United States Patent [19]

Kuck

[11] **3,778,204**

[45] **Dec. 11, 1973**

[54] **APPARATUS FOR ERECTING CONCRETE STRUCTURES**

[76] Inventor: **Ewald D. Kuck,** R.R. No. 1 4247 Road 90, New Breman, Ohio 45869

[22] Filed: **Apr. 20, 1971**

[21] Appl. No.: **135,598**

[52] **U.S. Cl.** **425/63,** 249/20

[51] **Int. Cl.** **E04g 11/22**

[58] **Field of Search** 249/20, 173, 17, 249/22, 33, 1, 13; 425/60, 63, 64, 65, 213, 186; 264/31, 32, 33

[56] **References Cited**

UNITED STATES PATENTS

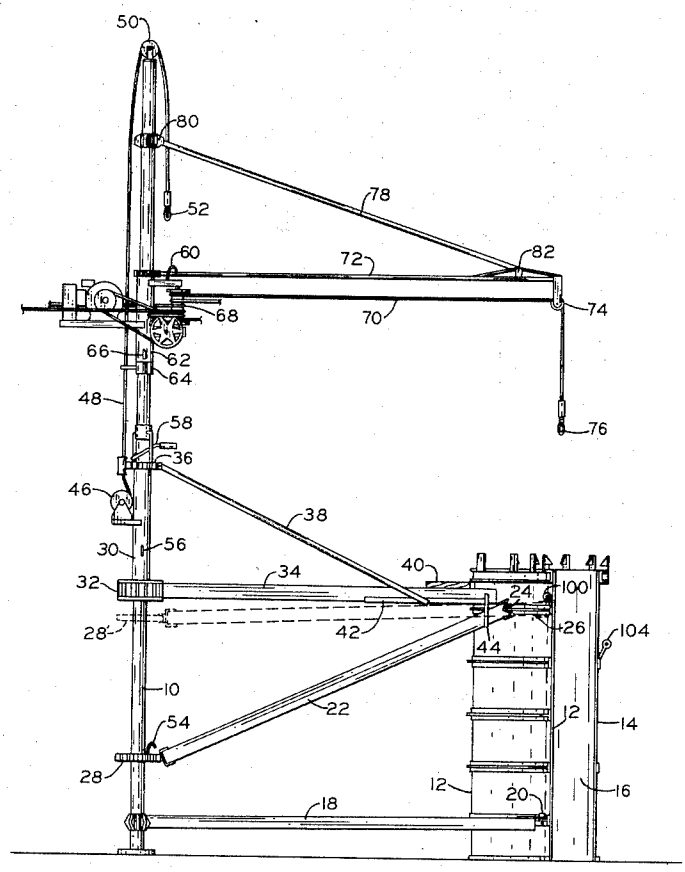
3,510,098	5/1970	Fox	249/20
2,396,174	3/1946	Hawes	249/33 X
1,457,089	5/1923	Sellman	249/17
839,496	12/1906	Milam	249/33 X
1,020,005	3/1912	Witthoefft	249/17 X
1,208,398	12/1916	Stoeser	264/32 X
2,556,594	6/1951	McDonnell	249/173 X
3,252,199	5/1966	Bossner	249/20 X
3,045,313	7/1962	Dorn	249/17
3,509,606	5/1970	Fisher	249/20 X
3,521,335	7/1970	Heinzle	249/20 X
1,438,784	12/1922	Polk	425/64
1,457,090	5/1923	Sellman	425/64
1,163,798	12/1915	Williams	425/64
1,208,398	12/1916	Stoeser	425/64 X
1,213,838	1/1917	Conklin	425/64
1,376,911	5/1921	Abram	425/64
1,442,294	1/1923	Polk	425/213
3,619,431	11/1971	Weaver	425/186

Primary Examiner—Robert D. Baldwin
Assistant Examiner—John S. Brown
Attorney—Jeffers & Rickert

[57] **ABSTRACT**

An apparatus, for erecting concrete structures, particularly cylindrical structures, such as silos. The apparatus includes axial form sections with the structure beng erected by pouring concrete into one form section consisting of inner and outer forms with a second portion of the structure being poured in a second set of forms mounted on top of the first set. Further portions of the structure are poured by removing the lower set of sections and setting them on top of the upper set of sections, and continuing this shifting of forms until the structure is completely erected. A center pole erected on the axis of the structure includes winches for lifting the forms and a plurality of radially extending braces can also be included on the center pole for bracing the forms against movement.

