United States Patent

[11] 3,619,432

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[45] Patented **Nov. 9, 1971**

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a part interest

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[54] **METHOD AND APPARATUS FOR CONSTRUCTION OF CONCRETE SHELLS**
10 Claims, 13 Drawing Figs.

[52] **U.S. Cl.** **264/32,** 249/20, 249/65, 264/33, 264/34, 264/314
[51] **Int. Cl.** **B28b 7/32,** E04g 11/04
[50] **Field of Search** ..... 264/32–35, 314; 249/11, 65, 20; 25/131.6, 128 D, 131.5 D; 52/677, 686

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ABSTRACT: A method of constructing a concrete shell, employing a form assembly comprising a rigid structural frame with an inflatable fabric form mounted on the frame, the frame having a configuration generally conforming to one segment of the concrete shell. The form assembly is aligned with a portion of a building foundation structure and is inflated; metal reinforcements are then positioned on the external surface of the form. Concrete is deposited over the form and allowed to set, after which the form is deflated and the form assembly moved to a new position adjacent the completed shell segment for construction of the next segment of the shell. Small precast concrete chair members, used to support the metal reinforcement of the fabric form, become a part of the completed shell.

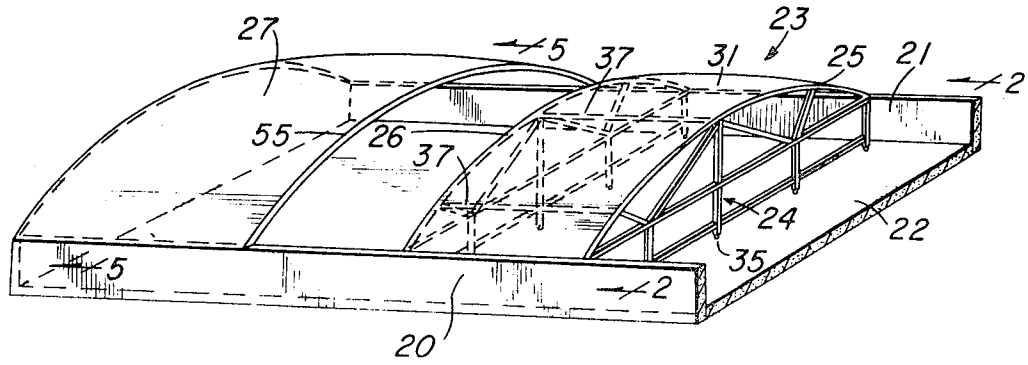


FIG. 1

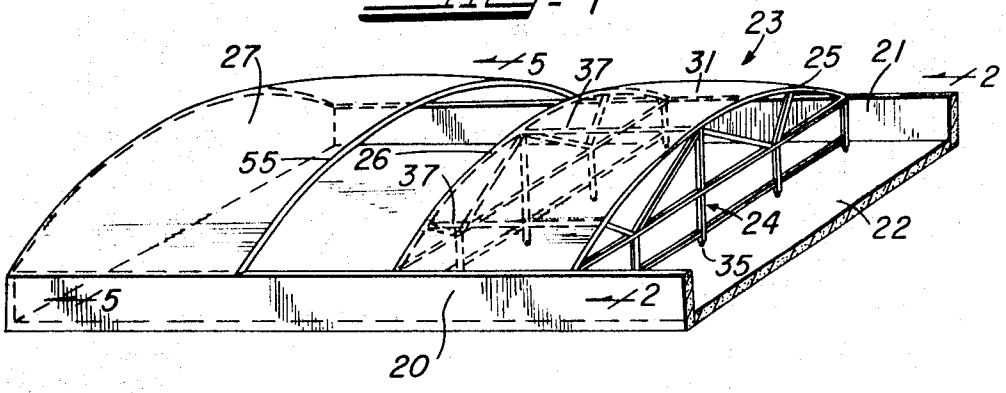


FIG. 2

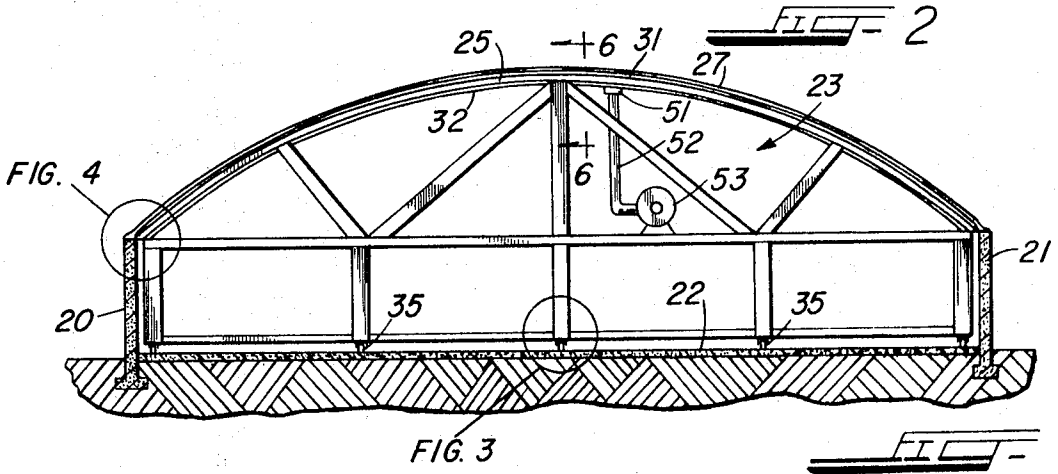


FIG. 3

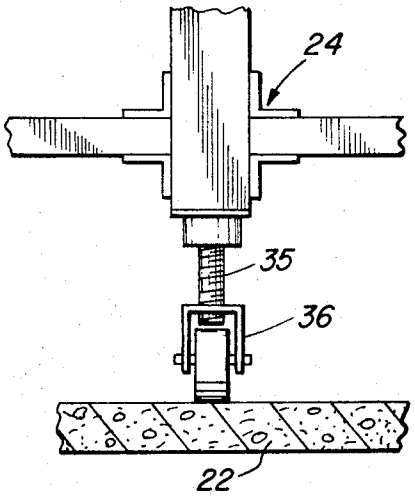
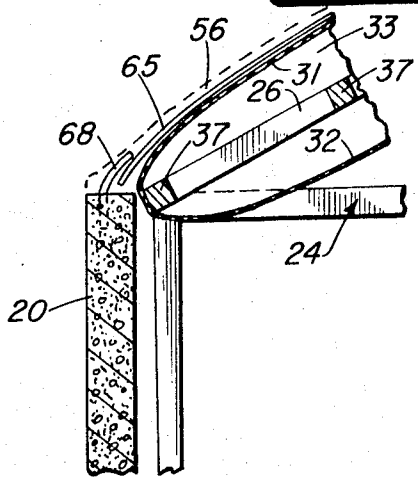


