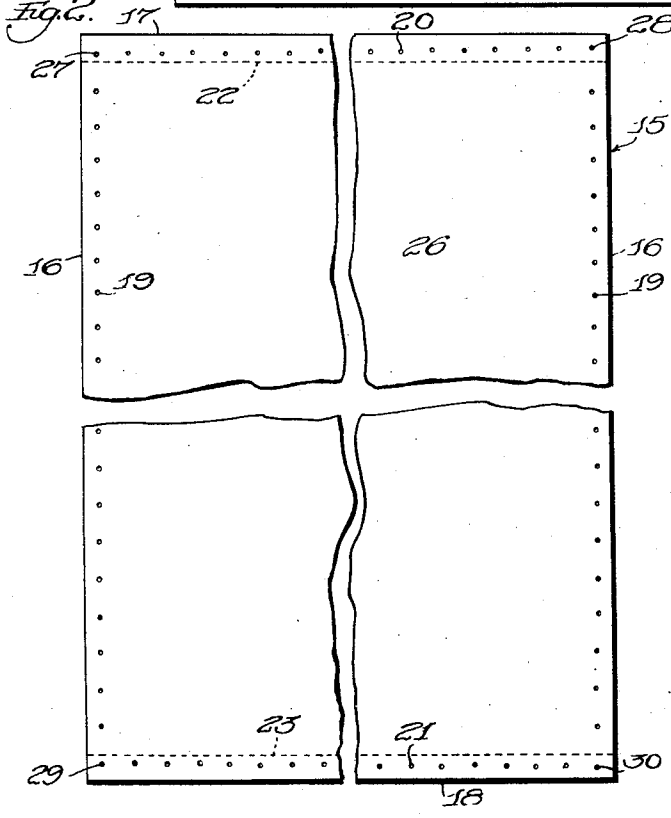

Fig. 3.

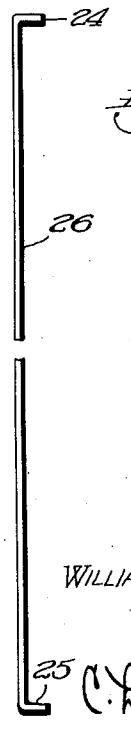

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Fig. 4.

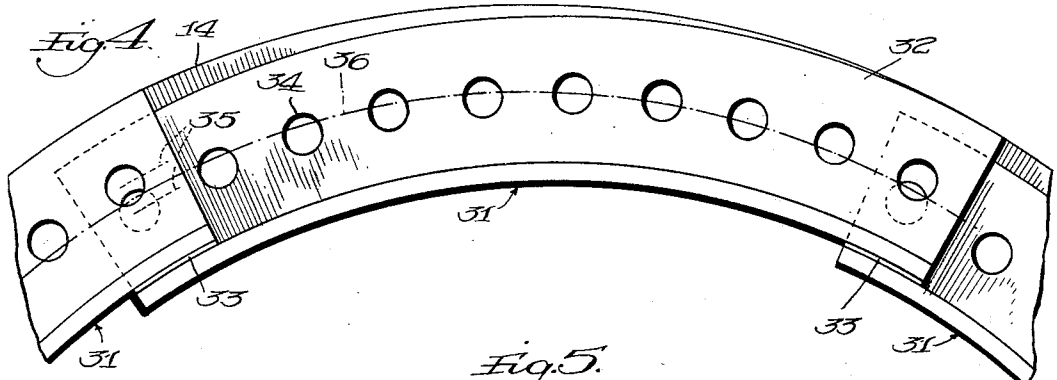


Fig. 5.

