Oct. 20, 1964 J. E. WHEELER 3,153,303

BUILDING CONSTRUCTION

Filed March 20, 1959 3 Sheets-Sheet 1

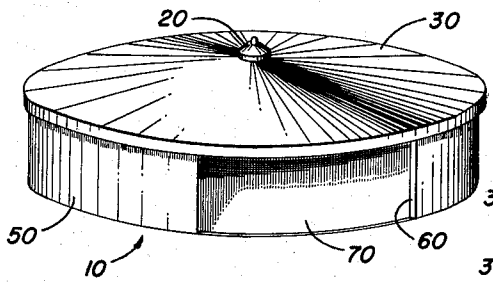

Fig. 1

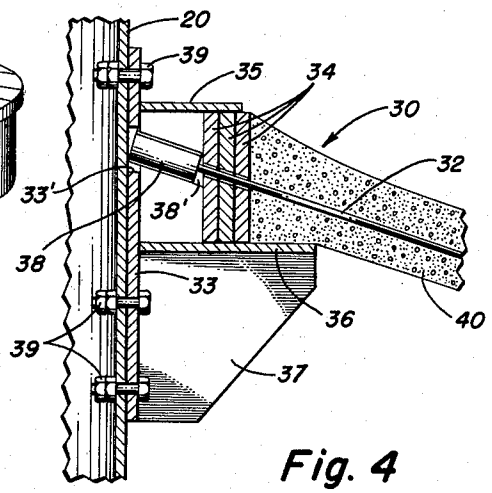

Fig. 4

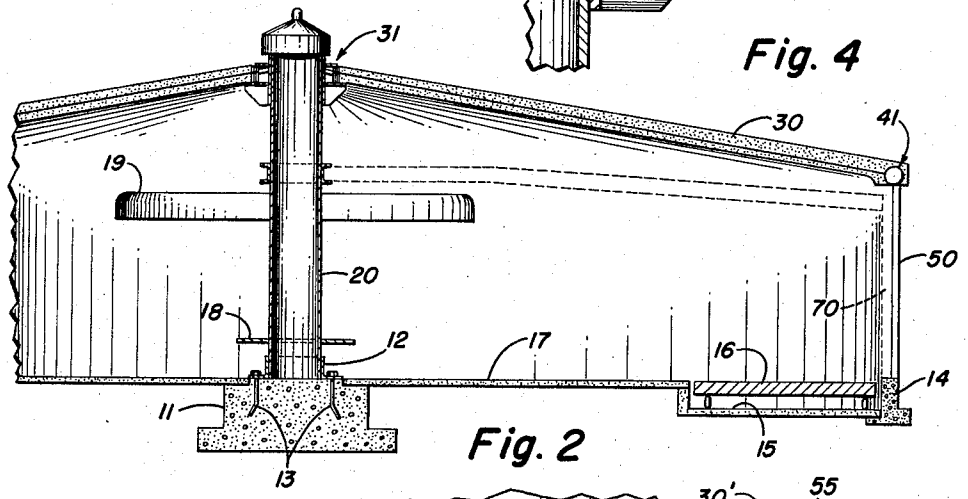

Fig. 2

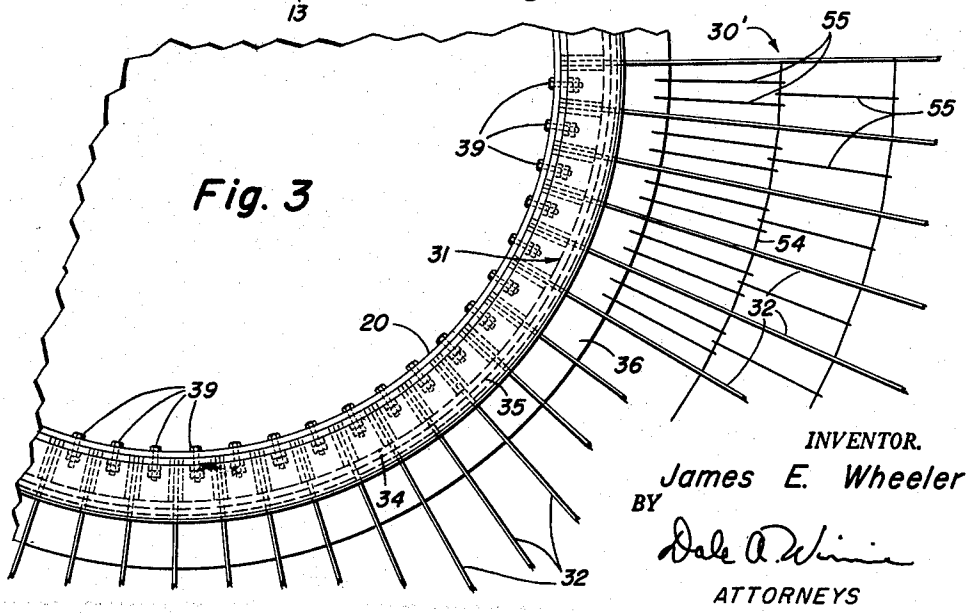

Fig. 3

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BUILDING CONSTRUCTION

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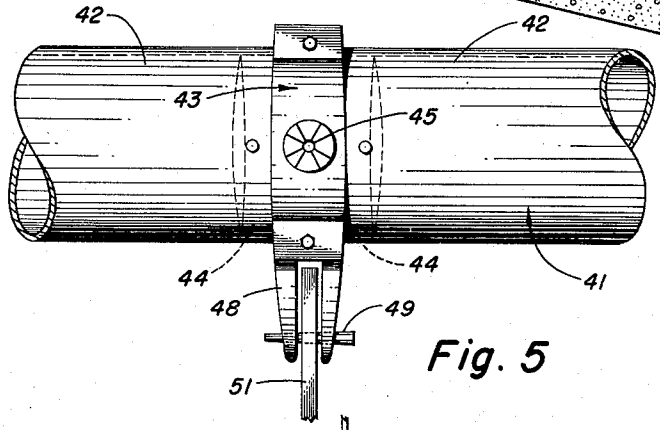

