Nov. 16, 1971 A. VIESI 3,619,958

OVERHEAD COVERING IN A DUAL CABLE SYSTEM FOR POLYGONAL, ELLIPTICAL OR CIRCULAR PLAN BUILDINGS ETC.

Original Filed June 19, 1968 6 Sheets-Sheet 1

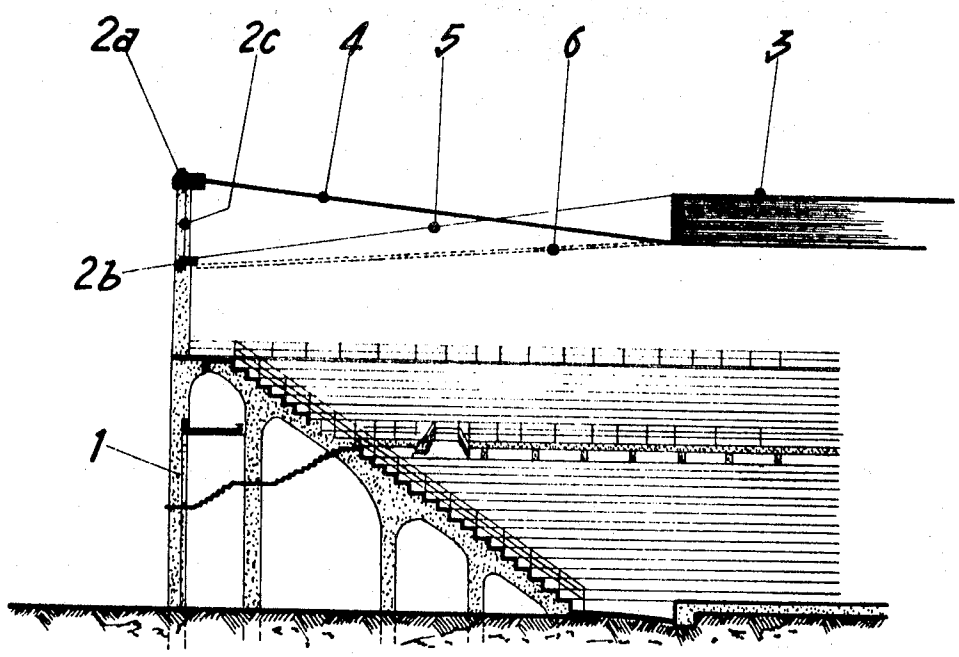


FIG. 1

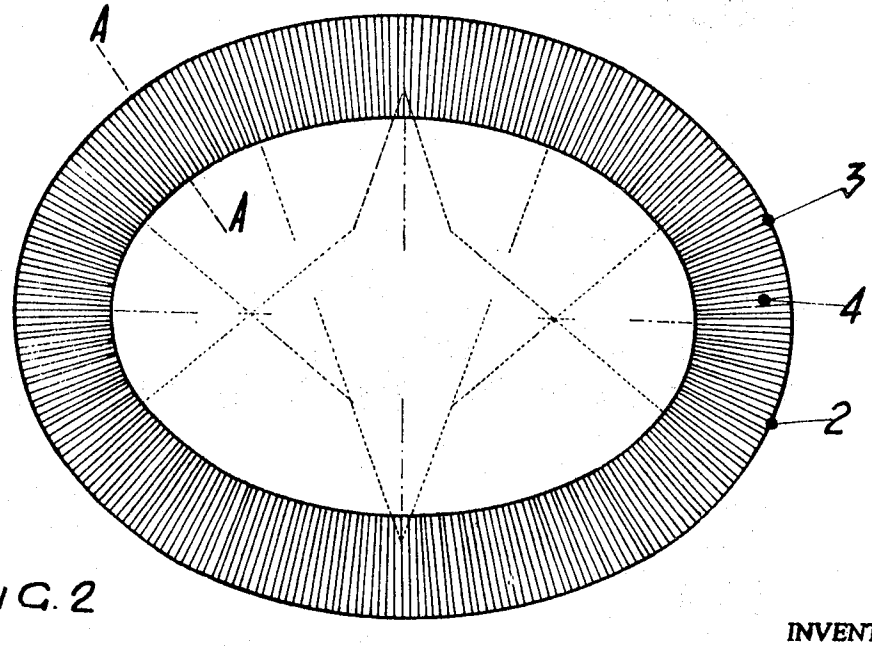


FIG. 2

INVENTOR
ALDO VIESI

BY Newton, Hopkins, & Ormsby
Attorneys

Nov. 16, 1971 A. VIESI 3,619,958
OVERHEAD COVERING IN A DUAL CABLE SYSTEM FOR POLYGONAL, ELLIPTICAL OR CIRCULAR PLAN BUILDINGS ETC.
Original Filed June 19, 1968 6 Sheets-Sheet 3

