

Aug. 5, 1952

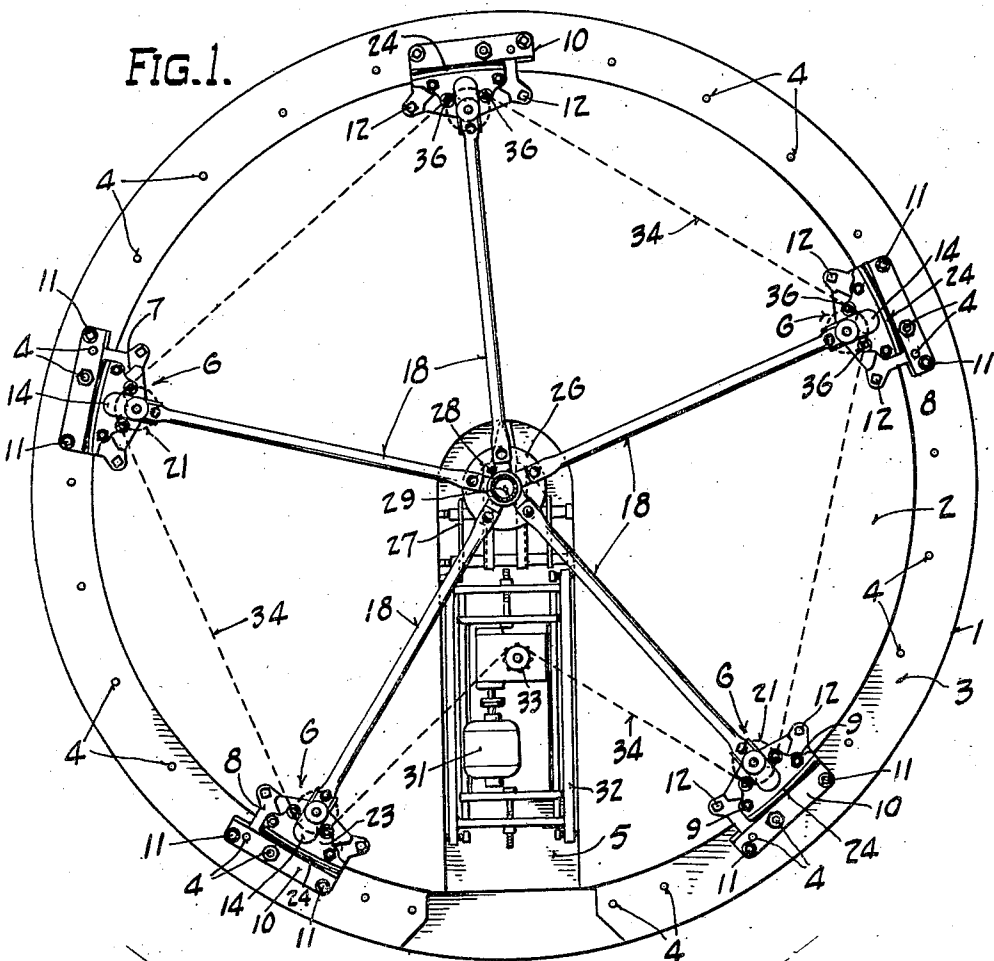
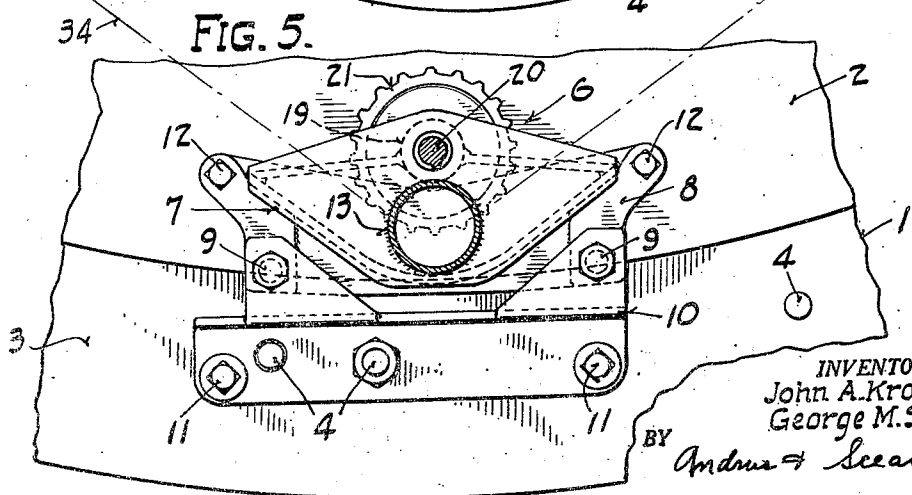
J. A. KROLL ET AL