Fig. 5

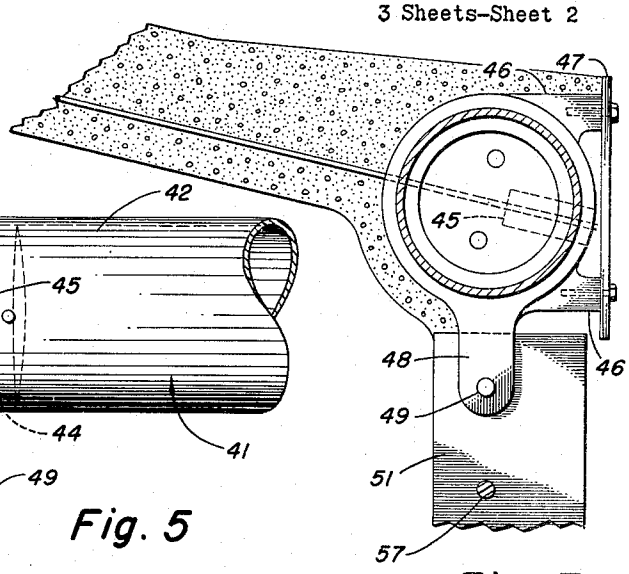

Fig. 7

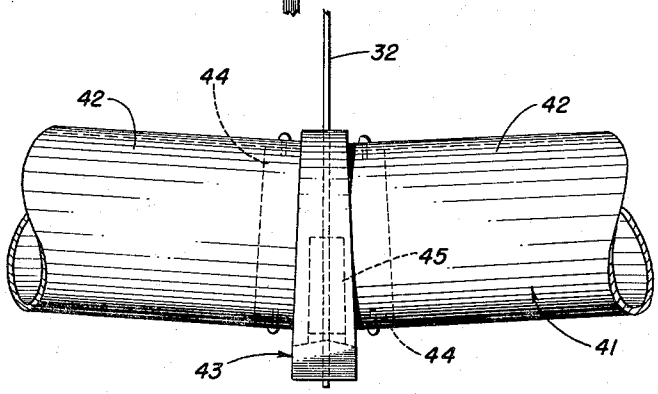

Fig. 6

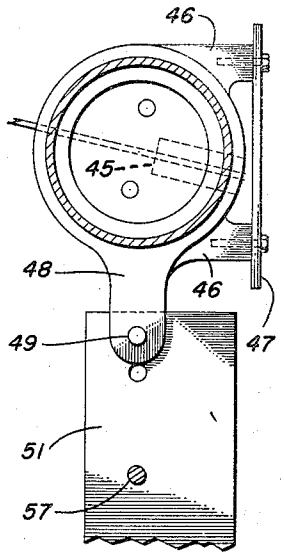