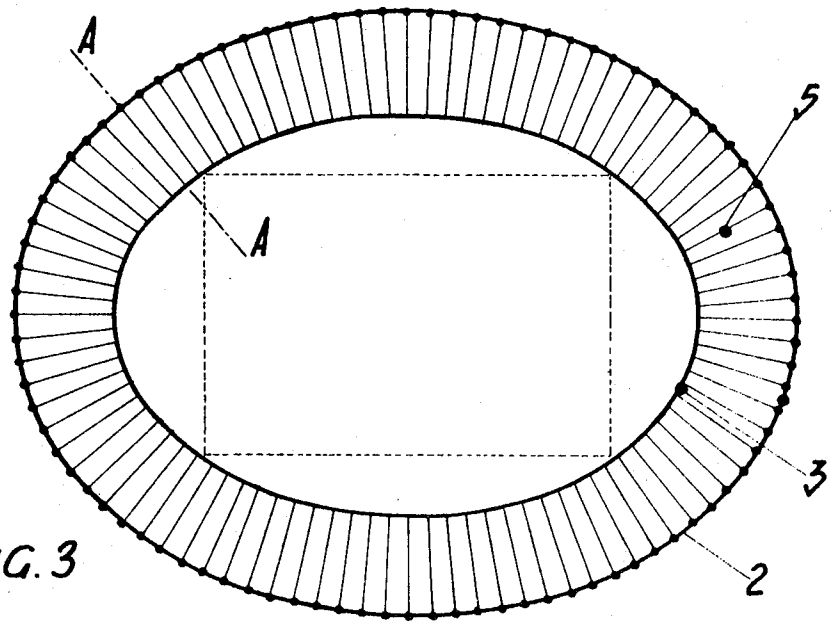


FIG. 3

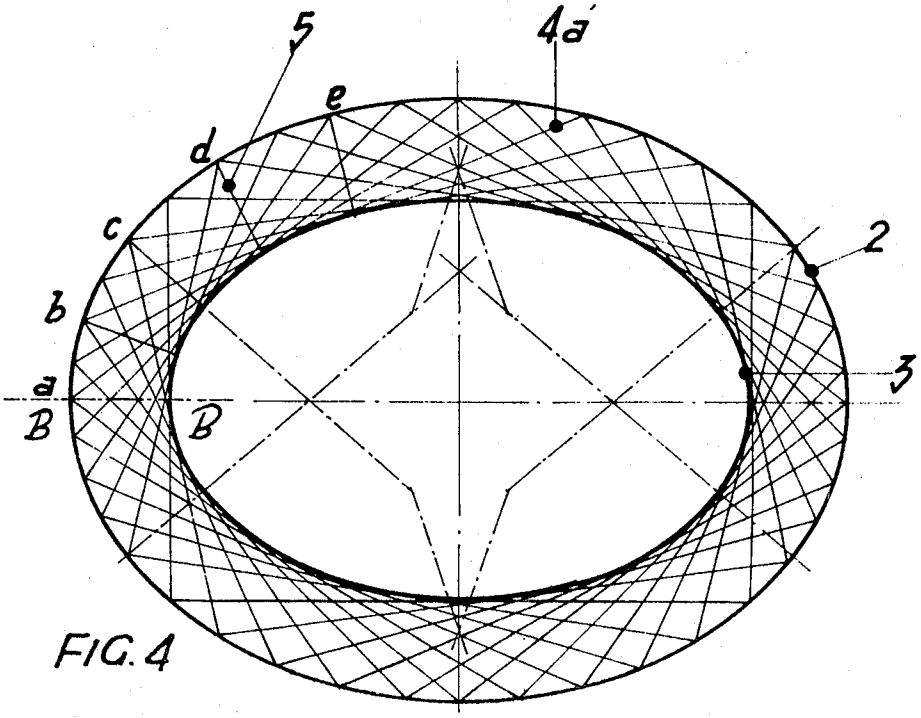


FIG. 4

INVENTOR
ALDO VIESI

BY Newton, Hopkins, & Ormsby
Attorneys

Nov. 16, 1971 A. VIESI 3,619,958
OVERHEAD COVERING IN A DUAL CABLE SYSTEM FOR POLYGONAL, ELLIPTICAL OR CIRCULAR PLAN BUILDINGS ETC.
Original Filed June 19, 1968 6 Sheets-Sheet 3

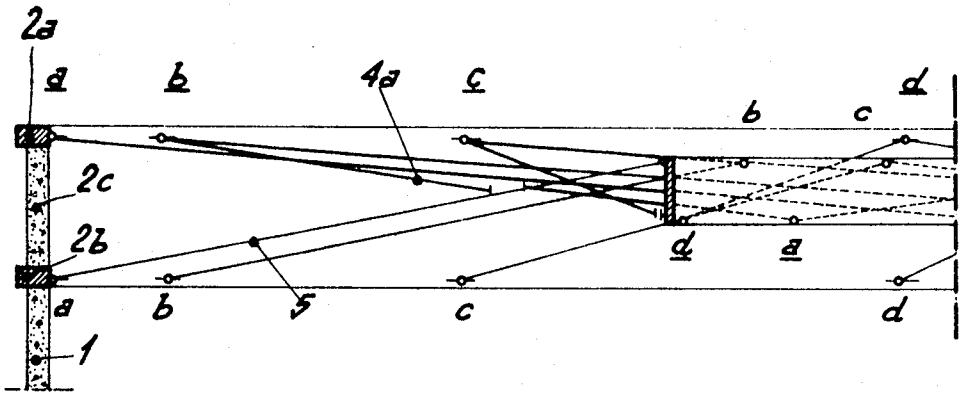


FIG. 5

INVENTOR
ALDO VIESI

BY Newton, Hopkins, & Ormsby
Attorneys

Nov. 16, 1971 A. VIESI 3,619,958
OVERHEAD COVERING IN A DUAL CABLE SYSTEM FOR POLYGONAL, ELLIPTICAL OR CIRCULAR PLAN BUILDINGS ETC.
Original Filed June 19, 1968 6 Sheets-Sheet 4

