Oct. 9, 1962

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Filed Jan. 19, 1959

4 Sheets-Sheet 1

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3,057,054

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Fig. 17

Fig. 18

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This invention relates in general to certain new and useful improvements in methods for erecting steel tanks and similar enclosed structures.

In erecting cylindrical steel tanks and similar structures, it is conventional practice to form large rectangular sheets of steel, aluminum, or other suitable metal into arcuate sections which conform to the desired cylindrical contour of the finished tank. These sheets are then set up upon a suitable foundation and welded or riveted marginally together in a series of vertically superposed annular courses or rings. Thereby, the several superposed rings are staggered or offset somewhat in the manner of brickwork to increase the strength of the total structure. Finally, after the tank has reached the desired height, a suitably shaped roof will be constructed as a top closure thereafter. Ordinarily, arcuately formed sections which comprise the tank are several feet long and several feet high. The actual dimensions, of course, will depend upon the size and character of the tank being constructed. However, the first or ground ring of sections can be set up on the foundation and assembled by workmen at ground level, but successive rings above ground level cannot usually be reached from ground level. Therefore, it is necessary for the workmen to erect some type of scaffolding upon which to stand as the tank increases in height and it is also necessary to employ some type of hoisting equipment, such as a derrick or crane, to lift the sections up into place. Since steel tanks and similar structures are usually quite large, both in diameter and vertical height, the problems of scaffolding and the hoisting of materials and parts become serious, with the result that tank erection is a somewhat slow and expensive process.

It is the primary object of the present invention to provide methods for erecting steel tanks and similar structures by which the need for scaffolding is eliminated. It is also an object of the present invention to provide methods for erecting steel tanks by which the need for cranes, derricks, or similar external hoisting equipment is eliminated.

With the above and other objects in view, my invention resides in the novel features of form, construction, arrangement, and combination of parts presently described and pointed out in the claims.

In the accompanying drawings—

FIG. 1 is a vertical sectional view of a tank foundation and tank-roof in the first stages of tank erection utilizing the means and methods of the present invention;

FIGS. 2, 3, 4, 5, and 6 are similar vertical sectional views showing successive stages of tank erection utilizing the means and methods of the present invention;

FIG. 7 is a perspective view of a steel tank erected in accordance with the methods of the present invention, showing such steel tank in its final stages of its construction;

FIG. 8 is a transverse sectional view taken along line 8--8 of FIG. 7;

FIG. 9 is a fragmentary sectional view taken along line 9--9 of FIG. 5;

FIG. 10 is a fragmentary sectional view taken along line 10--10 of FIG. 9;

FIG. 11 is a fragmentary sectional view taken along line 11--11 of FIG. 9;

FIG. 12 is a fragmentary sectional view taken along line 12--12 of FIG. 7;

FIG. 13 is a fragmentary exploded perspective view showing a portion of the top ring for the hoisting bag which forms a part of the present invention;

FIG. 14 is a fragmentary sectional view taken along line 14--14 of FIG. 8 and showing in specific detail the bottom-construction of the hoisting bag forming a part of the present invention;

FIG. 15 is a fragmentary sectional view taken along line 15--15 of FIG. 7;

FIG. 16 is a fragmentary sectional view taken along line 16--16 of FIG. 15;

FIG. 17 is a top plan view of a central connection spider forming a part of the present invention; and

FIG. 18 is a perspective view of the central connection spider in operative position.

Broadly speaking, the present invention resides in the use of a lightweight inflatable bag which can be set up on the foundation or other site upon which the steel tank is to be erected. The inflatable bag is provided around its upper portion or top wall with a skeletonized framework of steel or other suitable material. The plurality of these small, easily transported parts or components which can be quickly and conveniently assembled on the job or dismantled when the work has been completed. The framework or so-called "spider" is provided with a plurality of outriggers which can be temporarily attached to a completely assembled ring of tank-sections, so that when air under pressure is introduced into the inflatable bag, the entire assembled ring of tank-sections will be lifted vertically upwardly and held in such elevated position while a succeeding ring of tank-sections is assembled at ground level. When the succeeding ring of tank-sections has been completely assembled, the elevated ring of tank-sections can be lowered slightly by letting some of the pressure out of the inflatable bag until the two rings are brought into endwise abutment, whereupon they can be riveted, welded or otherwise securely fastened together. The outriggers are then released from the uppermost of these two rings of tank-sections and the inflatable bag is completely deflated so that the outriggers will be lowered and can be fastened to the particular ring of tank-sections which is at ground level, whereupon the entire upper portion of the tank which has thus far been assembled can be elevated by again introducing air under pressure into the inflatable bag so that a further succeeding ring of tank-sections can be assembled at ground level. Obviously, this series of steps can be repeated any number of times, within reasonable limits, until a tank of the desired height has been assembled and erected. When the tank has reached the desired height and the lowermost ring of tank-sections is being assembled, one or two such tank-sections can be temporarily omitted, as shown in FIG. 7, so that the spider can be disassembled and removed from the interior of the tank, together with the inflatable bag and all other related equipment.