2,605,540

METHOD OF ERECTING STORAGE STRUCTURES

Filed March 18, 1950

3 Sheets-Sheet 1



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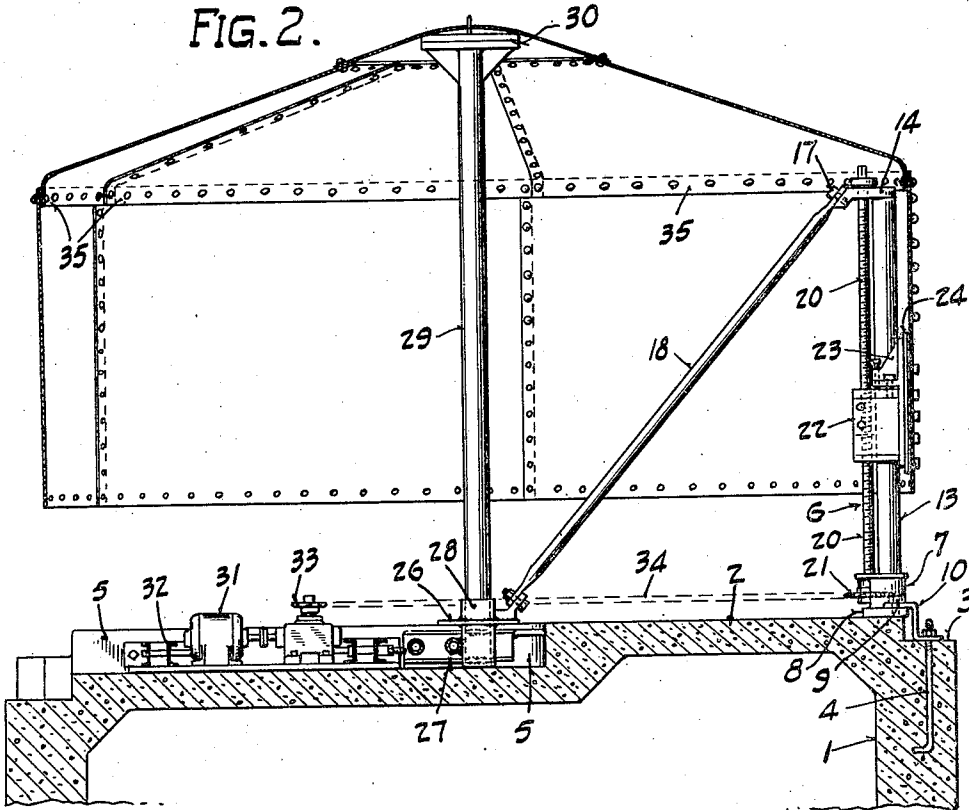
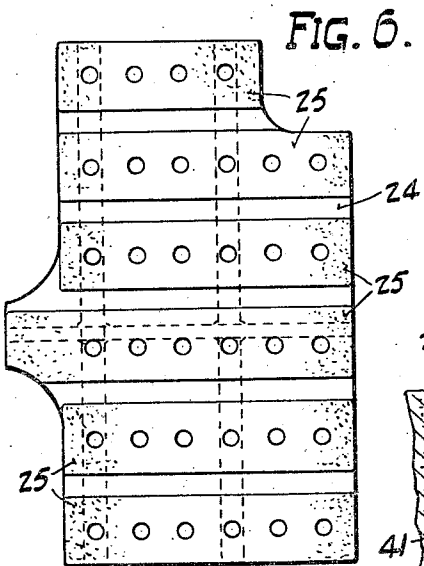
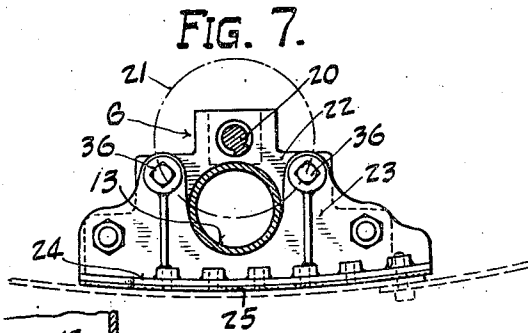
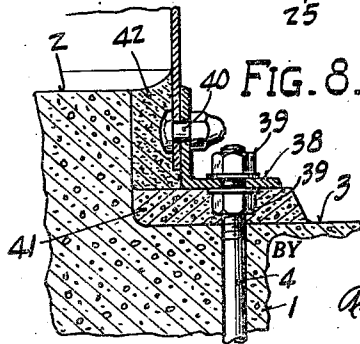
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**2,605,540**