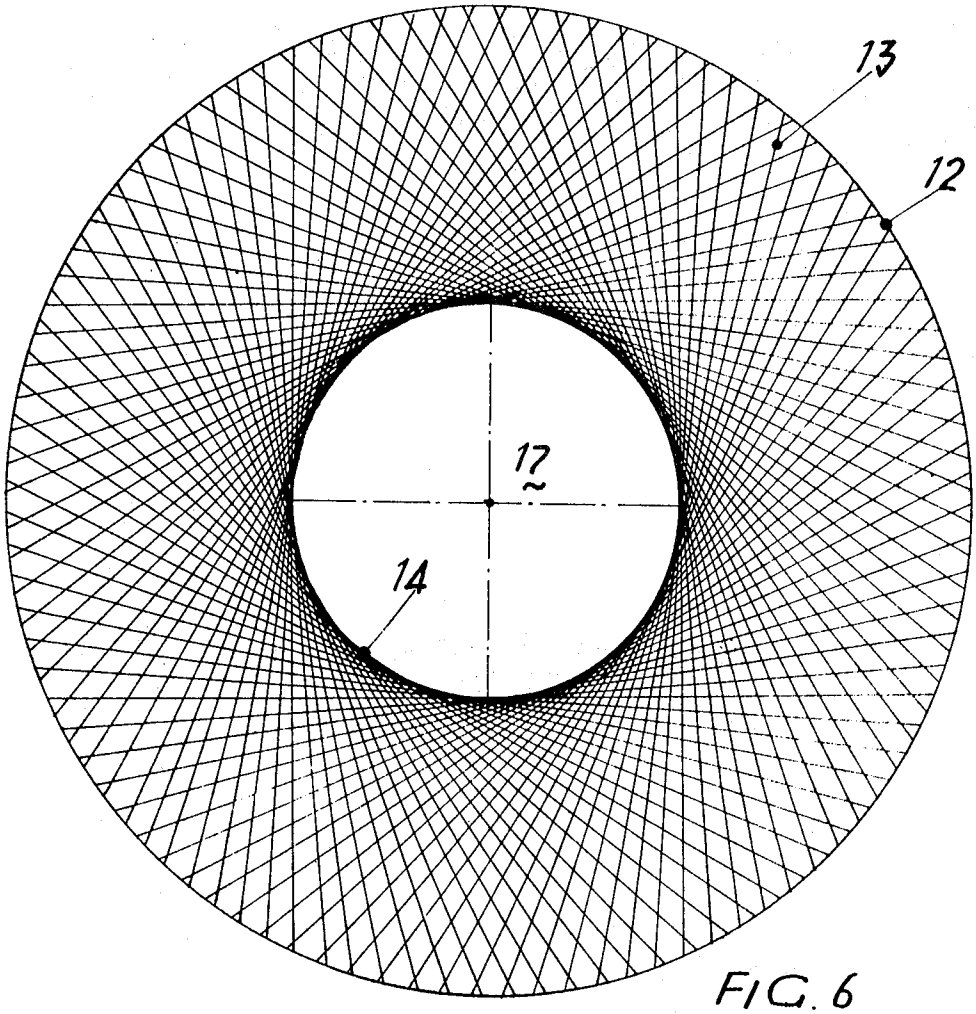


FIG. 6

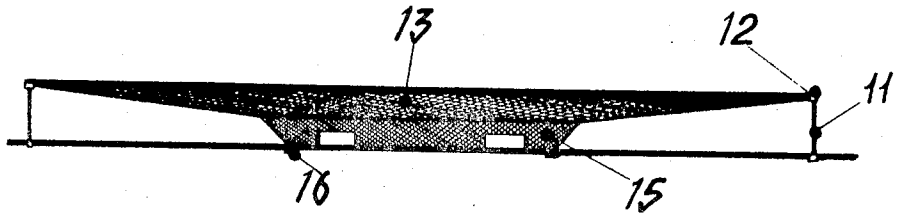


FIG. 9

INVENTOR
ALDO VIESI

BY Newton, Hopkins, & Ormsby
Attorneys

Nov. 16, 1971 A. VIESI 3,619,958

OVERHEAD COVERING IN A DUAL CABLE SYSTEM FOR POLYGONAL, ELLIPTICAL OR CIRCULAR PLAN BUILDINGS ETC.

