Feb. 3, 1953 W. M. SCHIEFELBEIN 2,627,390

ERECTING APPARATUS FOR STORAGE STRUCTURES

Filed March 16, 1951 3 Sheets-Sheet 1

FIG. 1.

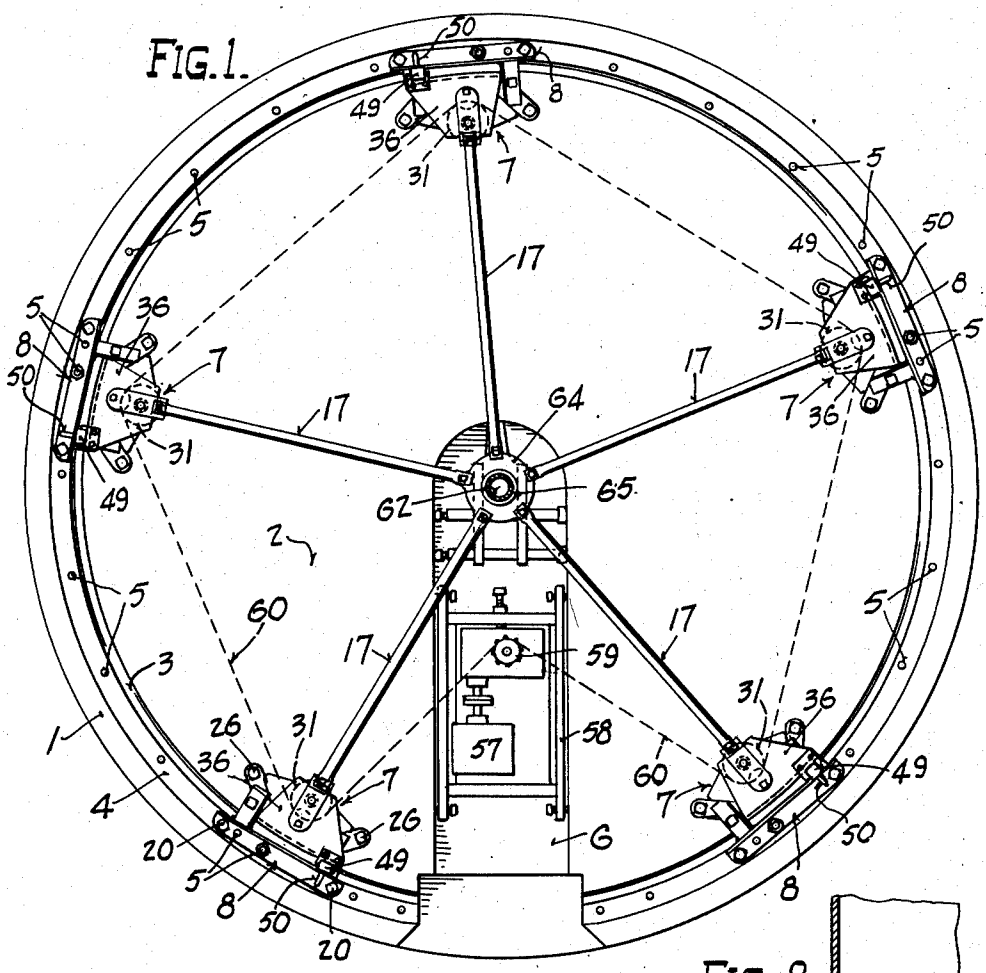


FIG. 7.

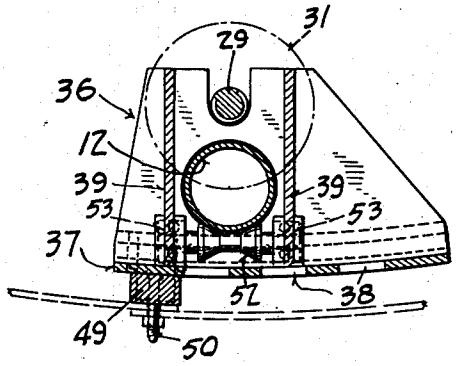
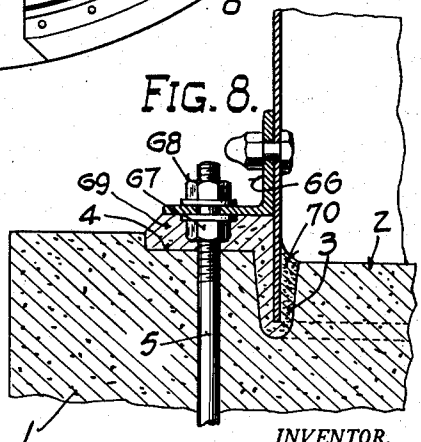


FIG. 8.