14 Claims, 8 Drawing Figures



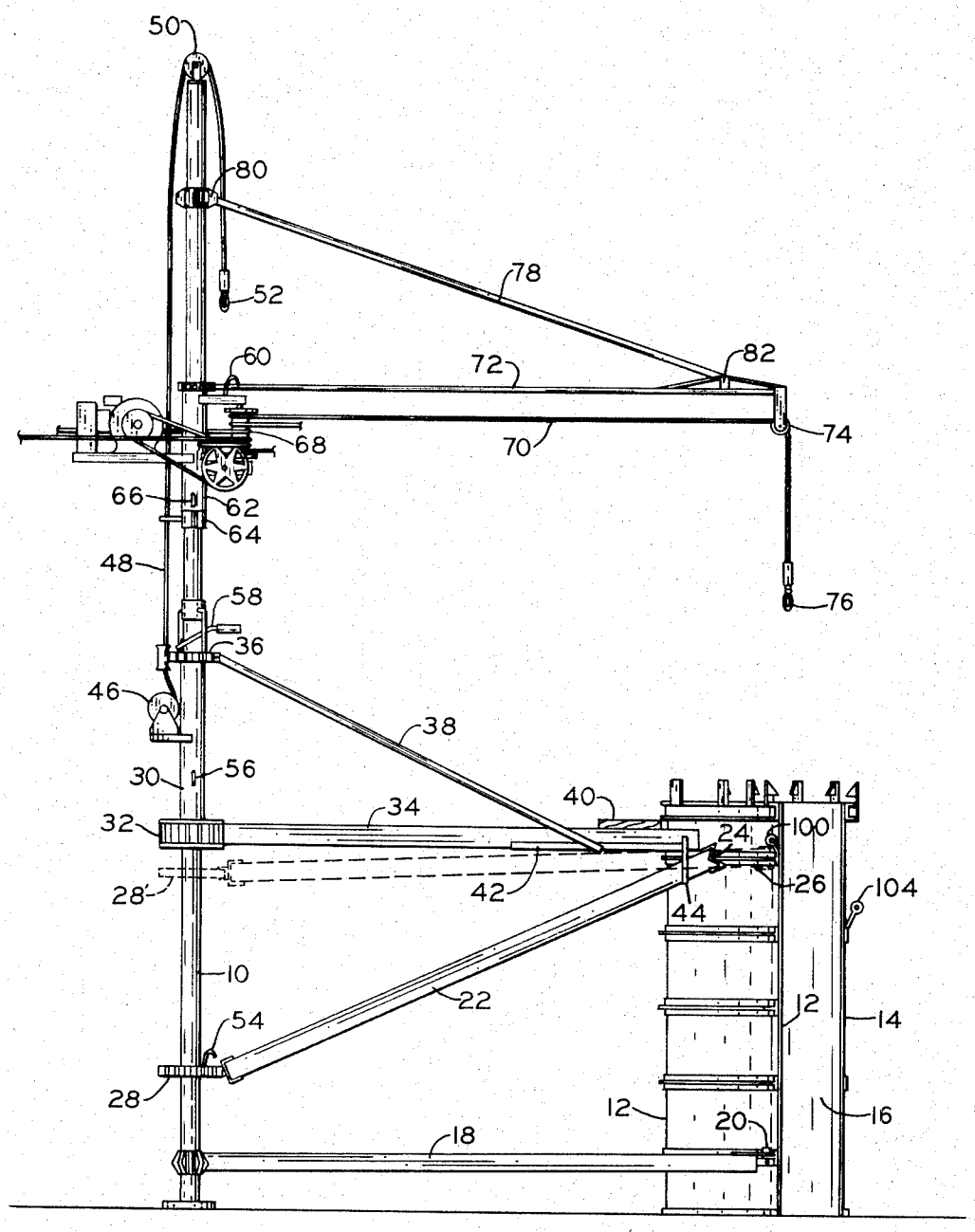


FIG. 1

INVENTOR
EWALD D. KUCK
BY Jeffers and Rickert
ATTORNEYS

