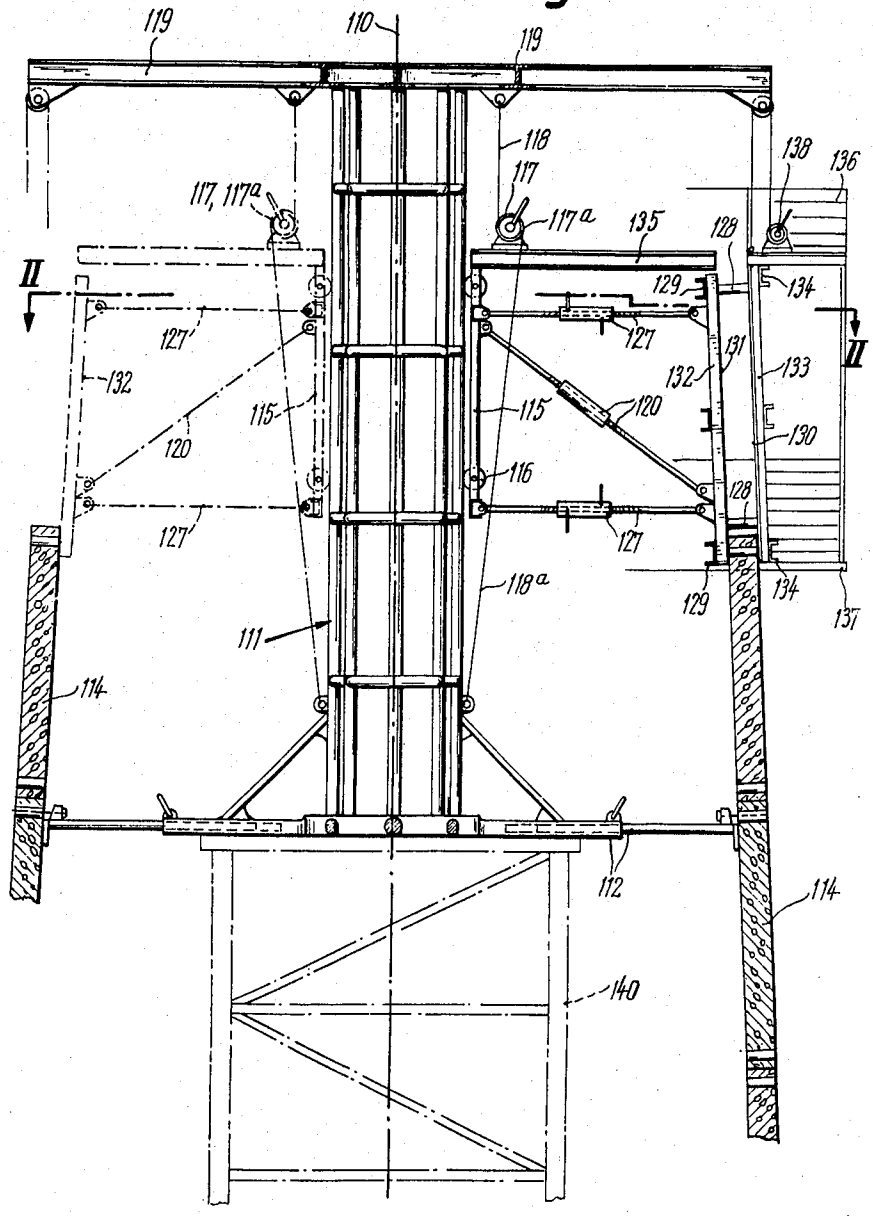
May 24, 1966 J. BÖSSNER 3,252,199

FORMWORK FOR ERECTING CONCRETE STRUCTURES

Filed May 17, 1962 10 Sheets-Sheet 1

Fig. 1



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FORMWORK FOR ERECTING CONCRETE STRUCTURES

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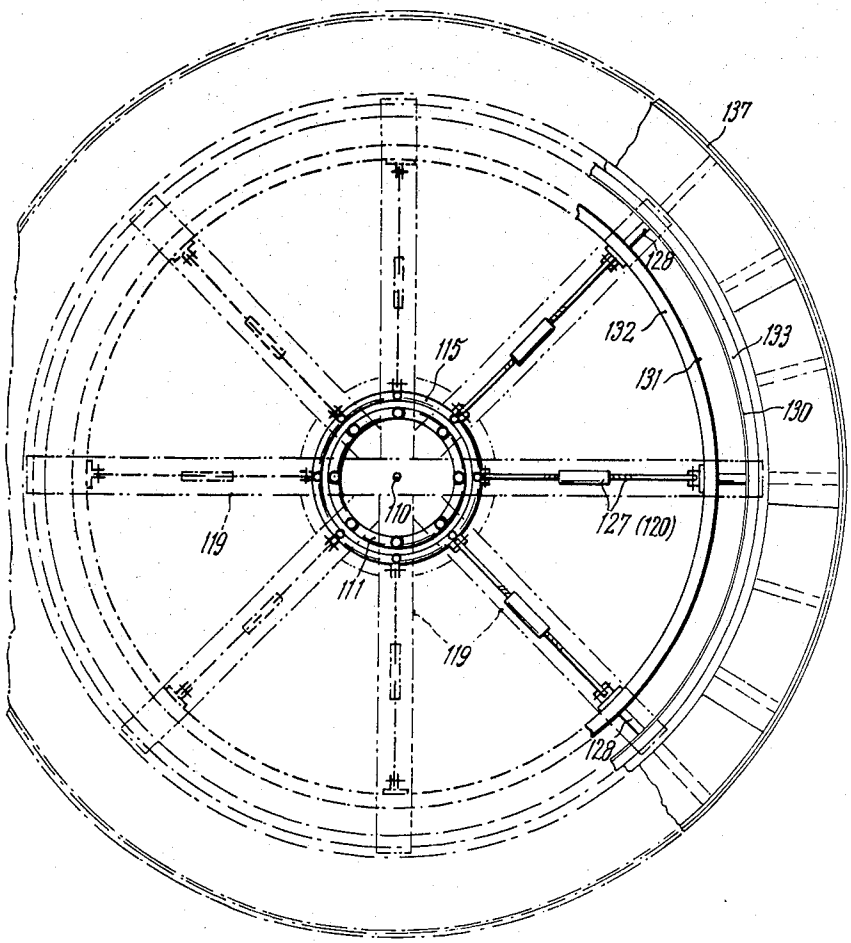
Fig. 2



