This invention relates to metal storage tanks of the kind in which the side wall of the tank is composed of a plurality of ring shaped sections arranged in superimposed relation and having their adjacent edge portions joined together by welding or in any other suitable manner.

One object of my invention is to provide a novel method or procedure for building a tank side wall of the kind referred to that makes it possible for the ring shaped sections of the wall to be fabricated and joined together by workmen located at ground level, and that is particularly adapted for use in constructing tank walls having a diameter of 120' or more.

Another object is to provide a novel mechanism for practicing or carrying out my improved method which is of such design and construction that when said mechanism is moving the ring shaped sections of the wall into operative relationship with each other, said sections will be maintained in a truly circular form even though said sections may be of relatively great diameter.

And still another object of my invention is to provide a mechanism that is adapted to be used for the two-fold purpose of (a) building a circular tank side wall at ground lever, and (b) subsequently used in the operation of fabricating the roof of the tank at ground level and then hoisting said roof into a position where the periphery of said roof can be attached to the top edge of the tank side wall. Other objects and desirable features of my invention will hereinafter be pointed out.

Figure 1 of the drawings is a fragmentary, vertical, transverse sectional view illustrating my improved erection mechanism and the method of using same to produce a tank side wall composed of a plurality of ring shaped sections arranged in superimposed relation.

Figure 2 is a fragmentary, top plan view showing a portion of the outer ring girder compression member that is adapted to be detachably connected to the ring shaped sections that constitute the tank side wall, and some of the radially disposed tension members that support said compression member and attach it to or suspend it from the hoisting apparatus, and

Figure 3 is a view similar to Figure 1, showing three sections of the side wall arranged in operative relationship with each other.

Briefly described, my method or procedure for building a circular tank side wall consists in first assembling metal plates and joining them together at ground level, usually on the bottom of the tank, so as to produce a horizontally disposed circular shell or ring shaped member that rests on the tank bottom and which is used to form the top section or first section of the tank side wall, then temporarily attaching a stiff compression ring girder to the lower end portion of said shell so as to ensure that said shell will remain in a truly circular shape when it is subsequently raised from the bottom of the tank, then moving said ring girder upwardly to a height or level such that a second circular shell (which is to constitute the second section of the wall) can be fabricated on the bottom of the tank and attached at its top edge to the bottom edge of said top wall section, and repeating the above described procedure until a circular wall of the desired or required height is produced. The mechanism that I have devised for practicing or carrying out the above described method consists of or comprises a vertically disposed support or tower located at the center of the bottom of the tank that is being built and having a height greater than the height of the tank side wall, a hoisting or lifting apparatus carried by or combined with said vertical support or tower, and a circular frame work adapted to be moved upwardly by said hoisting or lifting apparatus and composed of the above mentioned stiff, compression ring girder and a means for suspending said girder from the hoisting apparatus. Preferably said circular frame work consists of a center tension ring that surrounds the tower or vertical support at the center of the bottom of the tank and is of such diameter as to be capable of moving vertically relatively to said center support, the above mentioned compression ring girder that constitutes the peripheral portion of said frame work and which is arranged in a lower horizontal plane than said center tension ring, and a plurality of radially disposed tension members attached to and extending downwardly and outwardly from said center ring and joined at their outer ends to the peripheral compression ring girder of the frame work. Said peripheral compression ring girder is of slightly less diameter than the circular shells from which the side wall is formed and means is provided for enabling said peripheral compression ring to be rigidly combined with said circular shells or wall sections, or alternate ones of said sections, during the operation of building or erecting the wall as hereinafter described.

In the drawings which illustrate the preferred form of my invention the reference character 1 designates the top section or first section of the tank side wall, 1 designates the second section and 1 designates the third section, said sections being of circular shape and fabricated from metal plates, and the top section preferably having a compression member peripherally attached to the top edge of same. If the tank is to be used for storing oil and has a diameter of approximately 120', the side wall will be composed of five ring shaped sections that produce a circular wall of relatively great height (usually 40'), each ring shaped section having a depth or height of about 8', and the lower most sections being of greater thickness than the topmost sections.