INVENTOR.
Walter M. Schiefelbein
BY Andrus & Sceales
ATTORNEYS.

Feb. 3, 1953 W. M. SCHIEFELBEIN 2,627,390

ERECTING APPARATUS FOR STORAGE STRUCTURES

Filed March 16, 1951 3 Sheets-Sheet 2

FIG. 2.

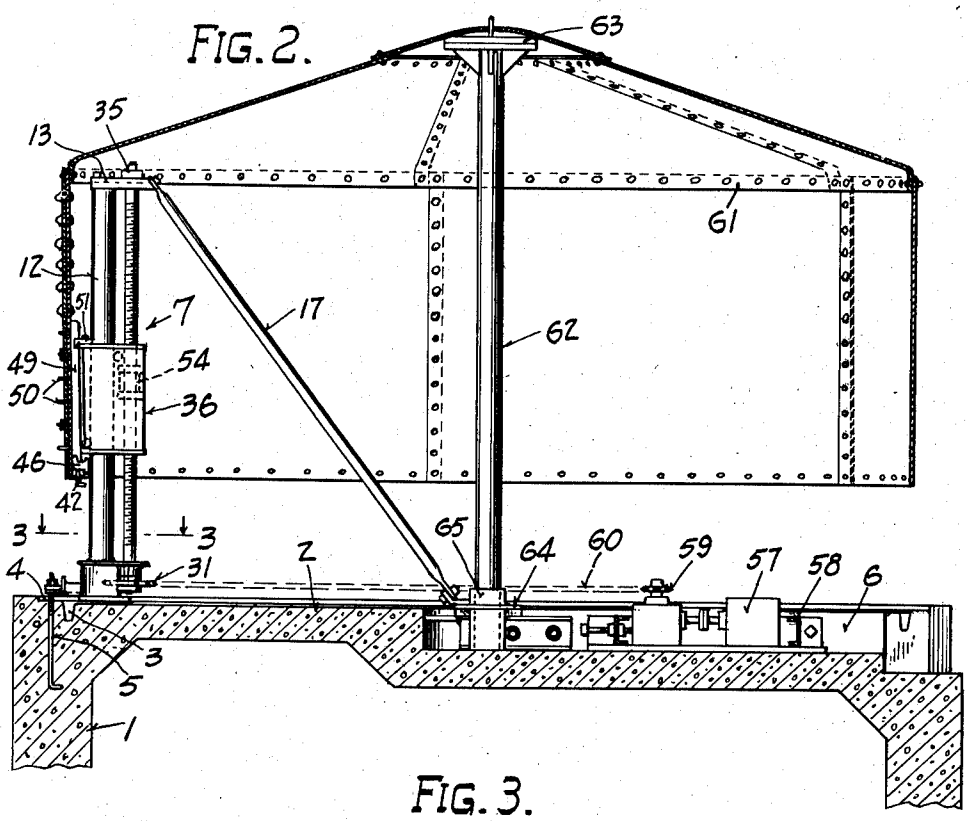
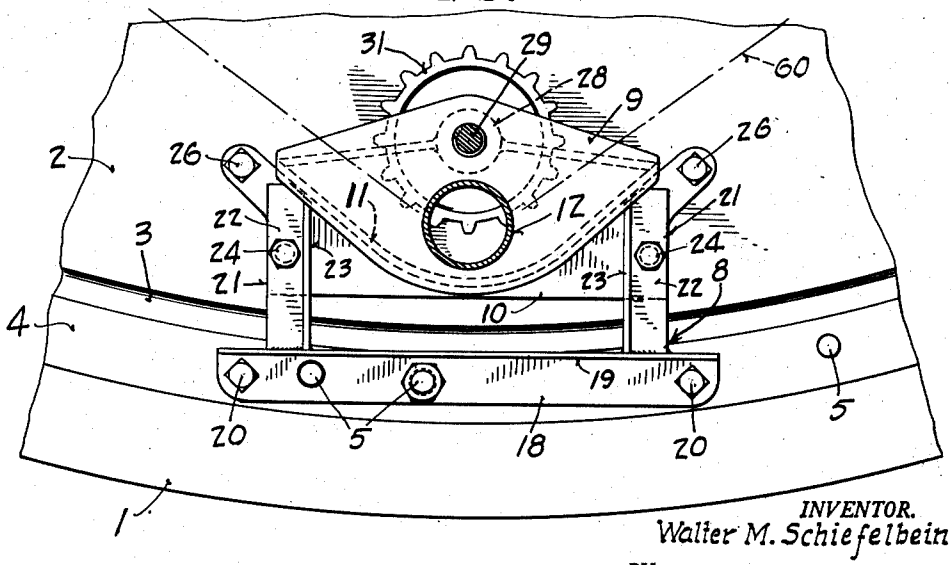