# METHOD OF ERECTING STORAGE STRUCTURES

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3 Sheets-Sheet 2



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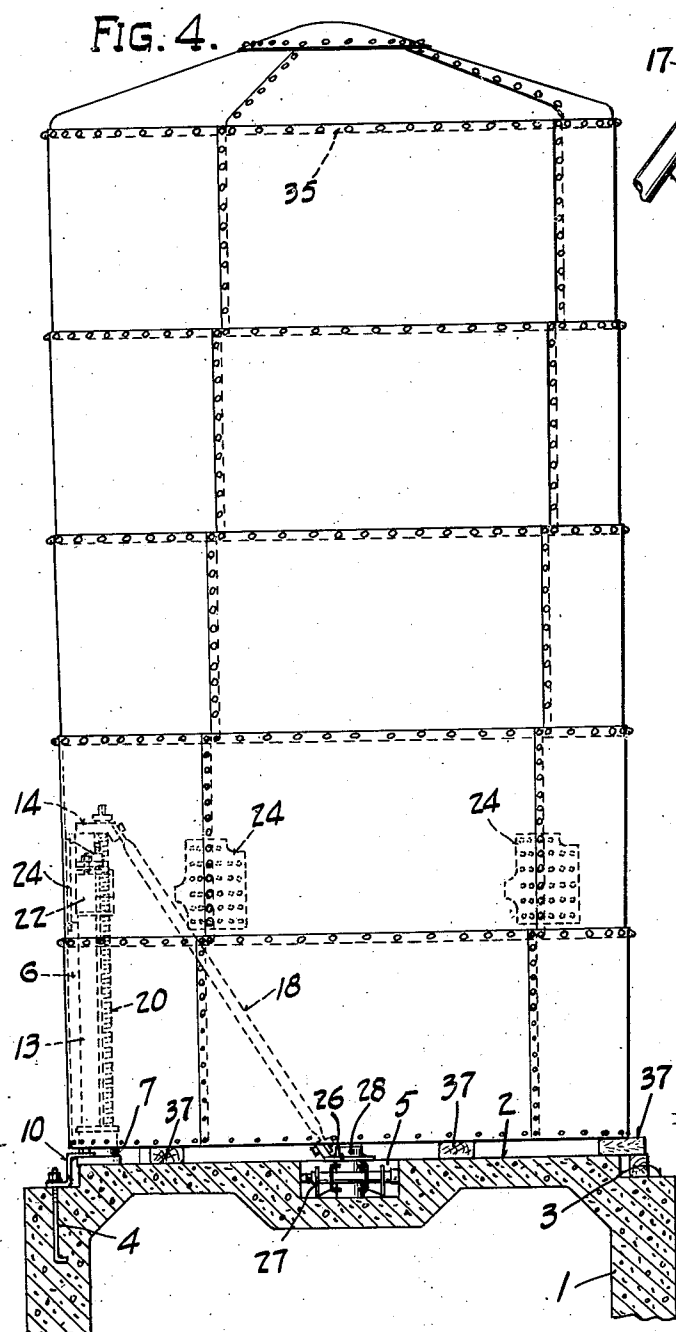
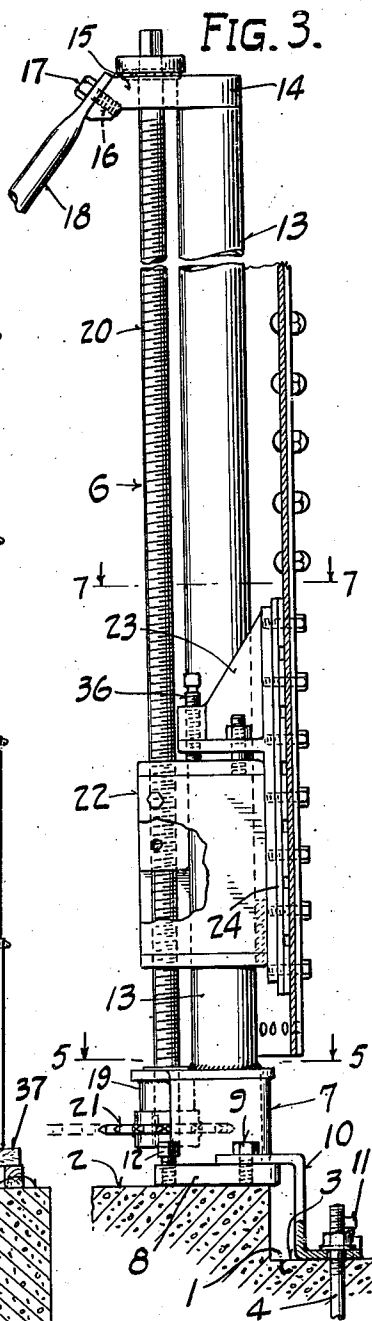
J. A. KROLL ET AL