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FORMWORK FOR ERECTING CONCRETE STRUCTURES

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Fig. 3

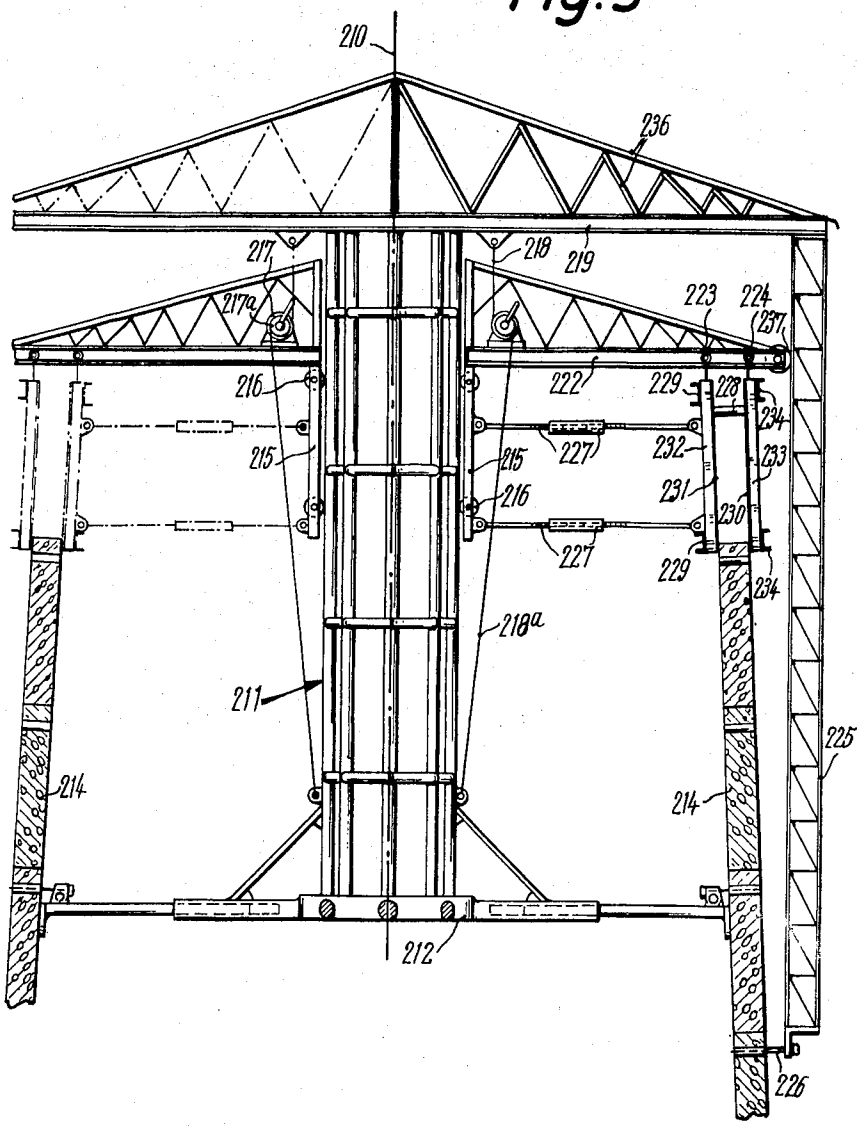

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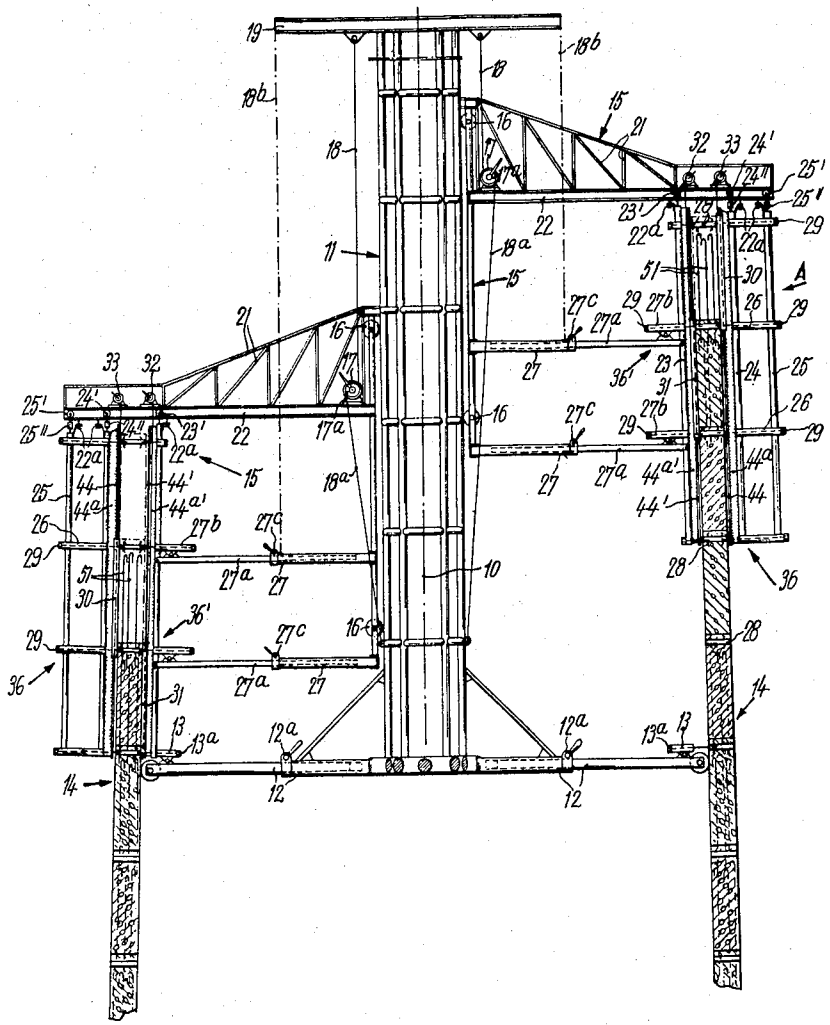
Fig. 4



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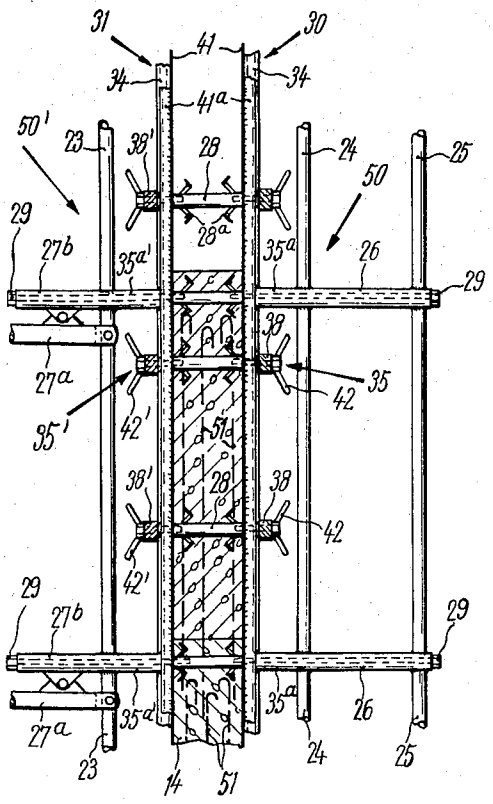

Fig. 4a

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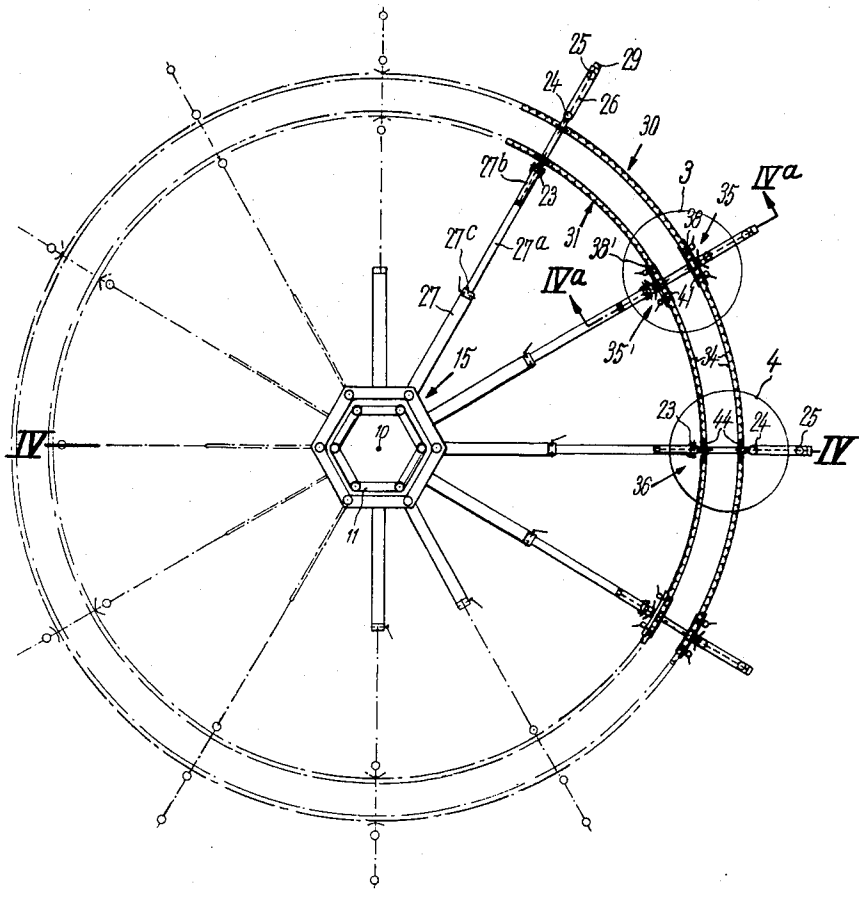
Fig. 5