FIG. 4



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FIG. 5

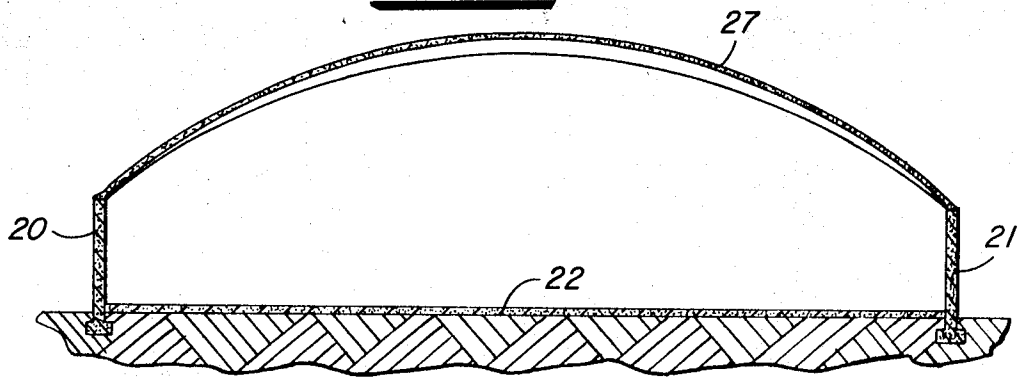


FIG. 6

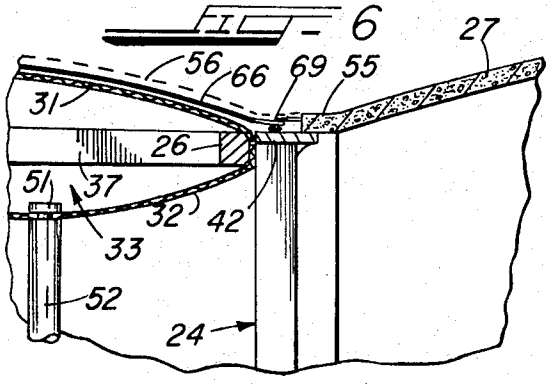


FIG. 7

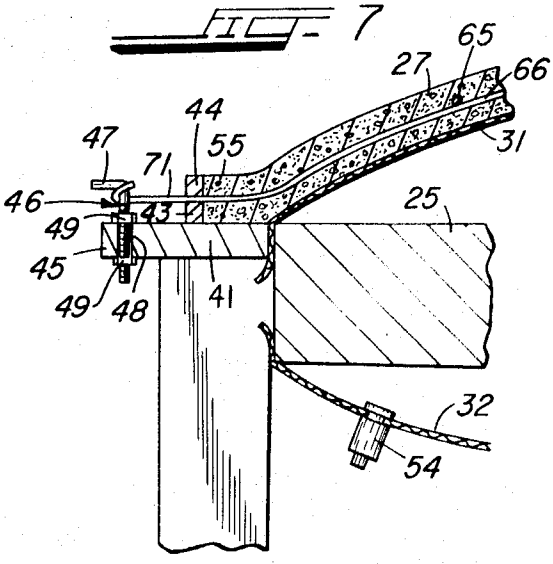


FIG. 9

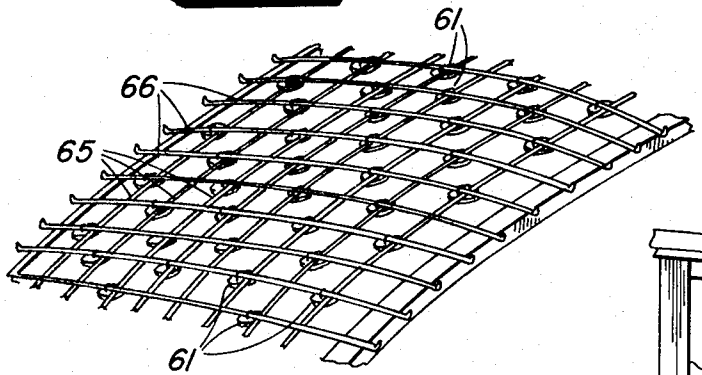


FIG. 7A

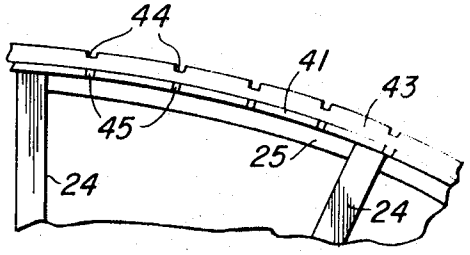
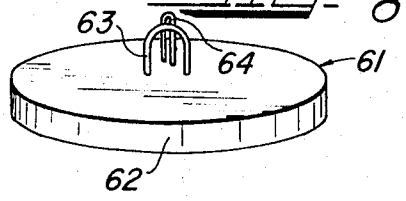


FIG. 8



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FIG- 10

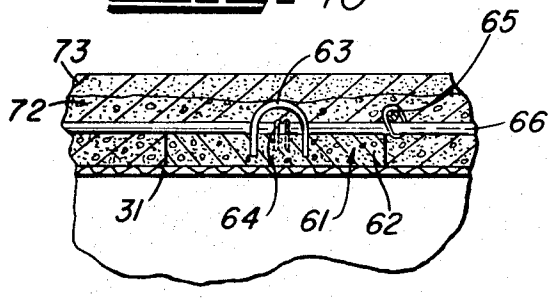


FIG- 11

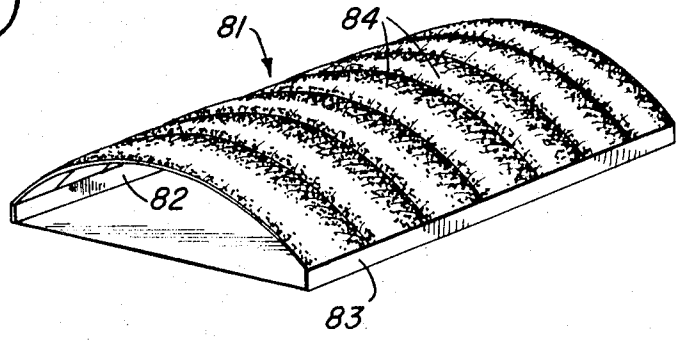


FIG- 12

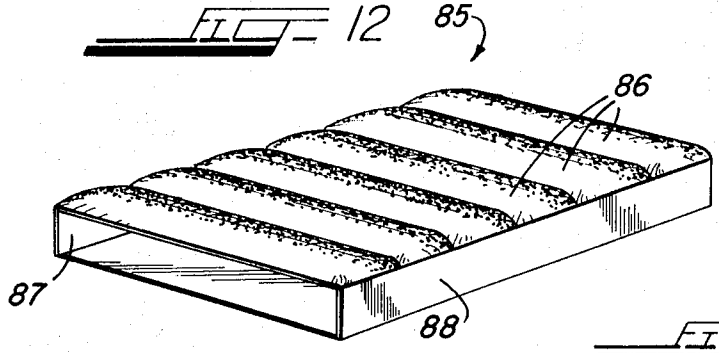
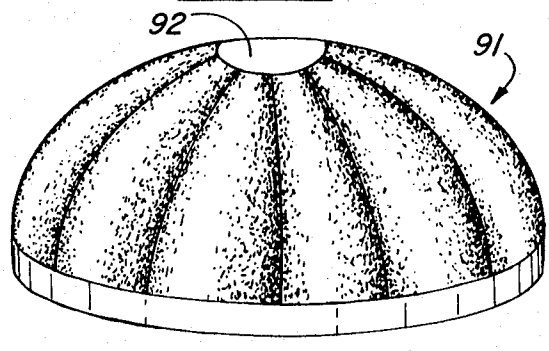


FIG- 13



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METHOD AND APPARATUS FOR CONSTRUCTION OF CONCRETE SHELLS

BACKGROUND OF THE INVENTION

Concrete shells have been in use for many years. A substantial body of technical literature on stress analysis and design data is available on structures of this kind and many concrete shell buildings have been erected, primarily in Europe and Latin America. Comprehensive design data for concrete shells is available from the Portland Cement Association.