**2,605,540**

# METHOD OF ERECTING STORAGE STRUCTURES

Filed March 18, 1950

3 Sheets-Sheet 3



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## UNITED STATES PATENT OFFICE

2,605,540

## METHOD OF ERECTING STORAGE STRUCTURES

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9 Claims. (Cl. 29—148.2)

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This invention relates generally to a method for erecting storage structures, such as silos and gas tanks.

The object of the invention is to provide a method for erecting a metal storage tank or structure in which the various sections are substantially assembled and joined to one another successively at ground level.

A further object is to provide a method for erecting metal storage tanks which permits joining of the seams of the various sections of the structure without having to resort to costly and time consuming scaffolding.

Another object is to provide a method for erecting metal storage tanks in which the uppermost section, including the top, is first assembled and then is raised a sufficient height so that the adjacent lower section may be assembled and joined to the preceeding section at ground level.

These and other objects and advantages will be more fully set forth in the following description of a preferred embodiment of the invention as illustrated in the accompanying drawings:

In the drawings:

Figure 1 is a plan view of the elevating mechanism employed in the method of the invention;

Fig. 2 is a central elevational view of the mechanism of Fig. 1 with certain duplicate structure omitted but including a center post or holder for the top section;

Fig. 3 is a detail view of a portion of the elevating mechanism secured to the foundation of the structure;

Fig. 4 is an elevational view of a partially erected storage structure showing five assembled horizontal sections of a normal seven-section structure;

Fig. 5 is a view taken on line 5—5 of Fig. 3;

Fig. 6 is an elevational view of a plate utilized in raising the cylindrical sections of the silo;

Fig. 7 is a view taken on line 7—7 of Fig. 3; and

Fig. 8 is a detail sectional view illustrating the attachment and sealing of the lowermost shell section to the foundation.

Briefly the invention which is here described in connections with the erection of glass linked silo or storage structure, comprises assembling the top of the silo and joining it to the uppermost cylindrical section of the silo at near ground level. The top and adjacent cylindrical sections are then elevated a sufficient height to permit the joining together of the plates of the next adjacent lower section and after joining adjacent cylindrical sections together successively the same

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are raised to permit repetition of the steps until a silo of desired height is erected.

According to the invention the foundation 1 of the silo is generally of poured concrete which extends into the ground for an appreciable depth. The floor 2 of the foundation is elevated from the outer circumference to provide a ledge 3 around the outer circumference of substantial width upon which the structure is supported. Anchor bolts 4 are spaced about ledge 3 and are securely anchored in the foundation when it is poured. These bolts are utilized in the erection of the structure and also to hold the completed assembly in place as will be described.

The foundation is provided with a generally rectangular shaped trough 5 which extends from the outer circumference to substantially the middle of the foundation. Generally the trough is utilized for the reception of a bottom unloading mechanism for delivery of stored silage to the outside of the silo. For the purposes of this invention however, trough 5 is used during erection of the silo as a base to receive the motive power to operate a plurality of screw-jacks 6 for raising successively the cylindrical sections of the structure.

The screw-jacks 6 are equally spaced circumferentially around the floor 2 of the foundation and are removably secured to the ledge 3 of the foundation in any suitable manner. Each screw-jack assembly consists of a lower housing 7 which is provided with a flange 8 at the bottom thereof. The flange is provided with threaded apertures for the reception of screws 9. Hold down brackets 10 of generally Z-shape are utilized to removably secure the screw-jacks where desired, the horizontal legs of brackets 10 being secured to the flange 8, and to the ledge 3 of the foundation by screws 9 and bolts 4, respectively. Bolts 11 which are threaded into the lower flange of bracket 10 may be used to level the bracket with respect to the housing 7 and its attendant flange 8. Bolts 12 are threadedly secured at the inner edge of flange 8 and serve to level the jack assemblies relative to the floor of the foundation.

