Nov. 12, 1957 J. H. WIGGINS 2,812,574

METHOD OF BUILDING METAL STORAGE TANKS

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FIG. 1.

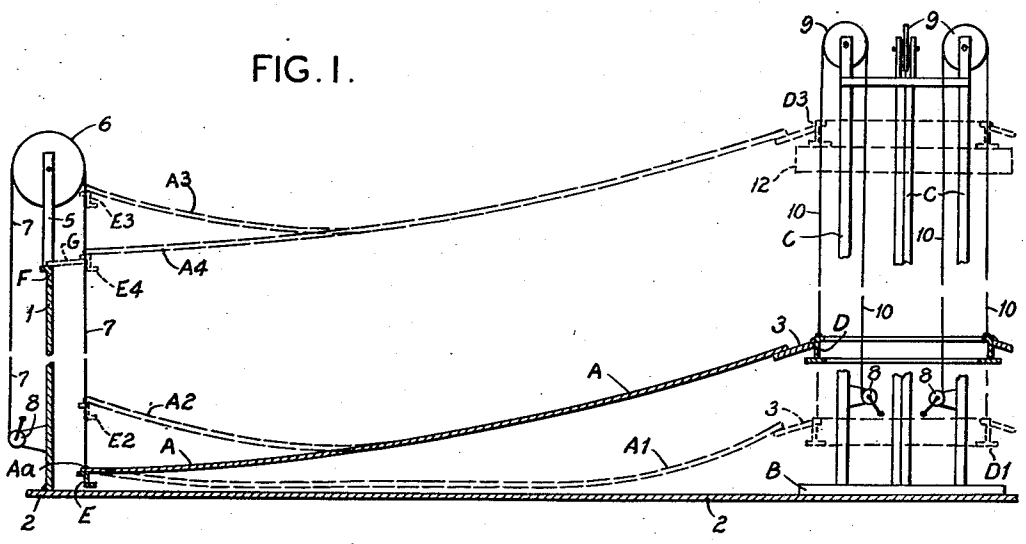
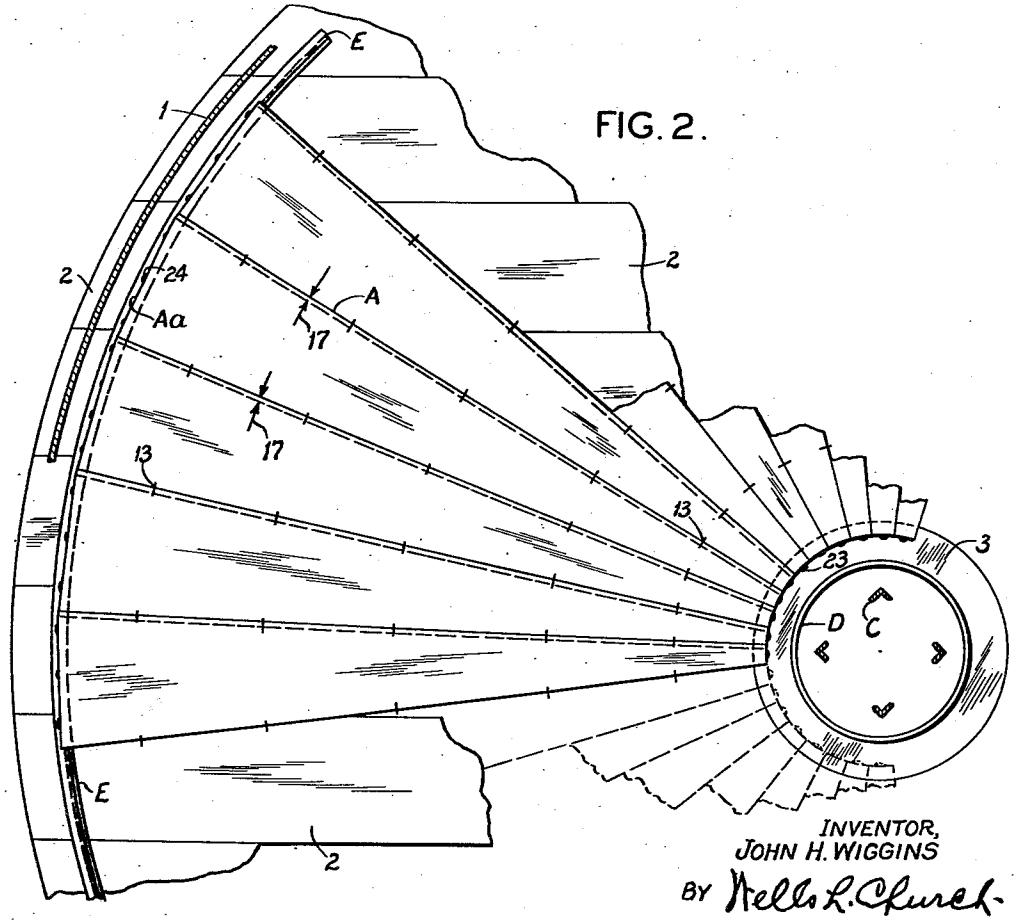