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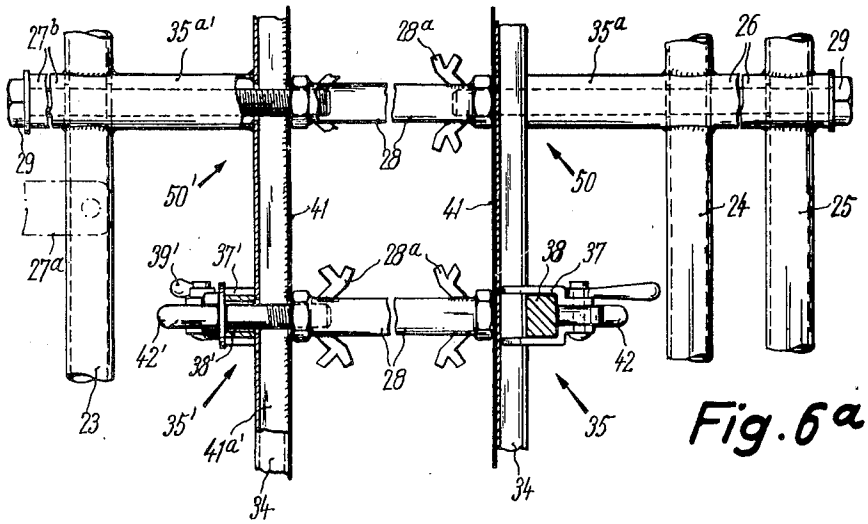

Fig. 6a

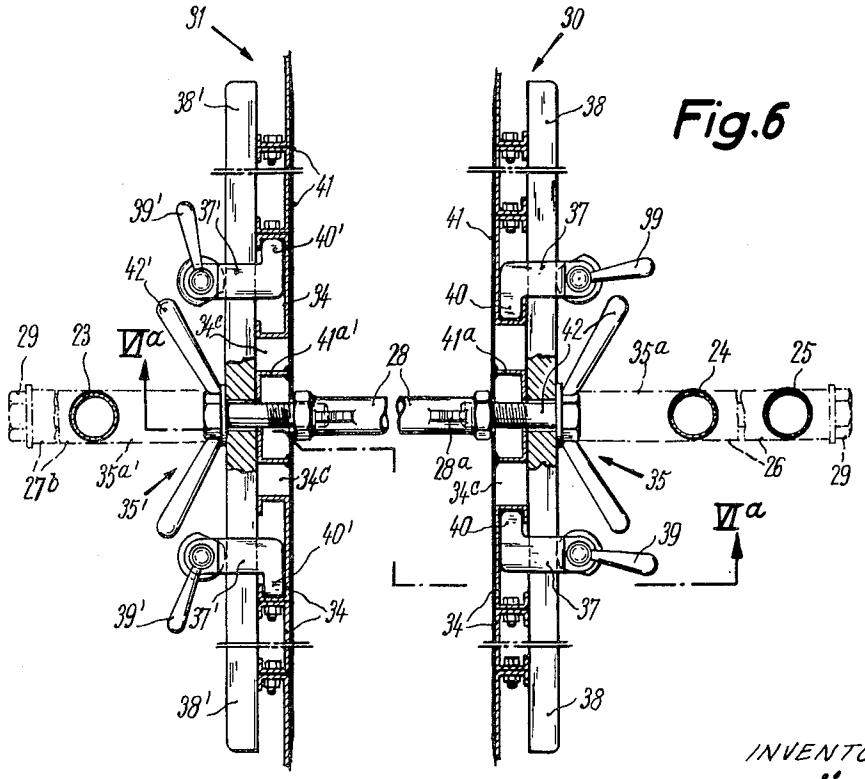

Fig. 6

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Fig. 7a

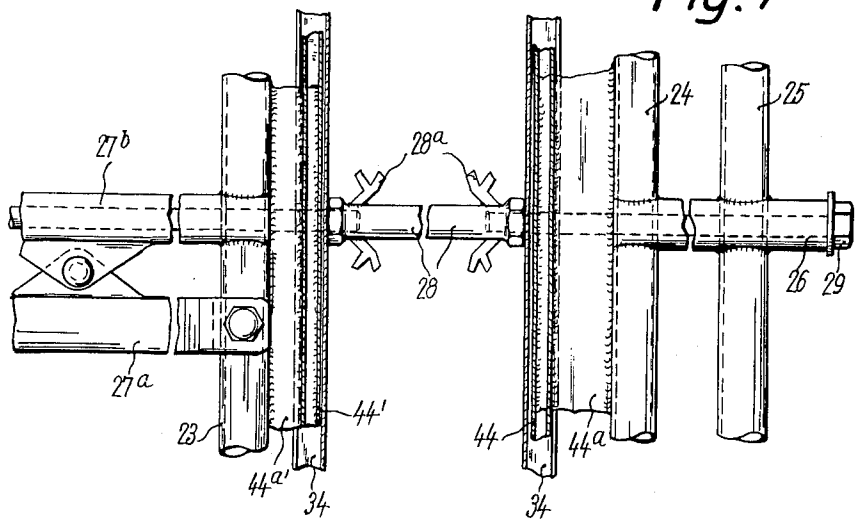
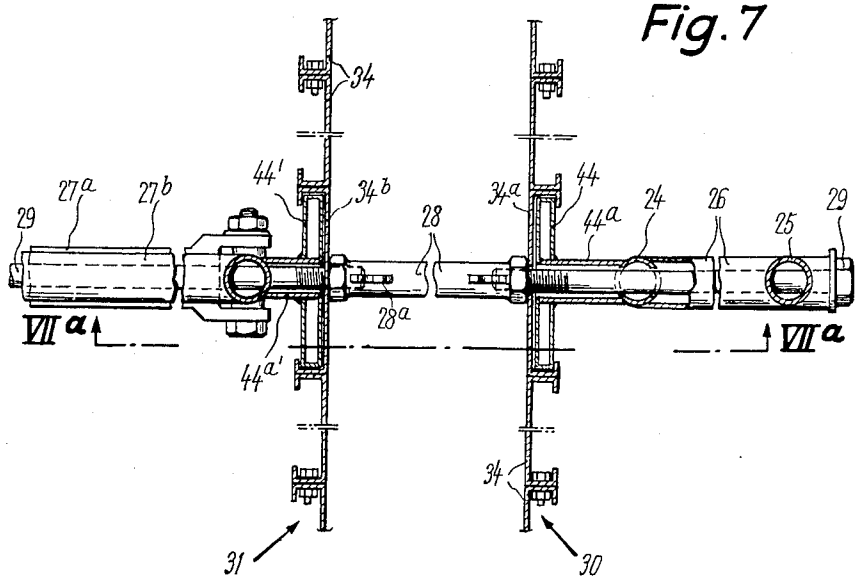