FIG. 3.



INVENTOR.
Walter M. Schiefelbein
BY Andrus & Sceales
ATTORNEYS.

Feb. 3, 1953 W. M. SCHIEFELBEIN 2,627,390

ERECTING APPARATUS FOR STORAGE STRUCTURES

Filed March 16, 1951 3 Sheets-Sheet 3

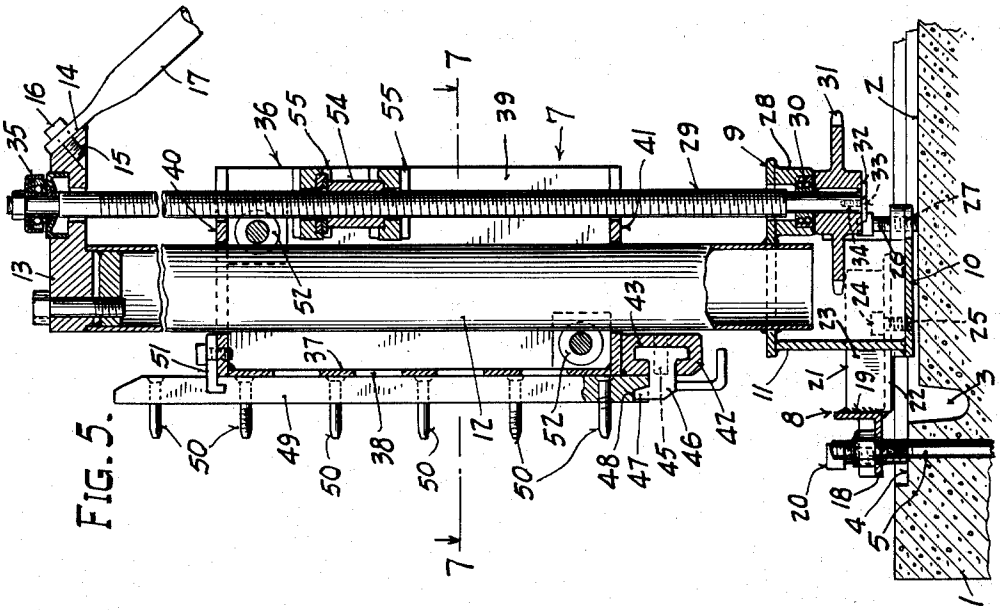


FIG. 5.