Original Filed June 19, 1968 6 Sheets-Sheet 5

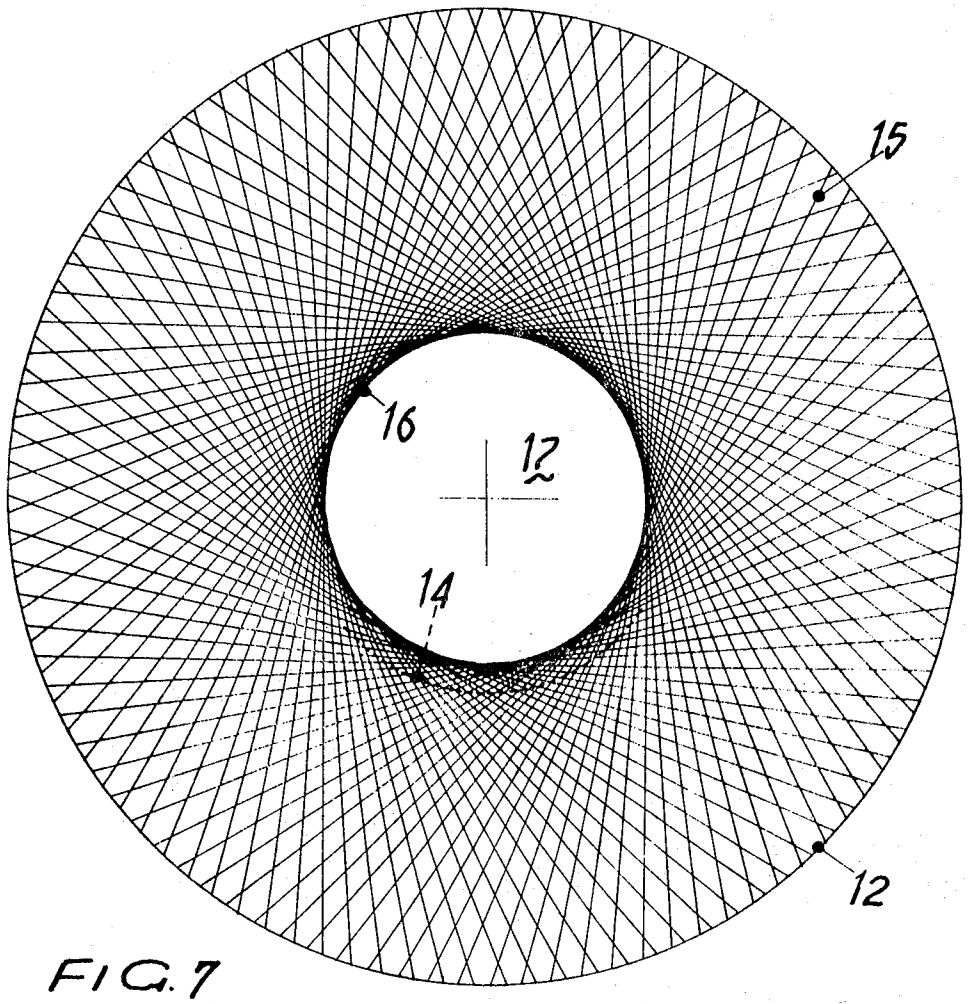


FIG. 7

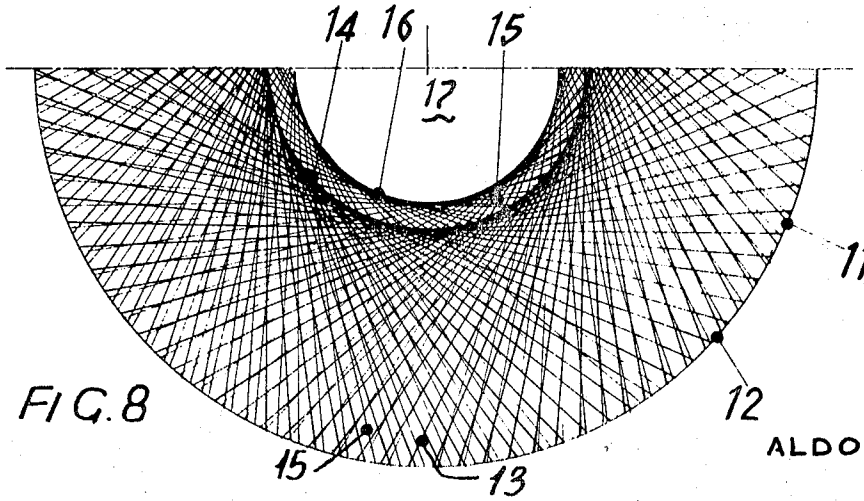


FIG. 8

INVENTOR
ALDO VIESI

BY Newton, Hopkins, & Ormsby
Attorneys

Nov. 16, 1971 A. VIESI 3,619,958

OVERHEAD COVERING IN A DUAL CABLE SYSTEM FOR POLYGONAL, ELLIPTICAL OR CIRCULAR PLAN BUILDINGS ETC.