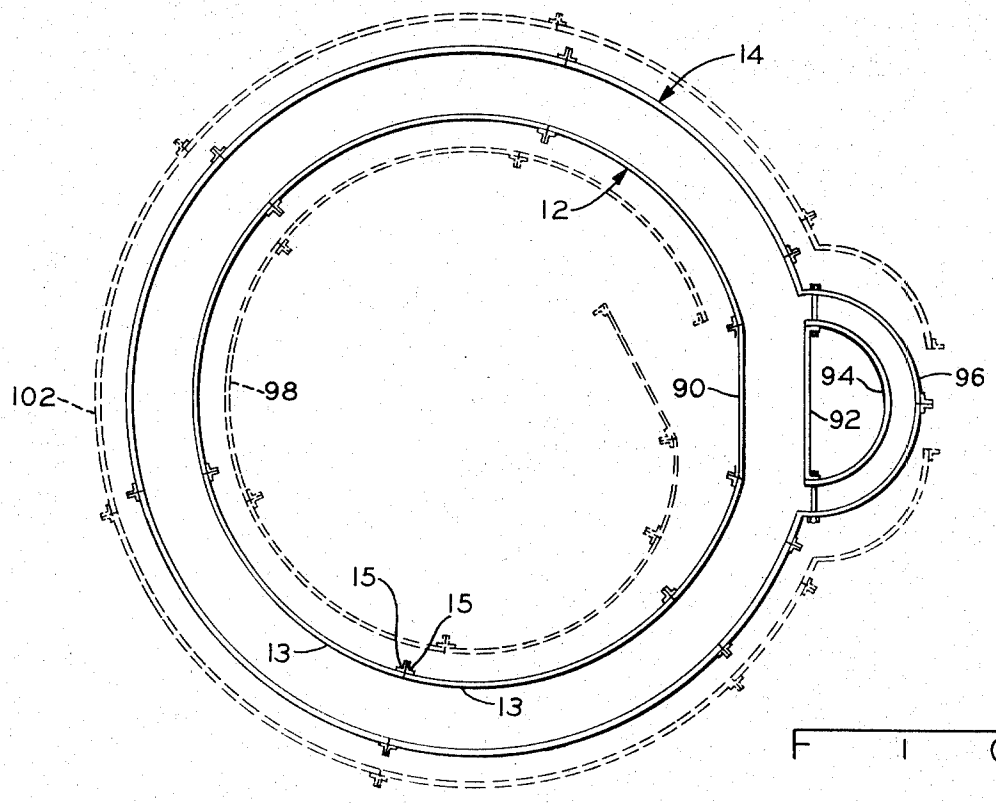


FIG. 2

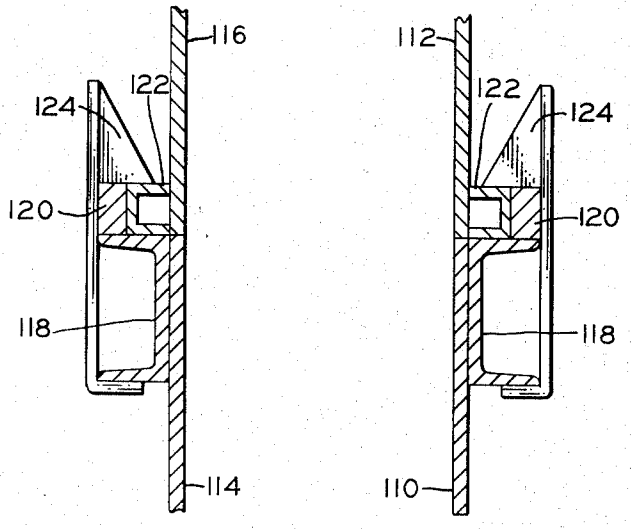


FIG. 3

INVENTOR
EWALD D. KUCK
BY Jeffers and Richert