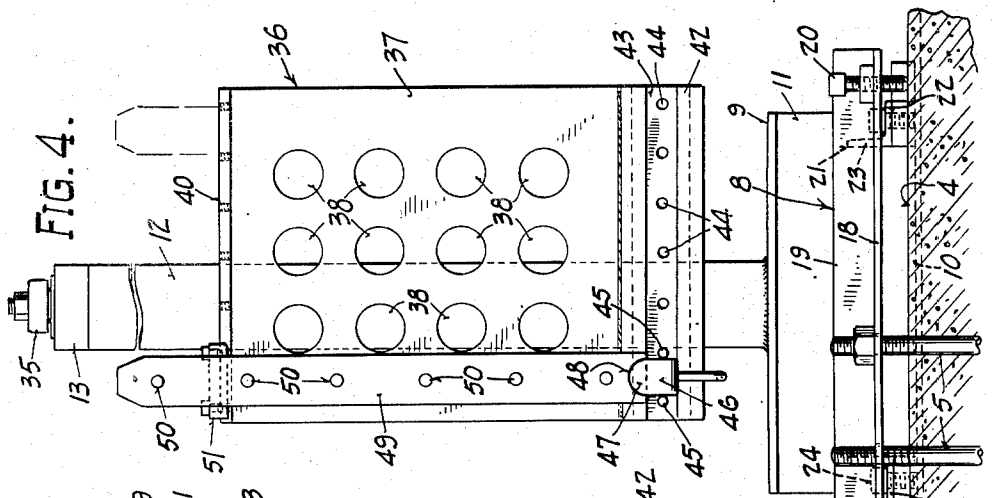


FIG. 4.

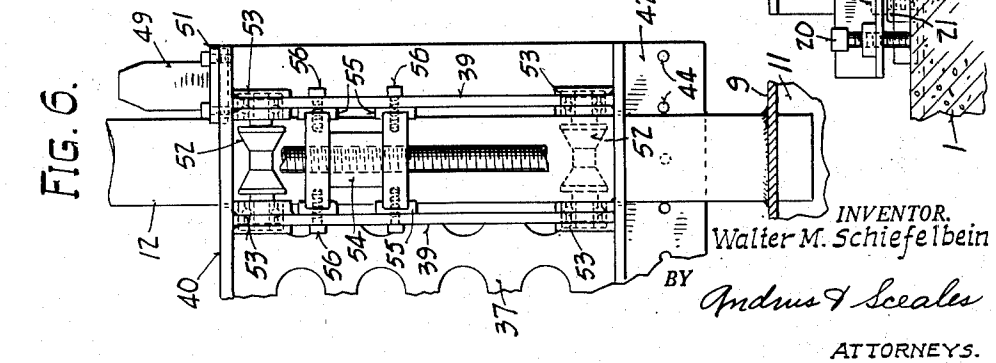


FIG. 6.

INVENTOR.
Walter M. Schiefelbein
BY
Andrus & Sceales
ATTORNEYS.

Patented Feb. 3, 1953 2,627,390

UNITED STATES PATENT OFFICE

2,627,390

ERECTING APPARATUS FOR STORAGE STRUCTURES

Walter M. Schiefelbein, Milwaukee, Wis., assignor to A. O. Smith Corporation, Milwaukee, Wis., a corporation of New York

Application March 16, 1951, Serial No. 216,013

6 Claims. (Cl. 254—92)

1

This invention relates generally to apparatus used in the erection of storage structures or gas tanks of considerable height.

The primary object of the invention is to provide apparatus for erecting storage structures or the like which are fabricated from a plurality of cylindrical sections secured together and disposed one above the other. The cylindrical sections are fabricated generally from a plurality of plates provided adjacent their edges with vertically and horizontally spaced apertures for the reception of bolts. When the vertically disposed apertures of one plate are aligned with similar apertures in the adjacent plate and the plates are secured together as by bolts, for instance, and this procedure is followed until the requisite number of plates are joined end to end, the result is the formation of a cylindrical section which forms an integral part of the finished structure.

The above described cylindrical sections are fabricated or formed at ground level and are raised successively from ground level to the position they will ultimately occupy in the finished structure. The individual sections are joined to one another along adjacent horizontal top and bottom edges in a manner similar to the joining of the vertical apertures, to wit, by bolting overlapping edges together.

A further object is to provide apparatus for erecting storage structures or the like which includes among other elements of the apparatus, a plurality of removable pin bars which are formed precisely so that the pins carried thereby may, with great facility, be inserted into the vertical apertures of the plates above mentioned to permit a cylindrical section formed from the plates to be raised from ground level a distance sufficient to form and join the next lower successive section to the preceding section.

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

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

Fig. 2 is a central sectional view of the apparatus of Fig. 1 with certain duplicate structure omitted but including a center post for holding the top in position while it is being assembled to the uppermost cylindrical section;

Fig. 3 is a transverse section taken on line 3—3 of Fig. 2;

Fig. 4 is a front elevation of the jack;

2

Fig. 5 is a vertical sectional view of the jack;

Fig. 6 is a fragmentary rear elevation of the jack;

Fig. 7 is a transverse section taken on line 7—7 of Fig. 5; and

Fig. 8 is a detail vertical section of the foundation and lower section.