FIG. 2.



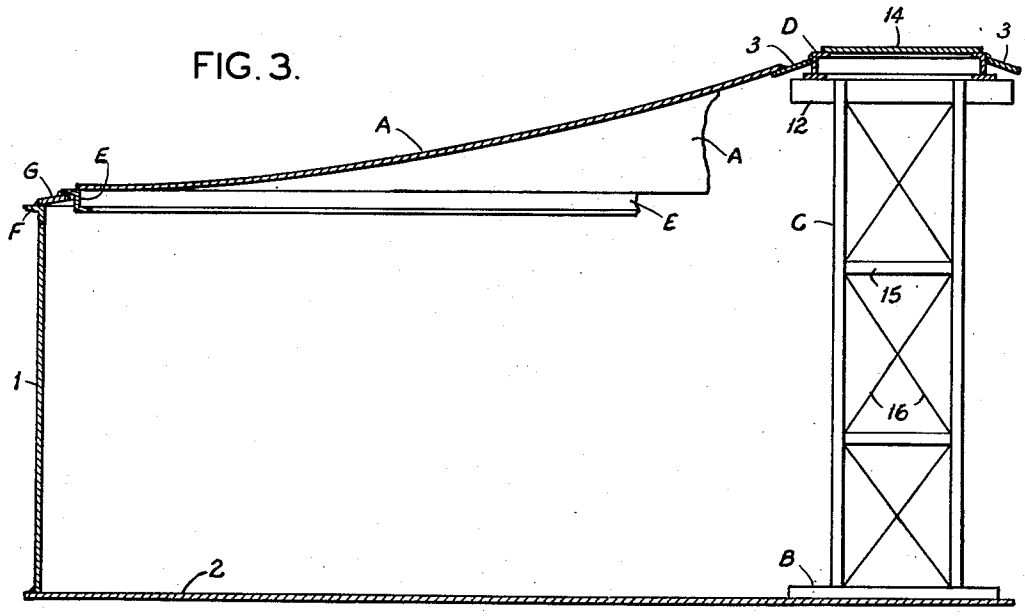
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FIG. 3.