Fig. 7



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FORMWORK FOR ERECTING CONCRETE STRUCTURES

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Fig. 8

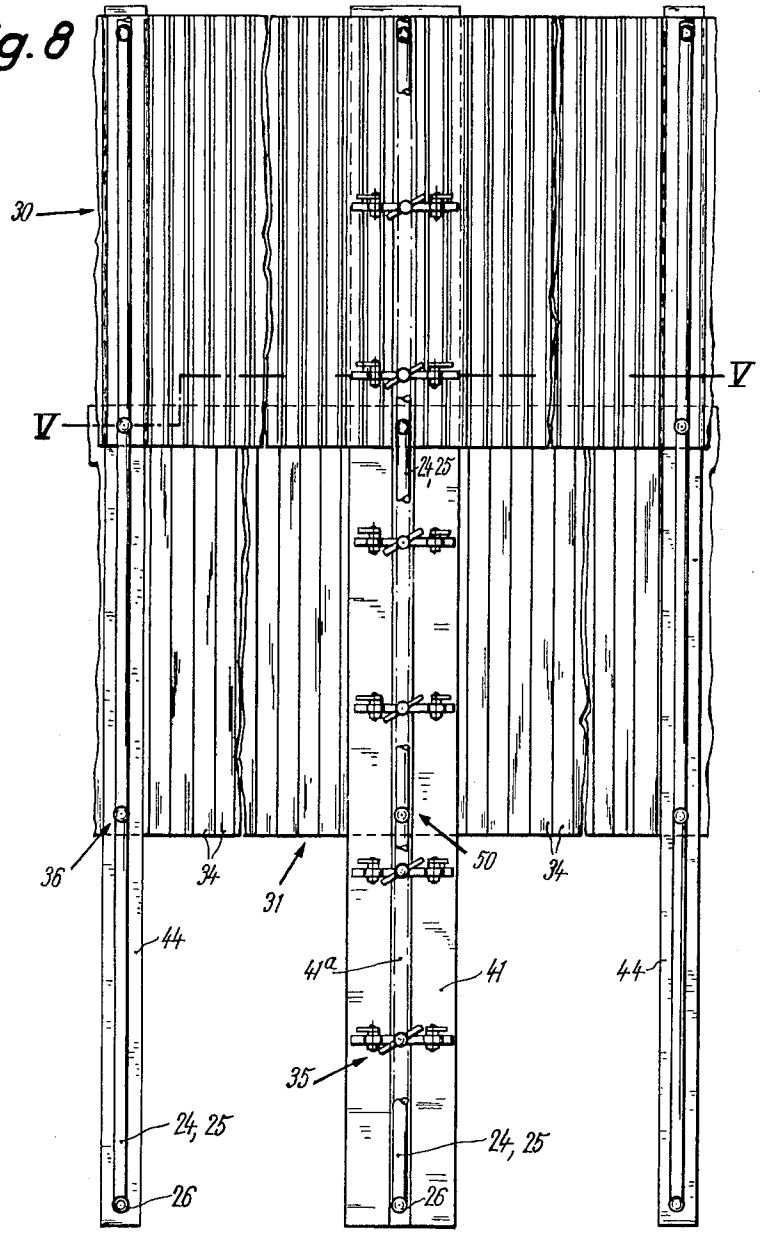

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Fig. 9a

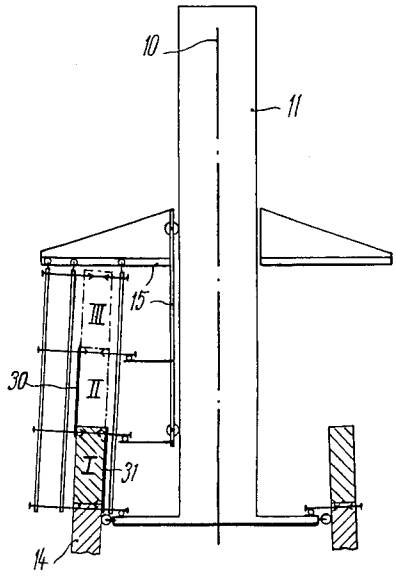


Fig. 9b

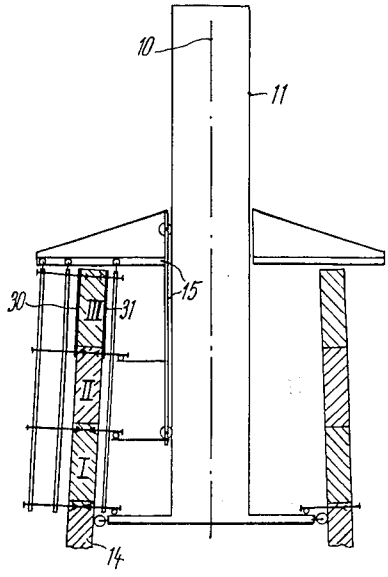


Fig. 9c

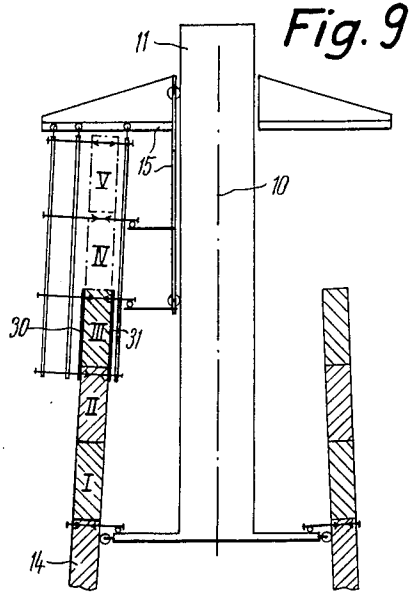
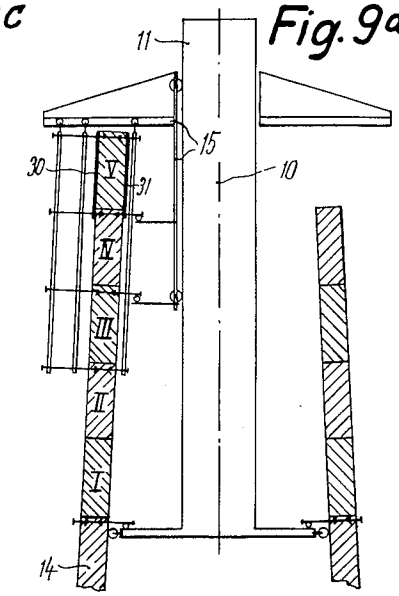


Fig. 9d



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United States Patent Office 3,252,199 Patented May 24, 1966

3,252,199

FORMWORK FOR ERECTING CONCRETE STRUCTURES

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Filed May 17, 1962, Ser. No. 195,473
Claims priority, application Germany, May 17, 1961, B 62,522
5 Claims. (Cl. 25—131)

This invention relates to a formwork for erecting towerlike structures of concrete, of any desired longitudinal and transverse sectional profiles, which formwork comprises a vertically extending central pole anchored on the completed part of the structure, and inner and outer formwork skins, both of which have a variable peripheral extent.