Original Filed June 19, 1968 6 Sheets-Sheet 6

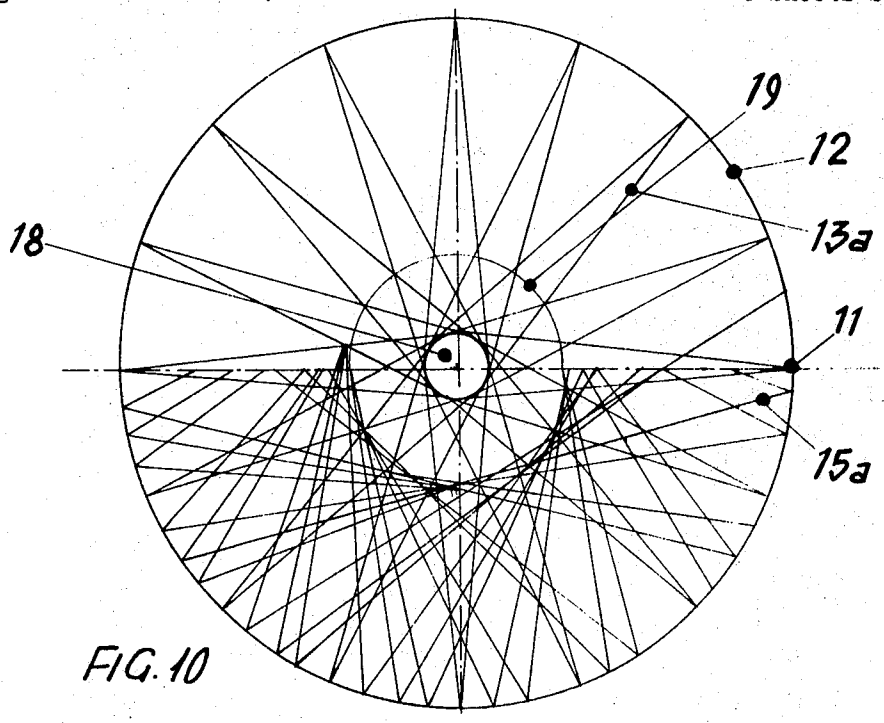


FIG. 10

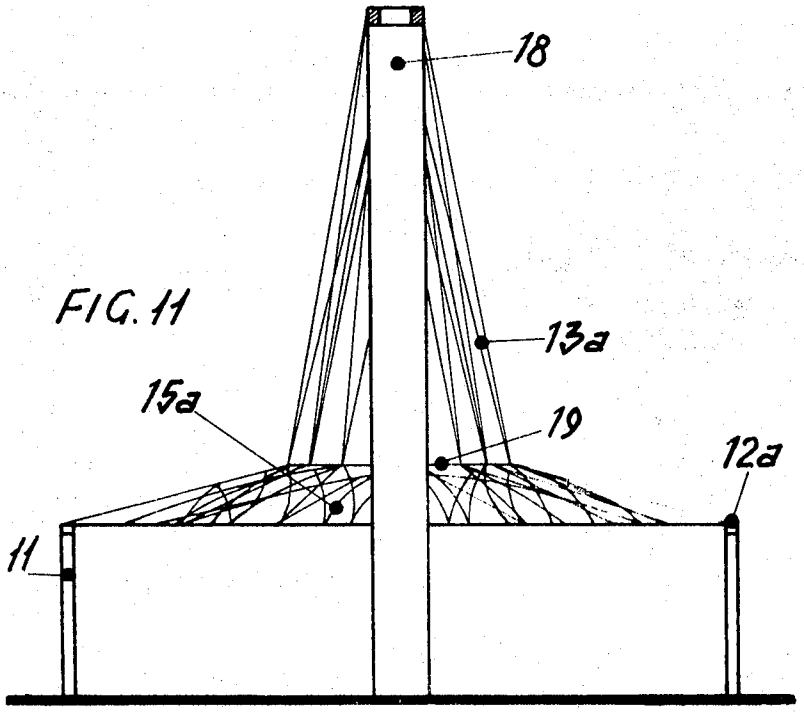


FIG. 11

INVENTOR
ALDO VIESI

BY Newton, Hopkins, & Ormsby
Attorneys

United States Patent Office

3,619,958

Patented Nov. 16, 1971

3,619,958

OVERHEAD COVERING IN A DUAL CABLE SYSTEM FOR POLYGONAL, ELLIPTICAL OR CIRCULAR PLAN BUILDINGS ETC.

Aldo Viesi, Rome, Italy, assignor to Grandi Padiglioni, S.p.A., Isorelle (Brescia), Italy

Continuation of application Ser. No. 738,196, June 19, 1968. This application Mar. 24, 1970, Ser. No. 20,460

Claims priority, application Italy, Jan. 3, 1968, 806,664/68, 806,715/68

Int. Cl. E04d *13/00;* E04h *3/12*

U.S. Cl. 52—83

9 Claims

ABSTRACT OF THE DISCLOSURE

An annular overhead covering including an outside semi-rigid ring, an inside semi-rigid ring of a diameter smaller than the outside ring, a first plurality of supporting cables connecting the lower portion of the inside ring with the upper portion of the outside ring, a second plurality of tensioning cables connecting the upper portion of the inside ring with the lower portion of the outside ring, means for supporting the outside ring, and means carried by the cables for covering the space between the rings.

