Feb. 17, 1970 C. H. HARPER 3,495,286

TUNNEL-LIKE STRUCTURES

Filed Jan. 24, 1968

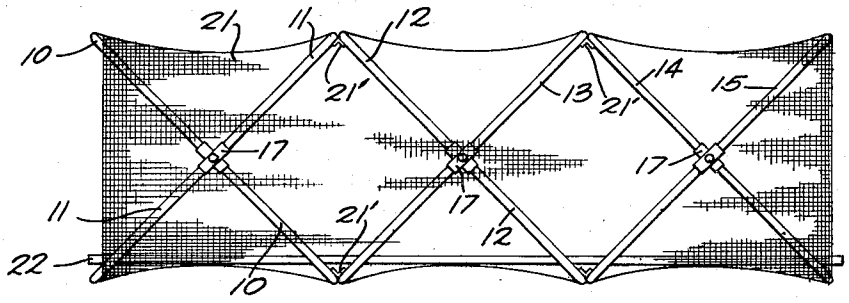


Fig. 1

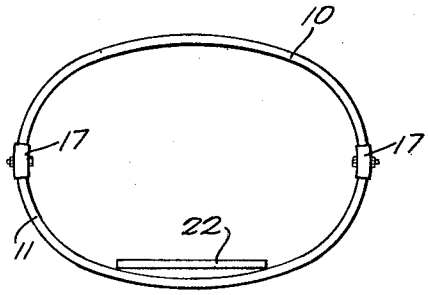


Fig. 2

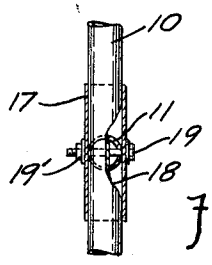


Fig. 3

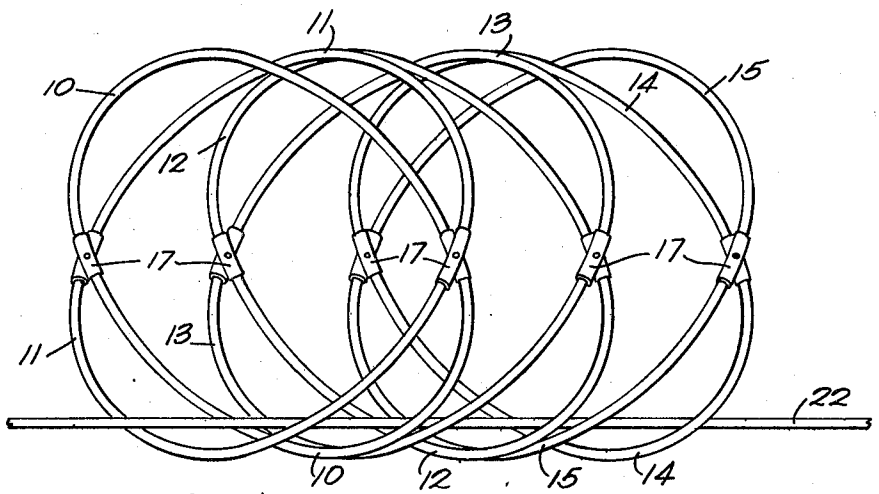


Fig. 4

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TUNNEL-LIKE STRUCTURES

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ABSTRACT OF THE DISCLOSURE

To form a tunnel-like structure a plurality of rings are connected together in angular relationship on a common axis, and a series of said interconnected rings is provided with a tensioned exterior covering to reinforce and support the same, the tunnel-like opening formed by said rings providing a passageway for use as a self-contained bridge for automobiles or pedestrians, or for use in buildings as a combined structural support and heating or cooling duct, as well as other uses.

BACKGROUND OF THE INVENTION

Field of the invention

The present invention pertains to structural supporting members, and more particularly to an integral structural unit of novel design that can be advantageously employed for multiple uses.

Description of the prior art

Heretofore in the construction industry to applicant's knowledge there has never been a self-contained and substantially self-supporting structural unit comparable to the present invention in either design or versatility. As far as applicant has been able to ascertain there are no prior patents nor other prior art anticipating this invention.

SUMMARY OF THE INVENTION

The present invention provides a structure consisting of a plurality of interconnected and angularly related rings which are arranged as a unit on a common axis and reinforced and retained under tension by a skin-like covering consisting of a network of interlaced cables or the like, said cables or other covering coacting with said interconnected ring unit to distribute a load or strain on one portion of said unit evenly about its entire circumference. The result is that said unit can withstand greater loads or stresses than conventional bridges or other structures of standard design without the necessity of supplemental supporting cables, strut, or towers.