According to the invention, which will be described in connection with the erection of a glass lined silo comprising a plurality of adjoined cylindrical sections and a top secured to the upper edge of the top section, 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 depressed from the outer circumference of the foundation. A narrow channel 3 is circumferentially disposed between the outer circumference of the floor 2 and a step-down ledge 4 between the inner edge of the foundation 1 and the channel. As will be hereafter more fully explained, the channel 3 receives the bottom edge of the lowermost cylindrical section when the silo is completely erected.

A plurality of bolts 5 are spaced about ledge 4 and are securely anchored in the foundation when it is poured. These bolts are utilized during the erection of the structure and also to hold the completed assembly in place.

The foundation is provided with a generally rectangular shaped trough 6 which extends from the outer circumference to the center of the foundation. The trough is generally utilized to receive a bottom unloading mechanism for delivery of stored silage to the outside of the silo. For the purpose of this invention, however, trough 6 is used during erection of the silo to receive the motive power to operate a plurality of screw jacks 7 for raising or lowering successively the cylindrical sections of the structure.

The screw jacks 7 are equally spaced circumferentially around the floor of the foundation and are removably secured to the ledge 4 of the foundation through a foot 8 as more fully explained later. Each screw jack assembly consists of a lower housing member having a top 9, a bottom 10 and a vertical wall 11 extending therebetween and being secured to the top and bottom as for instance by welding.

Top 9 has an opening extending therethrough for receiving a column 12 which is secured to the upper and lower surfaces of the top 9 as by welding. Column 12 is disposed vertically with respect to the horizontally disposed top 9 and has secured to its upper end a cap member 13 which is suitably apertured for the reception of a screw,

as will be explained more fully later. The inner end 14 of the cap is beveled and is provided with a threaded aperture 15 for the reception of a bolt 16 utilized to secure stay brace 17 to the beveled inner end surface 14.

Foot member 8, as best seen in Figs. 4 and 5, is an angle member having a horizontally disposed leg 18 and a vertically disposed leg 19. Leg 18 is apertured for receiving anchor bolts 5, and also for receiving bolts 20, the lower ends of which bear against ledge 4 so the screw jacks may be leveled with respect to the foundation prior to using the jacks for lifting the respective cylindrical sections of the structure being erected.

Angle members 21 each having a horizontally disposed leg 22 and a vertically disposed leg 23 are secured to the foot 8 and extend inwardly therefrom to co-operate with the screw jack housing to properly position and provide the necessary rigidity to the screw jacks during use. Leg 22 of member 21 is apertured for the reception of bolts 24 which extend into threaded apertures 25 in bottom 10 of the screw jack housing. The foot 8 is therefore removably secured to the foundation and also to the screw jack housing. Bolts 26 extend through threaded apertures 27 adjacent the inner end of bottom 10. The end of bolts 26 bears directly on floor 2 of the foundation and when manipulated in conjunction with bolts 20 serve to level the screw jacks with respect to the foundation of the structure.

Subhousing 28 is secured as by welding to the undersurface of top member 9 at the inner end thereof. The inner end of top 9 and subhousing 28 are suitably apertured to receive a vertically disposed threaded screw 29 which is commensurate in length with column 12. The screw and column are disposed in parallel relationship to one another.

The bottom of subhousing 28 is recessed to receive a bearing 30 which journals an unthreaded portion of screw 29. Sprocket 31 is keyed to the lowermost end of the screw 29 and is secured thereto by disc 32 having a threaded bolt 33 extending upwardly from the disc and removably secured into a threaded opening 34 in the bottom of the screw 29.

The upper unthreaded end of screw 29 extends through cap 13 and is provided at its reduced outer portion with a combination thrust and spherical bearing 35. Because of structure, later described, the thrust of the screw shaft is taken only by the bearing 35.

Nut housing 36 as shown in Figs. 5 and 7, for example, comprises an outer plate 37 which is provided with a plurality of apertures 38 for purposes of lightening the housing. Plate 37 is curved to conform generally with the curvature of the plates which form the above described cylindrical sections of the storage structure. In addition to curved outer plate 37 the housing comprises side plates 39, upper plate 40 and lower plate 41. Both of these latter plates have aligned openings through which column 12 extends and also aligned slots through which screw 29 extends.