This application is a continuation of applicant's application Ser. No. 738,196 filed June 19, 1968 and now abandoned.

This invention relates to an annularly shaped overhead covering for sports grounds or generally other such buildings of a substantially polygonal or elliptical, particularly circular plan, as designed to be covered without using intermediate pillars. Such a covering is substantially characterized by a rigid or semi-rigid ring and a concentric central element in the form of a disc or ring, connected by two cable systems, one of which is the supporting system and the other is the supported or tensioning system, forming frustoconically extending surfaces, covering members as anchored to at least one of said stretched cable systems being superimposed on such surfaces.

According to one embodiment the covering comprises in combination two similar, concentric, substantially rigid rings of a predetermined height, one of which is made fast with the supporting frame of the building, while the other is overhanging to former by the combined action of two stretched cable systems, the first system of which comprises the supporting cables extending from the top of the supporting ring and anchoring to the bottom of the supported ring, while the second cable system is a retaining system wherein the cables are anchored adjacent the lower edge of the supporting ring and at the upper edge of the supported ring, these cables being suitably tensioned.

Where the covering is related to sports grounds and the like, the supporting ring is the outer ring, and the supported ring is the inner ring, defining the uncovered zone over the playground, but such a zone could in turn be closed by a further stationary or dismantleable or openable covering carried on the supported ring. Each of the cables, crossing relative to the adjoining cables pertaining to the other system, being incident or oblique to said adjoining cables.

In the case of a circular plan the two cable systems can be radially arranged, or so as to be substantially at right angles to the vertical planes tangential to the supporting and supported rings at application locations in the case of an elliptical or polygonal plan.

In a further embodiment said two cable systems can

be arranged so as to envelop the inner ring, being secured thereto at tangential points. This embodiment is advantageous in that the cables of each system would cross to one another, being interconnected thereby at crossing locations, thus providing a more linked reticular carrying or supporting member, to which the coating for the outer covering can be more easily attached.

Further, the supporting cable system preferably comprises a larger number of cables than the stiffening cable system, so as to have for such a coating closer bearing members.

According to a further embodiment, the covering comprises a supporting system including a plurality of reticularly arranged supporting cables, cables supported by at least a supporting ring and mounted so as to shape the surface intended to make up the covering and which are then stiffened and tensioned by a second retaining cable system superimposed to the former, the latter cables being anchored to said ring and possibily to a further ring preferably ground located.

By suitably proportioning the length for the supporting cables and tensioning cables, the shape of the covering surface can be modified according to a wide range. Preferably, the supporting cables are arranged as a network, but in some cases they could be radially arranged, whereas the retaining or tensioning cables, overlapping the supporting cable system, are always reticularly arranged, pressing from top to bottom on the supporting system, so as to tension it, and possibly cooperating therewith to impart a preselected shape to the covering.

This embodiment is particularly suitable for providing coverings in substantially circular buildings which are to present wide peripheral access apertures, such as for example sheds for accomodating stores, vehicles, aircraft hangars or the like.

In this case the retaining cable system will be anchored to an outer peripheral ring and ground at the central area. The covering surface will then take the shape substantially approaching that of two sections of coaxial cones having a different aperture and a common base. However, the same informing concept could be applied for providing a full covering which will have a configuration of a shape opposite to the former, when the supporting cables are stretched between a central post and a peripheral ring of different heights, while the retaining cable system comprises an annular network of cables located above the supporting cables, the linking cables being anchored in this case at the ends of the peripheral ring.

The accompanying drawings show by way of illustrative and not restrictive example some embodiments of the invention, and more particularly:

FIG. 1 is a vertical cross-section A—A of a first embodiment of an annular covering for an elliptical plan building, wherein the two cable systems are substantially radially arranged;

FIG. 2 is a top view of only the supporting cables;

FIG. 3 is a similar view, wherein the only stiffening cables are shown;

FIG. 4 is a top view showing the supporting cables for a second embodiment, wherein the stiffening cables are still substantially radially arranged, whereas the supporting cables are arranged so as to envelop the inner ring, defining the uncovered portion, or portion covered by an auxiliary covering system;

FIG. 5 is a detailed view of section B—B in FIG. 4, wherein only the cables departing from points *a, b, c, d* and *e* have been shown for a clearer representation of the drawing;

FIGS. 6 and 7 show, respectively, in a top view in FIG. 6 the arrangement for the supporting cables and in FIG. 7 the arrangement for the retaining cables, in the

case of a second embodiment, wherein the covering for an annularly shaped building is contemplated;

FIG. 8 is a top view of the supporting cable system as completed with the retaining cable system of said second embodiment;

FIG. 9 is an axial vertical section showing the supporting structure for the covering in FIGS. 6–8;

FIG. 10 is a schematic view showing a modification of said second embodiment for carrying out a full covering of a substantially circular plan building having its covering in the shape of a double cone dome; in one half of said figure only the supporting cables have been shown, whereas both of said two cable systems have been shown in the other half of said figure; and

FIG. 11 is an axial section of the building according to the modified embodiment in FIG. 10.