Fig. 8

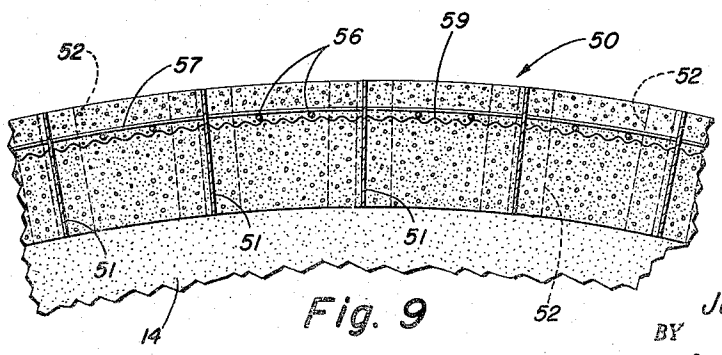

Fig. 9

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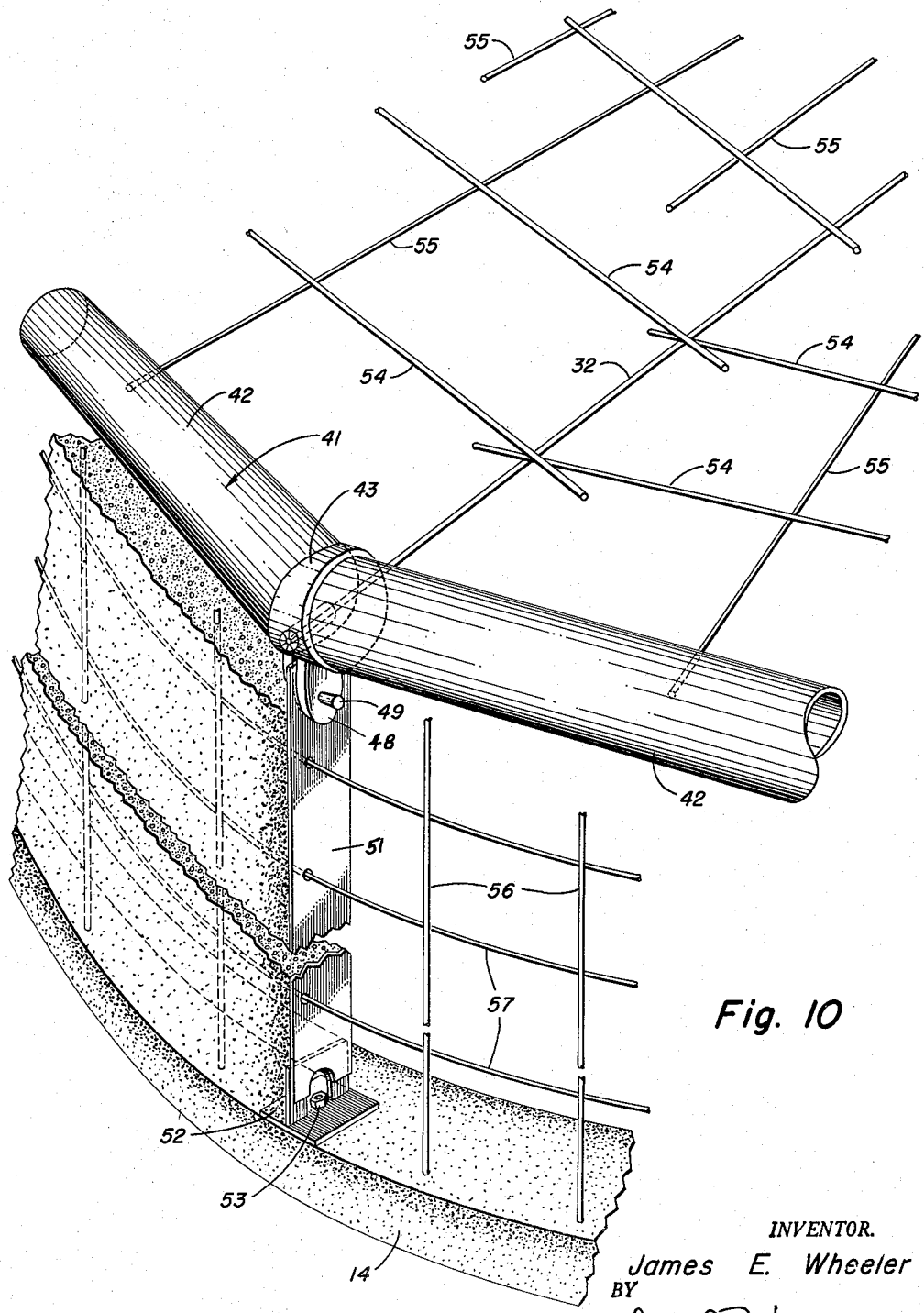