Such a formwork is known, which comprises a central pole, from which a carrying ring structure radially displaceably carrying the outer formwork skin is suspended by means of a jib arm and ropes.

In the known formwork, the inner formwork skin is not suspended from the carrying ring structure but is carried by a working platform provided on the completed part of the structure.

Where the known formwork is used, the operation of placing the concrete is performed by first moving the outer formwork by lifting tackles to the height section where the concrete is to be placed, whereafter the construction of the inner formwork skin is continued from the working platform, followed by placing the concrete.

Whereas the outer formwork skin is advantageously suspended in the known formwork so as to be vertically adjustable and radially displaceable, the inner formwork must be constructed piecemeal in the orthodox manner by the workers standing on the working platform; this is very troublesome and time-consuming.

To avoid the disadvantages of the known formwork for tower structures, the formwork of the type mentioned above is so constructed according to the invention that the central pole is surrounded by a slider which is vertically slidable on the pole and from which at least the inner formwork skin is suspended by suitable means so as to be radially displaceable and tiltable relative to the tower axis.

The outer formwork skin may be vertically adjustably suspended in a manner known per se from jib arms radially extending from the central pole and may be connected by spacers to the inner formwork skin.

In a particularly suitable embodiment, the formwork according to the invention comprises radially extending rails which are secured to the top end of the slider and from which the inner formwork skin and the outer formwork skin are suspended by suitable means so as to be radially displaceable and tiltable.

In the formwork according to the invention, the formwork skins may consist of overlapping sheet metal members. Alternatively, the formwork skins may be formed by the web portions of vertically extending channels, which are contiguous at their flanges, and the skins may consist of individual sections, the wedge-shaped or triangular gaps between the individual sections being spanned by a stressable cover plate.

If the formwork skins of the formwork according to the invention are composed of channels lying one beside

the other, with cover plates provided between the individual formwork skin sections, a preferred embodiment comprises adjustable power transmitting members which span the gaps in the outer formwork skin and in the inner formwork skin in such a manner that the annular tensile stress set up in the outer formwork skin and the annular compressive stress set up in the inner formwork skin when the concrete is being filled in are transmitted by these members from one formwork skin section to the next.

The method of erecting towerlike structures of concrete, of any desired longitudinal and transverse sectional profile, with the formwork according to the invention is characterized in that the inner and outer formwork skins are first pulled upwardly by a distance substantially corresponding to their height relative to the central pole, which is secured to the previously completed part of the structure, whereafter concrete is placed into the section concerned, followed by pulling the formwork skins upwardly to the next section, where they are adjusted to the new dimensions of the structure to be erected, and so forth, until the top end of the central pole is reached, whereafter at least the inner formwork skin is secured to the previously completed part of the structure, followed by releasing the central pole and pulling it upwardly along the slider to such an extent that the lower end of the central pole engages the lower edge of the formwork skins, whereafter the central pole is again secured to the concrete which has set, the formwork skins are released and pulled upwardly in height sections etc.

The advantages and details of the invention will become apparent from the following description of illustrative embodiments shown in the accompanying drawings, in which:

FIG. 1 is a vertical sectional view taken through the center line of a first embodiment of the formwork according to the invention, which is applied to a partly completed towerlike structure.

FIG. 2 is a sectional view taken on line II—II in FIG. 1, with the jib arms at the top end of the central pole being shown in dash lines.

FIG. 3 is a vertical sectional view similar to FIG. 1 and shows a second embodiment of the formwork according to the invention.

FIG. 4 is a view taken partly in vertical section on line IV—IV of FIG. 5, similar to FIGS. 1 and 3, and shows another embodiment of the formwork according to the invention, the slider being shown on the left of the figure on another level than on the right.

FIG. 4*a* is an enlarged view partly in vertical section on line IV*a*—IV*a* of FIG. 2.

FIG. 5 is a view partly in transverse section taken at right angles to the center line of the tower along the line V—V of FIG. 8 and shows the embodiment of the formwork illustrated in FIG. 4.

FIG. 6 is an enlarged view showing a portion of FIG. 5 (circle 3).

FIG. 6*a* is a sectional view taken on line VI*a*—VI*a* in FIG. 6.

FIG. 7 is an enlarged view showing another portion of FIG. 5 (circle 4).

FIG. 7*a* is a sectional view taken on line VII*a*—VII*a* in FIG. 7.

FIG. 8 is an elevation taken in the direction of the arrow

A in FIG. 4 and showing the formwork skins, the outer formwork skin being disposed in the upper third and the inner formwork skin in the middle third.

FIGS. 9*a*, *b*, *c* and *d* are a diagrammatical illustration of the method according to the invention.

According to FIG. 1, a central pole **111** is releasably secured to the top end of a previously partly completed structure **114** by radially extending carrying arms **112**. The central pole **111** may be a tube or, as shown in FIG. 4, consist of steel tubes welded together. Radially extending jib arms **119**, which are indicated with dash and dot lines in FIG. 2, are secured to the top end of the central pole **111**. An outer formwork skin **130** is vertically adjustably suspended from these jib arms in known manner by means of ropes, which can be wound on a winch **138**. Working platforms **136**, **137** and usual protective devices may be provided on the outer formwork skin.

The crux of the invention is constituted by a slider **115**, which surrounds the central pole **111** and just as the central pole **111** may consist of a tube or of steel tubes welded together. The slider **115** is secured to the central pole **111** so that the slider **115** is vertically displaceable relative to the central pole **111**. For this purpose, the slider **115** may be provided, e.g., with rollers **116**, which run on rails suitably arranged on the central pole **111**. It is obvious that any other sliding connection between the slider and the central pole may be provided.

An inner formwork skin **131** is suspended by radially adjustable means from the slider. The length-adjustable members consist, e.g., of radially extending screws **127** and diagonally extending stiffening screws **120**. The screws are articulated at one end to the slider and at the other end to a skeleton structure **129**, **132** serving to stiffen the inner formwork skin **131**.

The skeleton for stiffening the inner formwork skin **131** consists of substantially vertical posts **132** and annular channels **129**. An outer formwork skin **130** may be similarly stiffened by vertical posts **133** and annular channels **134**.

It is obvious that the curved annular channels must be re-bent and shortened at each new height section in which concrete is to be placed.

A working platform **135** is provided at the top end of the slider. It is obvious that working platforms may be provided at other points as may be required.

The placing of the concrete for the tower with the aid of the described formwork is performed as follows:

When the central pole **111** has been secured with carrying arms **112** to the top end of the previously completed part **114** of the structure, the winches **138** are operated to pull the outer formwork skin **130** upwardly into the next height section in which concrete is to be placed. The outer formwork skin is then adjusted to the dimensions of the tower which are desired in this height section. Before the inner formwork skin is caused to follow up, the iron reinforcements are introduced from the inside into the space to be filled with concrete.

Then the slider **115**, from which the inner formwork skin **131** is suspended by means of the screws **120**, **127**, is pulled upwardly by means of winches **117** and ropes **118** along the central pole **111** until the skin **131** is aligned with the outer formwork skin **130** and is thus disposed in the height section in which concrete is to be placed. The inner formwork skin **131** is adjusted to the changed dimensions of the tower by actuation of the screws **120**, **127** and by a change in the peripheral extent and replacement of the channels **129**.

It is apparent that the formwork skins in the formwork according to the invention cannot only be adjusted in a radial direction but may also be tilted relative to the center line **110** of the tower. This may be accomplished by a simultaneous actuation of the screws **127**. Hence, the formwork according to the invention is not only suitable for making towers having a straight generatrix (cylinder, cone) but also for making towers having a curved generatrix, e.g., in the form of a parabola. The vertical section of the formwork skins may nevertheless be a straight line in general because the curvature of the generatrix of the tower will be very small in most cases. Strictly speaking, the generatrix will not be a continuously curved line but a repeatedly broken line in these cases. For towers having a highly curved generatrix it is possible, of course, to use formwork skins which are curved in the vertical direction.