The mechanism I have devised for enabling workmen located at ground level, to move the sections of the wall upwardly into superimposed relation with each other, comprises a vertically disposed support, tower or column C located at the center of the tank and having a height in excess of the height of the tank side wall, the frame work being provided with a rigid, compression ring girder of slightly less diameter than the ring shaped sections of the wall, constructed and arranged so that it serves as a carrier or elevator for moving said wall sections upwardly into operative relationship with each other after said sections have been fabricated or constructed, and a means combined with or mounted on the vertical support or tower and the center of the tank for hoisting, raising or moving said frame work upwardly. The above mentioned frame work may be of any preferred construction so long as it comprises a rigid, compression girder that supports the weight of the wall sections and maintain the circular shape or form of said sections while they are being raised or moved upwardly into superimposed relation with each other, and any suitable type of hoisting mechanism may be used for progressively raising or moving said frame work upwardly. In the form of my invention herein illustrated the above mentioned frame work is composed of a ring shaped tension member D that surrounds the
center support C and which is of such diameter that it is capable of moving vertically relatively to said center support, a stiff compression ring girder I that constitutes the peripheral portion of the frame work and which is arranged in a lower horizontal plane than the center tension ring D, and a plurality of radially disposed tension members J attached to the center ring D and projecting downwardly and outwardly from same to the peripheral ring girder I to which the outer ends of said tension members J are suitably attached in a suitable way, as, for example by means of pins 37 that engage lug 35 attached to the top flange of the girder I. Said girder must be of very stiff construction and usually will be composed of segmental sections of I beams joined together so as to form an annular compression beam of only slightly less diameter than the tank side wall. The means that I have herein illustrated for raising the above described frame work, consists of a hoisting apparatus composed of a plurality of sheaves 8 carried by bearings 9 mounted on a top plate 4 carried by a supporting ring 3 at the top of the tower C, and cables 20 attached to the center ring D of the frame work and leading upwardly from same over the sheaves 8 and thence downwardly to winches 21 mounted on the lower end portion of said tower and provided with drums to which the cables 20 are attached. The center support or tower C also may be of any preferred construction and is herein illustrated as being composed of a plurality of vertically disposed uprights 5 joined together by roundabout horizontal braces 6 and diagonal braces 7.

After the first section or topmost section 1 of the tank side wall has been fabricated and provided at its top edge with a compression member H, said section rests in a horizontal position on the bottom 2 of the tank as shown in full lines in Figure 1. The annular compression and beam member I of the mechanism that is used to raise said wall section 1 is then rigidly attached to said section preferably by welding the ends of the lugs 35 on the member I to the inner face of the section 1 and also welding relatively wide horizontally disposed plate or flat lugs 38 to said wall section and to the top flange of the beam member I as shown in Figure 2, said beam member being placed a few inches inside of the wall section 1 at the extreme lower end of said section. By joining the peripheral girder I of the lifting frame to the wall section 1 in the manner above described, said girder and wall section form a very tall or deep circular beam K whose top and bottom edge is formed by the compression member H on the side wall section 1, whose bottom stiffening element is formed by the peripheral girder I of the lifting frame and whose vertical web is formed by the wall plates of which said section 1 is constructed. Also I produce a very stiff and radically wide compression member designated by the reference character L in Figure 2, that is capable of carrying the circumferentially directed compression forces set up by the slanting tension members J of the lifting frame.