Referring to the embodiment of FIGS. 1–3, there is generally shown at **1** the framework of a building, particularly a sports ground or other similar building, to be covered only at a peripheral rim by an overhead covering without any inner bearing points.

Said supporting structure **1** is not shown, being conventional per se and receiving but substantially vertical stresses from the covering.

The covering comprises an outer peripheral ring preferably formed of the combination of two rings **2***a* and **2***b*, spaced apart from each other and connected by suitable means **2***c*, so as to provide a single elliptical bond of a suitable height and forming the outer ring, generally designated at **2** in FIGS. 2 and 3.

The connection between the outer rings **2***a* and **2***b* is preferably by latticework members **2***c* and will be so designed as to take into account that said latticework shall also take up the horizontal or sub-horizontal thrusts due to the wind.

Obviously, ring **2** could also be made of a single member of a suitable height, but being less advantageous from an economical standpoint. Instead, the inner ring **3** is made of a single member of a proper height. At **4** and **5** the cables are shown for the two systems, wherein cables **4** are the supporting cables, while cables **5** are the retaining and opposing cables. Thus, an overhead annular structure is provided, the structure of which is substantially rigid and statically defined and adapted to resist both the action of its own weight, water, snow or the like, and that of draughts which may also be directed from bottom to top.

In said covering system rings **2***a* and **2***b*, stiffened by members **2***c*, work under compression, while inner ring **3** works under tension.

The embodiment of FIGS. 4 and 5 substantially similar. Also in this case there are two outer rings **2***a*, **2***b*, joined to each other by connecting members **2***c* and an inner ring **3**.

Said members have been designated by the same numerals, as being identical and working in an equivalent manner. Also the retaining cables **5** are in the same radial arrangement as in the preceding arrangement shown in FIG. 3. For clarity, only some cables **5** have been shown in FIG. 4.

The only difference is that the supporting cables **4***a* are so arranged as to envelop the inner ring **3** and, therefore, extending so that the orthogonal projectiions or plan views thereof envelop the conical projection of ring **3**, these cables being anchored to said supported ring **3** at tangential points.

In both of the embodiments shown, the coating can be provided, by plane sheet elements, such as plate, plastic material, cement, asbestos or the like.

Said coating, as well as rain water gutters **6**, can be secured to support cables **4** or **4***a*; to this purpose, in the embodiment of FIGS. 1–3, the number of these cables is larger than that of cables **5**.

However, nothing would impede that the covering be wholly or partly also supported by said supported or stiffening cables **5**.

Preferably, rings **2***a*, **2***b*, as well as ring **3**, will be made of prefabricated segments, preferably steel segments, which are then joined to one another at site by bolts or welding.

As hereinabove mentioned, on said support ring **3** there could in turn be also carried any suitable covering system, either stationary, or openable, or dismantleable.

Obviously, the supported ring could also be the outer ring and in this case the building would take a mushroom shape with an annular zone outward projecting.

Referring to the second embodiment, as shown in FIGS. 6–9, and relating to an annular plan building, the supporting structure thereof comprises a plurality of peripheral pillars **11** carrying a ring **12** (FIG. 9).

Supporting cables **13** are so arranged as to envelop a circular area **14** (FIG. 6) surrounding an inner open space **17**, which is left exposed or may be occupied by a tower structure, conventionally made and however independent of supporting system **11**. The length or rather the camber for cables **13** when tensioned will depend on the curving which for aesthetic purposes will be possibly desired to be given to the annular connecting area between the ceiling and the inner wall of the so-covered annular building. When desiring to have a substantially planar surface, cables **13** are initially secured according to a substantially horizontal arrangement.

Cables **13** will be crosswise arranged so as to form a first cable network, to which the supporting function of the covering will be assigned.

At **15** there are designated the cables of the second system, such cables being anchored to the ground at a circle **16** internal to and coaxial with circle **14** enveloped by the first cable system **13** and are subsequently anchored to the peripheral ring **12**. Said cables **15** form a second network pressing from the top onto the network formed of supporting cables **13**, tensioning the latter and stiffening the supporting system for the covering, on which any coating system can then be applied.

After tensioning the retaining cables **15** through conventional or less turnbuckle means as carried on ring **12**, the covering system still free of coating will present, as shown in FIG. 9, as an almost planar annular ceiling portion, somewhat inclined to the building axis, or approaching a semi-hyperboloid of rotation, being formed in combination by said two cable systems **13** and **15**, while in the portion surrounding said circular area **17** the only retaininng cables **15** downward extent to anchor to the ground at locations of a ring **16**.

When on assembling no substantial camber is assigned to cables **13**, at the ceiling and innermost wall said annular building will approximately present as comprising two frusto-conical surfaces, having a common base and being formed of right circular cones with downward apexes, the apex of which forming the ceiling has an aperture angle approaching 90°, whereas the lower apex has a very reduced aperture, tending to be almost equivalent to a cylinder.