ATTORNEYS

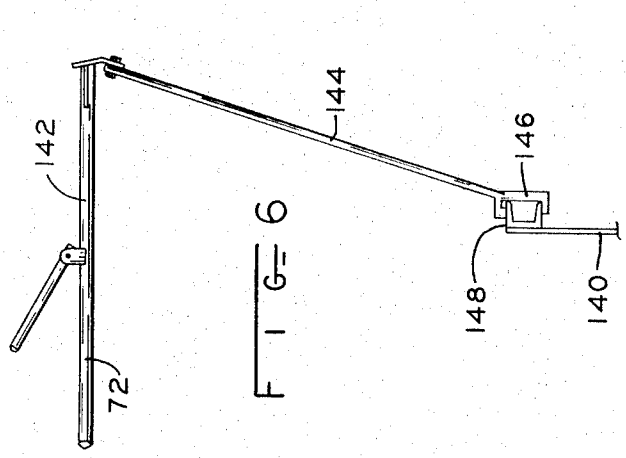


FIG. 6

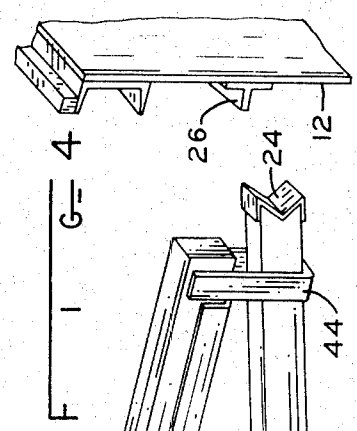
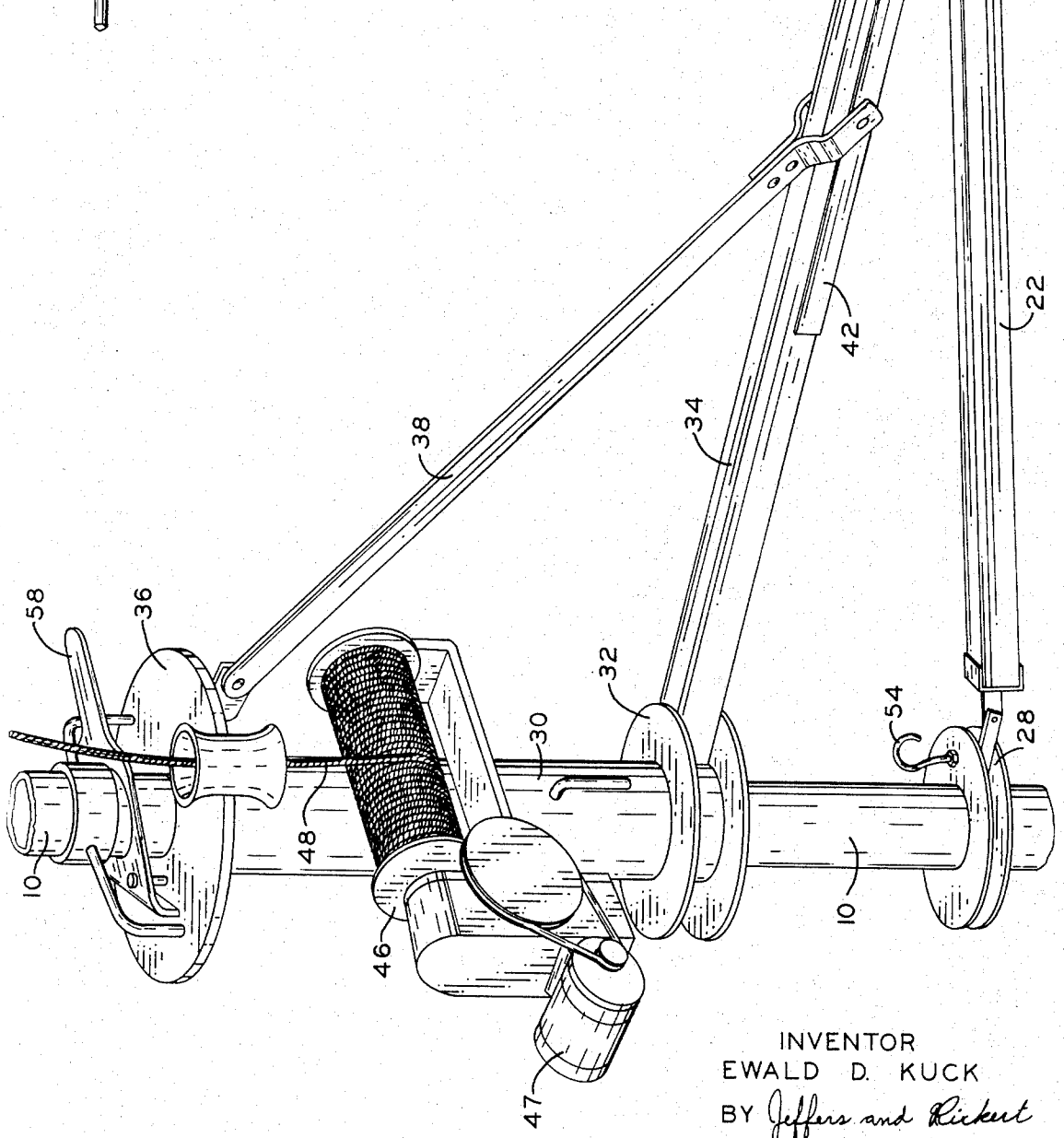