After the peripheral compression girder I of the frame work of the lifting or hoisting apparatus has been combined with or attached to the topmost section 1 of the wall as above described, the winches 21 are operated so as to raise said section 1 a distance approximately equal to the height or depth of the second ring shaped section of the wall that is to be constructed as shown in broken lines in Figure 1 and depending vertical plates or lugs 36 are attached to the bottom edge of the wall section 1 so as to help position the second wall section. The plates used in said second section are so attached to the bottom of the tank and joined together so as to produce the second wall section 1 whose top edge is then welded roundabout to the section 1. Thereafter the winches are again operated to raise both of the sections 1 and 1 a distance approximately equal to the depth or height of the third section 1 which after completion of the fabricating operation is attached to the bottom edge of the wall section 1 as shown in Figure 3. It should be noted that this far only two of the sections of the wall, which are the lightest weight sections, have been lifted. The next step in the procedure is to disconnect the lugs 35 and 38 from said section, and then lowering said compression member I to a level near the bottom of the third wall section 1 and attaching said frame member J to said third section in the manner previously described. The third wall section 1 is made of plates of greater thickness than the plates of which the first and second sections are constructed, with the result that after the peripheral girder I of the lifting frame has been attached to section 1, the previously mentioned beam K, formed by the two sections and the girder I, is much deeper and hence stronger, and the previously mentioned radically wide compression member L, formed by the wall sections and the girder I, is much stronger because wall section 1 is thicker than section 1. This is highly desirable inasmuch as the wide compression member L must carry the circumferentially directed compression forces set up by the slanting tension members J which hold said compression member L in a true circle. Another desirable characteristic of my improved method of constructing a circular tank wall, is that the wall plates take up their full share of the circumferentially directed compression forces set up by the slanting tension members, the slope of the lifting frame being such as when the topmost section 1 is being raised, those compression forces are not very great, but as the wall progressively increases in height those compression forces increase, but this is compensated for or taken care of by the fact that the relatively wide compression member L becomes stronger and stronger. The total compression set up in compression member L is a function of the steepness of slope of the tension members J. The steeper this slope, the less the compression. It is also desirable to lift more than one wall section with a single attachment of the peripheral compression girder I of the lifting frame to the wall structure. Therefore, I prefer to make the center support C of such height and the tension members J of such slope, that at least two wall sections can be raised or lifted with a single setting or attachment of the peripheral compression girder I of the lifting frame to the wall structure. If the vertical height between the tension ring D of the lifting frame and the points where the tension members J are attached to the side wall structure (namely by the lugs 35) is thirty feet, for a tank of radius sixty feet and if the peripheral girder I of the lifting frame weighs 12 pounds per foot, then the steel for compression in member L is ample to lift four wall sections at the same time, but if more compression steel is required or if it is desired to make the girder I lighter in weight, then additional wide horizontally disposed plates or lugs 38 can be attached to the bottom edge of the girder I and to the wall section inside which said girder is arranged. If the wall is to comprise more than the three sections illustrated, said sections are raised high enough to permit the top edge of the fourth section to be fabricated and joined to the bottom edge of the third wall section, after which, if more steel is needed for member L, the girder I may be disconnected from the third section and attached to the fourth wall section and so on. In this essentially a single unit, when the hoisting apparatus is operated to position the fourth section high enough above the bottom 2 of the tank to permit the fifth section or bottom section of the tank side wall to be fabricated and attached to the lower end of the fourth wall section. During the operation of raising each ring shaped section of the wall successively so that the next section of the
wall can be fabricated beneath it and attached to the wall section immediately above, the sections are kept level and centered, by means of guys cables 34 and three or more winches 39 mounted on the bottom of the tank, said cables being preferably attached to the top most wall section and slack off as the wall progressively increases in height.

From the foregoing it will be seen that with the procedure and mechanism above described, it is possible for workmen, stationed at ground level, to quickly construct a circular tank side wall, even a wall of relatively great diameter, and maintain the ring shaped sections of the wall in a truly circular form while they are being arranged in superimposed relationship with each other, due to the fact that each ring shaped section of the wall, as it is being raised or lifted, is reinforced and strengthened either by an annular compression girder that extends around the entire circumference of same or by being permanently and rigidly attached to the edge portion of an adjacent section of the wall which has said girder attached to some.