On increasing the camber, the axial section of the surface forming said walls will take up the configuration of a round surface having a semi-hyperbola as median section.

In the embodiment of FIGS. 10 and 11 it is contemplated to have an entire covering for a building, at the center of which a sturdy pillar **18** is provided, such a building being defined by a plurality of peripheral pillars **1**, or a continuous or discontinuous wall carrying a ring **12***a*.

For clarity, in FIGS. 10 and 11 only a reduced number of cables are shown and the diameter for pillar **18** has been increased.

Supporting cables **13***a* are stretched between the upper edge of pillar **18** and ring **12***a*, preferably according to a network arrangement.

In this case, in order to accomplish the intended function, the reticular system of retaining cables **15***a* is

mounted according to such an arrangement that said cables have as image in a plan view the cords enveloping a more or less wide circle **10**, depending on the desired configuration for the covering, said cables **15***a* being mounted so as to anchored to be capable of downward pulling the supporting cables. Therefore, on assembling completion said covering will have a shape substantially of an inversed configuration with respect to that of the embodiment shown in FIG. 9. In other terms, the covering will comprise an upper central member having a reduced aperture and connecting at base **19** to another lower conical member of a larger aperture, the apexes of both members being upward directed, being it possible to vary said aperture angles by varying the initial camber for the supporting cables **13***a*, so that the larger said camber, the larger the aperture angle for the conical surface defining the peripheral annular covering portion tending to approach a planar horizontal surface and the lesser the aperture angle for the upper cone.

Obviously, the diameter of circle **19** can also be varied to obtain different aesthetical effects.

Rings **12** and **12***a* can be made of reinforced concrete or metal. In this case, they can be prefabricated as segments, interconnectable by suitable means upon laying.

What is claimed is:

I claim:

1. An annular overhead covering comprising an outside supporting ring and an inside supporting ring, each of said rings having a substantial vertical extent, plurality of supporting cables connecting the upper portion of the outer ring with the lower portion of the inner ring and extending substantially tangentially to the inner ring, a plurality of retaining cables connecting the lower portion of the outer ring with the upper portion of the inner ring and extending in a direction generally radial of the two rings, a rigid supporting structure carrying the outside ring and covering means carried by the cables between the rings to cover the space therebetween.

2. The structure of claim **1** in which the covering means is substantially flat and is suspended below the cables.

3. The structure of claim **1** in which the outside supporting ring includes upper and lower ring portions connected by rigid spacing means.

4. The structure of claim **1** in which the number of supporting cables is greater than the number of retaining cables and is sufficient to provide a support for the covering means.

5. The structure of claim **1** in which the entire covering, including the inside ring, is supported, through the outside ring, on the rigid supporting structure.

6. An overhead roofing structure of curved configuration comprising an outer ring, an inner ring surrounded by the outer ring and substantially centered within the outer ring, a rigid structure carrying the outer ring, a first system of supporting cables stretched in the form of a network over the space between the two said rings, a second system of stiffening cables for tensioning the cables of said first system and stretched in the form of a network over said first system, and means to tension said second system of cables, one of said systems of cables being anchored at both ends to said outer ring and extending chordally to said outer ring and tangentially to an imaginary circle whose diameter is less than the diameter of said outer ring, the other of said system of cables extending between and being anchored at one end to the outer ring and at the other end to the inner ring.

7. An overhead roofing structure as claimed in claim **6**, the lengths of the cables of said first system being at least as great as the distance between the anchoring points of said cables whereby the greater is the camber of said supporting cables the less is the radius of curvature of the axial section of the structure.

8. An overhead roofing structure as claimed in claim **6**, said inner ring being supported by the ground, said supporting cables being anchored at both ends to the outer ring and circumscribing in plan said inner ring, said stiffening cables being anchored at one end to the outer ring and at the other end to the inner ring adjacent the ground.

9. An overhead roofing structure as claimed in claim **6**, and a rigid structure carrying the inner ring, said rigid structure comprising a pillar of a height greater than the height of said structure carrying the outer ring, said supporting cables being anchored at one end to said outer ring and at the other end to said inner ring carried by said pillar, said stiffening cables being anchored at both ends to said outer ring and being tangential to an imagitary circle whose diameter is greater than the diameter of the pillar but less than the diameter of said outer ring, said stiffening cables being mounted at heights to engage over said supporting cables to pull said supporting cables downwardly as said stiffening cables are tensioned by said tensioning means.

References Cited

UNITED STATES PATENTS

1,825,800	10/1931	Houseman	52—83
1,885,781	11/1932	St. John	52—83
3,139,957	7/1964	Fuller	52—83
3,153,302	10/1964	Wheeler	52—82

FOREIGN PATENTS

266,692	1963	Australia	52—83
59,386	1967	Germany	52—83
1,469,048	1967	France	52—6

OTHER REFERENCES

Eng. News-Record: Mar. 5, 1959, pp. 30–32.
Eng. News-Record: Aug. 20, 1959, p. 45.

HENRY C. SUTHERLAND, Primary Examiner

U.S. Cl. X.R.

52—6