

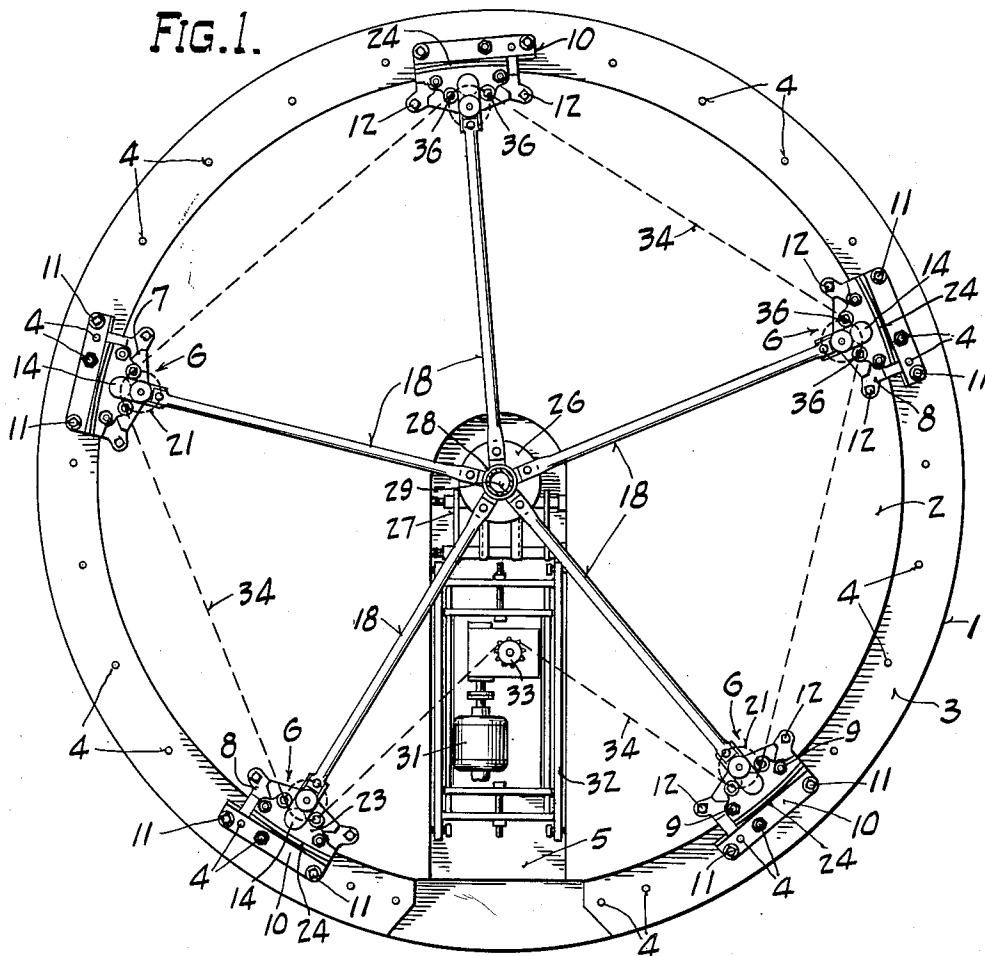
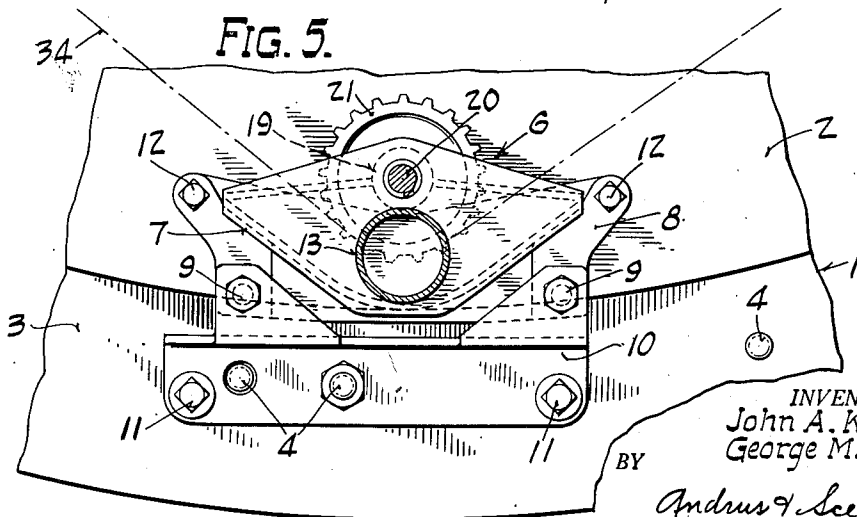
March 10, 1953