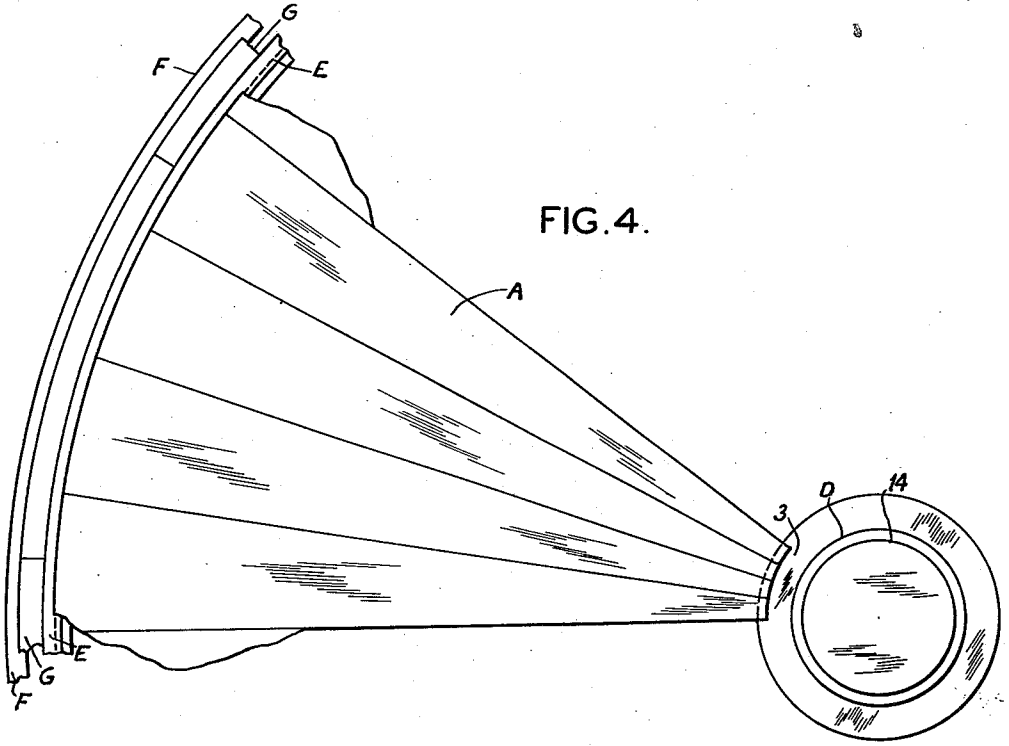


FIG. 4.

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METHOD OF BUILDING METAL STORAGE TANKS

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4 Claims. (Cl. 29—429)

This invention relates to a novel method of building metal tanks that are used for holding liquid, grain and various other materials, and particularly storage tanks for petroleum products of the kind that are equipped with a stationary roof as distinguished from a roof which floats on the liquid confined in the tank.

The main object of my invention is to provide a method of building metal tanks that reduces the labor cost and simplifies the procedure of constructing large storage tanks of the kind that are provided with a self draining, stationary roof which has a continuous downward and outward slope from the center of the roof to the periphery of the roof.

Figure 1 of the drawings is fragmentary, vertical transverse sectional view, illustrating the procedure of fabricating or building the tank roof as a complete unit on the bottom of the tank and thereafter hoisting said roof to the position it occupies in the finished structure.

Figure 2 is a fragmentary view partly in top plan and partly in horizontal section, primarily for the purpose of illustrating how the roof plates are arranged in relationship with each other and in relationship with two concentric ring shaped frame members located at the center and at the periphery of the roof, preparatory to joining or welding the longitudinal edges of the roof plates together.

Figure 3 is a fragmentary, vertical, transverse sectional view of the finished structure, and

Figure 4 is a fragmentary, top plan view of the tank shown in Figure 3.

I have herein illustrated my improved method as being used to build or produce a metal tank provided with a bottom 2, a side wall 1 of circular form provided at its top edge with an annular shaped reinforcing member F, and a roof A suspended between and attached to said side wall and to a permanent vertical roof support C at the center of the tank. Said center roof support may be of any preferred construction and is herein illustrated as consisting of a tower mounted on a base grid B and composed of a plurality of vertical uprights joined to each other by cross members 16 and inclined braces 15. The roof A is self draining and has a continuous downward and outward slope from the center roof support C to the top edge of the side wall 1 of the tank. Said roof is formed by a prefabricated metal diaphragm of circular form, which is built as a complete unit on the bottom of the tank and thereafter raised or hoisted to its operative position and attached in any preferred way to the tank side wall and to the center roof support.