Fig. 10

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3,153,303

BUILDING CONSTRUCTION

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3 Claims. (Cl. 50—49)

This invention relates to building construction in general and more particularly to circular buildings and a novel roof construction therefor.

Buildings having open, expansive and unobstructed floor areas are in considerable demand. Such buildings are most needed for public service facilities and are therefore also required to be fireproof. In recent years most buildings of the type mentioned have been built of steel and reinforced concrete.

Concrete or other cementitious material used in building construction is largely provided as preformed members. It is common to have slabs and joist formed of concrete material. The concrete building materials usually also include reinforcing rods and wire mesh. Unfortunately, the use of such materials is quite expensive. Although the material itself is relatively inexpensive there is considerable cost involved in transporting concrete forms to the building site, setting them up, stripping them off, and moving them to storage or the next building site. If preformed concrete members are used the problem is one of transporting and erecting the precast members rather than the forms themselves.

Furthermore, although the present concrete building materials are desirable because of their fireproof nature, there are limitations to their use for wide unsupported overhead spans. Concrete, even though reinforced, is weak in tension and such tensile forces are imposed across wide spans by both dead and live loads.

In relatively recent years, prestressed concrete building materials have come into use. Such materials are known as having either pretensioned or posttensioned steel inserts or bands. In pretensioned concrete members the reinforcement is placed in tension within the concrete mold form before the concrete is poured. When the tensioning force is removed the concrete is placed in compression and is capable of carrying greater loads or spanning greater distances than theretofore. Posttensioning requires that a subsequent tensioning force be imposed and held on the reinforcement within or about a concrete member to achieve the same tensile balancing compressive force.

These innovations have only served to increase the size of the preformed concrete member which may be formed and to magnify the problems and cost of shipping the preformed member.

In a previous patent application Serial No. 769,790 filed October 27, 1958 and titled Building Construction, in the name of this inventor, a new and novel form of building construction was disclosed whereby all of the advantages of prestressed concrete construction could be obtained without the disadvantages mentioned. Such construction comprises on the job prestressing of high tensile members used to provide a framework for the object being formed and the covering of such members, while in tension, with an air-borne and lightweight concrete aggregate.

It is an object of this invention to disclose further features of improvement in job site prestressed concrete construction.

Among the features of improvement is the use of singular cable or high tensile rod construction to form the tensile load bearing members.

Also among the features of improvement, particularly in circular roof construction, is the use of an annular compression ring formed of polygonal segments joined by connectors. The connectors are also formed to receive the tensionable cable or rod members and, further, to provide tie down means used in applying the pretensioning force to such cables or rods.

Further among the features of improvement disclosed by this invention is the use of peripheral wall forming members for applying the pretensioning forces required.

Still further among the features of improvement disclosed by this invention is the use of vice grips within the inner and outer circular roof forming rings and having one of the rings formed of laminated steel bands.

These and other features of improvement will be more apparent in the illustration and description of one particularly suitable form of building construction within which the teachings of this invention are best applied.

The drawings disclose a circular building including the different features of this invention and useable as an aircraft hangar. Certain features of this inventor's copending application Serial No. 691,404, filed October 21, 1957 and titled Aircraft Hangar, now Patent No. 2,964,144, as well as Serial No. 763,974, filed September 29, 1958 and titled Circular Aircraft Hangar and Method of Construction Thereof, now Patent No. 3,075,654, are also incidentally disclosed.

The circular aircraft hangar comprises a central column having a circular roof structure supported thereon. The roof structure is formed by inner and outer annular rings with tensionable members disposed radially therebetween. The inner ring is formed of contiguous and concentrically disposed steel bands. The outer ring is an assemble of cylindrical members arranged to form a polygonal shape and having precast connectors joining the adjacent ends together. The tensionable members are singular cables or rods of high tensile strength which are engaged by vice grips or rod retaining means to the inner and outer rings.