Column 13 is secured to the top of housing 7 and is provided at its upper end with a cap member 14, suitably apertured to provide a bearing for a screw which will be hereinafter described. The inner end 15 of the cap is beveled and is provided with a threaded aperture 16 for the reception of bolt 17 which secures stay brace 18 to the beveled inner end surface 15.

Housing member 7 is open at the inner side thereof to receive bearing 19. Screw member 20

having its lower end unthreaded, is rotatably disposed within bearing 19. The upper end of screw 20 is likewise unthreaded and is journaled in the aperture provided in cap 14. The extreme lower end of screw 20 is keyed to a sprocket 21, which when rotated, turns screw 20.

Nut housing 22 encircles column 13 and is provided at its top with a bracket 23 which supports a plate 24 threadedly apertured for the reception of bolts to removably secure the lapped ends of two adjoining sections of the silo to plate 24 during erection of the silo. Plate 24 is curved to conform generally with the silo wall and is provided with a plurality of vertically and horizontally disposed apertures to receive securing means such as bolts as will be hereinafter explained. The outer face of plate 24 is provided with suitable non-abrasive material 25 as indicated by the speckled surface in Fig. 6 so that no injury will occur to the glass lined plates of the silo during erection.

The inner portion of nut housing 22 is threaded for engagement with screw 20 which it encircles. When screw 20 is rotated, housing 22 will be either raised or lowered and the plates of the silo attached to the plate 24 will be moved correspondingly.

A horizontal disk 26 is positioned above a positioning frame 27 about floor level and is secured to a vertical socket 28 disposed centrally of the silo and welded to the frame 27. The jack-screws of frame 27 engage the side walls of trough 5 and secure the socket 28 in place.

The socket 28 serves to support a central mast 29 having a cap 30 secured to its upper end. The mast is utilized to temporarily support the top of the silo while the upper or first cylindrical wall section is being assembled therewith. Other types of supports may be used for this purpose.

The lower end of each brace 18 of the respective jacks 6 is removably secured to brackets integral with plate 26 to brace the jacks in service.

Motor 31 which is supported within a suitable frame 32, is removably secured within trough 5 of the foundation. The motor drives a vertically disposed shaft through a reduction gearing, the shaft having a drive sprocket 33 at the upper end thereof. As shown in Fig. 1 endless chain 34 connects the drive sprocket 33 with the plurality of sprockets 21 so that nut housings 22 of each jack 6 may be raised or lowered simultaneously.

In the practice of the invention the top of the silo is formed by securing a plurality of segmental shaped plates together, the edges of which overlap. A suitable waterproofing means such as mastic or the like, not shown, is disposed between the overlapping edges of all plates which are used in the fabrication of the structure to seal the joints against air and moisture. A circumferential flange 35 depends from the lower edge of each segmental plate and serves as a joining member between the top and the shell of the structure. In assembling the unit the top is disposed over support 29 and rests on cap 30 at a height above the foundation to permit the forming of the uppermost section of the shell therebeneath.

The next step is to join a plurality of plates together to complete the first or uppermost section of the shell. This is done by joining the plates end-to-end by vertically securing the overlapping edges to form the circular section. The nut housings 22, which are then in their lowered position, are initially leveled up relative

to one another by individual rotation of the screws 20.

With the nut housings 22 in this position, the plates 24, which are secured to the brackets 23 of the nut housings, will be disposed adjacent the lower edge of the cylindrical section where the right-hand series of vertically spaced bolt holes, extending through the plates 24, are utilized to secure the plates of the wall section thereto. Screws are disposed in the vertically spaced bolt holes from the bottom of the wall plates to substantially the mid-portion of the wall section. However, the lowermost holes in the vertical seams are not used at this particular time, thereby permitting the lowest circumferentially disposed holes to be utilized in attaching the next lower cylindrical section.

A fine adjustment of each mounting plate 24 can be obtained by adjusting set screws 36 which are threaded vertically through the bracket 23 upon which each plate 24 is mounted. A pair of set screws 36 are employed with each bracket for vertical adjustment or separate adjustment of each side of the bracket.

Chain 34 is then placed in position to mesh with drive sprocket 33 and the several sprockets 21 secured to the screws 20. The motor 31 is started and rotates the screws 20 to raise the nut housings threaded thereon and thus elevate the uppermost shell section to the desired height, which in this instance will be adjacent to the flange 35 depending from the cover of the structure. The upper section is then secured circumferentially to the cover section and the cover of the silo together with the upper section is elevated a distance sufficient for the assembly therebeneath of the second shell section.