A support bar 42 is secured to the under surface of nut housing 36 at the outer edge of plate 41, and is provided for its full length with a T-shaped slot 43. The support bar is provided with a plurality of equally spaced apertures 44 throughout its length for the reception of pins 45 to properly position a T-shaped dog 46 slidable within slot 43.

The forward end of dog 46 is provided with a semicircular shaped hook 47. The hook 47 extends upwardly into a complementary shaped recess 48 in the lower end of a pin bar 49.

The plates utilized in the fabrication of the cylindrical sections of the storage structure are provided along their vertical and longitudinal edges with a plurality of equally spaced apertures for the reception of bolts which secure the plates to one another in overlapping relationship to form seams. The vertically disposed apertures in conjunction with pin bars, are also utilized in raising the successive sections during erection of the structure. This is accomplished by inserting through the vertically aligned apertures adjacent the side edges of the overlapping plates, pins which form part of a pin bar, and then disposing the pin bars over the sliding dogs which are removably secured to the nut housings. The nut housings are then run up to the desired position and a subsequent cylindrical section is formed beneath the preceding raised section and joined thereto.

Pin bar 49 is a vertically disposed bar to which is secured a plurality of equally spaced forwardly projecting pins 50.

The pins 50 are spaced to conform with the spacing between the vertically disposed apertures adjacent the side edges of the sheets which form the cylindrical sections. Certain of the pins are threaded for a reason that will be explained hereafter. The pin bar 49 is slotted adjacent its upper end at the back for reception of a hook shaped retaining plate 51 which is in turn removably secured to the upper nut housing plate 40 as best seen in Fig. 5.

Nut housing 36 is provided with means to substantially reduce any friction which might be present during vertical movement of the housing along the column 12 and the screw 29. This is accomplished by rollers 52 disposed adjacent the column which permits rolling of the nut housing along the column. Rollers 52 are disposed between the walls 39 of housing 36 at the upper inner end and at the lower outer end of the nut housing respectively in suitable bearings 53.

Closely adjacent and below the upper roller 52 a threaded nut assembly 54 is mounted in brackets 55 on side plates 39 and secured in place by screws 56.

Motor 57, preferably an air motor, is mounted within a suitable frame 58 which is removably secured within trough 6. The motor drives a vertically disposed shaft through a reduction gearing, the shaft having a drive sprocket 59 at the upper end thereof. As best shown in Fig. 1 endless chain 60 connects the drive sprocket 59 with a plurality of sprockets 31 so that the nut housings 36 of the several jacks 7 may be raised or lowered simultaneously.

The top of the silo is formed from a plurality of segmental shaped plates which are secured together at radially extending seams. 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 61 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 top with the uppermost cylindrical shell section, the top is disposed over support 62 and rests on cap 63. After the top and the uppermost section are secured together and

lifted a sufficient distance by the jacks the support 62 may be removed.

A frame 64 is disposed at the inner end of trough 6 and supports a vertical sockets 65 disposed centrally of the silo and welded to the frame. The jackscrews of frame 64 engage the side walls of trough 6 and secure the socket 65 in place. The frame 64 provides an attachment for the lower ends of the braces 17.

In erecting a storage structure such as a silo with the apparatus of the invention the uppermost cylindrical section is formed first and joined to the depending flange 61 of the top. This is accomplished in the following manner.

The nut housings 36 of the screw jacks 7 are first leveled up with respect to each other in the same horizontal plane and the dog 46 on each jack is disposed centrally of the two apertures 44 at the right hand side of the support bar 43. Pins are inserted in these apertures on either side of each dog to properly center the same and to keep each dog from shifting along its support bar. Each pin bar 49 is then positioned over a dog 46 and lowered to engage hook 47 within recess 48 in the lower end of the pin bar to position and support the first cylindrical section. The upper end of each pin bar is also supported by the hooked end of the retaining plate 51 which engages a slot in the upper end of the bar. The plates of the first section are then mounted over pins 50 of bars 49, the pins passing through the lower vertical apertures of each plate. Nuts may be threaded onto the pins 50 which are threaded to retain the plates in position while the plates are joined together at their vertical joints above the pin bars by insertion of bolts therethrough except at the uppermost end of the joints.