When the outer and inner formwork skins have been aligned and connected to each other by spacers **128**, the liquid concrete may be filled in after it has been lifted by a lift or elevator in the interior of the tower. When the concrete has set, the formwork skins remain temporarily in position. The carrying arms **112** of the central pole **111** are detached from the wall **114** of the structure. Then the central pole **111** is pulled upwardly by means of winches **117***a* and ropes **118***a* along the slider **115** anchored in the wall **114** of the structure until the carrying arms **112** are closely below the formwork skins **130**, **131**. Then the carrying arms **112** are again secured to the wall **114** of the structure, the formwork skins are detached and pulled upwardly in the manner described hereinbefore to the next height section in which concrete is to be placed.

Whereas this climbing operation of a formwork is known per se, it enables a very fast and economical erection of towerlike structures in conjunction with the formwork according to the invention.

It is suitable to construct below and up to the central pole **111** a frame structure **140**, which serves for accommodating a lift and stairs or ladders for the workers.

FIG. 3 is a vertical sectional view showing another embodiment of the formwork according to the invention. In this embodiment, two formwork skins **230**, **231** are suspended from a slider **215** by means of slide rails **222**. The suitably stiffened rail **222** is secured to the top end of the slider and extends radially. The two formwork skins **230**, **231** are radially displaceably suspended from the rail **222** by means of rollers **223**, **224**. The inner formwork skin is again radially supported by screws **227**, which are articulated at one end to the slider **215** and at the other end to substantially vertical posts **232**. The outer formwork skin is adjusted by means of spacers **228**. The formwork skins **230**, **231** are again stiffened by vertical posts **233**, **232** and **234**, **229**. As in the example shown in FIGS. 1 and 2, a central pole **211** is detachably secured by means of carrying arms **212** to the previously completed part **214** of the structure. In this embodiment, jib arms **219** extending to all sides from the center line **210** of the tower are provided at the top end of the central pole **211**. These arms may preferably carry a roof **236** protecting the structure being erected from the weather.

Frame structures **225** may be provided, if desired, which vertically depend from the outer ends of radial jib arms **219** and are secured by suitable means **226** to the wall **214** of the structure being erected. The frame **225** may carry working platforms or vertical rails, which may serve as tracks for rollers **237** at the outer ends of the slide rails **222**. This will further improve the guidance of the slider **215**.

The method of erecting towerlike structures with the embodiment of the formwork according to the invention shown in FIG. 3 is similar to the method performed with the formwork shown in FIG. 1. However, the inner formwork skin **231** and the outer formwork skin **230** are jointly pulled upwardly. The slider is pulled up along the central pole **211** by means of winches **217** and ropes **218** and the lifting of the central pole **211** along the fixed slider **215** is effected by winches **217***a*, on which ropes **218***a* are wound up.

Whereas it has been assumed that the tower has a circular cross-section in connection with the two embodiments described hereinbefore and with those to be de-

scribed hereinafter, it will be obvious that the cross-section could alternatively be oval or cornered. In this case, the radially extending parts and the form of the formwork skins will have to be selected accordingly whereas the basic structure of the formwork according to the invention and the method will not be changed.

In the third embodiment of the formwork according to the invention, shown in FIGS. 4 to 9, the entire formwork has hexadic symmetry. In the vertical sectional view shown in FIG. 4, a showing only on one side of the axis of symmetry **10** would be sufficient. To illustrate the method to be described hereinafter of erecting a tower with a formwork according to this embodiment, two different phases of the method are shown on the left and right of the tower axis **10**.

A central pole **11** of the formwork is anchored to the previously completed part **14** of the tower by spreader arms **12**, sleeves **13** welded to these arms, bolts **13***a* and spacers **28** embedded in the concrete. The arms **12** can be locked in position by levers **12***a*. A vertically slidable slider **15** surrounds the central pole **11**. Rollers **16** connect the central pole **11** to the slider **15** and radially locate the latter.

The slider **15** is provided at its top end with jib arms **22**, which are at right angles to the center line **10** of the tower and extend radially outwardly. The embodiment described comprises twelve of such jib arms, which are regularly angularly spaced (FIG. 5).

The jib arms **22** are stiffened by a grid structure **21** and formed as rails on their underside.

Below each jib arm **22**, the slider **15** is provided with two spreader arms **27**, **27***a*, which extend parallel to the respective jib arm and have a predetermined spacing with respect to the jib arm and to each other.

The slider **15** is suspended from ropes **18**, which are secured at one end to jib arms **19** carried by the central pole and at the other end to a winch **17** carried by the slider. The slider may be additionally connected to the jib arms **19** by means of ropes, holding rods or the like **18***b*.

Whereas the winches **17** serve to pull the slider **15** upwardly along the central pole **11**, further winches **17***a* are provided with which the pole can be pulled upwardly relative to the slider anchored on the previously completed part of the towerlike structure, when the anchoring means (**13***a*, **12***a*) of the pole have been released. As is shown in FIG. 4, the two winches **17**, **17** form suitably a unit.

Each of the raillike jib arms **22** carries three radially displaceable rollers **23'**, **24'** and **25'**, which can be fixed in position by suitable means and from which substantially vertically depending carrying rods **23**, **24** and **25** are suspended.

The innermost carrying rod **23** is articulated at two points to portions **27***a* of the two spreader arms so that this rod **23** can be adjusted to and fixed at a desired distance from and angle to the tower axis.

The two outer carrying rods **24**, **25**, which are radially displaceable and can be fixed in position, are connected by connecting tubes **26** to form a rigid frame. As contrasted with the carrying rod **23**, the two carrying rods **24**, **25** are not directly connected to the associated rollers **24'**, **25'**. Between each roller **24'** and **25'** and the associated carrying rod **24** or **25**, a screwed or telescopic connection **24''** or **25''** is provided so that the distance between the roller and the associated carrying rod can be decreased or increased. Operation of the two screwed or telescopic connections in mutually opposite senses will enable an adjustment of the fixed frame formed by the carrying rods **24**, **25** and the connecting tubes **26** to a desired angle with respect to the tower axis, and the fixation of the frame at this angle, just as has been described for the carrying rods **23**.

By means which will be described hereinafter, the inner formwork skin is suspended from the inner carrying rods **23** and the outer formwork skin is suspended from the frame **24**, **25**, **26**. By an adjustment of the rods **23**, **24**, **25**, the two formwork skins may be adjusted in each height section in which concrete is to be placed to the desired tower diameter, the desired wall thickness of the tower and the desired taper of the tower. When the carrying rods **23** and the frame **24**, **25**, **26** have been adjusted, they are firmly screw-connected by means of bolts **29** to the spacers **28** between the two formwork skins **30**, **31** so that the formwork skins are held in position by an extremely rigid and strong structure. Whereas the bolts **29** of the outer formwork skin **30** extend through the tubes **26**, the bolts **29** of the inner formwork skin **31** extend through sleeves **27***b* articulated to the spreader arms **27***a*.

With reference to FIGS. 5 to 8, the structure of the formwork skin and its fixation to the previously described structure will be explained hereinafter.