In the construction of the circular aircraft hangar the aforementioned roof framework is elevated on the central column to dispose the outer annular ring at substantially the desired roof height. Thereafter peripheral wall forming members for the building are erected and the outer ring is engaged to such members. Following the addition of suitable reinforcement across and between the tensionable members, the inner roof forming ring is elevated further on the central column, and is secured thereto, to place the tensionable members in tension. Thereafter concrete or other cementitious material is applied to the roof framework as an air-borne aggregate. Subsequently the outer annular ring is disengaged from the wall forming members, which have served as tie downs, and the tension force in the tensionable members becomes a compressive force within the completed roof structure.

In the drawings:

FIG. 1 is a perspective view of a circular building, for aircraft hangar use, made in accord with the teachings of this invention.

FIG. 2 is an enlarged cross sectional side view through the aircraft hangar shown by FIG. 1.

FIG. 3 is an enlarged cross sectional view through the building roof supporting column and shows the connection of the tensionable roof forming members therewith.

FIG. 4 is an enlarged partial side cross sectional view of the roof structure, near the center column, as shown by FIG. 2.

FIG. 5 is an enlarged side view of a part of the outer roof forming compression ring of this invention.

FIG. 6 is a top view of the compression ring part shown by FIG. 5.

FIG. 7 is an enlarged cross sectional view through the outer roof forming compression ring and shows the connection with the wall forming members to provide the pretensioning force in the disclosed building construction.

FIG. 8 is similar to FIG. 7 but is simplified and is principally to show the relation of the compression ring

to the wall forming members after the tensioning force is relieved.

FIG. 9 is a fragmentary cross sectional view through the peripheral wall of the disclosed building.

FIG. 10 is an enlarged perspective view of a section of the proposed building framework.

The circular building **10** disclosed, includes a central column **20** which supports a conical roof structure **30**. A peripheral wall **50** encloses the space under the roof **30**. An opening **60** may be provided within the wall **50** and may be sufficiently large (one-fifth of the wall perimeter) to enable ease of ingress and egress for large aircraft or the like. The opening **60** may be closed by a door **70** provided in accord with the teachings of my copending application Serial No. 691,404, filed October 21, 1957 and titled Aircraft Hanger, now Patent No. 2,964,144. Such a door arrangement is shown in phantom outline in FIG. 2.

The central column **20** is embedded within or secured to a central foundation **11**. In the present instance a flange **12** at the base of the column is secured to the foundation **11** by tie bolts **13** embedded therein. After the roof framework has been erected as will be described, the exterior wall **50** is erected upon an annular foundation **14** arranged concentrically of the central foundation **11**. The foundation **14** serves to support the non-load bearing wall **50** and serves as part of a turntable pit **15**. In the outfitting of the building **10** as an aircraft hanger, an annular turntable member **16** is disposed within the recess area **15** in accord with the teachings of my copending application Serial No. 763,974, filed September 29, 1958 and titled Circular Aircraft Hanger. A concrete or other floor **17** covers the remainder of the enclosed area.

FIG. 2 shows the use of a worktable **18** and an overhead canopy **19** about the central column **20** in the completed building. The overhead canopy **19** may be used to provide better lighting for the work area and may include a fabric or other enclosing curtain wall to hold heat within the work area.

Returning now to the description of the building construction itself:

After the central column **20** is erected, the framework for the roof structure **30** is formed about the base of the column. The roof framework, designated **30'** in FIG. 3, includes an inner annular ring **31**, sleeved about the central column so as to be vertically adjustable, and an outer annular ring **41** in spaced concentric relation thereto. A plurality of singular elastic members in the form of cables or rods **32** are disposed in radial and circumferentially spaced relation between the rings **31** and **41**. The cables or rods **32** are elastic in the conventional sense as this term is applied to high tensile wire rope or rods well known to those skilled in the art relating to prestressed concrete construction; that is, they exhibit a restoring force, when elongated by a tensile stress not exceeding their elastic limit, substantially equal to the tensile stress causing elongation. These cables, or rods, **32** are of high tensile strength and, as will be shown, are subsequently strained under a tensile load which causes the rings **31** and **41** to serve as tensile and compression rings, respectively.