Most concrete shells, as heretofore erected, have employed forms constructed of conventional rigid materials including wood and steel. The labor requirements for fabrication and erection of such forms are usually quite extensive, due to the cutting and fitting necessary to obtain the compound curved configurations characteristic of most shell structures. Another technique that has been successfully employed has been to utilize a comprehensive fabric form for the complete shell, the form being inflated to afford a continuous cover for the building structure. In that technique, the concrete is applied to the surface of the inflated fabric form, preferably the internal surface of the form, as disclosed in detail in Pat. No. 3,118,010 to Horrall Harrington issued Jan. 14, 1964.

For many applications shells have been unduly expensive due to the high labor requirements for erection of the conventional forms. On the other hand, the inflated fabric form as heretofore known is limited in the size and number of building configurations to which it may be applied. Moreover, tailoring of a complete fabric form for a full shell may itself involve relatively high expense, in some instances, particularly with large buildings.

SUMMARY OF THE INVENTION

It is a principal object of the present invention to provide a new and improved method for erection of concrete shell buildings employing relatively inexpensive inflatable fabric forms that can be used repeatedly to construct a multiple-segment shell structure.

A further object of the invention is to provide a new and improved form assembly, including an inflatable fabric form, that can be rapidly shifted from one position to another in forming a series of concrete shell segments constituting a complete shell structure.

A further object of the invention is to provide a novel method and an improved apparatus, for formation of a multiple-segment concrete shell, that are adaptable to a wide variety of building shapes and configurations and that produce practical, integrated multisegment shell structures.

Accordingly, the invention relates to a method erecting the concrete shell for a building comprising a foundation structure defining a building space and a concrete shell covering that space. The steps of the method comprise positioning a form assembly within the building space, in alignment with a portion of the foundation structure, the form assembly including a rigid structural frame and an inflatable fabric form mounted on the frame. The fabric form is inflated and metal reinforcing members are positioned on the external surface of the inflated form. At least one layer of concrete is then deposited on the external surface of the inflated form, that concrete layer also extending over the adjacent portion of the foundation structure; the concrete is allowed to set to form a first segment of the concrete shell. When the first segment has set, the fabric form is deflated to release it from the shell segment and the form assembly is moved to a new position adjacent the completed segment. The foregoing steps are then repeated until the complete multisegment shell is formed, covering the building space.

The apparatus of the invention is a form assembly for use in the fabrication of a multisegment concrete building shell. The form assembly comprises a rigid structural frame having spaced form-supporting members each conforming to the required configuration for an edge portion of one segment of the concrete shell. A two-layer fabric form is included in the assembly and extends between the form-supporting members of the frame, affording a substantially airtight chamber between the two fabric layers. The form assembly further includes means for introducing air under pressure into the chamber between the fabric layers to distend the fabric form into the required configuration for forming one segment of the concrete shell by application of concrete to the external surface of the fabric form.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of a portion of a partially completed building incorporating a concrete shell erected in accordance with the method of the present invention and illustrates a form assembly constructed in accordance with the invention;

FIG. 2 is a sectional elevation view taken approximately along line 2–2 in FIG. 1;

FIG. 3 is a detail view of a part of the form assembly as indicated by the encircled portion 3 in FIG. 2;

FIG. 4 is a detail sectional view of a part of the form assembly generally corresponding to the portion encompassed by the circle 4 in FIG. 2;

FIG. 5 is a sectional elevation view taken approximately along line 5–5 in FIG. 1;

FIG. 6 is a detail sectional view taken approximately as indicated by line 6–6 in FIG. 2;

FIG. 7 is a detail sectional view illustrating the end mounting of reinforcing bars in one edge of the form assembly;

FIG. 7A is a detail view of a limited portion of one edge of the form assembly;

FIG. 8 is a detail perspective view of a chair employed to mount the reinforcing bars on the form;

FIG. 9 is a detail view generally illustrating the mounting of reinforcing bars on the fabric form prior to depositing concrete on the form;

FIG. 10 is a detail sectional view showing one chair and the associated reinforcing bars in a completed segment of the concrete shell immediately prior to removal of the form; and

FIGS. 11, 12 and 13 are perspective views of some of the different building configurations that can be erected using the method and apparatus of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

In utilizing the method and apparatus of the present invention in the erection of a concrete shell building, it is first necessary to erect a foundation structure that will define the building space to be covered by the concrete shell. The concrete shell can start from ground level, in which case the foundation structure may include simple footings. In most applications, however, it is desirable to have vertical walls or a plurality of columns around the periphery of the building, requiring a foundation structure that extends above ground level.

For a generally rectangular building having vertical side and end walls, the basic foundation structure may be as illustrated in FIG. 1, comprising two side walls 20 and 21. Walls 20 and 21 may be of any conventional structural material, including concrete, steel, or wood, so long as they have adequate strength for supporting the concrete shell that is to cover the building. Walls 20 and 21 may be supported upon suitable footings below the ground surface, as illustrated in FIGS. 2 and 5. A floor 22 extending between walls 20 and 21 may be formed before the shell is constructed, as a part of the foundation structure. On the other hand, floor 22 may be constructed after the shell has been completed. In the building shown in the process of erection in FIG. 1, no end walls between the side walls 20 and 21 have as yet been erected; the construction of the end walls for the building is preferably deferred until after erection of the shell.