FIG. 4



INVENTOR
EWALD D. KUCK
BY Jeffers and Rickert
ATTORNEYS

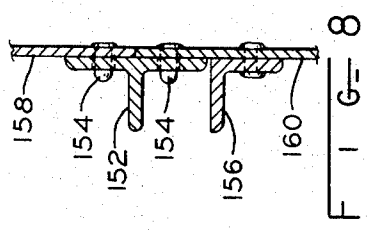


FIG 8

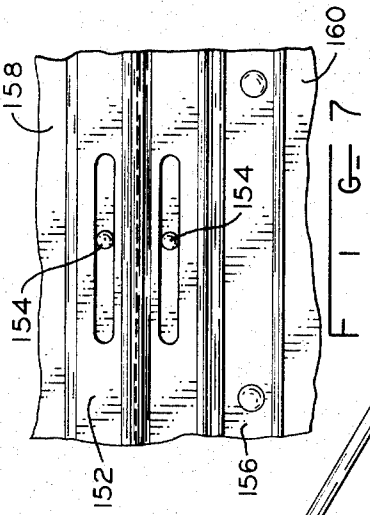


FIG 7

FIG 5

INVENTOR
EWALD D. KUCK
BY Jeffers and Rickert
ATTORNEYS

APPARATUS FOR ERECTING CONCRETE STRUCTURES

BACKGROUND OF THE INVENTION

The present invention relates to an apparatus for erecting concrete structures, particularly cylindrical structures such as silos.

The erecting of a structure such as a silo requires a great deal of form work unless slip casting is resorted to. Slip casting, however, requires considerable apparatus and fairly complex controls to maintain the forms in continuous motion and for this reason slip casting techniques are not relied on to any great extent for the erection of silos and the like. To use conventional forms to erect a silo requires considerable form setting which is time consuming and expensive.

A primary object of the present invention is the provision of an apparatus for erecting concrete structures such as silos and the like which is economical and relatively rapid and in which the setting of forms is made relatively simple.

Another object of this invention is the provision of an apparatus for erecting concrete structures such as silos in which only two basic sets of forms are required with the individual forms being used several times in the erection of a single structure.

A still further object of this invention is the provision of an apparatus for erecting silos in which the silo includes a ladder column integrally formed on the side thereof.

These and other objects and advantages of the present invention will become more apparent upon reference to the following detailed specification taken in connection with the accompanying drawings in which:

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a fragmentary view showing the apparatus set up preparatory to pouring the first ring for the structure;

FIG. 2 is a somewhat schematic planned view looking down on top of the form arrangement for the structure and illustrating how the inner and outer forms can be collapsed to remove them from the structure;

FIG. 3 is a fragmentary sectional view drawn at enlarged scale showing how the form sections of the structure are arranged to be mounted in superposed relation;

FIG. 4 is a perspective view showing a part of the structure for manipulating the form sections;

FIG. 5 is a perspective view showing an alternate form of the portion of the structure located above that shown in FIG. 4;

FIG. 6 is a fragmentary view showing an arrangement that can be employed for supporting outer form sections;

FIG. 7 is a fragmentary sectional view illustrating an alternative approach for holding the form sections in superposed relationship which allows those forms to be used in constructing various diameter structures; and

FIG. 8 is a cross sectional view of the modification of FIG. 7.

BRIEF SUMMARY OF THE INVENTION

The invention pertains to an apparatus for erecting structures of concrete, particularly cylindrical structures, such as silos, in which inner and outer form sections are provided into which concrete is poured and

on top of which form sections other form sections are mounted for receiving further concrete. Following the pouring of concrete in the last mentioned form sections, the lowermost sections are removed from the concrete which has been poured therein by collapsing the inner section inwardly and the outer section outwardly whereupon the sections are then elevated and disposed on top of the previously upper sections and a further portion of the structure is then poured. The forms are progressively moved from lower positions to upper positions with additional portions of the structure being poured until a structure of the required height is completed.

The apparatus employed includes a center pole supported on the axis of the structure to be erected and including winch means or the like for lifting the form sections and also including a plurality of radially extending brace members for supporting the form sections and a working platform for workmen.

DETAILED DESCRIPTION OF THE INVENTION

Referring to the drawings somewhat more in detail, in FIG. 1, a center pole **10** is mounted on the vertical axis of a cylindrical structure, such as a silo, which is to be erected. Concentrically arranged with pole **10** is an inner form section **12** and an outer form section **14.** The annular space **16** between the form sections is adapted for having concrete poured therein to form a portion of the structure to be erected. According to well known practices, reinforcing iron in the form of rods or screen can be placed in space **16** prior to pouring concrete therein and the reinforcing would normally extend out of the top of the form sections so as to be engageable by the concrete of the next portion of the structure which is poured.

The inner form section **12** is braced at the bottom by the radial members **18** which have their radially inner ends connected to pole **10** and their radially outer ends connected to form section **12** near the bottom as by bolts **20.**

The upper portion of inner form section **12** is adapted for being engaged by the radial members **22.** The radially outer ends of members **22** are notched as at **24** for engagement with a brace ring **26** extending about the inner side of form **12.** The radially inner ends of members **22** are pivotally connected to a hub member **28** which is vertically slidable on pole **10.** Hub member **28** is movable from its full line position in FIG. **1** up to its dotted line position **28'** therein and this will cause the members **22** to assume a substantially horizontal position with their notched outer ends at **24** supportingly engaging the brace ring **26** near the upper end of inner form section **12.**

Located above hub **28** on pole **10** is a support structure **30** having at the bottom a lower ring **32** which supports the inner ends of radial members **34** which, at their radial outer ends, terminate a substantial distance inwardly from inner form section **12.** Support **30** includes an upper ring at **36** and connected between ring **36** and a point near the outer ends of horizontal members **34** are braces **38** which hold members **34** in a horizontal position. Members **34** are adapted for supporting planks **40** which form an annular walk-way about the inside of the structure being erected.