After the section has been formed into a cylindrical shape the nut housings are run up simultaneously for a distance sufficient to bring the top edge of the section to the position of the flange 61 of the silo top when supported on the mast 62. The top is then formed from segmental sections and bolts are disposed in the apertures along the bottom edge of the depending flange 61 and in the apertures in the upper edge of the first section to secure the section and the top together. Bolts are then disposed in the remaining aligned apertures along the uppermost vertical side edges of adjacent plates which overlap to form vertical seams.

After the uppermost section and the top have been bolted together the two are elevated by the screw jacks to a height sufficient that the plates of the next succeeding section may be handled therebeneath with ease, in other words, near ground level. As the respective plates are moved into position under the uppermost section the plates are bolted along their upper horizontal row of apertures to the apertures disposed horizontally along the bottom edge of the formed section. Bolts are also inserted through the apertures disposed vertically along the side edges of the plates which are now in overlapping relationship. A plurality of the apertures, depending upon the number of pins on each pin bar, do not at this time receive bolts therethrough. The bolt holes, both horizontal or vertical, are punched into the plates with considerable accuracy so that when the plates are secured horizontally the vertical apertures will be in alignment.

A plurality of wooden blocks, not shown, may be disposed around the foundation of the silo to receive the bottom edge of the circular section which may be disposed thereon by running the screw jacks down with the supported structure carried by the pins of the pin bar.

After a subsequent section has been formed by being bolted circumferentially and vertically, as above described, and a second set of pin bars has been properly disposed so that the pins thereof extend through certain selected vertically disposed apertures, as above described, the screw jacks are run down from the pin bars which are still connected to the first section, the dogs moving down with the housing 36 so that the lower edge of the last formed section is permitted to rest on the wooden blocks disposed around the foundation. As soon as this has been accomplished the sliding dogs are then shifted to their next position to the left where they will line up with the bottom of the pin bars of the newly formed section, each vertical seam of which is offset to the left of the formed vertical seam of the previous section. The previous pin bars connected to the first section are then removed and bolts are inserted in the apertures. The screw jacks are then run up again to lift the assembled top and first section and the second section and the above described operations are again performed to form and elevate the desired number of subsequent sections.

As above described, the pin bars are formed very accurately so that the pins are spaced vertically to accord with the spacing of the vertical apertures. This fact together with the fact that the apertures along the vertical overlapping edges of the plates are aligned permits easy insertion of the pins into the respective apertures. The bar and pins unit requires the insertion of all of such pins and insures sufficient support to the supported structure.

After the lowermost cylindrical section has been formed and secured to the preceding section, as above described, the foot members 8 are removed from their respective positions so that the entire structure may be lowered to permit the lower edge of the bottom section to be disposed in the channel 3. The bottom edge of the lowermost section does not touch the bottom of the channel 3, the weight of the structure being taken by an angle supporting ring 66 secured to the structure and to anchor bolts 5 in the foundation, as later explained. Subsequent to disposing the bottom edge of the lowermost section within the channel 3, the anchor bolts 5, which are provided with washers and nuts 67 for leveling the structure, receive the horizontal flange of angle ring 66. Washers are then placed onto the end of bolts 5, extending through the flange of ring 66, and nuts 68 threaded thereon as shown in Fig. 8. The entire weight of the structure is on the angle ring 66.

Grouting 69 is disposed beneath the horizontal flange of ring 66 and mastic or other suitable waterproof cementitious material 70 is placed into the channel 3 inside the structure around the portion of the lowermost section which extends into channel 3 to seal the joint. The screw jacks may be removed from the interior of the silo at any time subsequent to securing retaining ring 66 in place. The ledge 4 provides clearance for the nuts 67 and provides an annular confinement for the grouting 69.

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 various positions which the sliding dogs are placed into along the support bar 42 correspond to the vertical seams of the silo. It has been explained

heretofore that the sliding dogs are positioned between successive pairs of apertures on the grooved support bar beginning from the right side of the support bar, as seen in Fig. 4, and progressing to the left as each cylindrical section is formed and elevated. Each position of the sliding dogs on the support bar i. e., from right to left, corresponds with the staggered vertical seams of the cylindrical sections.