In the erection of the concrete shell for the building, a form assembly 23 is employed. Form assembly 23 comprises a rigid structural frame 24 having two spaced form-supporting mem-

bers 25 and 26. For the particular building shown under erection in FIG. 1, the form-supporting members 25 and 26 of the frame 24 are of arcuate configuration conforming to the required configuration for the edge portions of each segment of the concrete shell that is to constitute the building roof. One such concrete shell segment 27 has a already been completed, in the building illustrated in FIG. 1. The form-supporting members 25 and 26 may be formed of steel, laminated wood, or any other suitable structural material affording sufficient strength to hold the shape of a fabric form as described more fully hereinafter.

Form assembly 23 further comprises a fabric form that extends between the two form-supporting members 25 and 26 of frame 24. As shown in FIGS. 4 and 6, the fabric form comprises an upper fabric layer 31 and a lower fabric layer 32. The two fabric layers are mounted on the frame of the form assembly in a manner such that they afford a substantially airtight chamber 33 between the 2 layers. It is not essential that an absolutely airtight chamber be provided and, in fact, pressure venting may be desirable to facilitate maintenance of a constant pressure within chamber 33 during use of the form. Furthermore, small tears or other holes in either of the fabric layers can be tolerated by providing an adequate supply of air.

In the building under construction that is illustrated in FIG. 1, the two side walls 20 and 21 are parallel to each other. The frame 24 of form assembly 23 extends across the space between the two building walls and the fabric form 31, 32 spans the entire space between the two form-supporting members 25 and 26 of the frame. Thus, the frame assembly spans a complete segment of the building between the two walls 20 and 21 and extends into close conjunction with the walls as shown in FIG. 4.

The frame 24 of the form assembly 23 is mounted upon a series of jacks 35. The jacks 35 may be of conventional construction; one of these jacks is illustrated generally in FIG. 3. Screw-type jacks may be utilized, as shown in FIG. 3; on the other hand, individual hydraulic jacks or other comparable known devices can be employed as desired. Preferably, each of the jacks 35 is mounted upon a supporting wheel 36 to provide for convenient movement of the form assembly in the course of erection of the concrete shell.

To afford adequate rigidity for frame 24, a plurality of horizontal struts 37 are incorporated in the frame between the two form-supporting members 25 and 26, two such struts 37 being shown in FIG. 1. The number of struts required is determined by the overall size of the form assembly and the tension forces created in the fabric form 31, 32 which tend to pull the form-supporting members 25 and 26 toward each other when the fabric form is inflated. As shown in FIG. 4, the struts 37 may be located between the two fabric layers and do not interfere with or alter the configuration of the fabric form when it is inflated.

As shown in FIG. 6, the form-supporting member 26 is provided with a shelflike extension 42 that projects outwardly beyond the fabric form 31, 32. A similar construction is provided for the opposed form-supporting member 25, which carries a form extension 41. THe form extensions 41 and 42 are illustrated as separate structural elements but they can be formed integrally with the main form-supporting member 25 and 26.

The form extension member 41 on member 25 has mounted upon it an upwardly projecting edge form member 43. Member 43 has a plurality of slots 44 formed therein at spaced intervals as shown in FIGS. 7 and 7A. Furthermore, the outwardly projecting portion of form extension member 41 includes a series of slots 45 that are individually aligned with respective ones of the slots 44. A releasable clip 46 is mounted in each of the slots 45. A simple clip structure, illustrated in FIG. 7, may comprise a hook-shaped bar 47 having a threaded portion 48 that can be releasably secured in the slot 45 of the form extension 41 by suitable means such as a pair of nuts 49.

Form assembly 23 also includes means for introducing air under pressure into the chamber 33 formed by the two fabric layers 31 and 32 that constitute the fabric portion of the form. This air pressure means may comprise a simple hose connection 51 mounted in the lower fabric member 32 and connected to a hose 52 that in turn extends to a blower 53. Only a relatively small blower is required and commercially available centrifugal blowers are adequate for use as blower 53. In most applications, a five to ten horsepower centrifugal blower is adequate to maintain the appropriate pressure for inflation of the form. One or more individual relief valves 54 (FIG. 7) or other pressure control valves may be incorporated in the lower layer 32 of the fabric form to provide a means for maintaining a uniform pressure within the fabric form when it is inflated.

In considering the basic method of the invention, in the erection of a segmented concrete shell, a starting point may be taken from the position of the form assembly shown in FIG. 1. From the illustrated position, the form assembly is moved into alignment with the already completed shell segment 27. This movement is accomplished with the frame of the form assembly lowered, by means of the jacks 35, so that there is a clearance of at least 1 or 2 inches below the projecting edge 55 of shell segment 27. Moreover, the movement of the form assembly into position is preferably accomplished with the form deflated.