The prefabricated diaphragm that constitutes the roof A is made up of radially disposed roof plates whose longitudinal edges are lapped and joined together by welding, and a plurality of stiff frame members of approximately circular form in general outline, arranged in concentric relation with each other and with the center roof support C and welded to the roof plates. At the center of said diaphragm there is a stiff, ring shaped tension member D which surrounds the center roof support C and at the periphery of said diaphragm there is an annular shaped beam and compression member E which is of stiff construction, said tension and compression members being used to support the roof plates during the operation of joining said plates together; also said members D and E are used to stiffen and strengthen the diaphragm while it is being hoisted to its operative position and to form part of the means employed to attach the roof unit to the tank side wall and to the center roof support.

Any suitable means or mechanism may be used to move the roof diaphragm upwardly into its final position and for supporting it while it is being attached to the center roof support and to the tank side wall, but I prefer to use hoisting devices that are removably mounted on the center roof support C and on the tank side wall 1 so that after they have performed their function they can be removed and used in building and erecting other tanks. The hoisting mechanism herein shown comprises a plurality of winches 8 removably mounted on the lower end portion of the tower or center roof support C and a group of cables 10 leading upwardly from said winches over sheaves or pulleys 9 at the top of the center roof support and thence downwardly to the center frame member or tension ring D of the roof diaphragm to which said cables 10 are attached as shown in Figure 1. Said hoisting mechanism also comprises a plurality of winches 8 removably attached to and arranged in spaced relation around the side wall of the tank at the lower end of same, cables 7 leading upwardly from said winches over pulleys or sheaves 6 mounted in pulley supports 5 detachably connected to the top edge portion of the tank side wall, and thence downwardly from said pulleys 6 to the peripheral compression frame member E of the roof diaphragm to which said cables 7 are attached.

In practicing my method, I prefer to first lay and weld the plates that constitute the bottom 2 of the tank and then weld the peripheral edge of said tank bottom to the lowermost ring of the tank side wall. The side wall may either be built at this time or after fabrication of the roof diaphragm has been completed. The center roof support C is then fabricated or constructed as a complete unit which lies in a horizontal position on the bottom of the tank and the sheaves 9, winches 8 and cables 10 are combined with same. Thereafter said roof support C is raised into a vertical position on the base plate B which is located at the center of the tank. The next step is to assemble and join together the parts that constitute the peripheral compression member E and the center tension member D of the diaphragm and arrange said members in properly spaced, concentric relation and with the vertical roof support C projecting upwardly through the center member D. I prefer to provide said center frame member D with a substantially cone shaped portion or part 3 to which the ends of the roof plates can be welded as this provides an ample bearing area for the roof plates on the center frame member D and facilitates attaching the roof plates to said member. After the center member D has been completed, the cables 10 are attached to same and the winches 8 on the center roof support are operated so as to set said center member D a slight distance above the bottom of the tank as shown in broken lines in Figure 1 wherein the center tension ring is designated by the reference character D^1. At this time the peripheral compression member E rests on the bottom of the tank as shown in full lines in Figure 1.

The roof plates, which are tapered longitudinally, are now arranged in radial relationshp on the bottom of the tank as shown in Figures 1 and 2, with the wide outer ends of said plates resting on and supported by the pe-