In addition to being adapted for use in the construction of a circular side wall composed of a plurality of horizontally disposed sections arranged one above the other, as previously described, the erecting mechanism herein described is also capable of use in constructing a metal tank roof as a complete unit or in proximity to the bottom of the tank, and then raising said unit or moving it upwardly and attaching the periphery of said unit to the top edge of the tank side wall.

When employed in the fabrication and erection of a metal tank roof, the annular compression girder I of the mechanism herein illustrated, is used to form the peripheral portion of a frame work on which the roof plates are placed and are permanently combined with the attached to the peripheral portion of the roof, the center tension ring D is used to form the center portion of said frame work and is permanently combined with or attached to the center of the roof, the center tower or vertical support C can be used without change as a supporting structure for the means employed to lift, raise or hoist the frame work of which the center and peripheral rings D and I form a part as the dead plus live load said tower would have to carry would be about the same in constructing either a tank roof or tank side wall, the cables, sheaves and winches can be used to move the roof unit upwardly, and the radially disposed tension members of the mechanism herein shown, may if desired be used to tie the rings D and I together and form part of the frame work that supports the roof plates while said plates are being joined to each other. Thus it will be seen that by a slight rearrangement of certain parts of the mechanism herein shown, it can be used to construct the roof of a metal tank after the side wall of the tank has been built.

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 a tank side wall composed of a plurality of circular shaped sections arranged in superimposed relation, characterized by constructing the first or topmost section of the wall at ground level from metal plates joined together so as to form a cylindrical shell, detachably connecting to the lower end portion of said shell a self-resting ring shaped compression girder that extends continuously around the circumference of said shell and maintains it in a truly circular shape or form, hoisting said shell into a certain approximate position by exerting an upward pull on said girder at a plurality of points around the circumference of same, constructing the second section of the wall underneath said first section and permanently attaching the top edge of said second section to the bottom edge of said first section, and thereafter disengaging said compression girder from said first section and subsequently using said girder to progressively raise the wall structure, step by step, as successive sections of the wall are constructed and assembled one under the other and permanently joined together by attaching the top edge of the section last constructed to the bottom edge of the section located immediately above same.

2. A method of building a tank side wall composed of a plurality of horizontally disposed circular shaped sections arranged one above the other, which involves the following procedure: fabricating metal plates so as to produce a circular shell that rests on the bottom of the tank and which is used to form a first or topmost section of the wall, then, detachably connecting the lower end portion of said shell to a rigid ring shaped compression girder arranged inside of said shell and extending continuously around the circumference of same, then, moving said girder and shell upwardly and attaching the periphery of said shell to the top edge of the tank side wall.

3. A mechanism for erecting a tank side wall composed of a plurality of horizontally disposed circular shaped shells arranged one above the other, comprising a rigid, self-resting compression girder that is adapted to be arranged on the bottom of the tank in a position where said girder will be surrounded by and can be detachably connected to a wall shell that has been fabricated on the bottom of the tank, a vertically disposed support located at the center of the bottom of the tank, and a hoisting apparatus carried by said vertical support and attached to said girder for raising and lowering said girder during the operation of building up the wall, step by step.

4. A mechanism of the kind described in claim 3, in which the hoisting apparatus is attached to the girder by a plurality of radially disposed tension members fastened at their outer ends to said girder at points in spaced relation around the circumference of said girder.

5. A mechanism of the kind described in claim 3, in which the means used to attach the hoisting apparatus to the girder, consists of a tension ring surrounding the vertical center support and arranged in close proximity to same at a level higher than the girder, and a plurality of radially disposed tension members slanting downwardly and outwardly from said tension ring and pivotally attached at their outer ends to said girder at points in spaced relation around the circumference of said girder.

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