J. A. KROLL ET AL
ELEVATING APPARATUS

2,631,008

Filed Sept. 2, 1950

3 Sheets-Sheet 1



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FIG. 2.

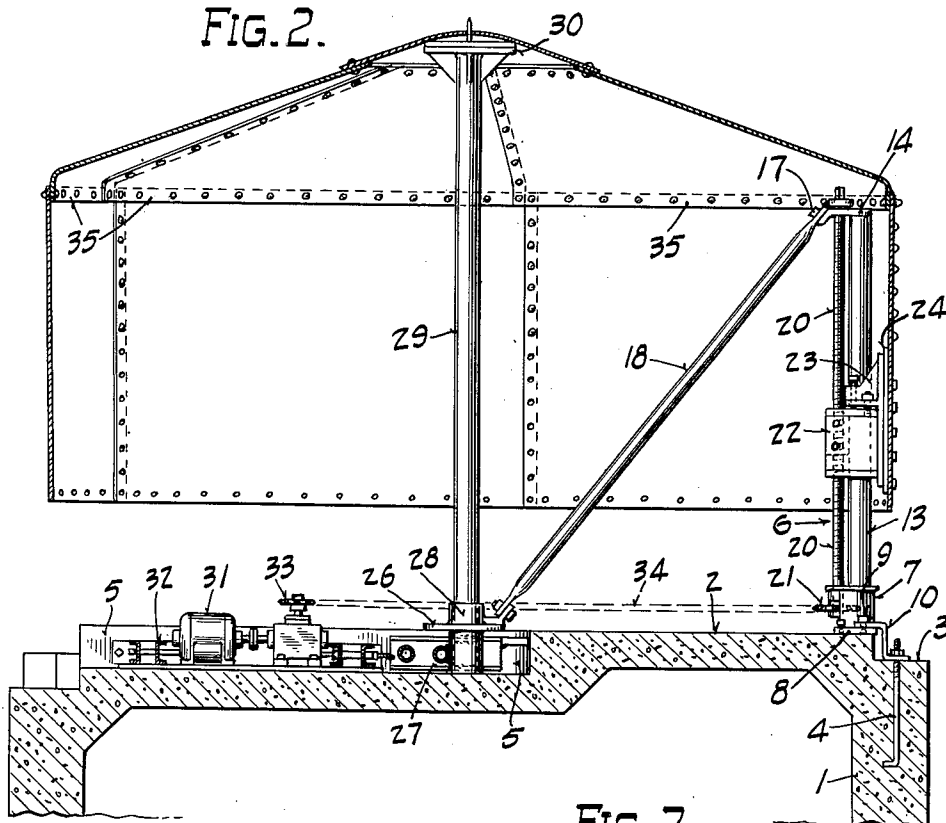


FIG. 7.

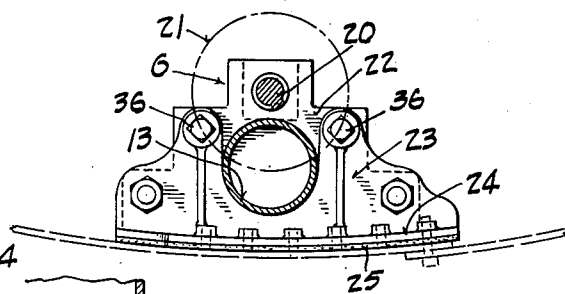


FIG. 6.