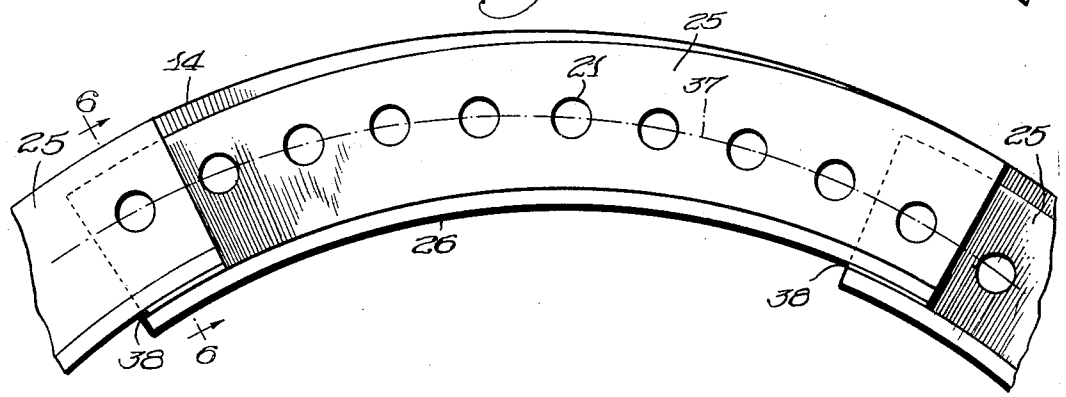
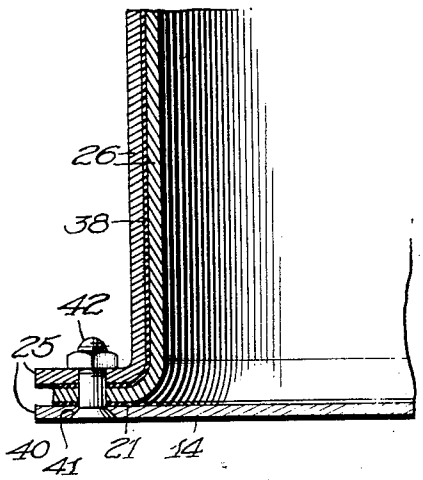


Fig. 6.



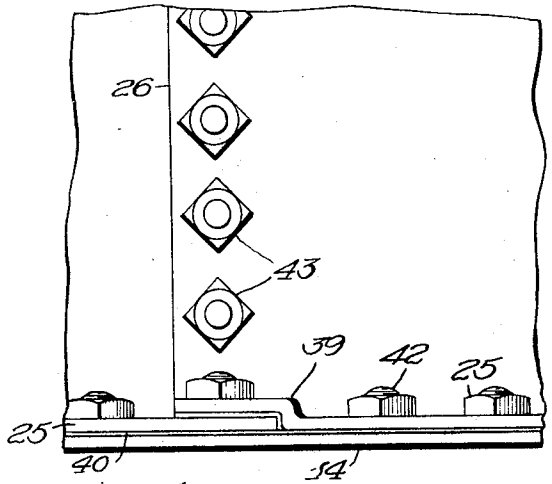


Fig. 7.

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FABRICATED TANK

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Application February 16, 1933. Serial No. 657,117

6 Claims. (Cl. 220—1)

This invention relates to fabricated sheet metal tanks, and more particularly to the bolted steel tanks commonly employed for the storage of oil.

Heretofore, it has been the common practice to fabricate steel tanks by suitably forming the side sheets or staves with outwardly turned flanges at the upper and lower edges thereof, and to bolt the flanges to the decks and bottoms of the tank. In the larger size tanks, two or more tiers of staves are employed in which case the top and bottom edges respectively of the lower and upper tiers of staves are secured respectively to the deck and bottom of the tank, while the other horizontal flanges of the staves are secured to each other.

In the manufacture of the tank elements referred to, it has been the common practice to form the individual staves by shearing a blank to size, punching the bolt openings through the sheet thus provided, and then forming the sheet with the proper tank curvature and bending the upper and lower edges of the sheet outwardly to form the horizontal flanges by means of which the sheet is secured to the deck or bottom of the tank or to the flanges of adjacent tiers of staves. In forming the bolt openings, the openings through each horizontal flange are punched on a line spaced a constant distance from the adjacent curved face of the sheet.

In assembling the staves, the vertical edges of each stave are overlapped with respect to the vertical edges of the adjacent staves, and the same is true of the horizontal attaching flanges, and accordingly the ends of the horizontal flanges adjacent one vertical edge of the stave are offset to provide a space to receive the overlapping portions of the horizontal flanges of the adjacent staves.