With the form assembly approximately aligned with the edge 55 of shell segment 27, the form assembly frame is jacked up by means of the jacks 35 until the form extension 42 is in approximate engagement with the extending lip 55 on shell segment 27, as shown in FIG. 6. It is thus seen that the shelflike form extension 42 provides for the completion of a transition section between the edges of the two adjacent segments of the concrete shell. The jacks for the form assembly are also adjusted so that the ends of the form assembly are closely aligned with the tops of the adjacent foundation structure walls 20 and 21. This relationship is best shown in FIG. 4 with respect to wall 20.

When form assembly 23 is aligned with the previously completed shell segment 27 and is also aligned with the portion of the foundation structure (walls 20 and 21) that is to be spanned by the next shell segment, the form assembly is blocked in position by any appropriate means. Blower 53 is then actuated to force air under pressure into the chamber 33 intermediate fabric layers 31 and 32, inflating the fabric form to the condition illustrated in FIGS. 4, 6 and 7.

Once the fabric form is inflated, it is time to position appropriate metal reinforcing members on the external surface of the form. The preferred technique for mounting the reinforcing members on the form and for interlocking those reinforcing members with the previously formed shell segment 27 and with the walls of the foundation structure is described more fully hereinafter. Once the metal reinforcing members are in place on and supported by the inflated fabric form, a layer of concrete is deposited on the external surface of the fabric form, covering the reinforcing members. This concrete layer extends over the top of the adjacent walls of the foundation structure, as indicated by the dash line 56 in FIGS. 4 and 6. Furthermore, the concrete extends across both of the form extensions 41 and 42 at the edges of the inflated fabric form. Wet mix pneumatic application is most effective for depositing the concrete although, with proper care to avoid damage to the fabric, conventional crane and bucket application can be used. Even on steeply sloped, nearly vertical, surfaces, pneumatic placement is possible by application in layers not exceeding 1 inch in thickness. For more nearly horizontal surfaces, as shown in FIGS. 1, 2 and 5, thicker layers may be employed.

A relatively small concrete pump is adequate, for most applications, because most concrete shells are only approximately 2½ to 3½ inches thick. Placement rates of 6 to 12-cubic yards per hour are adequate to produce a reasonable rate of shell deposition.

For thin shells not requiring a fine surface finish, the complete shell could be deposited in a single operation.

Usually, however, it is preferable to deposit the concrete for the shell in two layers, a first thick layer that forms the main body of the shell and a final thin layer that constitutes a finished surface. A typical and suitable concrete mix may utilize six bags of cement for each yard, with pea gravel as the coarse aggregate and with a water reducing agent to give a low water/cement ratio and a slump of 3 to 4 inches. A mix of this nature will afford a rapid set without requiring the use of high-early cement. For winter conditions, some calcium chloride or other additives for accelerating setting without freezing may be used. Concrete mixes of this general type are ordinarily available from ready-mix suppliers so that on-site mixing is seldom needed.

Once the concrete has set, the shell segment is complete and it is time to move the form assembly into position for the next shell segment. To this end, the fabric form is deflated to release the upper fabric layer **31** from the concrete. This can be most effectively accomplished by changing the connection to the blower **53** and using the blower to exhaust the chamber, affording a relatively small vacuum within the chamber to assist in separation of the fabric from the concrete of the shell. The jacks **35** are then used to lower form assembly **23** enough to assure clearance from the shell segment that has just been formed and the form assembly is rolled out from under the completed shell segment. It is then ready to be aligned with the leading edge of the completed shell segment and the steps set forth above are repeated to form the next shell segment.

For reinforcement of the concrete shell, conventional reinforcing bars or prefabricated metal mesh are usually suitable. The low stresses characteristic of most concrete shells permit the use of relatively light reinforcement. No. 3 bars at nine inch spacing in each direction is a typical arrangement affording adequate reinforcement for the shell. Heavier bars, with greater spacing, can be utilized if desired. Furthermore, a prefabricated metal wire or rod mesh is quite suitable in many applications.

The fabric form renders the use of conventional metal chairs undesirable. Furthermore, chairs and similar members cannot be nailed to the fabric form. Nevertheless, it is necessary to maintain the metal reinforcements in position during pouring of the concrete and to afford some means for interconnecting the reinforcement members between adjacent segments of the shell. The reinforcing members that run longitudinally of the shell segment may be secured, at their ends, to the walls or other adjacent elements of the foundation structure. In any event, the reinforcements should overlap the foundation structure.

FIG. **8** illustrates a chair for use in supporting the metal reinforcing members on the fabric form prior to pouring of the concrete for the shell. The chair **61** shown in FIG. **8** comprises a precast concrete base **62** having a metal depth gauge loop **63** and a rebar clamping loop **64** mounted therein.

In mounting the reinforcing bars on the fabric form, a multiplicity of individual chairs such as the chair **61** are positioned on the external surface of the upper fabric layer **31** as shown in FIG. **9**. The chairs are preferably located approximately at alternate intersections of the longitudinal reinforcing bars **65** and the transverse reinforcing bars **66**. The transverse bar **66** is clamped to the chair by bending loop **64** over the bar, as shown in FIG. **10**. The longitudinal bars **65** may be tied to the transverse bars **66**, as also shown in FIG. **10**. On the other hand, if desired, each chair can be provided with a second mounting loop like the loop **64** and this second loop can be employed to secure the transverse bar **66** to the chair.