The second section and all succeeding sections are formed in a similar manner. With the upper part of the structure elevated sufficiently, the top edges of a plurality of side plates are secured circumferentially to the lower circumferential edge of the upper section while at the same time the plates are secured together vertically throughout substantially the upper half of their entire depth. Bolts are used as a securing means and a few of these adjacent the lower edge are omitted in the vertical seam at this time to permit the plates 24 of nut housings 22 to be subsequently secured thereto. The lower edge of the second section when formed, will be disposed above the foundation for a relatively short height. Wooden blocks 37 are spaced around the foundation under the shell sections and upon running the housings 22 downwardly a short distance, the lower edge of the second shell section is permitted to rest upon the wooden blocks 37. Housings 22 are then disengaged and lowered to the bottom edge of the second section where plates 24 are again secured vertically to the second section. The nut housings 22 are again run up on their respective jacks 6 to elevate the section.

With reference to Fig. 4 of the drawing, it will be noted that the vertical bolted joints which join the plates end-to-end to form a section are slightly offset from an adjacent joint of the section above or below the same. Provision is made so that the plates 24 of the nut housings 22 may be temporarily secured vertically for elevating purposes to each shell section with the bolt holes of each shell section offset from an adjacent section. As explained above plates 24 are curved to conform generally with the curvature of the plates of the structure. The plates 24 are pro-

vided with a series of horizontally and vertically spaced apertures to receive bolts or the like for temporarily securing each shell section thereto for elevating the same.

As an example, if the housing plates 24 as shown in Fig. 4 are secured vertically to the plates of the fourth cylindrical section from the top, and the upper edge of the fifth section is circumferentially secured to the lower edge of the fourth section, the nut housings would be run down to permit the lower edge of the fifth cylindrical section to rest upon the wooden blocks 37 to temporarily support the structure. The plates 24 are then disengaged from the plates of the fourth section, and the nut housings run down to adjacent the lower edge of the fifth section for securing the plates 24 thereto. In temporarily securing plates 24 to the fifth section, it is necessary to insert bolts in the series of vertically spaced apertures to the left of those used for the fourth section. This may be readily done because the plates 24 are provided with the requisite series of vertical apertures to accommodate the vertical apertures in the plates of each succeeding wall section.

The vertical seams of the cylindrical sections are offset to the left successively in each section from the top to the bottom of the structure as disclosed in application of A. W. Ernestus, Serial No. 109,507 and which is assigned to the assignee of the present application. The vertical seams of the respective cylindrical sections may be in staggered relationship to one another, offset to the right, or in alignment vertically. By virtue of the method of fabrication it is unnecessary to provide for moving the elevating jacks prior to lifting each section into position.

In Fig. 4 plates 24 are shown in dotted outline as they are disposed along the vertical seams of the fourth cylindrical section showing also the utilization of the fourth series of vertically spaced holes in the plates.

All necessary bolts are secured wherever needed as the structure progresses. This procedure is repeated until the desired number of sections have been elevated to form the structure.

After the lowermost shell section of the completed wall is bolted in place to the adjacent section above, the jack hold down brackets 10 are removed and replaced by an angle iron ring 38 which extends circumferentially around the silo at ledge 3 of the foundation and is secured thereto by use of bolts 4. As shown by the sectional view in Fig. 8, nuts 39 engage ring 38 beneath and above the same to level the silo if necessary. The lowermost section of the silo shell is bolted to the vertical flange of ring 38 by circumferentially spaced bolts 40. Concrete 41 is disposed beneath ring 38 and a mastic 42 suitable for sealing purposes is lodged between the ring and floor 2 of the foundation to seal the joint herebetween. The elevating mechanism is removed from the interior of the structure through an opening in the lower section which later serves as an opening for a door in this section.

The invention provides a method for erecting a storage structure, such as a silo, in which the assembling of the cylindrical shell sections from flat sheet may be done in the field without necessitating the nesting of the sections prior to successively elevating the sections to the position they will occupy in the finished structure and a method in which the top of the structure is assembled and secured to the upper section at

ground level and prior to elevating the upper section so that it is unnecessary to put the top on after the structure is in elevated position. The simultaneous use of a plurality of interconnected elevating screw-jacks which have first been leveled assures that the various sections of the structure will be positioned as desired.

The number of lifting jacks employed should correspond to the number of vertical seams in each cylindrical section, and there should be at least three in order to give stability to the structure during erection. In the embodiment of the invention shown five lifting jacks are employed.

Various embodiments of the invention may be employed within the scope of the following claims.