Referring now in more detail and by reference characters to the drawings, which illustrate a preferred embodiment of the present invention, A designates a conventional concrete foundation constructed in the form of an annular footing enclosing a circular ground-level floor I. The concrete footing A and floor I are conventional and may be constructed in the usual manner. In fact, any other suitable type of floor or foundation may, with equal facility, be used as a base upon which a steel tank can be erected with the means and methods of the present invention.

Secured to the upper horizontal face of the footing A by means of a series of lag-bolts 2 is a ring-shaped foot-
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ing-channel 3, which ultimately serves as a means for securing the finished steel tank to the foundation or footing A, as will be presently more fully described. This footing-channel 3 also serves the intermediate purpose of supporting and holding the various rings of tank-sections in place during assembly, as will be presently more fully pointed out.

Provided for use in assembling the steel tanks and related structures, in accordance with the methods of the present invention, is a relatively large inflatable bag B integrally including a corrugated cylindrical side wall 4 and substantially flat top and bottom walls 5, 6, the side wall 4 being so constructed that it can be collapsed into a relatively small vertical height, as shown in FIG. 1, or extended accordion-wise to full height, as shown in FIG. 4. Preferably, though not necessarily, a rigid disc-like top-plate d is placed over the top wall 5 to provide greater and more uniform distribution of the load stresses.

Integrally formed in the side wall 4, preferably adjacent to the bottom wall 6, is a laterally projecting tubular sleeve 7 adapted for removable receiving an elongated intake pipe 8, the sleeve 7 and intake pipe 8 being secured tightly together by means of a clamping band 9.

The inflatable bag B may be formed of any suitable material such as thin woven fabric impregnated with rubber or neoprene to render it imperVIOUS to the passage of air or a nylon type of material suitably impregnated for air impermeability.

At the beginning of tank-erecting operations, the deflated bag B may be set up on the floor 1 of the tank-site in a substantially centralized position, as shown in FIG. 1, and the air intake pipe 8 run out radially over the floor 1 and beyond the foundation or footing A for connection by means of another clamping band 10 to a circular flange 11 surrounding the outlet opening 12 of a valve housing 13, the latter also being provided with an intake opening 14 surrounded by an outwardly extending flange 15, which is, in turn, connected by means of a clamping band 16 to a pipe or conduit 17 leading to a large motor driven air blower 18. It will, of course, be understood that this blower 18 may be powered in any conventional manner, as, for instance, by an electric motor or by a gasoline engine.

Secured upon the inner face of the housing 13 in position loosely across the intake opening 14 is a heavy rubber disk or so-called "flipper" 19, which, as can be seen from FIG. 16, is secured only along the upper portion of its periphery. Consequently, the flipper 19 will swing freely inwardly out of the path of incoming air from the blower and will allow such air to pass through the valve housing 13 into the intake pipe 8. However, the flipper 19 will swing down across the intake opening 14 and prevent reverse flow of air, operating, in a manner of speaking, as a check valve.

The valve housing 13 is also provided with a laterally presented opening 20 which is normally closed by a circular valve-plate 21 rotatably secured upon the lower end of a valve-screw 22 which is threadedly mounted in a collar 23 integrally formed with a U-shaped supporting saddle 24 which is rigidly fastened to the valve-housing 13 and extends upwardly over and across the opening 20, as shown in FIG. 14. At its upper end, the valve-screw 22 is provided with a suitable handle 25 which can be manipulated to lift the valve-plate 21 upwardly out of closure-forming position across the opening 20 whenever it is desired to allow air to flow reversely through the intake pipe 8 and out of the opening 20.