BRIEF DESCRIPTION OF THE DRAWING

In the drawing, wherein the same reference numerals designate the same or similar parts in all of the views:

FIG. 1 is a side elevational view of the tunnel-like structure comprising the invention;

FIG. 2 is an end view of said structure

FIG. 3 is an enlarged fragmentary elevational and vertical sectional view showing the interconnection of two right-angularly disposed rings; and

FIG. 4 is a perspective view of a plurality of interconnected ring members prior to the application of the exterior covering thereover, and with a walkway or bottom member positioned therein.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now more particularly to the drawing, the invention comprises a plurality of angularly-disposed circular rings **10**, **11**, **12**, **13**, **14** and **15**, arranged on a common axis and interconnected as shown. While six

of said interconnected ring members are shown in the illustrated form of the invention, there is no limit as to the number of similarly connected rings that can be utilized in accordance with the present invention, and the invention is by no means to be confined in this respect.

As best appears in FIGS. 1 and 4, said rings **10**–**15** are connected in crossed pairs, the rings **10** and **11** being joined at the points where they cross by brackets **17**, the rings **12** and **13** being similarly connected, and the ring **14** being similarly connected to the ring **15**. While it is preferred to arrange said rings at right angles to each other this is not critical and other angular relationships could be employed.

One suitable form of connecting bracket is shown in FIG. 3 of the drawing, and it will be noted therein that said bracket includes a tubular member **17** surrounding a portion of the ring **10**, and within said tubular bracket the ring **10** has a portion **18** of reduced diameter. Similarly, the ring **11**, which is arranged at a right angle to said ring **10**, has a complementary portion of reduced diameter, thus providing a thickness at the point where said rings cross no greater than the normal diameter of said individual rings. A connecting bolt **19** is projected through said crossed ring portions, as well as through the tubular bracket **17**, and a nut **19'** threaded onto the end of said bolt securely joins said ring members together. As mentioned, said illustrated bracket and connecting bolt assembly is merely one suitable means of securely joining the rings in the desired angular relationship. Numerous other equivalent connecting means could also be employed, however, and the invention is not to be limited in this respect.

While the illustrated bracket members **17** are designed to retain the interconnected rings in a rigid, non-pivotal manner, it is contemplated that for many uses it might be advantageous to have said rings pivotally connected, or at least pivotal within prescribed limits, as will be hereinafter described in greater detail.

With reference again to FIG. 1, it will be seen that in the complete structure the first pair of interconnected rings **10**, **11** is rigidly joined to the second pair of rings **12**, **13**, by means of suitable connectors **21'** joining the points on their circumferences at which said rings meet, which is the uppermost points of the rings **11** and **12**, and the bottommost points of the rings **10** and **13**. The interconnected rings **12**, **13** are similarly joined to the rings **14** and **15** by connectors **21'**, as shown. In addition to the connectors **21'** joining said angularly-disposed rings, it might be preferred in some installations to also include vertically-arranged rings (not shown) interposed between said biased rings to add strength and rigidity to the structure.

In the complete assembly of the tunnel-like structure comprising the present invention, after a desired number of rings has been joined together as described, which can be accomplished quickly and without the necessity for sepecial equipment or tools, a skin-like covering of interlaced wire cables or mesh **21** (FIG. 1), or other desired material, is secured to and stretched tautly around the exterior of said rings. Said covering is connected to each of said rings and is applied under predetermined and controlled tension, thus functioning to reinforce said rings and to form an integral unit which is retained under tension.

A flat walkway or roadway **22** (FIGS. 2 and 4) can be positioned and secured in the bottom of said tunnel-like unit, and when anchored at its ends said unit can be utilized as a self-contained bridge. As mentioned, with the novel structure comprising the persent invention it is ordinarily unnecessary to employ elaborate supporting towers and coacting cables as in conventional suspension bridges, inasmuch as the present structure is a self-supporting.

integral unit. In some situations, as when the unit is utilized as a bridge over a river or the like, it may be desirable to employ cables between the ends of said unit and some type of permanent support to provide additional continuous tension, and in the case of a bridge of substantial length it might be preferred to utilize some support intermediate the length of said bridge. In many applications, however, the use of such supplemental supporting devices is unnecessary.

Due to the substantially cylindrical form of the present unit, and the fact that the entire structure is unitized by the tensioned exterior covering thereon, weight loads or stresses placed on one portion thereof, as for example by the weight and compression of a vehicle on the bottom member **22**, are distributed evenly about the entire circumference of said unit. Moreover, and as hereinabove described, the pin members **19** connecting the adjacent rings can be designed to permit limited pivotal movement of said rings relative to each other. As a result, any load on the bottom of the structure which tends to spread the lower portions of the interconnected rings will cause a simultaneous and equal spreading of the upper portions of said rings, thus providing an increased tautness or tensioning of the covering **21** therebetween to transfer and distribute the tension and stress on the lower portion of said structure evenly about its entire circumference. The result is that said unit can withstand or accommodate greater loads without requiring supplemental supports than is possible with bridges of conventional design.