The inner tensile ring **31** includes a sleeve portion **33** which is received about the column **20**. Disposed in slightly spaced circumferential relation about the sleeve **33** are steel bands **34** to provide a laminated tension load bearing ring. The bands **34** are formed from plate material, rolled to a full circle, butt welded and assembled in the contiguous laminated relation shown. Upper and lower flange members **35** and **36** secure the bands to the sleeve **33**, as best shown by FIG. 4. Radially disposed saddle or brace members **37** are welded to ring **36** and serve to anchor the ring to the sleeve **33** for greater strength.

The laminated bands **34** are drilled or otherwise formed at regularly spaced intervals to receive the inner ends of

the cables or bars **32** therethrough. Within the space between the sleeve **33** and the bands **34** are disposed vice grip cable retaining members or special threaded rod receiving nut members **38**. A tapered washer **38'** may be used to align the retainer members **38** in a desired angular disposition. If required, the sleeve **33** may be formed to include holes **33'** directly behind the retainers **38** to facilitate any adjustment thereof during installation. Bolt fasteners **39** serve to secure the inner ring assembly **31** to the column **30** at its subsequent elevated position thereon.

The outer or compression ring **41** is formed by a plurality of relatively short length cylindrical members **42**, as for example lengths of iron pipe. The members **42** are thus cordal members arranged in tandem to form a polygon and adjacent ends thereof are secured together by preformed connectors **43**. The connectors **43** are formed having outwardly divergent side faces and integrally formed collars **44** thereon, over which the members **42** are telescoped and to which they may be welded or riveted. The center section of the connectors **43** are formed to receive vice grip anchors or threaded nut members **45** which retain and secure the outer ends of the tensionable cables or rods **32** thereto.

The connectors **43** are also formed to include ears or depending tabs **46** to which a peripheral plate or band **47** may be secured. Such member subsequently serves as a circular facia about the periphery of the roof structure.

A clevis **48** is formed on the underside of each of the connectors **43** and, as will be shown, is used in tying down the outer ring **41** while the inner ring **31** is raised to tension the cables or rods **32**.

After the assembly of the inner and outer roof forming rings **31** and **41**, with the cables or rods **32** therebetween, and having the cables or rods tuned for uniformity, the unit is elevated on the central column **20**. The weight of the outer ring **41** and the cables **32**, of themselves, will cause the assembly to assume a conical shape and will place the cables or rods **32** under a moderate dead load bearing tension.

The assembly of the rings **31** and **41**, with the cables or rods **32**, is elevated on the column **20** until the outer ring **41** is at the desired height of the outer peripheral wall **50**.

The peripheral wall **50**, for the disclosed building, is essentially a curtain wall since it is not required to bear the load of the roof **30**. The wall **50** is formed with the use of circumferentially spaced and vertically disposed members **51** which initially serve another purpose.

The members **51**, subsequently used in forming the peripheral wall **50**, are of relatively thin walled (about 3/16") bar or strap iron stock and of high tensile strength. They are secured to anchors **52** which are in turn secured by bolt fasteners **53** to the foundation **14**, at spaced intervals thereon. The upper ends of the wall forming members **51** are received within the clevis **48** of the connectors **43**, and are engaged thereto by a removable taper pin **49**.

Reinforcing rods **54** and **55** are provided between and across the tensionable cable or bar members **32**, as shown by FIG. 10. The annular reinforcement members **54** are arranged in concentric relation, with decreased radial spacing towards the outer periphery of the roof framework. The reinforcing members **55** extend between adjacent of the tensionable cables or rods **32** and are tied to the cables and reinforcement members **54** where they intersect. The radially disposed reinforcing rods **55** are increased in number near the tensile ring assembly **31** and act as shear bars for greater strength in supporting the weight of the conical roof **30**.

Following the addition of the reinforcement of the roof assembly, and being assured that the compression ring **41** is tied down by the members **51**, the inner ring **31** is elevated to place the cables or bars **32** under a predetermined tensile force.

In tensioning the bars or cables **32**, the wall studs **51** are

also placed in tension. While the wall studs are in tension, the wall 50 is formed by having reinforcing members 56 and 57 arranged vertically and horizontally therebetween. A wire mesh 59 is used between the wall studs 51 and behind the reinforcing rods. Such wire mesh is shown by FIG. 9, but is not shown in FIG. 10. Thereafter the wall studs, reinforcing members, and the wire mesh are covered with a lightweight air-borne cementitious aggregate to a heighth just below the clevis 48 of the compression ring assembly 41. The wire mesh serves as a binder to hold the wall providing concrete aggregate in place and, as disposed between adjacent wall studs, provides a form of wall panel construction.