ripheral frame member E, with the narrow inner ends of said plates resting on and supported by the center frame member D, and with the intermediate portions of said plates sagged downwardly and resting on the bottom of the tank. Due to the fact that the center frame member D is arranged at a higher level than the peripheral frame member E, the inner end portions of the roof plates adjacent said center frame member, will have a steeper pitch or slope than the outer end portions of said plates adjacent said peripheral frame member and the diaphragm formed by the plates will be of approximately the shape A^1 in Figure 1. As each successive roof plate is laid, one of its longitudinal edges is lapped about 2" over the adjacent roof plate, its inner end is attached by a tack weld **23** to the cone shaped portion **3** of the center frame member D, its outer end is attached by tack welds **24** to the peripheral frame member E and its longitudinal edge that laps over the adjacent plate (designated by the reference character **17** in Figure 2) is slidingly clamped to said adjacent plate at intervals of three to four feet, by means of clamps **13**. The roof plates are now practically lying flat on the bottom of the tank, but they are in such a condition that the overlapped longitudinal edge portions of said plates are capable of sliding circumferentially and radially a slight degree relatively to each other. Before the roof plates are welded or joined to each other, the center frame member D is moved upwardly into the position shown in solid lines in Figure 1, by actuating the center cables **10**, so as to take up the downward sag in the roof plates and set said plates in such a position that they form a diaphragm which has a continuous downward and outward slope from its center to its periphery as shown in solid lines in Figure 1 and indicated by the reference character A. This change in the shape or form of the diaphragm from A^1 to A, is made possible by the fact that the overlapped longitudinal edges of the plates are not rigidly attached to each other, but instead are slidingly clamped together by clamps **13** which permit adjacent plates to move slightly relatively to each other, both circumferentially and radially when the center tension ring D is moved upwardly to the position shown in full lines in Figure 1. The circumferential movement, i. e., change in width of the laps **17** of the plates, is of the order of ¼" or less. The relative radial movement of the plates is less. While the plates are sustained or supported by the frame members D and E in the position above described, the overlapped longitudinal edge portions of the plates are rigidly joined together by welding, and the ends of said plates are securely welded to said frame members. The fabrication of the roof diaphragm or roof unit on the bottom of the tank has now been completed and said diaphragm is now ready to be hoisted into its operative position at the top edge of the tank side wall.

I have discovered that this can be accomplished easily and without kinking the roof plates or injuring said plates by overbending them, if the following procedure is employed to hoist the roof: First, while the roof diaphragm A is supported by the center cables **10** in the position shown in solid lines in Figure 1 with the peripheral compression member E resting on the bottom of the tank, I attach the cables **7** of the side wall hoisting mechanism to said compression member E in widely spaced relation of from **15'** to **20'**, and thereafter I operate the side wall winches so as to raise the compression member E into the position E^2 in Figure 1, thereby distorting or deforming the peripheral portion A^2 of the diaphragm and causing it to flex into an upwardly and outwardly sloped position as shown in broken lines in Figure 1. Second, the winches on the center roof support C and on the tank side wall **1** are thereafter operated preferably substantially simultaneously, so that the two sets of cables **10** and **7** will cooperate with each other to raise the roof diaphragm to a height or level such that the center tension ring of the diaphragm (shown in broken lines in Figure 1 and designated D^3) is in the position it occupies in the finished structure, and the peripheral compression member of the diaphragm (shown in broken lines in Figure 1 and designated E^3) is located a substantial distance above the top edge of the side wall **1** of the tank. Third, while the roof diaphragm is supported by the cables **10** and **7** in the position above described, horizontally disposed beams **12** are attached to the center roof support C as shown in broken lines in Figure 1, so as to form a bearing or support for the center tension ring of the diaphragm to rest on, and segmental plates G are attached to the reinforcing member F at the top edge of the tank side wall so as to form an inwardly projecting annular flange at the top edge of the tank wall whose inner edge portion is enough smaller in diameter than the outer edge portion of the diaphragm to enable it to be used to support and attach the peripheral edge of the roof to the tank side wall. The center cables **10** are now slacked off so as to transfer the load of the roof from the cables **10** to the beams **12** at the upper end of the center roof support and subsequently the cables **7** are slacked off so as to permit the distorted or upwardly deflected peripheral portion of the diaphragm to resume its original shape (designated by the reference character A^4 in Figure 1) and cause the peripheral compression member of the diaphragm (designated by the reference character E^4) to engage and bear upon the flange formed by the inwardly projecting plates G attached to the top edge portion of the tank side wall. Thereafter said peripheral compresson member is welded to the plates G. After the winches, sheaves and cables of the hoisting mechanism have been removed, the portion of the center roof C projecting upwardly above the center tension ring D of the roof is cut off and a cover plate **14** welded to the top side of said ring D so as to reinforce and strengthen same and close the opening at the center of the roof diaphragm up through which the center roof support C extended during the operation of fabricating said diaphragm and hoisting it into its operative position.