We claim:

1. In the method of forming a storage structure having a top and a plurality of cylindrical sections which comprises forming the top from a plurality of plates and disposing the same on a support at a level above the ground sufficient for the positioning of at least one cylindrical section therebeneath, forming a cylindrical section from a plurality of plates by securing the upper edge thereof horizontally to the lower edge of the top and securing the plates end-to-end, removably securing a plurality of lifting means to the lower edge of said section, elevating the section a height sufficient to receive a second section therebeneath, securing the lower edge of the first section to the upper edge of a subsequently formed similar second section, removably securing said lifting means to the last formed section and continuing the cylindrical section forming operation and elevating operation until all sections are connected in position and securing the lower horizontal edge of the last formed section to a foundation.

2. The method of forming a storage structure having a top and a plurality of cylindrical sections which comprises forming the top from a plurality of plates and disposing the same on a support at level above the ground sufficient for the positioning of at least one cylindrical section therebeneath, forming a cylindrical section from a plurality of plates by securing the upper edge thereof horizontally to the lower edge of the top and securing the plates ends-to-end, removably securing a plurality of lifting means to the lower edge of said section, elevating the section a height sufficient to receive a second section therebeneath, securing the lower edge of the first section to the upper edge of a subsequently formed similar second section, reversing said elevating means to cause the lower edge of said section to be disposed upon supports spaced circumferentially about a structure foundation, detaching said lifting means from the lower edge of said first section and removably securing said means to the subsequently formed second section, continuing the cylindrical section forming operations and elevating operations until all sections are connected in position and securing the lower edge of the last formed section circumferentially to a foundation.

3. The method of forming a storage structure having a top and a plurality of horizontal cylindrical sections which comprises forming the top from a plurality of plates and disposing the same on a support at a level above the ground sufficient for the positioning of at least one cylindrical section therebeneath, forming a cylindrical section from a plurality of plates by securing the upper edge thereof horizontally to the lower edge

of the top and securing the plates end-to-end, removably securing a plurality of lifting means to the said section, elevating the section a height sufficient to receive a second section therebeneath, securing the lower edge of the first section to the upper edge of a subsequently formed similar second section, reversing said elevating means to cause the lower edge of said section to be disposed upon supports spaced circumferentially about a structure foundation, detaching said lifting means from the said first section and removably securing said means to the subsequently formed second section, continuing the cylindrical section forming operations and elevating operations until all sections are connected in position and securing the lower edge of the last formed section circumferentially to a vertically disposed leg of an annular angular ring and securing a horizontally disposed leg of said ring to a foundation.

4. The method of forming a storage structure having a top and a plurality of cylindrical sections which comprises forming the top from a plurality of plates having a depending flange at the outer edge thereof and disposing the same on a support at a level above the ground sufficient for the forming and positioning of at least one cylindrical section therebeneath, forming a cylindrical section from a plurality of plates by securing the plates end-to-end, removably securing a plurality of lifting means to the said section, elevating the section a height sufficient to receive a second section therebeneath, securing the upper edge thereof to the flange of the top section, elevating the top and said section a height sufficient to receive a second section therebeneath, forming a second section by circumferentially securing the top edges of a plurality of plates to the lower edge of the previous section while simultaneously alternately securing the plates of the second section together vertically end-to-end, removably securing said lifting means to said second section, elevating the top and said sections a height sufficient to form another cylindrical section therebeneath and continuing the last section forming operation and elevating operation until all sections are connected in position and securing the lower horizontal edge of the last formed section to a foundation.

5. The method of forming a storage structure having a top and a plurality of horizontal sections which comprises forming the top from a plurality of plates having a depending flange at the outer edge thereof and disposing the same on a support at a level above the ground sufficient for the forming and positioning of at least one cylindrical section therebeneath, forming a cylindrical section from a plurality of plates by securing the plates end-to-end, removably securing a plurality of lifting means to the said section, securing the upper edge of the cylindrical section to the flange of the top section, elevating the top and said section a height sufficient to receive a second section therebeneath, forming a second section by circumferentially securing the top edges of a plurality of plates to the lower edge of the previous section while simultaneously alternately securing the plates of the second section together vertically end-to-end, reversing said lifting means to cause the lower edge of the second section to be disposed upon supports spaced circumferentially about a structure foundation, detaching said lifting means from the said first section and removably securing said

means vertically adjacent the lower edge of the subsequently formed second section, continuing the cylindrical section forming operations and elevating operations until all sections are connected in position and securing the lower edge of the last formed section circumferentially to a foundation.