Also provided for co-operation with the bag B is a plurality of arcuate flange-segments 26 integrally including a top flange 27 and a side flange 28 shaped or contoured to fit around the upper peripheral margin x of the bag B, as shown in FIG. 9. Rigidly mounted in and extending vertically upwardly from the top flange 27 is a plurality of uniformly spaced threaded studs 29 adapted to fit within apertures 30 of arcuate connector plates 31, which are preferably, though not necessarily, of the same arcuate length as the flange-segments 26. For example, as shown in FIGS. 8 and 13, the flange-segments 26 are of quarter-circle shape and the connector plates 31 are also of quarter-circle size. Thus, in setting up the tank erecting equipment of the present invention, four matching flange-segments 26 are placed in edge-to-edge relationship annularly around the upper margin x of the bag B and connector plates 31 are laid on top of the flange-segments 26 in such a manner that the connector plates 31 extend approximately equidistantly across the abutting edges between each of two adjacent flange-segments 26 and the studs thereof project upwardly through the apertures 30. Nuts 32 are then threaded down tightly upon the studs 30 to hold the flange-segments 26 securely vertically in a complete annular circle or rim around the top of the bag B.

The connector plates 31 are provided centrally with two radially spaced upstanding threaded studs 33, 34, being adapted to fit through any two adjacent apertures 30 formed in an outrigger bar 36. As will be seen by reference to FIG. 8, when the flange-segments 26 are operatively mounted upon the bag B four such outrigger arms 36 has been found to be satisfactory for construction of most types of tanks. It will be understood, in the connection of course, that it is possible, within the scope of the present invention, to provide a greater number of outrigger arms 36 if the size of the tank or other circumstances should require. Each of the outrigger arms 36 is provided at its outer ends with an upturned flange 37 which can be bolted to the Z-shaped upright posts P to form a part of the tank being constructed. Inasmuch as these posts P are conventional and commonly used in constructing steel tanks, it is not necessary to describe them in detail, but it is sufficient to point out that these posts are provided at their upper and lower ends with flat connector plates 38 by which the posts P are secured endwise in vertical alignment as the tank progresses upwardly. Moreover, the posts P are bolted to the overlapping joints between the arcuate plates from which the tank is constructed, as may be best seen in FIGS. 9 and 10.

Also provided for connection to the inner ends of the outrigger arms 36 is a central connection spider 39 which is generally cross-shaped and integrally includes four identical arms 40 as having a series of bolt-holes 41 for receiving bolts 42, 43, by which the respective arms 40 are firmly attached to the interior ends of the outrigger arms 36, thereby connecting such outrigger arms 36 in a firm stable structure capable of bearing substantial weight and distributing the load more or less uniformly over the entire top of the bag B, as illustrated in FIG. 18.

When the bag B is fully set up with flange-segments 23 and outrigger arms 36 in place, the conical roof r can be assembled on the outrigger arms 36, substantially in the manner shown in FIG. 1, and, thereupon, the bag B can be inflated, elevating the roof to the position shown in FIG. 2. It is obvious, of course, that the bag B will lift the roof r to a level substantially above the plane of connection with the top cover 44 and so form the side wall w of the tank. Consequently, the initial or top course of the tank side wall can then be assembled on the foundation by workmen working a ground level. This can be accomplished in the conventional manner by setting together an annular circle of arcuate steel plates 39 around the entire peripheral margin of the bag B, omitting, however, one such plate or segment 44 in the area of the intake pipe 8. Thereupon, the bag B may be deflated slightly to lower the roof r down upon the upper margin of the side wall w, whereupon the roof r...
and the first or uppermost course of side wall-forming plates 44 may be bolted together in the manner shown in FIG. 4, and the side wall-forming plate 44 may then be bolted to the outermost arms 36 located at 90° intervals around the periphery of the tank. Thereupon, the bag B may be inflated slightly, lifting the first course of the tank side wall w and roof r upwardly as a unit until the lower margin thereof clears the intake pipe 8. The uppermost course of side wall-forming plate 44 may then be bolted into the gap over the intake pipe 8 so as to complete the first annular side wall-forming course of the tank.