Members **34** are preferably reinforced along the bottom toward their outer ends by metal plates **42** and adjacent the radially outer ends of members **34** are con-

nected the dependant U-shaped members 44 through which the members 22 slidably extend. The members 44 support the outer ends of members 22 during reciprocating movements thereof as hub 28 moves vertically on post 10.

Support 30 has a motor driven winch 46 thereon from which a cable 48 leads upwardly to pass over a pulley 50 on the upper end of pole 10. After cable 48 passes over pulley 50 it leads downwardly to a free end 52. The free end 52 of cable 48 is engageable with a hook 54 on hub 28 so that hub can be power operated when moved vertically upwardly. When the hub 28 is in its upper form bracing position, it can be made rigid with pole 10 or it can be fixed to some part of support 30 and cable 48 can then be detached therefrom.

Support 30 is also slidable on pole 10 and may be held in any adjusted position thereon as by a pin 56 extending through holes in support 30 and pole 10.

Ring 36 advantageously has pivoted thereto an inclined plate 58 having an aperture therein through which pole 10 extends. Plate 58 forms a transom latch so that, if pin 56 is removed and support 30 is not otherwise supported, plate 58 will prevent the support from sliding downwardly on pole 10.

Support 30 can be moved upwardly by connecting end 52 of cable 48 to a hook 60 carried on an upper support structure generally indicated at 62, and then pulling pin 56 out of support 30 and operating winch 46 to cause support 30 to move upwardly to a new position where pin 56 can be reinserted through support 30 and pole 10.

The support 62 referred to above comprises a tubular member slidable on pole 10 and adapted for being clamped in position as by clamp 64 or locked against movement by removable pin 66. Support 62 has a plurality of cable drums 68 rotatable thereon as illustrated in FIG. 5 or about an axis parallel thereto as shown in FIG. 1 and each having a respective cable 70 entrained thereabout. Each cable 70 leads outwardly along a respective boom 72 to a pulley 74 and then drops downwardly to a free end 76.

Each boom 72 is supported at its inner end on support structure 62 and is held in horizontal position by a brace 78 each of which is secured at its inner end at 80 to the upper end of support structure 62 and at its outer end at 82 is connected to the respective boom.

Support structure 62 has the aforementioned hooks 60 on the top engageable by free end 52 of cable 48 by means of which structure 62 can be adjusted vertically on pole 10 if so desired by releasing support 62 from pole 10 and operating winch 46.

FIG. 5 will show that the cable drums 68 are fixed together and connected to a gear 69 meshing with a pinion 71 that is driven by a motor 73. Motor 73 is preferably reversible so that the cables leading from drums 68 can be reversibly actuated.

Similarly, FIG. 4 will show that winch 46 includes a reversible drive motor 57 for reversibly actuating cable 48.

Referring now to FIGS. 2 and 3, in FIG. 2 inner and outer form sctions 12 and 13, respectively, are shown in working position in full lines. Each of these form sections is preferably made up of segments bolted together at the ends and forming a cylinder. For example, inner section 12 may be made up of the segments 13 having angles 15 at the ends interconnected by bolts. Similar segments are employed in connection with outer form section 14.

In the construction of a silo it is customary to include a vertical passageway along the outside within which a ladder can be mounted and along which passageway there are provided doors, or windows, opening to the interior of the silo. The form arrangement of FIG. 2 takes this into account by having short panels 90 provided in the inner form section and similar short panels 92 opposite thereto in the outer form section. These panels may be replaced with blocks which interrupt the circumference wall of the structure and provide the doors or windows referred to.

The ladder column along the outside of the silo is provided by the arcuate inner member 94 and the arcuate outer member 96 carried by the outer form section and arranged in radially spaced relation so that when the forms are filled with concrete this region is also filled with concrete and the column along the side of the silo in which the ladder is to be mounted will thereby be formed.

In FIG. 2 the dotted outline shown for each of the inner and outer form sections shows the sections when they have been collapsed in a direction away from the concrete therebetween. In respect of the inner section, the section is unbolted where a pair of the angles 15 join and then the section is resiliently collapsed inwardly into the dotted line position indicated at 98. With the inner form section thus collapsed, it can be elevated and re-expanded on top of another form section thereabove.