Preferably, the longitudinal reinforcing bars **65** are long enough to extend beyond the ends of the fabric form. This makes it possible to overlap these reinforcing bars with other bars **68** cast into and extending out of wall **20** (see FIG. **4**).

Each of the transverse reinforcing bars **66** extends beyond the edge of the fabric form at both sides of the shell. On the side adjacent the previously formed shell segment **27**, the reinforcing bars **66** are individually tied to the projecting end **69** of the bars from the adjacent shell segment, as shown in FIG. **6** to hold bars **66** in position during placement of concrete. In most instances, simply clinching the ends of the individual bars in a hook connection is adequate.

At the other edge of the assembly, as shown in FIG. **7**, each of the transverse reinforcing bars **66** is placed in of the locating and aligning slots **44** in the edge form member **43**. The end **71** of the reinforcing bar **66** is formed to a hook shape and is engaged with the hook portion **47** of the releasable clip **46**. Subsequently, after the concrete has been poured and when it is desired to remove the form assembly, clip **46** is released by releasing one or both of the nuts **49** and turning the clip until the hook portion of rod **47** is free of the end **71** of the reinforcing bar **66**. If necessary, the releasable clip **46** can be removed completely from the form assembly so that there will be no possibility of deformation of the reinforcing bar **66** when the form assembly is removed. It will be seen that, upon removal of the form assembly, the projecting ends **71** of each of the transverse reinforcing bars **66** will be available for connection to the next segment of the shell.

As shown in FIG. **10**, the concrete is preferably formed in two layers **72** and **73**. The initial layer **72** forms the main body of the shell and outer layer **73** is a finish layer. In the construction illustrated in FIG. **10**, the initial layer **72** has been applied to approximately the height of gauge loop **63** on chair **61** and finish layer **73** extends beyond the gauge loop. Alternatively, the first or base layer **72** of the concrete can be brought approximately flush with the tops of reinforcing bars, leaving gauge loop **63** available as a depth gauge for finish layer **73**. In any of these constructions, the precast concrete base **62** of chair **61** becomes an integral part of the concrete shell structure. The loop shapes are used for elements **63** and **64** to prevent accidental damage to the fabric during placement of the chairs and reinforcement bars on the form.

In general, the fabric for the form assembly must be one having a high tensile strength and having a surface that will strip away easily from the concrete after the concrete has set. Commercially available polymer films reinforced with nylon or polyester webs are quite suitable, affording the requisite strength and stripping characteristics and being substantially air tight. Fabrics of this kind can be reused many times without replacement.

As noted above, inflation pressure for the fabric form need not be extremely high. In most installations, a pressure of 5 to 10 inches water gauge is sufficient to provide the required support for the wet concrete. Some leakage will occur at the perimeter of the fabric form and at imperfect joints in the fabric. The blower **53** must normally be maintained in continuous operation to maintain a constant pressure in the form until the concrete has set sufficiently to maintain its structural integrity without support from the form. However, this is not a difficult problem as far as air supply is concerned; a form having a surface area of over 10,000 square feet can be maintained in inflated condition with a 5 to 10-horsepower blower. A pressure adequate to support the wet concrete produces good stability against wind forces and is sufficient to support the weight of several workmen walking on the inflated fabric form during placement of the metal reinforcing members and application of concrete. Localized deformations where the men are working during depositing and finishing of the concrete disappear as the men move on and are effectively obliterated long before the concrete starts to set. These deformations extend no more than 6 to 10 inches beyond the man's foot and are ordinarily less than ½ inch deep.

FIGS. **11**, **12** and **13** illustrate three substantially different building configurations that may be constructed using the apparatus and method of the present invention. The building **81** illustrated in FIG. **11** is generally similar in configuration to the building shown under erection in FIGS. **1**, **2** and **5**. It constitutes two parallel vertical walls **82** and **83** spanned by a series of shell segments **84**. This construction is particularly suitable for large bulk storage, aircraft hangers, fieldhouses, and other large buildings. The clear span between walls **82** and **83** may extend to 300 feet or more and the overall peak height

may be one-fifth to one-half of the lateral span of the building. Typically, the width of individual segments of the shell in a building of this kind may be of the order of 15 to 30 feet.

FIG. 12 illustrates another rectangular building 85 having a roof composed of multiple shell segments 86 that are of a different contour from the segments illustrated in previous figures, being substantially flattened across the span of the shell. This configuration for the shell functions as a beam instead of as an arch, as illustrated in previous figures, and eliminates the lateral thrust reaction of an arch. This construction is particularly suitable for merchandising structures as well as manufacturing, warehousing, and other industrial buildings. Usually, the span between the side walls 87 and 88 of a structure of this configuration is limited to distances of about 100 feet.