As previously stated, it has been customary to manufacture bolted steel tanks in accordance with the method outlined, and such method involves serious disadvantages which have been accepted in the industry as necessary evils, and tanks manufactured in accordance with the method referred to have been accepted as standard. As previously stated, the bolt openings of the attaching flanges are arranged on lines spaced constant distances from the curved surface of the stave, and when each stave is assembled in overlapping relationship with respect to the adjacent staves, the openings in each end of each flange are radially offset with respect to the openings in the adjacent ends of the adjacent staves. In other words, the flange openings have been arranged a constant distance from the curved surfaces of the staves, and the staves being curved horizontally approximately in accordance with the curvature of the desired finished tank, the bolt openings in each horizontal flange will be arranged on an arc of a circle, and such arc will be eccentric to each other arc, due to the overlapping of the stave edges.

In making the decks and bottoms of the tanks, however, the corresponding bolt openings are arranged on a true circle, and accordingly there can never be more than one flange opening in registration with its corresponding opening in the deck or bottom, and it accordingly is necessary to drift or otherwise elongate all of the remaining bolt openings of each flange in order to permit the bolts to be inserted. The overlapping relationship referred to also disturbs the desired registration of the flange openings of the contacting horizontal flanges of adjacent tiers in the larger sized tanks. The drifting of the openings obviously increases the danger of leakage in a tank, and the manufacture of a tank under such conditions requires a considerable amount of labor in view of the large number of bolt openings which must be drifted. As previously stated, only one opening in a horizontal flange, if any, will register with a corresponding opening in the deck or bottom of the tank, and such opening will lie substantially centrally of the width of the stave, and from such opening the successive openings toward the vertical edges of the stave must be drifted to progressively increasing extents.

An important object of the present invention is to eliminate the difficulties involved in prior constructions by providing a stave structure so formed that perfect registration is secured between the bolt openings of the flanges and the corresponding openings of the elements to be bolted thereto.

A further object is to provide a tank structure wherein the horizontal flanges of the staves are provided with bolt openings arranged eccentrically with respect to the adjacent curved surfaces of the staves, whereby the assembly of the staves in overlapping relationship causes the flange openings to be arranged in a substantially perfect circle corresponding in diameter to the circle of the corresponding openings in the elements to which the horizontal flanges are to be secured.

A further object is to provide a tank structure of the character referred to wherein the bolt openings of each horizontal flange are arranged at progressively different distances from the curved surface of the stave whereby the differ-

ence in the distances from the curved surface of the stave to the end openings of the horizontal flange is equal to the distance between the outer curved surfaces of two adjacent staves at their overlapping point.

Other objects and advantages of the invention will become apparent during the course of the following description.

In the drawings I have shown one embodiment of the invention. In this showing,

Figure 1 is a side elevation of an oil storage tank,

Figure 2 is a face view of a stave blank, parts being broken away,

Figure 3 is an edge elevation of a stave showing the horizontal flanges formed at the upper and lower edge thereof, parts being broken away,

Figure 4 is a fragmentary horizontal sectional view, somewhat exaggerated, showing overlapping tank staves formed in accordance with prior methods,

Figure 5 is a similar view showing the assembly of tank staves in accordance with the present method,

Figure 6 is a fragmentary section on line 6—6 of Figure 5, and,

Figure 7 is a fragmentary side elevation of a portion of the bottom of a tank.

Referring to Figure 1, the numeral 10 designates an oil storage tank shown in the present instance as being formed of two tiers of staves, 11 and 12. The tank is provided with a deck 13 secured to the upper ends of the top tier of staves, while a bottom 14 is secured to the lower edge of the lower tier of staves. It will become apparent that the present invention is applicable either to a multi-tier tank or to a tank having a single tier of staves, in which latter case the upper and lower edges of the staves will be secured respectively to the deck and bottom of the tank.

In Figure 2 of the drawings a blank from which a finishd stave is made has been illustrated and is designated by the numeral 15. In forming the blank, a suitable sheet is sheared to rectangular form to provide parallel vertical edges 16 and horizontal upper and lower edges 17 and 18. The blank is provided adjacent each vertical edge with a series of bolt receiving openings 19 arranged parallel to the adjacent edges.

The top and bottom edge portions of the blank are punched to provide two series of bolt openings 20 and 21, and each of these series is arranged on a line varying in its distance from the adjacent edge of the sheet in a manner and for a purpose to be described. The blank is formed into a finished stave by curving the sheet horizontally substantially to the curvature of the desired finished tank, and by bending the sheet adjacent the top and bottom edges thereof along lines 22 and 23 to form upper and lower horizontal flanges 24 and 25. This operation completes the finished stave indicated by the numeral 26, except that it is necessary to offset one end of each horizontal flange for a purpose to be described.