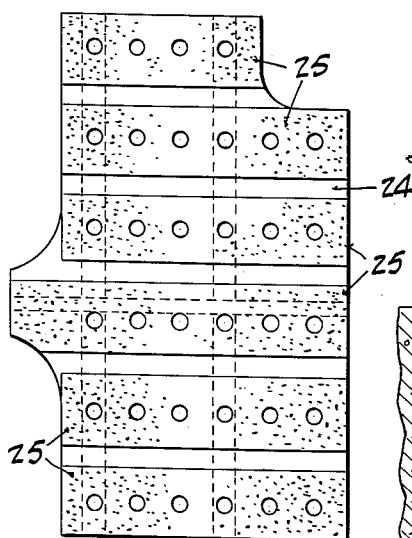
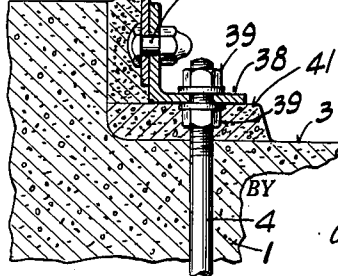


FIG. 8.



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FIG. 4.

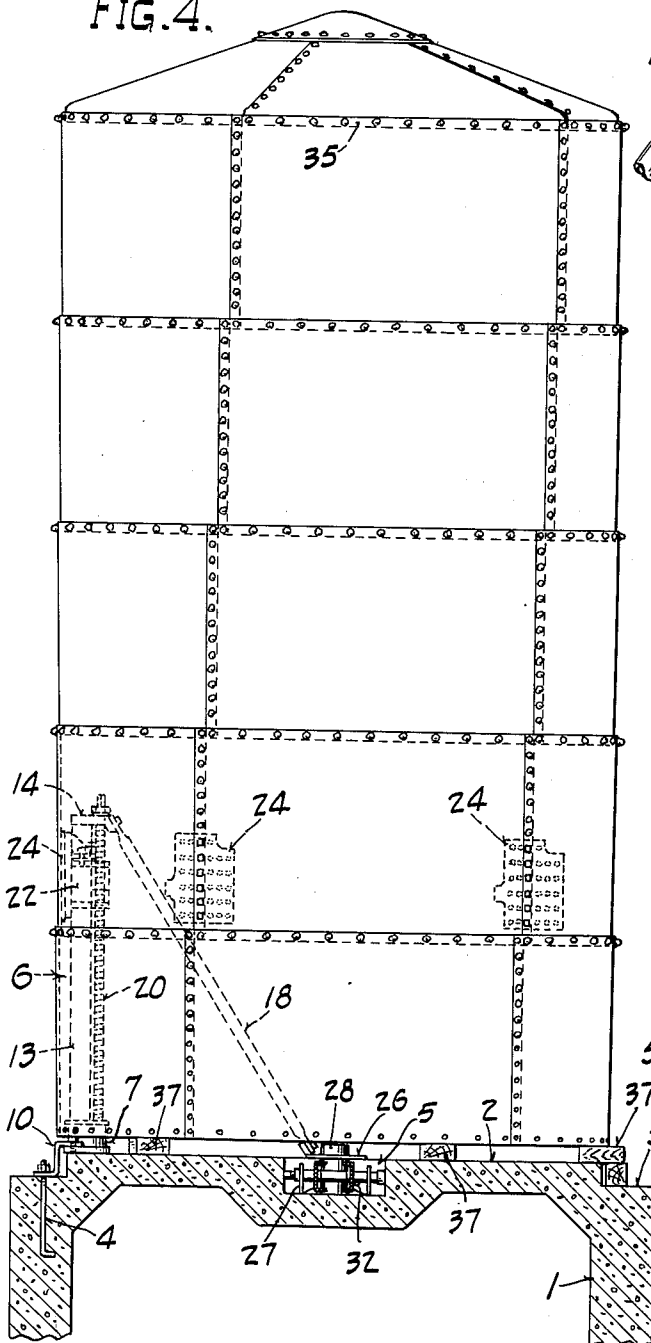
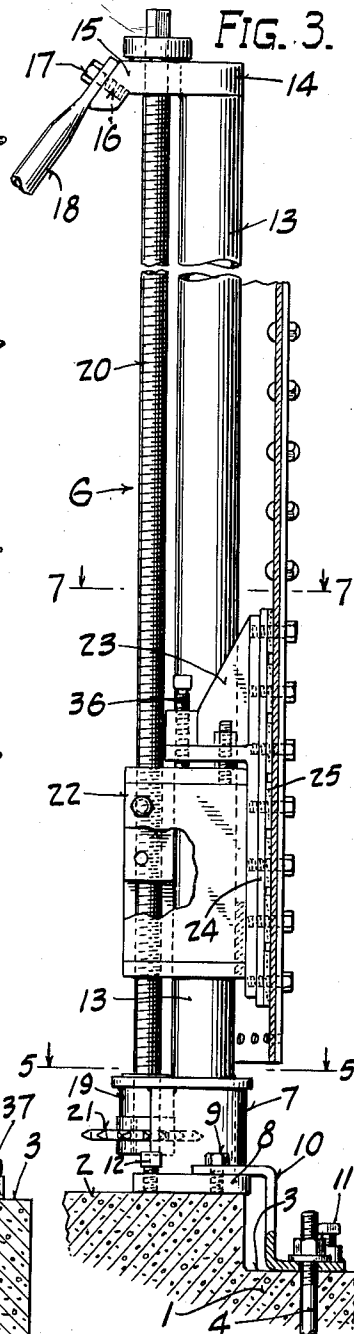