As will be seen in FIG. 1, the inner form section 12 is provided with eyes 100 which are adapted for being engaged by the free ends 76 of cables 70 so that the inner form section 12, after being collapsed inwardly, can be lifted upwardly and then expanded and rested on top of a form section thereabove.

Similarly, the outer form section 14 can be opened and collapsed to the dotted line position indicated at 102 in FIG. 2 and then eyes 104 (FIG. 1) availed of for permitting the outer form section to be elevated by cables 70 to above the next form section thereabove and then expanded back to its original diameter and rested on top of the form section therebeneath.

When both of the inner and outer form sections have been raised up and expanded back to their original diameters and are in place on top of the form sections therebeneath, structure 30 can be elevated to a new position and members 22 again expanded into supporting relation with the upper region of the inner form section. The lower part of the most recently placed form section is supported on the top of the form section therebeneath so that members 18 can remain in their original position near the bottom of post 10 during construction of the first two layers.

The outer form section will have its lower end supported on top of the outer form section therebeneath and the upper edge can be supported by bolting it to inner form section 12, or the upper end of the outer form section can be left unsupported.

With respect to the sections being supported in superposed relation, in FIG. 3 the upper end of a lower outer form section is indicated at 110 and resting thereon is an upper outer form section 112. FIG. 3 also shows the upper end of a lower inner form section at 114 and the lower end of an upper inner form section at 116.

Each of the inner and outer form sections has fixed thereto and extending around the top a channel member **118** and secured to the outer edge of the channel member is a ring **120.** The lower edge of each of the form sections has a box like ring **122** secured thereto which fits inside the respective ring **120** and rests on top of the respective channel **118** of the form section therebeneath. The form sections at spaced points around the upper edges may be provided with hooks **124** which engage over rings **122** and hold the form sections in assembled relation.

FIGS. **7** and **8** illustrate a scheme alternative to that shown in FIG. **3** for connecting a lower form section **160** to an upper form section **158** which is applicable to both inner and outer form sections. An angled brace ring **156** analogous to the brace ring **26** of FIG. **1** extends circumferentially around the lower form section **160** and is permanently affixed thereto. A connecting member of T-shaped cross section **152** having a pair of slots therein for accepting a pin **154** from each of the lower and upper form sections serves to hold those two sections together. The connecting member **152** is of T-shaped cross sectional configuration for rigidity and is slotted to accept the pins **154** to compensate for slight misalignment problems between the lower form section **160** and the upper form section **158.** This slotting further allows the use of the same form sections and connecting members in the construction of structures of varying diameters.

It is often desirable that the forms and other equipment used in the present invention be sufficiently flexible to allow the construction of, for example, different silos of different diameters. Form sections are typically four foot lengths, however, the provision of some fractional form sections or panels allows the same basic set of form sections to be used to construct **16, 20** and **24** foot silos. The pins **154** may fall at different points for these differing diameter structures and thus it is desirable that the T-shaped connecting member **152** be slotted rather than merely being provided with circular holes. In making the equipment more flexible so as to allow the construction of different size structures it may also be desirable to make the radially extending members and form section lifting structure adjustable if the range of silo diameters desired exceeds the limiations of the equipment as previously disclosed.

FIG. **6** shows a manner in which the booms **72** could be availed of for supporting the upper ends of outer form section **140.** Each boom **72** is provided with an extension member **142** rigid with the respective boom and pivotally dependant from the outer ends of the extension members **142** are the rods **144** having clamps **146** at the lower end for engaging the channel members **148** extending about the upper edge of outer form section **140.**

Advantageously, two of the members **144** are provided on each extension member and these extend downwardly in diverging relation from the outer end of the respective extension so that form **140** is supportingly engaged at a plurality of circumferentially spaced points about the top thereof. The arrangement of FIG. **6** is generally employed only for the first and lowermost form section of the structure which is formed and form sections of the structure above the first form section are generally supported and located on each other. As mentioned, the outer form section can be located on the internally supported inner form section by bolts or spacer members or the like.

The erection of the building according to the arrangement disclosed herein is relatively rapid and efficient and considerable economy is realized because not more than two of each of the inner and outer form sections is required.

Modifications may be made within the scope of the appended claims.