In moving the sliding dogs from right to left along the slotted support bar to correspond with the successively formed and elevated cylindrical sections the bending moment about the support column remains substantially the same due to the offset of the support bar to the right of the column 12 at which side the lighter load is handled.

As above explained, the pin bars and the pins are machined to a high degree of accuracy and the apertures for receiving the pins and structure bolts are precisely punched in the plates. All pins on the bar must be utilized. This combination provides the required number of pins with an equal load on each pin of the pin bars during elevation of the structure. Because of this the danger of pin breakage or deforming of apertures because of unequal load on the pins or insufficient pins is obviated. Likewise there is no danger of cracking the vitreous enamel coating on the surfaces of the plates around the apertures.

The invention provides apparatus for erecting storage structures or the like, such as silos for instance, in which the lifting heads are provided with means which may be quickly transferred from one head to another as the various cylindrical sections are elevated, means which may be positively positioned successively with respect to the respective sections as they are elevated and improved means to elevate the lifting heads wherein friction in the lifting mechanism is reduced to a minimum.

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

I 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 supported freely on said lifting head for engagement with said sections to support the latter for vertical movement, said means being disposed between the lifting head and the cylindrical sections and comprising a plate and a bar, said bar having a plurality of spaced pins projecting from one side of said bar for engagement with the sections to support the latter for vertical movement, means interconnecting said screw jacks, and means to drive said interconnecting means to raise or lower the cylindrical sections by simultaneous raising or lowering of said lifting heads.

2. Apparaus 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, a grooved bar secured to the lifting head, means disposed in said bar for sliding movement with respect to said bar, means supported freely on said last recited means for engagement with said sections to support the latter for vertical movement, 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 head.

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, a grooved bar secured to the lifting head, means disposed in said bar for sliding movement with respect to said bar and having at one end thereof a substantially semicircular vertically disposed hook, a member adapted to be freely supported on said hook for engagement with the cylindrical sections to support the latter for vertical movement and having a cut out in the lower surface thereof for engagement with said hook, 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 head.

4. Apparatus for erecting storage structures or the like having a plurality of cylindrical vertically disposed successively adjoined plate sections on which the 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, a plate and a bar said bar being freely disposed vertically on said head and having a plurality of equally spaced pins projecting therefrom for disposition in a like number of the aligned apertures of the plate, means adapted to adjust the position of the bar relative to the vertical center line of the lifting head to thereby dispose equal pressure on each pin, means interconnecting said screw jacks, and means to raise or lower the cylindrical sections by the simultaneous raising or lowering of said lifting head.

5. Apparatus for erecting storage structures or the like having a plurality of cylindrical vertically disposed successively adjoined plate sections on which the 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 horizontally disposed grooved bar secured thereto, means disposed in said bar for sliding movement with respect to said bar, a plurality of equally spaced apertures extending through the bar and adapted to receive means in successive pairs of the apertures to cause the vertical center line of the means disposed in said grooved bar to be aligned with the apertures adjacent the side edges of the plates, a bar adapted to be freely disposed vertically on said head and having a plurality of equally spaced pins projecting therefrom for disposition in a like number of aligned apertures in adjacent plates whose side edges overlap, means interconnecting said screw jacks, and means to raise or lower the cylindrical sections by the simultaneous raising or lowering of said lifting head.

6. An apparatus for erecting storage structures or the like having a plurality of cylindrical vertically disposed successively adjoined sections, a screw jack, a foot adapted to be removably secured to the foundation of said

structure, a housing member removably secured to the foot and having a column extending upwardly from said housing, a screw disposed adjacent said column in parallel relationship thereto and extending upwardly from said housing, a nut housing disposed above said housing member and having aligned apertures therein through which said column and screw extend, vertically spaced roller means disposed in diametrically opposed corners of said nut housing for engagement with the column, a driving nut secured to the nut housing and encircling the screw, a sprocket secured to the lower end of the screw, and means comprising a plate and a bar, and adapted to be freely supported ver-

tically in a plurality of positions adjacent the nut housing to engage successive cylindrical section to raise or lower the same in response to rotation of said screw, and said bar being adjustable horizontally with respect to said plate.

WALTER M. SCHIEFELBEIN.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,184,801	McCarthy	Dec. 26, 1939
2,530,807	Campbell	Nov. 21, 1950