FIG. 3.



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UNITED STATES PATENT OFFICE

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ELEVATING APPARATUS

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Application September 2, 1950, Serial No. 182,968

17 Claims. (Cl. 254—92)

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

The object of the invention is to provide elevating apparatus for erecting storage tanks or structures whereby the various sections of the tanks or structures are substantially joined to one another successively at ground level and are then raised by the apparatus of the invention to the location they will occupy in the finished structure.

Another object of the invention is to provide elevating apparatus for erecting metal storage tanks of considerable height without having to resort to costly and time consuming scaffolding.

Another object is to provide elevating apparatus to be utilized in erecting metal storage tanks in which the uppermost section, including the top, is first assembled at ground level and is then raised by the apparatus of the invention a sufficient height so that the adjacent lower section may then be assembled at ground level and joined to the preceding section. The elevating apparatus of the invention is utilized to raise from ground level, and successively, all previously formed sections as a unit, until a structure of desired height is accomplished.

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 which:

Figure 1 is a plan view of the elevating apparatus of the invention;

Fig. 2 is a central elevational view of the apparatus 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 apparatus secured to the foundation of the structure;

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

This application is a continuation-in-part of application Serial No. 150,496, filed March 18, 1950, which issued August 5, 1952, to Patent No. 2,605,540.

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Briefly the invention which is here described in connection with the erection of a glass lined silo or storage structure, comprises a plurality of interconnected elevating screw-jacks which may be circumferentially spaced within the interior of the silo and which contemplates the utilization of a plurality of nut housings each having a plate secured thereto. The plates are removably and successively secured to the lower portion of each cylindrical section of the silo, one at each vertical seam. The nut housings are caused to travel as a unit either upwardly or downwardly along vertically disposed screws which are rotated from a source of power located within the structure which is being fabricated and 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 screw-jacks 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 using the elevating apparatus 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

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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 provided 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. The vertical seams of the respective cylindrical sections may be in staggered relationship to one another, offset to the right, or in alignment vertically.

All necessary bolts are secured whenever 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 18 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 angle ring 38 beneath and above the ring 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 therebetween.

After erection of the structure is completed 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 the lower section.