What is claimed is:

1. Apparatus for use in erecting substantially cylindrical concrete structures, such as silos, and comprising; a center pole stationarily mounted on the axis of the structure, inner and outer form means concentric with said center pole and radially spaced from each other and adapted for receiving concrete therebetween, each of said inner and outer form means comprising axial sections adapted to be mounted in superimposed relation and each being in the form of a cylindrical member, said inner sections being collapsible inwardly and said outer sections being collapsible outwardly, each axial section having first alignment means at the bottom and second alignment means at the top, the said first alignment means on the bottom of an upper axial section cooperating with the said second alignment means on the top of an axial section therebeneath so as to locate the said upper sections on the sections therebeneath, a slidable tubular support on said center pole, locking means for securing said tubular support in selected positions on said center pole, radial booms having their inner ends connected to said tubular support and having their outer ends disposed over said form means, winch means including a cable drum on said tubular support having cables extending outwardly along said booms and leading downwardly from the outer ends thereof, and means for connecting the free ends of said cables to spaced points about said sections whereby the lower ones of a pair of superimposed said sections can be collapsed and then lifted in collapsed position to above the other one of the said pair and then expanded to operative position and mounted on the upper end of the said other one of said sections, each set of inner and outer axial sections at the same level being adapted to receive concrete therebetween prior to mounting the next set of inner and outer axial sections thereon and each set of inner and outer axial sections being adapted to be moved upwardly following the supply of concrete to the space between the inner and outer axial sections mounted on top thereof.

2. An apparatus according to claim **1** which includes means carried by said pole at the bottom and supportingly engaging an inner section disposed at the level of the bottom of the pole on the inside thereof near the bottom.

3. An apparatus according to claim **1** in which said pole includes brace means mounted thereon and adapted for supportingly engaging the inside of an inner section to support the section while concrete is supplied to the space between it and an outer section at the same level, said brace means being collapsible radially inwardly to disengage from a respective inner section and being expansible radially outwardly to engage a respective inner section, said brace means when it is collapsed permitting movement of collapsed inner sections upwardly through the radial space between the outer ends of said brace means and a said inner section at the same level.

4. An apparatus according to claim 3 in which said brace means comprises a hub reciprocable on said pole, a plurality of radial brace elements pivoted at their inner ends to said hub and adapted at their outer ends to engage the inside of an inner section at circumferentially spaced points, guide means for said brace elements near the outer ends thereof and in a common horizontal plane, and means for moving said hub along said pole while said guide means remain at the same level to cause the outer ends of said brace elements to move between radially inner and radially outer positions.

5. An apparatus according to claim 4 which includes a support member on said pole, radial and horizontal support elements connected at their inner ends to said support member and at their outer ends being spaced radially inwardly from a said inner section at the same level, said guide means being carried by said support elements on the underside thereof, said support elements being adapted to support plank members forming a work platform surrounding said pole.

6. An apparatus according to claim 5 in which said support member is adjustable along said pole in the vertical direction.

7. An apparatus according to claim 1 in which said tubular support is adjustable along said pole and said winch means comprises an inner part, a drive motor on said tubular support connected to drive said inner part, a plurality of rotatable sheaves having a common axis and supported by said inner part and driven by said motor, and a cable on each sheave leading therefrom along a respective boom.

8. An apparatus according to claim 6 in which said tubular support is adjustable along said pole and said winch means comprises an inner part, a drive motor on said tubular support connected to drive said inner part, a plurality of rotatable sheaves having a common axis and supported by said inner part and driven by said motor, and a cable on each sheave leading therefrom along a respective boom, a second winch on said support member having a drive motor and a drum driven thereby, a pulley on the pole near the top, and a cable leading from said drum over said pulley and then downwardly and adapted for connection to at least one of said tubular part of said winch means, said support member, and said hub, and means for selectively locking said support member and said tubular part of said winch means and said hub to said pole.

9. An apparatus according to claim 8 in which at least said support member includes a transom latch connecting it to said pole and preventing dropping of the support member on the pole.

10. An apparatus according to claim 1 which includes means adapted for connection to the outer ends of said booms and including rods extending downwardly therefrom for supporting engagement with the upper end of a said outer section.

11. An apparatus according to claim 1 in which each said section in the form of a cylindrical member is separable along an axial line at one side to permit collapsing of the respective sections.

12. An apparatus according to claim 1 in which said alignment means include first rings on the bottoms of said sections on the outside thereof with respect to the space between the sections, and second rings on the top of each section for engagement with the outer side of a said first ring on the bottom of a section resting thereon.

13. An apparatus according to claim 12 which includes hook elements on the top of at least each outer section adapted to engage over the said first ring on the bottom of an outer section resting thereon.

14. An apparatus according to claim 1 wherein said first alignment means on the bottom of an upper axial section and said second alignment means on the top of an axial section therebeneath are pins permanently affixed to said upper and said lower axial sections and further comprising at least one connecting member passing over at least one pin of each of said upper and said lower axial sections.

* * * * *