The bag B may then be fully inflated to lift the roof r and the first side wall-forming course to the position shown in FIG. 4, whereupon the second side wall-forming course can be assembled in the same manner as the first side wall-forming course. In order to stabilize the structure in elevated position and prevent accidents, it is desirable to lash the outermost arms 36 to the foundation A by guy ropes g. When the second course has been fully assembled, except for the one plate 44 which extends across the intake pipe 8, the previously assembled portion of the tank is lowered and the first and second course bolted together in the conventional manner. Then, the bag B is inflated slightly to lift the assembled structure above the intake pipe and the bag B is flatted into the gap of the second course bolted in place. Finally, the bag B is fully inflated to lift the roof and the upper two assembled courses or annular rings of the tank side wall into the position shown in FIG. 6. Then, the third or final course of plates 44 is assembled in the same manner as previously described.

Assuming that the tank is a three-tier tank, as shown in FIG. 7, the second course of plates 44 can be bolted to the third or bottom course of the plates 44 with one last or final plate 44 left out, as shown in FIG. 7. As soon as all of these assembly operations have been completed, except for the installation of this final plate 44, the outermost arms 36, the connector plates 31, and the flange segments 26 are disassembled, the bag B is fully deflated and rolled up into as compact a bundle as possible, and the entire assembly structure removed through the opening and, thereupon, the final plate 44 is conventionally bolted in place, completing the tank.

It will be understood that the foregoing procedure can be repeated to build into the tank as many courses as desired, so that the finished tank will have any required height within reasonable limits.

It should be understood that changes and modifications in the form, construction, arrangement, and combination of the several parts of the means and methods for erecting steel tanks and similar enclosed structures may be made and submitted for those herein shown and described without departing from the nature and principle of my invention.

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

1. The method of erecting steel tanks and similar structures which are made up of a series of steel plates and structural members connected in superposed annular side-wall forming courses; said method comprising forming a foundation for the structure, setting an inflatable bag upon the foundation, constructing the roof of the structure at ground level in such a manner that the roof is supported by the bag, inflating the bag to cause the roof to lift off the foundation, and, thereupon, inserting the assembled portion of the structure into the assembled portion of the wall-forming course of plates upon the foundation as a temporary support, partially deflating the bag and thereby lowering the roof to continuity with the top of the uppermost annular side-wall forming course and connecting said course and the roof together, further deflating the bag, connecting said course to the bag, and lifting the roof and uppermost course upwardly until the lower margin of said course is at a height above the foundation greater than the vertical height of the next succeeding annular course of plates, assembling the next succeeding course of plates upon the foundation as a temporary support partially deflating the bag until the lower margin of the uppermost course is in proper alignment for connection with the upper margin of the next succeeding course of plates, connecting said course and said next succeeding course, deflating said uppermost course from the bag, further deflating the bag, connecting said next succeeding course to the bag, and partially deflating the bag to elevate the assembled portion of the structure, and repeating the above-described sequence of course-elevating and course-assembling steps until the structure is fully assembled to the desired height.

2. The method of erecting steel tanks and similar structures which are made up of a series of steel plates and structural members connected in superposed annular side-wall forming courses; said method comprising forming a foundation for the structure, setting an inflatable bag upon the foundation, constructing the roof of the structure at ground level in such a manner that the roof is supported by the bag, inflating the bag to elevate the roof to a height greater than the vertical height of the uppermost annular side-wall forming course of plates, assembling the uppermost course of plates upon the foundation as a temporary support, partially deflating the bag and thereby lifting the roof to continuity with the top of the uppermost annular side-wall forming course and connecting said course and the roof together, further deflating the bag, connecting said course to the bag, and lifting the roof and uppermost course upwardly until the lower margin of said course is at a height above the foundation greater than the vertical height of the next succeeding annular course of plates, assembling the next succeeding course of plates upon the foundation as a temporary support partially deflating the bag until the lower margin of the uppermost course is in proper alignment for connection with the upper margin of the next succeeding course of plates, connecting said course and said next succeeding course, deflating said uppermost course from the bag, further deflating the bag, connecting said next succeeding course to the bag, and partially deflating the bag to elevate the assembled portion of the structure, and repeating the above-described sequence of course-elevating and course-assembling steps until the structure is fully assembled to the desired height.