A further important advantage of the present bridge structure is the unique manner in which it can be assembled, section by section. In this respect, a pair of rings, as for example the rings **15** and **14** (FIG. 1) can be joined together and reinforced as described, and anchored on one side of a river or the like which the bridge is intended to span. Another section, as for example the rings **13** and **12** can then be assembled on land and workmen supported on the first section can join said second section to the outer end thereof. The next section can be similarly assembled and secured to the end of the outermost section, and so on until the number of sections necessary to span the entire river have been joined together to form an integral unit. Thus, in accordance with the present invention the entire bridge can frequently be constructed without the necessity of using supporting towers or barges and other complex and expensive supplemental equipment ordinarily required in the construction of bridges. Supports or towers intermediate the length of the bridge might be desirable with bridges of unusual length, of course, as well as during the construction of some bridges, but even in such instances the number and massiveness of said supports is substantially less than is required with bridges of conventional design.

Another important feature of the present invention, in contrast to conventional bridges, is that it can be deflected or curved, which is accomplished merely by increasing the cover tension along one side thereof. Thus by putting predetermined tension on and constricting the covering on one side of said tunnel-like structure it can be curved or deflected to the exact degree desired, which can be useful in bypassing natural obstacles or the like, or in numerous other instances wherein it might be advantageous to employ a curved bridge. In addition to permitting the curvature of said structure in a horizontal plane, vertical deflection can also be achieved by increasing the tensioning on the upper or lower surface of said structure, as desired. If the unit is to be used as a walkway over a road or street, for example, by applying predetermined increased tension and constriction to the underside thereof said tunnel-like structure can be formed in an arc over said road.

While many suitable materials could be utilized to form the rings and covering used in the present invention, the invention is not to be limited in this respect, and it is contemplated that said members could be advantageously formed of aluminum to obtain both strength and durability with lightness in weight. In its disassembled condition, the lightweight and compact sections could be easily transported by army troops and the like, and then quickly assembled when it is desired to bridge a river.

As hereinabove mentioned, the novel structure comprising the present invention has numerous applications in addition to its use as a bridge. It could be utilized as an underground tunnel or roadway, for example, or in conjunction with a monorail train system, or it could used as a support in the construction of buildings.

When used in the building industry, the present tunnel-like structure can be employed as a supporting beam or joist for floors or ceilings, its strength and lightness in weight making it advantageous for this purpose, and it could also simultaneously serve as a duct for hot air or air conditioning systems, thus performing a dual function that is unavailable with present construction members. While the present structure will probably usually be utilized as a horizontal joist or support, it could also be mounted vertically if desired. When used in a building as a combination support and air duct a covering of flexible sheet aluminum or the like is employed in lieu of the wire mesh or interlaced cables hereinabove described, and said covering can be waterproofed to permit the use of said duct as a water conduit if desired.

From the foregoing detailed description it will be seen that the present invention provides a novel structural unit unlike conventional building structures intended for the same purposes, and which new unit has several important advantages over said prior devices. The present structure consists of a plurality of interconnected and angularly related rings which are arranged as a unit on a common axis, and which are reinforced and retained in position by a skin-like tensioned covering which functions to distribute a load or strain on one portion of said unit evenly about its entire circumference. The result is that the present invention can accommodate greater loads or strains than structures of standard design without the necessity for intermediate or supplemental supporting members. In addition, said novel structural unit is easy to assemble, it can be made lightweight and compact for easy transportability, it can be deflected or curved as desired, and it is versatile and can be utilized in numerous diverse ways in the construction and other industries.

It is to be understood that while a preferred embodiment of the invention has been illustrated and described herein, numerous variations therein are possible. What is intended to be covered herein is not only the illustrated form of the invention but also any and all variations or modifications thereof as may come within the spirit of said invention, and within the scope of the following claims.

What I claim is:

1. A tunnel-like trafficway structure comprising: a plurality of sections each formed of a crossed pair of rings joined together in angular relationship; means interconnecting sections in end-to-end, communicating relationship; a travelway supported within and extending through said interconnected ring sections; a covering surrounding the exterior periphery of said interconnected ring sections, said covering being applied under tension to reinforce said rings and to form an integral, tunnel-like structure for the passage of traffic.

2. The tunnel-like trafficway structure recited in claim **1** and including means joining said angularly-disposed rings in a manner permitting relative pivotal movement of the same.

3. The structure recited in claim **2** wherein the rings in each of said ring pairs are relatively pivotal within predetermined limits, and wherein a spreading movement of the lower portions of said interconnected rings in response to a load on said structure causes a comparable spreading action of said ring upper portions with a consequent substantially uniform tensioning of said skin-like peripheral covering which functions to distribute the force of

said load substantially evenly about the entire circumference of said structure.

4. The structure recited in claim 3 wherein said covering comprises a series of interlaced cables applied to the exterior of said rings under predetermined tension.

5. The structure recited in claim 3 wherein said tunnel-like trafficway is self-supporting and does not require any supplemental support means intermediate its length.

6. The structure recited in claim 3 wherein said tunnel-like structure can be curved in a vertical or horizontal plane by the application of predetermined tension and constriction along a selected side of said covering.

7. The structure recited in claim 3 wherein said tunnel-like structure is adapted to be used as a bridge, and wherein one of said sections can be anchored on one side of an area to be spanned and a plurality of sections connected to the outer end thereof, section by section, until

a sufficient number of sections have been connected together to span said area.

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