While the rows of bolt openings 20 and 21 appear as straight lines in the stave blank illustrated in Figure 2, it will be apparent that each row of such openings will be curved in the finished sheet due to the horizontal curvature of the body of the sheet and the flanges 24 and 25. The dotted lines 22 and 23 represent the vertical limits of the curved faces of the sheet, and it will be apparent that the rows of openings 20 and 21 are arranged varying distances therefrom. This variation in the distance of the openings 20 and 21 from the adjacent curved face in the stave depends on two elements, namely the gage of the metal from which the stave is made and the thickness of the gasket, if any, arranged between the overlapping vertical edges of the sheets.

Referring to Figure 2, it will be noted that the upper line of openings 20, for example, has its opening 27 at one end of the row arranged relatively closely to the curved surface of the sheet while the opening 28 at the opposite end of the row is arranged a relatively greater distance from the surface of the sheet. The difference in the distances of the openings 27 and 28 from the curved surface of the sheet will be equal to the sum of the thickness of the metal and the gasket employed, for a purpose to be described. The same relationship exists between the end openings 29 and 30 of the row of openings 21.

The reasons for the arrangement of the rows of bolt openings 20 and 21 will become apparent from an examination of Figure 4 wherein a portion of a standard tank structure has been illustrated in somewhat exaggerated form. Referring to Figure 4, the numeral 31 designates a plurality of standard staves the bodies of which are initially curved approximately to the desired curvature of the finished tank, and each stave is provided with upper and lower flanges 32, which are identical with each other and have their edges arranged concentric with the body of the stave. The sheets are assembled by being arranged with their edges in overlapping relationship, and gaskets 33 are arranged between the overlapping edges. The bolt openings 34 of the flanges 32 are stamped on a line equidistantly spaced from the edges of the flanges 32, and in the finished stave, it will be apparent that the line of openings 34 is arranged on an arc of a circle concentric with the curvature of the body of the stave.

Accordingly it will be apparent that when the adjacent edges of two staves are overlapped, the adjacent end openings 34 of the two staves are offset from each other as indicated by the dotted lines 35, and the distance to which these openings are offset will be exactly equal to the thickness of the stave plus the thickness of the gasket 33. It will be apparent that the left hand end opening 34 of the stave shown centrally of Figure 4 will be offset inwardly of the corresponding opening of the next stave, while the right hand end opening of such central stave is offset outwardly of the corresponding opening of the next adjacent stave. At the same time, the bolt openings of the tank bottom, assuming that the flanges 32, shown in Figure 4 are to be secured to the bottom, are arranged in a true circle, and an arc of this circle is indicated by the dot and dash lines 36 in Figure 4. The circle of the bottom bolt openings intersects the arc of the line or circles 34 substantially centrally of the width of the stave, as shown, and accordingly it will be apparent that the centers of the openings 34 all lie radially inwardly or radially outwardly of the line 36, unless one of the openings 34 should lie exactly centrally of the width of the stave. Such central opening accordingly can be the only opening which will register with its corresponding opening in the tank bottom and it is necessary to drift or otherwise radially enlarge all of the openings 34 in order to insert the bolts therein. The bottom opening corresponding to the end openings in adjacent flanges 32 lies between the centers of such end openings, and both of the latter accordingly must

be drifted to receive their bolt. In the case of heavier tanks, where the staves overlap to the extent of two bolt openings, it will be apparent that four openings must be drifted at each stave joint.

The conditions referred to, namely, the necessity for drifting practically all of the horizontal flange bolt openings, also exists for the same reasons at the top of the tank where the top stave flanges are to be secured to the deck. It also will be apparent that in the case of a tank having two or more tiers of staves, the same overlapping condition of the adjacent edges of the staves exists, and accordingly it is similarly necessary to drift the openings for the reception of the bolts for securing the stave tiers together.