3. The method of erecting steel tanks and similar structures which are made up of a series of steel plates and structural members connected in superposed annular side-wall forming courses in edgewise abutment so that the outer sides of the courses all lie along the same cylindrical surface; said method comprising forming a foundation for the structure, setting an inflatable bag upon the foundation, constructing the roof of the structure at ground level in such a manner that the roof is supported by the bag, inflating the bag to elevate the roof above the top of the uppermost course of plates, assembling the uppermost course of plates upon the foundation as a temporary support, partially deflating the bag and thereby lowering the roof to continuity with the top of the uppermost annular side-wall forming course and connecting said course and the roof together, further deflating the bag, connecting said course to the bag, and lifting the roof and uppermost course upwardly until the lower margin of said course is at a height above the foundation greater than the vertical height of the next succeeding annular course of plates, assembling the uppermost course of plates upon the foundation as a temporary support, partially deflating the bag and thereby lowering the roof to continuity with the top of the uppermost annular side-wall forming course and connecting said course and the roof together, further deflating the bag, connecting said course to the bag, and lifting the roof and uppermost course upwardly until the lower margin of said course is at a height above the foundation greater than the vertical height of the next succeeding annular course of plates, assembling the next succeeding course of plates upon the foundation as a temporary support partially deflating the bag until the lower margin of the uppermost course is in proper alignment for connection with the upper margin of the next succeeding course of plates, connecting said course and said next succeeding course, deflating said uppermost course from the bag, further deflating the bag, connecting said next succeeding course to the bag, and partially deflating the bag to elevate the assembled portion of the structure, and repeating the above-described sequence of course-elevating and course-assembling steps until the structure is fully assembled to the desired height, deflating the bag, removing the bag through the lowermost exit-opening, and closing the lowermost exit-opening.
greater than the vertical height of the next succeeding annular course of plates, assembling the next succeeding course of plates upon the foundation as a temporary support, partially deflating the bag until the lower margin of the uppermost course is in proper alignment for connection with the upper margin of the next succeeding course of plates, connecting said uppermost course of plates and said next succeeding course in edgewise coincident abutment, disconnecting said uppermost course from the bag, further deflating the bag, connecting said next succeeding course to the bag, reinflating the bag to elevate the assembled portion of the structure, repeating the above-described sequence of course-elevating and course-assembling steps until the structure is fully assembled to the desired height, and removing the bag.

4. The method of erecting steel tanks and similar structures which are made up of a series of steel plates and structural members connected in superposed annular side-wall forming courses; said method comprising forming a foundation for the structure, mounting a cylindrically flanged footing channel upon the foundation in such a manner that the flange of the channel projects upwardly, setting an inflatable bag upon the foundation, attaching outriggers to the bag, constructing the roof of the structure at ground level in such a manner that the roof is supported by the bag and the outriggers, inflating the bag to elevate the roof above the foundation to a height greater than the vertical height of the uppermost annular side-wall forming course of plates, assembling the uppermost course of plates upon the foundation within the footing channel as a temporary support, partially deflating the bag and thereby lowering the roof to contiguity with the top of the uppermost annular side-wall forming course and connecting said course and the roof together, further deflating the bag, connecting said course to the outriggers, reinflating the bag and thereby lifting the roof and uppermost course upwardly until the lower margin of said course is at a height above the foundation greater than the vertical height of the next succeeding annular course of plates, assembling the next succeeding course of plates upon the foundation as a temporary support omitting at least one plate from the succeeding course of plates to provide an exit-opening, partially deflating the bag until the lower margin of the uppermost course is in proper alignment for connection with the upper margin of the next succeeding course of plates, connecting said uppermost course of plates in edgewise coincident abutment with said next succeeding course, entering through the exit-opening and disconnecting said uppermost course from the bag, further deflating the bag, connecting said next succeeding course to the outriggers, egressing from the partially completed structure and thereafter attaching the omitted plate to the proper course, reinflating the bag to elevate the assembled portion of the structure, repeating the above-described sequence of course-elevating and course-assembling steps until the structure is fully assembled to the desired height, and removing the bag and outriggers through the lowermost exit-opening.

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