The above described method or procedure produces a tank whose roof is self draining and is less expensive to build than a tank roof produced by conventional procedure, due to the following reasons:

(*a*) No wood framing is required to support the roof plates while they are being assembled and welded.

(*b*) As the roof is assembled and welded at ground level, the workmen engaged in the operation perform their tasks more efficiently and in less time than would be possible if they were working on an elevated structure, and

(*c*) A considerable saving in man hours is effected by eleminating the necessity of the workmen climbing up and down ladders in going to and from their tasks.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent is the following:

1. A method of building metal storage tanks, characterized by erecting a permanent roof support in a vertical position at the center of the bottom of the tank, assembling roof plates and structural frame members on the tank bottom and welding said plates and members together so as to produce a complete roof unit consisting of a circular diaphragm having a continuous downward and outward slope from its center and provided at its center and periphery with stiff annular shaped frame members rigidly attached to the diaphragm and disposed in concentric relation with each other and with said center roof support, temporarily deflecting the peripheral portion of said diaphragm into an upwardly and outwardly inclined position and bodily raising said diaphragm into a position in which the periphery of the same is higher than the top edge of the side wall of the tank, attaching an inwardly projecting flange to the tank side wall so as to form a support for the peripheral edge of the diaphragm to rest upon, restoring the peripheral portion of the diaphragm to its original downwardly sloped position with its peripheral edge resting on said

side wall flange, and joining the center part of the diaphragm to the center roof support and permanently attaching the peripheral edge of said diaphragm to the said inwardly projecting flange on the tank side wall.

2. A method as described in claim 1, wherein a hoisting mechanism mounted on the tank side wall is used to temporarily deflect the peripheral portion of the roof into an upwardly inclined position and also to assist in bodily raising the diaphragm and restoring the peripheral portion of the diaphragm to its original downwardly sloped position.

3. A method as described in claim 1 wherein the annular shaped frame member at the center of the diaphragm is combined with the center roof support before the upwardly deflected peripheral portion of the diaphragm is restored to its original downwardly sloped position.

4. A method of building metal storage tanks, characterized by constructing the bottom of the tank, erecting a roof support in a vertical position at the center of the tank, assembling structural members on the bottom of the tank and joining said members together so as to form a tension ring that surrounds the center roof support and an annular compression member arranged in widely spaced, concentric relation with said tension ring, assembling tapered roof plates in radial relationship on said tension ring and compression member with the longitudinal edge portions of said plates overlapped, welding the ends of the plates to said tension ring and compression member, raising said tension ring by hoisting cables carried by the center roof support so as to impart a downward and outward slope to the plates, welding the overlapped longitudinal edges of the plates together thereby producing a roof diaphragm having a continuous downward and outward slope and provided at its center and periphery with stiff, ring shaped frame members, raising said peripheral compression member by hoisting cables carried by the tank side wall so as to temporarily deflect the peripheral portion of the diaphragm into an upwardly and outwardly inclined position, actuating both sets of cables so as to bodily raise the diaphragm into a position in which the peripheral edge of the diaphragm is higher than the top edge of the tank side wall, attaching a means to the center roof support that forms a bearing for the tension ring of the diaphragm to rest upon, attaching an inwardly projecting flange to the tank side wall so as to form a support for the peripheral compression member of the diaphragm to rest on, then slacking off the side wall cables so as tc restore the peripheral portion of the diaphragm to its original downwardly sloped position, and thereafter welding the peripheral compression member of the diaphragm to the inwardly projecting flange on the tank side wall.

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