The invention provides elevating apparatus 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. The simultaneous use of a plurality of intercon-

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nected elevating screw-jacks which have first been leveled assures that the various sections of the structure will be positioned as desired. The apparatus of the invention also makes unnecessary the use of time consuming and costly scaffolding in that the elevating means is operated from ground level to raise successively the cylindrical sections of the silo to the position each will ultimately occupy.

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

We claim:

1. Apparatus for erecting storage structures or the like having a plurality of cylindrical vertically disposed successively adjoined sections, which comprises a plurality of circumferentially spaced vertically disposed screw-jacks, a lifting head associated with each said jack, means for securing said lifting heads to the cylindrical sections, means interconnecting said screw-jacks, and means to drive said interconnecting means to raise or lower the cylindrical sections by the simultaneous raising or lowering of said lifting heads.

2. Apparatus for erecting storage structures or the like having a plurality of cylindrical vertically disposed successively adjoined sections, which comprises a plurality of circumferentially spaced vertically disposed screw-jacks, each said jack comprising a vertically disposed column, an elongated screw disposed in parallel relationship to said column, a lifting head threadedly engaged with said screw, means for securing said lifting heads to the cylindrical sections, means interconnecting said screw-jacks, and means to drive said interconnecting means to raise or lower the lifting heads simultaneously.

3. Apparatus for erecting storage structures or the like having a plurality of cylindrical vertically disposed successively adjoined sections, which comprises a plurality of circumferentially spaced vertically disposed screw-jacks, a lifting head associated with each said jack and having a plurality of series of vertically aligned apertures extending therethrough to receive means to removably secure the cylindrical sections to the lifting head, removable securing means disposed in a series of said apertures, means interconnecting said screw-jacks, and means to drive said interconnecting means to simultaneously raise and lower the lifting heads.

4. Apparatus for erecting storage structures or the like having a plurality of cylindrical vertically disposed successively adjoined sections, which comprises a plurality of circumferentially spaced vertically disposed screw-jacks; each said jack comprising a vertically disposed column, an elongated screw disposed in parallel relationship to said column, a nut encircling said column and being threadedly engaged with the screw, and a lifting head secured to the nut, means for securing said lifting heads to the cylindrical sections; means interconnecting said screw-jacks, and means to drive said interconnecting means to raise or lower the lifting heads simultaneously.

5. Apparatus for erecting storage structures or the like having a plurality of cylindrical vertically disposed successively adjoined sections, which comprises a plurality of circumferentially spaced vertically disposed screw-jacks; each said jack comprising a vertically disposed column, an elongated screw disposed in parallel relationship to said column, a nut encircling said column and being threadedly engaged with the screw, and a

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lifting head secured to the nut, and having a plurality of series of vertically aligned apertures extending therethrough to receive means to removably secure the cylindrical sections to the lifting head, and removable securing means disposed in a series of said apertures; means interconnecting said screw-jacks, and means to drive said interconnecting means to simultaneously raise or lower the lifting heads.

6. Apparatus for erecting storage structures or the like having a plurality of cylindrical vertically disposed successively adjoined plate sections whose plates are provided with vertically aligned apertures adjacent the side edges thereof, which comprises a plurality of circumferentially spaced vertically disposed screw-jacks, a lifting head associated with each screw-jack and having a plurality of vertically aligned apertures extending therethrough, securing means disposed in the apertures of said lifting head and the apertures of adjacent plates when the side edges of the plates are overlapped, means interconnecting said screw-jacks, and means to drive said interconnecting means to raise or lower the lifting heads simultaneously.

7. Apparatus for erecting storage structures or the like having a top and a plurality of cylindrical vertically disposed successively adjoined sections the lowermost of which is secured circumferentially to the floor of a foundation structure, which comprises a plurality of circumferentially spaced vertically disposed screw-jacks, a plate centrally disposed and removably secured to said foundation and having a vertically disposed socket extending upwardly from said plate, a support disposed in said socket and extending therefrom to the top during formation and securing of the upper cylindrical section to the top, a lifting head associated with each said jack, means for securing said lifting heads successively to the cylindrical sections, means interconnecting said screw-jacks, and means to drive said interconnecting means to raise or lower the lifting heads.