The application of the present invention will be apparent from the examination of Figure 5 in which one of the staves 26 is illustrated in somewhat exaggerated form in its relationship to the ends of the next adjacent staves. The flanges shown in Figure 5 may be considered the bottom flanges 25, but it will be apparent that the same structural features are present in both the upper and lower flanges of the staves. In the completed stave, the line of the centers of the openings 21 will be arcuate as indicated by the dot and dash lines 37. The arc on which the centers of the openings 21 lie will be a part of a circle whose radius is equal to the radius of the arc 36, but as previously stated, such arc is eccentric with respect to the arc of curvature of the body of the stave. Accordingly the line 37 will be closer to the body of the stave at one end than at the other, and the difference will amount to the thickness of the body of the stave plus the thickness of the gasket, if any, employed between the overlapping edges of the sheet. In fluid storage tank constructions, such as oil tanks, such a gasket is essential in order to provide leak-proof joints, and accordingly gaskets 38 have been illustrated in Figure 5 between the overlapping edges of the staves. These gaskets are compressible within reasonable limits, but their effective thickness, under compression, when the tank staves are bolted together, readily may be measured to determine the degree of eccentricity of the arc 37. In actual practice, the allowance for gasket thickness ordinarily is $\frac{1}{16}$ of an inch.

From the foregoing it will be apparent that the end opening of the series 21 at the left side of Figure 5 is arranged radially outwardly of the outer curved surface of the stave a greater distance than the end opening of the next adjacent stave flange and the difference in these distances, as previously stated, will be the thickness of the stave sheet plus the thickness of the packing, and when the staves are bolted in assembled relationship, the two end openings referred to will lie in registration. This condition holds good throughout the circumference of the tank, and accordingly the various arcs 37 become continuations of each other to complete a substantially true circle concentric with and equal in diameter to the circle 36 of the centers of the openings in the tank bottom. With the bottom openings and the openings 21 spaced the same distance apart, proper registration may be obtained to permit the insertion of the bolts for securing the side walls of the tank to the bottom.

In Figures 6 and 7, the relationship of the staves to the tank bottom has been illustrated. As previously stated, the staves are assembled with respect to each other by placing them in overlapping relationship, and obviously the flanges of the adjacent staves are similarly overlapped. Since such flanges lie in a common horizontal plane it is necessary to offset one end of each flange to receive the end of the adjacent flange therebeneath. Referring to Figure 7, it accordingly will be noted that one end of the bottom flange 25 is offset upwardly as at 39 to receive the ends of the adjacent flange 25.

In Figure 6, the overlapping vertical edges of two of the staves have been illustrated with the gasket 38 therebetween, and the same strip of packing, or a separate strip, extends outwardly between the overlapping flanges 25. Similarly, a gasket 40 is arranged between the flanges 25 and the tank bottom 14. As will be apparent from the foregoing description, the bottom is provided with the usual openings 41 which are arranged on the circle previously referred to and indicated by the numeral 36. In the manner referred to, the present invention operates to place the openings 21 in substantially perfect registration with the openings 41 to receive the usual attaching bolts 42. The overlapping vertical edges of the stave are secured together by the usual bolts 43. The elements shown and described in Figures 6 and 7 are shown substantially in their conventional form, except that it will be apparent that the openings 21 are not elongated in Figure 6 for the reason that the present invention eliminates the necessity for drifting the openings to permit the insertion of the bolts 42.

The arrangement shown in Figures 6 and 7 is substantially identical with the arrangement at the top of the tank for securing the staves to the deck 13. Moreover, it will be apparent that the arrangement of the openings 20 and 21 in the upper and lower flanges 24 and 25 is identical, and accordingly the openings 20, when the lower tier of staves is assembled, lie in a substantially perfect circle coinciding with the circle of the openings 21 in the lower flange of the upper tier of staves. Accordingly it is also unnecessary to drift any of the openings in the adjacent flanges of the staves of multi-stave tanks.

Accordingly it will be apparent that the present invention possesses substantial advantages over prior constructions in that it eliminates the substantial amount of time and labor ordinarily required to drift or otherwise enlarge the bolt openings of the flanges of tank staves to permit the flange openings to receive the bolts by which they are secured to adjacent elements of the tank. Moreover, it will be apparent that the danger of leakage is materially decreased by the elimination of a substantial number of bolt openings which are materially larger than is necessary in order for them to receive the bolts. It also will be apparent that the present invention provides a stave structure which readily may be manufactured as cheaply as the staves in present use without the disadvantages thereof.