FIG. 13 illustrates another shell construction in which the shell segments do not go completely across the building but converge at the peak of a dome. The building 91 shown in FIG. 13 may be constructed to diameters of 500 feet or more. Of course, with the construction illustrated in FIG. 13, it is necessary to provide temporary supports for the internal ends of the individual shell segments until the shell structure has been completed. The dome structure of FIG. 13 is particularly suitable for arenas and assembly halls and may also be suitable for large bulk storage. If desired, a substantial opening 92 can be provided at the crown of the dome if a skylight or clear opening is desired.

In any of the shell structures constructed in accordance with the method and apparatus of the present invention, the supporting foundation need not be a complete or continuous wall. Column and beam supports can be employed, the only requirement being sufficient strength to support the completed concrete shell.

I claim:

1. The method of constructing the concrete shell for a free-standing, above-grade building comprising a foundation structure defining the perimeter of a building space and a concrete shell covering that space, comprising the following steps:

A. positioning a form assembly within said building space, in horizontal and vertical alignment with the top of a first portion of said foundation structure, said form assembly comprising an inflatable two-layer form having an outer fabric layer, mounted on and supported by a rigid structural frame having an edge configuration corresponding to the edge configuration for a segment of said shell;

B. pumping air under pressure into said inflatable form to inflate said form to a maximum thickness much smaller than any principal dimension of said building, with said outer fabric layer spaced from said frame except at the edges of said form;

C. maintaining said form inflated to a pressure sufficient to support workmen on said outer fabric layer with only minimal deformation thereof;

D. positioning metal reinforcement members on the external surface of the outer fabric layer of the inflated form;

E. depositing at least one layer of concrete on the external surface of the outer fabric layer of the inflated form, said concrete layer extending over said portion of said foundation structure, and allowing said concrete to set to form a segment of the concrete shell;

F. deflating said form to release the fabric outer layer thereof from the shell segment;

G. lowering said form assembly out of vertical alignment with the top of said foundation structure;

H moving said form assembly to a new position adjacent the completed shell segment;

I. raising said form assembly to vertical alignment with the top of a further portion of said foundation structure;

and repeating the foregoing steps enough times to construct a complete multisegment shell covering said building space.

2. The method of constructing the concrete shell for a building, according to claim 1, in which some of the metal reinforcement members project beyond the edges of the inflated form, and including the further step of interlocking the reinforcement members for each subsequent shell segment with the projecting portions of the reinforcement members of the adjacent completed shell segment prior to depositing the concrete for the subsequent shell segment.

3. The method of constructing the concrete shell for a building according to claim 1, including the additional step of positioning a plurality of small precast concrete chairs on the external surface of the outer fabric layer of the inflated form and positioning the metal reinforcement members on said chairs so that said chairs support said reinforcement members in predetermined spaced relation to the external surface of the inflated form.

4. The method of constructing the concrete shell for a building according to claim 3, in which each chair includes a gauge member projecting upwardly of the chair by a distance substantially greater than the overall thickness of the reinforcement members, and in which step E is performed in two stages, first depositing a base layer of concrete to a thickness determined by said gauge members, and subsequently applying a finish layer over the base layer.

5. A plural-use form assembly for constructing a multi-segment concrete shell for a free-standing, above-grade building comprising a foundation structure defining the perimeter of a building space and a concrete shell covering that space, said form assembly comprising:

a rigid structural frame including two spaced form-supporting members each conforming in configuration to the required configuration for an edge portion of one segment of said shell;

a two-layer inflatable form, mounted on said frame and affording a substantially airtight chamber spanning the space between said form-supporting members, said inflatable form including an outer layer for said chamber formed of a strong, relatively inelastic fabric and having a maximum thickness, when inflated, much smaller than any principal dimension of said building;

and inflating means, including a pump, for inflating said inflatable form chamber and maintaining said form chamber at a pressure sufficient to support workmen on said outer fabric layer with only minimal deformation thereof and to support both a network of reinforcing steel and a substantial layer of wet concrete,

said outer fabric layer being spaced from said frame, except at the edges of said form, when said form is inflated.

6. A form assembly according to claim 5, in which said form-supporting members of said frame are of arcuate configuration, located on opposite sides of said frame, and in which said frame includes a plurality of struts extending through said chamber between said form-supporting members to resist tension forces in said fabric tending to pull said form-supporting members together when said form is inflated.

7. A form assembly according to claim 5, and further comprising means for elevating said form to align said form at a desired elevation and for lowering said form upon completion of a shell segment to allow movement to a new position.

8. A form assembly according to claim 7, in which said elevating and lowering means comprises a series of jacks mounted along each side of the form assembly for elevating and lowering the form assembly as a whole.

9. A form assembly according to claim 5, in which at least one of said form-supporting members includes a shelflike extension projecting outwardly of the fabric outer layer of said inflatable form to afford a supplemental form for a shell segment transition element interconnecting one shell segment with an adjacent similar shell segment.

10. A form assembly according to claim 9, in which said extension includes means for supporting and aligning the ends of a plurality of metal reinforcing members on the form assembly, said supporting and aligning means including a plurality of releasable reinforcing bar clip members mounted at spaced intervals along said extension.