6. The method of forming a storage structure having a top and a plurality of cylindrical sections which comprises forming the top from a plurality of plates having a depending flange at the outer edge thereof and disposing the same on a support at a level above the ground sufficient for the forming and positioning of at least one cylindrical section therebeneath, forming a cylindrical section from a plurality of plates by bolting the plates end-to-end, removably bolting a plurality of lifting means to the said section, bolting the upper edge of the cylindrical section to the flange of the top section, elevating the top and said section a height sufficient to receive a second section therebeneath, forming a second section by circumferentially bolting the top edges of a plurality of plates to the lower edge of the previous section while simultaneously alternately bolting the plates of the second section together vertically end-to-end, bolting said lifting means vertically to the said second section, elevating the top and the sections thus formed a height sufficient to form another cylindrical section therebeneath and continuing the last cylindrical forming operation and elevating operation until all sections are connected in position and securing the lower edge of the last formed section to a foundation.

7. The method of forming a storage structure having a top and a plurality of cylindrical sections which comprises forming the top from a plurality of plates having a depending flange at the outer edge thereof and disposing the same on a support at a level above the ground sufficient for the forming and positioning of at least one cylindrical section therebeneath, forming a cylindrical section from a plurality of plates by bolting the plates end-to-end, removably bolting a plurality of lifting means to the said section, and securing the upper edge thereof to the flange of the top section, elevating the top and said section a height sufficient to receive a second section therebeneath, forming a second section by circumferentially bolting the top edges of a plurality of plates to the lower edge of the previous section while simultaneously alternately bolting the plates of the second section together vertically end-to-end, reversing said elevating means to cause the lower edge of the second section to be disposed upon supports spaced circumferentially about a structure foundation, detaching said lifting means from the said first section and removably bolting said means vertically adjacent the lower edge of the subsequently formed second section, continuing the last cylindrical forming operation and elevating operation until all sections are connected in position and securing the lower edge of the last formed section circumferentially to a foundation.

8. The method of forming a storage structure having a top and a plurality of cylindrical sections fabricated from plates joined end-to-end into vertical seams which are progressively staggered in their entirety and in relation to one another relative to a vertical plane through any seam which comprises forming the top from a plurality of plates having a depending flange at the outer edge thereof and disposing the top on

a support at a level above the ground sufficient for forming and positioning of at least one cylindrical section therebeneath, forming a cylindrical section therebeneath, forming a cylindrical section from a plurality of plates by securing the plates end-to-end, removably securing a plurality of lifting means to the said section and along the vertical seams between the plates from which the section is formed, securing the upper edge of said cylindrical section to the flange of the top section, elevating the top and said section a height sufficient to receive a second section therebeneath, forming a second section by circumferentially securing the top edges of a plurality of plates to the lower edge of the previous section while simultaneously alternately securing the plates of a second section together vertically, end-to-end, removably securing said lifting means vertically along the seams of the section but in offset relationship to vertical seams of the previous section, elevating the top and said sections a height sufficient to form another cylindrical section therebeneath, continuing the subsequent section forming operations and elevating operations until all sections are connected in position, and securing the lower horizontal edge of the last formed section to a foundation.

9. The method of forming a storage structure having a top and a plurality of cylindrical sections fabricated from plates joined end-to-end into vertical seams which are progressively staggered in their entirety and in relation to one another relative to a vertical plane through any seam which comprises forming the top from a plurality of plates having a depending flange at the outer edge thereof and disposing the top on a support at a level above the ground sufficient for forming and positioning of at least one cylindrical section therebeneath, forming a cylindrical section from a plurality of plates by se-

curing the plates end-to-end, removably securing a plurality of lifting means adjacent the lower edge of said section and along the vertical seams between the plates from which the section is formed, securing the upper edge thereof to the flange of the top section, elevating the top and said section a height sufficient to receive a second section therebeneath, forming a second section by circumferentially securing the top edges of a plurality of plates to the lower edge of the previous section while simultaneously alternately securing the plates of the second section together vertically end-to-end, reversing said elevating means to cause the lower edge of the second section to be disposed upon supports spaced circumferentially about a structure foundation, detaching said lifting means for the said first section and removably securing the same vertically along the seams of the section and adjacent the lower edge of the second section but in offset relationship to the vertical seams of the previous section, elevating the top and said section a height sufficient to form another cylindrical section therebeneath, continuing the subsequent section forming operations and elevating operations until all sections are connected in position and securing the lower horizontal edge of the last formed section to a foundation.

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GEORGE M. SMITH.

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