It is to be understood that the form of the invention herewith shown and described is to be taken as a preferred example of the same and that various changes in the shape, size and arrangement of parts may be resorted to without departing from the spirit of the invention or the scope of the subjoined claims.

I claim:

1. A fabricated cylindrical tank comprising a plurality of tank elements including side walls made up of a plurality of staves each having its vertical edges arranged respectively inwardly and

outwardly of the adjacent vertical edges of the adjacent staves in overlapping relationship therewith, each stave having its body portion arcuate in horizontal cross-section, each stave having a horizontal flange at one vertical extremity thereof provided with a plurality of fastening element receiving openings arranged in an arcuate line eccentric to the cross-sectional arc of the stave, the difference in the distances of the extremities of said arcuate line from the body portion of the stave being substantially equal to the distance between the outer faces of two adjacent staves at their overlapping point whereby the arcuate lines of all of the stave flange openings lie on a circle, said flanges lying against an adjacent tank element provided with a plurality of openings lying on a circle coinciding with said first named circle, and fastening elements passing through the flange openings and the coinciding openings of said last named tank element.

2. A fabricated cylindrical tank comprising a plurality of tank elements including side walls made up of a plurality of staves each having its vertical edges arranged respectively inwardly and outwardly of the adjacent vertical edges of the adjacent staves in overlapping relationship therewith, each stave having its body portion arcuate in horizontal cross-section, each stave having horizontal flanges projecting radially outwardly from its upper and lower edges, each flange being provided with a plurality of fastening element receiving openings arranged in an arcuate line eccentric to the cross-sectional arc of the stave, the difference in the distances of the extremities of each arcuate line from the body portion of the stave being substantially equal to the distance between the outer faces of two adjacent staves at their overlapping point with the two arcuate lines coaxial whereby the arcuate lines of the lower flanges and the arcuate lines of the upper flanges lie in substantially true circles, the upper flanges and the lower flanges respectively lying against adjacent tank elements each provided with a plurality of openings lying on a circle of the same diameter as said first named circles, and fastening elements passing through the flange openings and the corresponding openings of said last named tank elements.

3. A fabricated cylindrical tank comprising a plurality of tank elements including a bottom, and side walls made up of a plurality of staves each having its vertical edges arranged respectively inwardly and outwardly of the adjacent vertical edges of the adjacent staves in overlapping relationship therewith, each stave having its body portion arcuate in horizontal cross-section, each stave having an outstanding horizontal flange at its lower edge provided with a plurality of fastening element receiving openings arranged in an arcuate line eccentric to the cross-sectional arc of the stave, the difference in the distances of the extremities of said arcuate line from the body portion of the stave being substantially equal to the distance between the outer faces of two adjacent staves at their overlapping point whereby the arcuate lines of all of the stave flange openings lie on a circle, said bottom lying beneath said flanges and provided with a plurality of openings lying on a circle coinciding with said first named circle, and fastening elements passing through the flange openings and the corresponding openings of said bottom.

4. A tank constructed in accordance with claim 3 wherein each stave is provided at its upper end with a horizontal outstanding flange provided with fastening element receiving openings corresponding in position to the openings in said lower flanges whereby the openings in said upper flanges lie substantially in a true circle, said tank including a tank element having a horizontal portion overlying said upper flanges and provided with a series of openings arranged substantially in a true circle coinciding with the circle of openings in said upper flanges, and fastening elements passing through the openings in said upper tank element and said upper flanges.

5. In a stave for fabricated cylindrical tanks comprising a transversely arcuate sheet metal body having an outstanding flange at one vertical extremity provided with a series of fastening element receiving openings arranged on an arcuate line eccentric to the curvature of the body of the stave, the radius of curvature of said arcuate line being equal to the radius of curvature of the outer surface of the body of the sheet plus the distance from said outer surface to said arcuate line substantially centrally of its length.

6. In a stave for fabricated cylindrical tanks comprising a transversely arcuate sheet metal body provided at its upper and lower extremities with outstanding flanges each provided with a series of fastening element receiving openings lying in an arcuate line eccentric to the curvature of said body, the radius of curvature of each of said arcuate lines being equal to the radius of curvature of the outer surface of the stave body plus the distance between said outer surface and the arcuate line substantially central of the length thereof, said arcuate lines being coaxial.

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