8. Apparatus for erecting storage structures or the like having a top and a plurality of cylindrical vertically disposed successively adjoined sections the lowermost of which is secured circumferentially to the floor of a foundation structure, which comprises a plurality of circumferentially spaced vertically disposed screw-jacks, a plate centrally disposed and removably secured to said foundation and having a vertically disposed socket extending upwardly from said plate, a support disposed in said socket and extending therefrom to the top during formation and securing of the upper cylindrical section to the top, radially disposed braces removably secured to and extending from the upper end of said screw-jacks to said plate and being removably secured to the latter, a lifting head associated with each jack, means for securing said lifting heads successively to the cylindrical sections, means interconnecting said screw-jacks and means to drive said interconnecting means to raise or lower the lifting heads.

9. Apparatus for erecting storage structures or the like having a plurality of cylindrical vertically disposed successively adjoined sections, a top, and a foundation therefor having an upstanding outer circumferential ledge to which the lowermost section of the structure is secured which comprises a plurality of circumferentially spaced vertically disposed screw-jacks adapted to be disposed within the structure during fabri-

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cation and erection of the same; a lifting head associated with each of said jacks, means for securing said lifting heads to the cylindrical sections, means interconnecting said screw-jacks, and means to drive said interconnecting means to raise or lower the cylindrical sections, said screw-jacks having a stroke to permit the lowermost of the sections to be lowered to a position where it encircles the foundation ledge so that the latter may be secured thereto.

10. Apparatus for erecting storage structures or the like having a plurality of cylindrical vertically disposed successively adjoined sections, a top, and a foundation therefor having an upstanding outer circumferential ledge to which the lowermost section of the structure is secured which comprises a plurality of circumferentially spaced vertically disposed screw-jacks adapted to be disposed within the structure during fabrication and erection of the same, each said jack comprising a vertically disposed column, an elongated screw disposed in parallel relationship to said column, a lifting head threadedly engaged with said screw, means for securing said lifting heads to the inner surfaces of the cylindrical sections, means interconnecting said screw-jacks and means to drive said interconnecting means in one direction to raise the lifting heads and in the opposite direction to lower the lifting heads to permit the lowermost section when attached to the heads to encircle the foundation ledge so that said section may be attached thereto.

11. Apparatus for erecting storage structures or the like having a plurality of cylindrical vertically disposed successively adjoined sections, a top, and a foundation therefor having an upstanding outer circumferential ledge to which the lowermost section of the structure is secured which comprises a plurality of circumferentially spaced vertically disposed screw-jacks adapted to be disposed within the structure during fabrication and erection of the same; a plate centrally disposed and removably secured to said foundation and having a vertically disposed socket extending upwardly from said plate, a support disposed in said socket and extending therefrom to the top of the structure to support the same during formation and securing of the upper cylindrical section to the top, radially disposed braces removably secured to and extending from the upper end of said screw-jacks to said plate and being removably secured to the latter, a lifting head associated with each of said jacks, means for securing said lifting heads to the cylindrical sections, means interconnecting said screw-jacks, and means to drive said interconnecting means in one direction to raise the lifting heads and in the opposite direction to lower the lifting heads to permit the lowermost section when attached to the heads to encircle the foundation ledge so that said section may be attached thereto.