While the ring connecting cables or rods 32 are strained in tension, and preferably after the wall 50 is provided, the framework 30' is covered with a lightweight air-borne cementitious aggregate 40. After the roof covering material 40 has set, the outer ring 41 is released from the tie down wall forming studs 51 by removing the taper pins 49. The release of the tension force in the cables or rods 32 is thereby transferred into a compressive force within the roof covering cementitious material. Such a force adequately compensates for the otherwise tensile weakness of the roof covering material.

When the taper pins 49 are withdrawn from the clevis 48, the tension in the wall studs 51 is also relieved. Accordingly, the outerwall 50 of the building is placed in vertical compression.

Thereafter, the clevis joints 48 are reengaged to the wall studs 51 and the space between the upper limit of the wall 50, as first formed, and the roof 30 is filled in. This is done to stabilize the roof structure against uneven wind and snow loads. The outer wall 50 serves only as a stabilizing curtain wall and does not serve as a true roof supporting wall structure.

In the course of construction, if desired, large wall openings such as 60 may be readily provided within the wall 50. This is accomplished simply by eliminating the reinforcement and concrete covering at the desired location and by subsequently removing the tie down studs 51 from such wall area. Openings as large as one-fifth of the perimeter of the building 10 may easily be provided. Furthermore, such openings may be provided at any desired location and two such large openings may even be provided on opposite sides of the building.

While a preferred embodiment of this invention has been described, it will be understood that other modifications and improvements may be made thereto. Such of these modifications and improvements as incorporate the principles of this invention are to be considered as included in the hereinafter appended claims unless these claims by their language expressly state otherwise.

I claim:

1. A form of building roof construction comprising: a central support, an inner annular ring surrounding said support, said inner annular ring being of a size relative to said central support to enable vertical movement thereof on said support, an outer annular ring spaced concentrically from said inner ring and including a plurality of chordal members disposed in tandem, a plurality of radially disposed strained elastic members anchored between said inner and outer rings, said outer annular ring including also connectors provided between adjacently disposed ends of said chordal members, said connectors having outwardly divergent side faces, the ends of said chordal members abutting said side faces and secured thereto, said connectors having means for anchoring the outer ends of said elastic members and depending tabs for providing tie-down restraint of said outer ring, and a cementitious covering about said elastic members and between said inner and outer rings, said covering being compressed radially between said inner and outer rings by the restoring force of said strained elastic members, substantially the entire dead-load weight of said roof, including said rings, said elastic members and said covering being supported by said central support.

2. The apparatus recited in claim 1 in which said elastic members extend within said inner annular member and said connecting means and including further, enlarged anchor means engaging opposite ends of each of said elastic members and positioned within said inner annular member and within said connector means, respectively.

3. The apparatus recited in claim 1 including vertically disposed wall-forming members arranged concentrically about said central column and under said connectors and releasable means for connecting the depending tabs on said connectors to said wall-forming members.

References Cited in the file of this patent

UNITED STATES PATENTS

375,999	Jackson	Jan. 3, 1888
865,490	Graham	Sept. 10, 1907
1,390,073	Allen	Sept. 6, 1921
1,402,077	Lanchester	Jan. 3, 1922
1,559,837	Allen	Nov. 3, 1925
1,825,800	Houseman	Oct. 6, 1931
2,202,850	Guignon	June 4, 1940
2,411,651	Darby	Nov. 26, 1946
2,670,818	Hacker	Mar. 2, 1954
2,671,253	Hensley	Mar. 9, 1954
2,812,574	Wiggins	Nov. 12, 1957

FOREIGN PATENTS

203,565	Australia	Oct. 20, 1955
205,211	Austria	Sept. 10, 1959
218,858	Australia	Oct. 7, 1958
235,247	Switzerland	Mar. 16, 1945
428,341	Great Britain	May 10, 1935
811,716	France	Jan. 23, 1937
1,151,949	France	Aug. 26, 1957

OTHER REFERENCES

Architectural Record, September 1956, pp. 221–216.
Architectural Record, August 1959, pp. 177–182.