According to FIGS. 5 to 8, an inner formwork skin **31** and an outer formwork skin **30** are provided, which consist in known manner of substantially vertical channels **34**, a certain number of which, e.g., thirty-nine in the outer formwork skin **30** and thirty-three in the inner formwork skin **31**, are firmly contiguous with each other at their narrow sides and are screwed or welded together to form formwork skin sections.

In the embodiment shown in FIG. 5, each of these sections extends over an angle of 60° so that the outer and inner formwork skins are composed of six of such sections each. The angular extent of each section will obviously depend on the dimensions of the structure to be erected and the value of 60° has been selected only as an example.

The central channel (the twentieth in the sections of the outer formwork skin and the seventeenth in the sections of the inner formwork skin as shown in FIG. 5) has a larger width than the other channels **34**, preferably twice the width thereof. This central channel **34***a* or **34***b* shown particularly in FIG. 7 is suitably not screw-connected but welded to the adjacent narrower channels **34**.

According to FIGS. 5 and 7, the flanges of the central channel **34***a* of each section of the outer formwork skin **30** extend over vertical guide rails **44**, which consist preferably of a plate formed into a hollow T. The rails are not fixed but have a certain freedom of movement behind the flanges of the channel **34***a* to permit of a slight curvature of the formwork skin surface corresponding to the curvature of the tower. A web portion **44***a* of the hollow T is welded throughout its length to the carrying rod **24**. Hence, the position of the inner formwork skin **31** is determined by the adjustment of the frame **24**, **25**, **26**. The guide devices are generally indicated at **36** in the drawing.

In each section of the inner formwork skin **31**, rails **44'** consisting of sheet metal formed into a hollow T are provided on the central channel **34***b* and have a web portion **44***a'* which is welded throughout its length to the carrying rod **23**. Hence, the position of the inner formwork skin **31** is determined by the adjustment of the carrying rod **23**. The guide devices for the inner formwork skin are generally indicated at **36'**.

A vertical displacement of the formwork skin is prevented by bolts **29**, which extend through connecting rods **26**, sleeves **27***a* articulated to the spreader arms and holes in the central channels **34***a* and **34***b* and in the formwork skins **30** and **31** into screw-threaded spacers **28**. The spacers **28** are provided with anchoring parts **28***a* because they are to remain in the concrete when the structure has been completed and serve for the fixation, e.g., of antennas or other means to the tower.

Hence, the bolts **29** perform a threefold function: They connect the frame **24**, **25**, **26** to the carrying rod **23**, hold the spacer **28** in position and locate the formwork skins in the vertical direction.

The formwork skins **30**, **31** are connected by ropes to winches **33** and **32**, respectively, shown in FIG. 4, and can thus be pulled upwardly when the bolts **29** have been removed.

The above-described subdivision of the annular form-

work skins into individual sections enables an adjustment to the tower dimensions, e.g., to the peripheral extent, wall thickness and taper of the tower, which change as the height increases. In general, the peripheral extent and the inclination relative to the axis **10** must be reduced and the curvature of the formwork skins must be increased as the height increases.

Whereas the curvature of the formwork skins can be readily varied within wide limits if the thickness of the material of the channels **34** has been properly selected, special measures must be taken to adjust the peripheral extent and the inclination of the formwork skins.

This adjustment is suitably enabled by leaving between two adjacent formwork skin sections a gap **34***c* (FIG. 6), which will be generally wedge-shaped or triangular in a conical tower. The gap **34***c* is covered by a plate **41**, which has the same length in the vertical direction as the rails **44**, **44'**. The plates **41** have a bracket **41***a* or **41***a'* welded to them, the width of which is exactly equal to the length of the flanges of the channels **34**. The brackets **41***a*, **41***a'* are firmly welded to the carrying rods **24** and **23**, respectively, at regularly spaced points **50**, **50'** by welded tubes **35***a* and **35***a'*. The tubes **35***a*, **35***a'* form preferably extensions of the tubes **26** and of the sleeves **27***b*, respectively.

Tightening devices **35**, **35'** according to the invention for transmitting the annular tensile stress set up in the outer formwork skin **30** and the annular compressive stress set up in the inner formwork skin **31** during the filling of the concrete between the formwork skins are provided between adjacent formwork skin sections at a plurality of points spaced along the brackets **41***a*, **41***a'* (FIGS. 4*a* and 8). The annular tensile and compressive stresses are set up because the concrete introduced between the formwork skins tends to urge the outer formwork skin outwardly and the inner formwork skin inwardly.

The devices **35**, **35'** consist of a ring tightening rail **38** or **38'**, which bears on the flanges of the channels of two adjacent formwork skin sections and on which two clamping riders **37** or **37'** are tangentially displaceable, which can be locked in position by levers **39**, **39'**.

The two clamping riders **37** on an outer ring tightening rail **38** have offset ends **40** facing each other and extending behind the channel flanges disposed at the end of each formwork skin section.

In the inner formwork skin **31**, the clamping riders **37'** are provided in an inverted arrangement. The offset ends **40'** of the clamping riders **37'** are oppositely directed and extend behind those ends of the two channels at the end of two formwork skin sections which are remote from the gap **34***c*.

The ring tightening rails are preferably slightly curved in accordance with the mean curvature of the tower.

Wing screws **42**, **42'** extend through holes in the ring tightening rails **38**, **38'**, in the brackets **41***a*, **41***a'* and in the cover plates **41** into screw-threaded openings in a spacer **28**. Tightening the wing screws **42**, **42'** will perfectly align the two sections of the formwork skin **30** or **31**, the cover plates **41**, **41'** and the ring tightening rails **38**, **38'**. The brackets **41***a*, **41***a'* will then firmly bear on the ring tightening rails **38**, **38'**.

The adjustment of the carrying frames (**23**, **24**, **25**, **26**) at the position of the tightening devices **35**, **35'** and at the positions **50**, **50'** is effected as described hereinbefore in connection with the positions of the sliding guide devices **36**, **36'**.

Being adjustable, the tightening devices **35**, **35'** can take up the annular tensile and compressive stresses set up when the concrete is being filled on any level so that the need for the stiffening members previously required is eliminated and the formwork skins are virtually self-supporting.

The tightening devices **35**, **35'** and the guide devices **36**, **36'** are arranged in alternation with a certain angular spacing on the periphery of the towerlike structure to be erected. In the embodiment shown in FIG. 5, the angular spacing between the tightening devices **35**, **35'** and the sliding guide devices **36**, **36'** is 30° whereas the spacing of two successive similar devices is 60°. As a result, the embodiment described comprises six tightening devices and six guide devices. The number of the tightening and guiding devices provided on the periphery of a climbing formwork according to the invention will obviously depend entirely on the diameter and peripheral extent of the towerlike structure to be erected.

When the erection of the tower has proceeded to a stage in which the gaps **34***c* are approximately equal to the length of the brackets **41***a*, **41***a'*, one or more of the screw-connected channels are removed to increase the gaps **34***c* to a desired size, whereafter they will again be progressively decreased.

When the bolts **29** and the locking levers **39**, **39'** have been released and pulled out, the formwork skin described will automatically adjust itself to the wall thickness, peripheral extent and conicity of the structure to be erected while the formwork skin is being pulled upwardly; these dimensions are determined by the carrying frames **23**, **24**, **25**, **26**. As has been mentioned, it is not necessary to rebend or cut off any parts but it is sufficient to release and resecure bolts and screws.

According to FIG. 6, the carrying rods **23**, **24** on the level of the tightening devices **35**, **35'** may be somewhat more widely spaced from the formwork skins to leave room for the wing screws **42**.

A particularly suitable method of manufacturing a towerlike structure with the above-described climbing formwork according to the invention is performed as follows:

The tower is constructed by placing concrete in height sections according to FIGS. 4 and 9*a* to *d*. A height section which corresponds approximately to the height of the formwork skin will be called a height subsection.