12. In apparatus for erecting storage structures or the like having a plurality of cylindrical vertically disposed successively adjoined sections, which comprises a plurality of circumferentially spaced vertically disposed screw-jacks, a lifting head associated with each said jack, said head comprising a vertically disposed plate formed to the curvature of the cylindrical sections and provided with a plurality of apertures disposed consecutively one above the other and spaced apart to correspond with the spacing of bolt holes in a corresponding vertical seam of the first cylindrical section, a second series of similarly disposed and spaced apertures circumferentially spaced

from said first series of apertures a distance corresponding to an offset of the vertical seam for the second cylindrical section from the vertical seam for said first section, and additional series of apertures similarly disposed to correspond with the offset of the vertical seams of successive cylindrical sections, means for securing said lifting heads to the cylindrical sections successively from the top section to the bottom section as the successive sections are applied and raised, means interconnecting said screw-jacks, and means to drive said interconnecting means to raise or lower the cylindrical sections.

13. Apparatus for erecting storage structures or the like having a plurality of cylindrical vertically disposed successively adjoined sections, a top, and a foundation therefor having an upstanding outer circumferential ledge to which the lowermost section of the structure is secured which comprises a plurality of circumferentially spaced vertically disposed screw-jacks adapted to be disposed within the structure and to rest on the circumferential ledge of the foundation during fabrication and erection of the same; a bracket having a depending portion and removably secured to the lower end of each jack to support said jack on the foundation, said brackets being removed prior to the disposition of the lowermost section on the foundation, a lifting head associated with each of said jacks, means for securing said lifting heads to the cylindrical sections, means interconnecting said screw-jacks, and means to drive said interconnecting means to raise or lower the cylindrical sections, said screw-jacks having a stroke to permit the lowermost of the sections to be lowered to a position where it encircles the foundation ledge so that the latter may be secured thereto.

14. Apparatus for erecting storage structures or the like having a plurality of cylindrical vertically disposed successively adjoined sections, a top, and a foundation therefor having an upstanding outer circumferential ledge to which the lowermost section of the structure is secured which comprises a plurality of circumferentially spaced vertically disposed screw-jacks adapted to be disposed within the structure and to rest on the circumferential ledge of the foundation during fabrication and erection of the same; means depending from the base of the screw-jacks and supporting the jacks on the outer circumferential portion of the foundation, a lifting head associated with each said jack, said head comprising a vertically disposed plate provided with a plurality of apertures disposed consecutively one above the other and spaced apart to correspond with the spacing of bolt holes in a corresponding vertical seam of a cylindrical section, means for securing said lifting heads to the cylindrical sections successively from the top section to the bottom section as the successive sections are applied and raised, means interconnecting said screw-jacks,

and means to drive said interconnecting means to raise or lower the cylindrical sections simultaneously.

15. Apparatus for erecting vertical structures or the like having a plurality of vertically disposed successively adjoined sections containing perforations, which comprises a plurality of vertically disposed screw-jacks, means rigidly supporting said screw-jacks with the same spaced equidistant from a given center corresponding substantially to the vertical axis of the structure to be erected, a lifting head associated with each said jack, means including at least one member adapted to enter a perforation in the structure to removably secure successive sections of said structure to said lifting heads, and common drive means interconnecting said screw-jacks to raise or lower the sections by the simultaneous raising or lowering of said lifting heads.

16. Apparatus for erecting vertical structures or the like having a plurality of vertically disposed successively adjoined sections containing perforations, which comprises a plurality of vertically disposed screw-jacks, means rigidly supporting said screw-jacks with the same spaced equidistant from a given center corresponding substantially to the vertical axis of the structure to be erected, a lifting head associated with each said jack, means including at least one member adapted to enter a perforation in the structure to removably secure successive sections of said structure to said lifting heads, means disposed adjacent said jacks to support the structure during lowering of said heads between successive lifting operations, and common drive means interconnecting said screw-jacks to raise or lower the sections by the simultaneous raising or lowering of said lifting heads.

17. Apparatus for erecting vertical structures or the like having a plurality of vertically disposed successively adjoined sections, which comprises a plurality of vertically disposed screw-jacks, each spaced an equal distance from a given center, a lifting head associated with each said jack, means for securing said lifting heads to the sections, means interconnecting said screw-jacks, and means to drive said interconnecting means to raise or lower the sections by the simultaneous raising or lowering of said lifting heads.

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