That section in which concrete can be placed without pulling the slider **15** will be referred to as a height subsection group. In the present embodiment it consists of two subsections but may be composed of three and more subsections depending on the prevailing conditions.

The method according to the invention is commenced by anchoring the central pole in the foundation or in a previously completed subsection I. The slider **15** is in its lowermost position, shown on the left in FIG. 4 and in FIG. 9*a*.

Now the carrying frames **24**, **25**, **26** and the carrying rod **23** are adjusted to the desired wall thickness, the desired peripheral extent and the desired taper of the structure in the respective height as has been described hereinbefore. This adjustment is locked by the locking means **22***a* and by clips **27***c* and the spreader arms **27**. The outer one of the formwork skins still disposed in the subsection I is now pulled upwardly by operation of the winches **33** when the corresponding bolts **29** have been removed and the clamping riders **37** have been released by actuation of the levers **39** (FIG. 6).

The slide rails **44**, **44'** and the cover plates **41** have a height corresponding to the length of about three subsections. By the frames **23**, **24**, **25**, **26** they are exactly aligned so that the upwardly sliding formwork-skin is exactly guided and need only be fixed by means of the bolts **29**, spacers **28**, clamping riders **37**, **37'** and wing screws **42**, **42'** in the new subsection II in which concrete is to be placed.

Before the inner formwork skin is caused to follow up by operation of the winches **32**, the method according to the invention calls for intrducing the reinforcement **51** into the space between the formwork skins from the inside. The reinforcement need not be introduced from above, as with known formwork, but may conveniently be brought into position from the inside.

When this has been done, the inner formwork skin is caused to follow up and concrete is placed in section II. When the concrete has set, the same procedure is repeated with respect to the subsection II in which concrete is to be placed (FIG. 9*b*). When the concrete has set also in this section and a subsection group has thus been completed, the slider **15** is pulled upwardly by one or more subsections, preferably by a subsection group.

Only now is it necessary to adjust the carrying structures **23, 24, 25, 26** to the tower dimensions desired in this section of the tower (FIGS. 4 and 9*a*). It may be necessary to remove some of the screw-connected channels, as has been mentioned hereinbefore, if the wedge-shaped or triangular gap **34***c* available at the tightening devices **35, 35'** has been used up.

When the adjustment has been effected, the method is continued as in the first subsection group (II, III) until the last subsection V has been completed (FIG. 9*d*). When the slider **15** has reached the top end of the central pole **11**, the latter is suspended by means of the ropes **18***a* and the winches **17***a* from the slider **15**, which is anchored in the previously completed part of the towerlike structure. Then the anchoring means at **13** and the locking means **12***a* are released and the winches **17***a* are operated to pull the central pole upwardly until it assumes the position shown on the left in FIG. 1 relative to the slider.

The method is now continued as has been described hereinbefore.

All parts of the climbing formwork are made from hollow material to reduce the weight as far as possible. The height corresponding to five height subsections in which concrete is to be placed has also been selected to ensure that the weight of the climbing formwork will be so light that the formwork may even be used for high and very high structures. The height may obviously be larger or smaller, as may be required.

The formwork skins **30, 31** shown in FIGS. 6 and 7 are straight. This would apply to polygonal structures. In the present case, the formwork skin is actually slightly curved.

The adjustment of the angle of the outer formwork skin relative to the tower axis may be effected by means other than the screwed or telescopic connections **24'', 25''**. For instance, the rod **25** may be exactly parallel to the center line **10** whereas the rod **24** is slidably mounted on the connecting tubes **26** for adjustment to the correct angle. It will be apparent that the rod **24** must be clamped fast on the connecting tubes **26** by suitable means after the adjustment has been made.

It will be understood that the method according to the invention could alternatively be carried out by pulling upwardly the inner formwork skin first and the outer formwork skin thereafter. This will be desirable if the working platforms and lifts or elevators for materials are disposed on the outside of the tower on the connecting tubes **26**.

Besides, the brackets **41***a*, **41***a'* (FIG. 6) may extend as far as to the tubes **24** or **23** and be welded there. In that case, the tubes **35***a* may be omitted. In this case, however, the brackets **41***a*, **41***a'* will have to be formed with recesses on the level of the tightening devices **35, 35'** to ensure the passage of the ring tightening rails **38, 38'** and the free movement of the wing screws **42, 42'**.

The wing screws may be replaced by other screws requiring less space. The use of wing screws is recommended, however, because they will enable an adjustment of the formwork skins without need for tools.

Whereas formwork according to the first two embodiments is particularly suitable for the erection of towers having a more highly curved generatrix, the formwork described last can be successfully employed for cylindrical or conical structures or for structures having only a slightly curved generatrix.

It will be understood that the structure of the formwork skins explained with reference to the third embodiment may also be used in the first two embodiments.

What is claimed is:

1. A framework for erecting a tower-like concrete structure of circular, oval or cornered cross-section, having a straight or curved generatrix, said formwork being successively elevated in increments as the structure is erected and comprising, in combination:

(a) a vertically extending, hollow central pole having a plurality of radially extending jib-arms fixedly connected to its upper end and radially extending adjustable arms fixedly connected to its lower end, said adjustable arms being securable to the upper part of the previously completed portion of the structure, below said formwork, for supporting the same;

(b) a hollow slider slidably disposed about said pole and having radially extending adjustable arms connected to the formwork skin assembly defined hereinafter;

(c) elevating means carried by said slider and operatively engaged with the opposite ends of said pole for lifting the slider relative to the pole, and for lifting the pole relative to the slider; and

(d) a formwork skin assembly comprising connected inner and outer formwork skins, each of which is supported by one of said pole and said slider and includes a plurality of skin sections, each of said skin sections comprising:

(1) a plurality of channels disposed one beside the other, adjacent ones of said sections defining gaps bridged by cover plates;

(2) a first set of adjustable power transmitting members bridging said gaps in said outer formwork skin and adapted to transmit annular tensile stresses between adjacent sections of said outer formwork skin, and

(3) a second set of adjustable power transmitting members bridging said gaps in said inner formwork skin and adapted to transmit annular compressive stresses between adjacent sections of said inner formwork skin;

each of said power transmitting members comprising a ring tightening rail, two clamping riders displaceably carried by said ring tightening rail, and levers for locking said riders in position on said ring tightening rail.

2. A formwork as set forth in claim **1**, in which said clamping riders have end portions offset at right angles.

3. A formwork as set forth in claim **2**, in which said end portions of the clamping riders of said power transmitting members of said outer formwork skin extend horizontally toward each other to engage said formwork skin sections and prevent an increase of the peripheral extent of the outer formwork skin.

4. A formwork as set forth in claim **2**, in which said end portions of the clamping riders of said power transmitting members of said inner formwork skin extend horizontally away from each other to engage said formwork skin sections and prevent a decrease of the peripheral extent of the inner formwork skin.

5. A formwork as set forth in claim **1**, in which said ring tightening rail of said inner formwork skin is radially in alignment with a ring tightening rail of said outer formwork skin and which comprises a plurality of spacers, each of which extends radially between a ring tightening rail of said inner formwork skin and a ring tightening rail of said outer formwork skin in radial alignment therewith, said spacers being formed with tapped bores at opposite ends, said cover plates and ring tightening rails being formed with bores in radial alignment with said tapped bores, and screws being provided which extend through said bores in said cover plates and ring tightening rails into said tapped bores to determine the spacing of said formwork skins and to position said cover plates.

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