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Ouellet

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[45] **July 31, 1973**

[54] **BUILDING STRUCTURE WITH COMPOSITE ARCHED UNITS AND METHOD OF CONSTRUCTION THEREOF**

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[52] **U.S. Cl.** **52/86,** 52/724

[51] **Int. Cl.** **E04b 1/32**

[58] **Field of Search** 52/86, 80, 724, 725, 52/653, 335, 336

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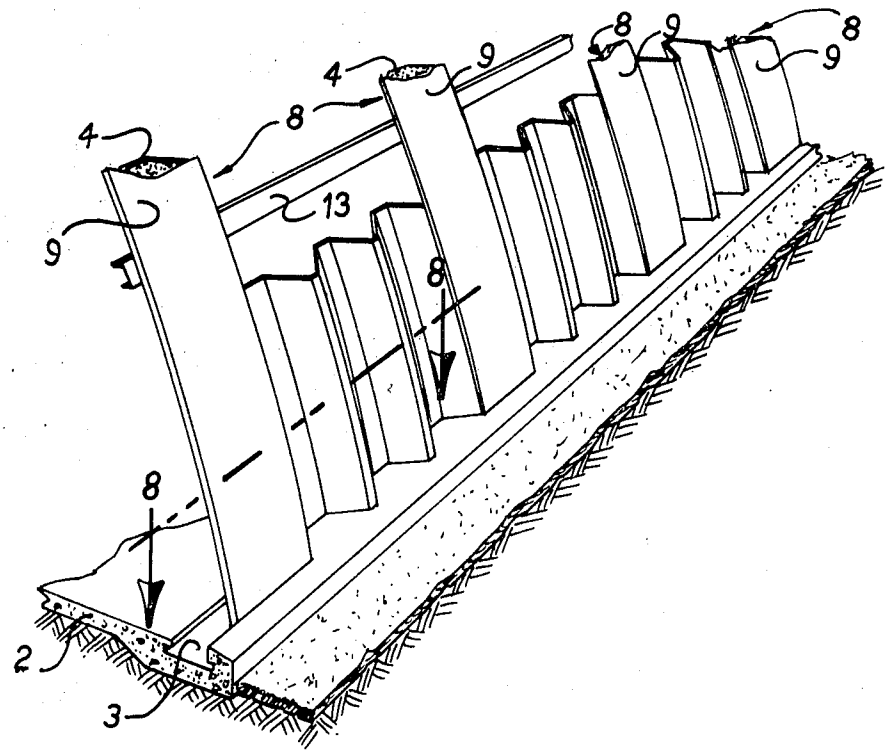
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Assistant Examiner—Henry E. Raduazo
Attorney—Pierre Lesperance

[57] **ABSTRACT**

A method of constructing a composite arch beam of concrete in situ to strengthen either an existing building structure or one under construction and a building structure including at least one composite arched unit arranged to strengthen the same. In a building structure including a plurality of elongated structural arched units arranged side by side in contiguous relationship, at least one composite arched units amongt the other arched units, each composite arched unit including an elongated reinforcing beam structure having a transverse cross section forming a closed plane figure defined by trussing or by a concrete beam formed into an enclosed arch shape space.

3 Claims, 16 Drawing Figures



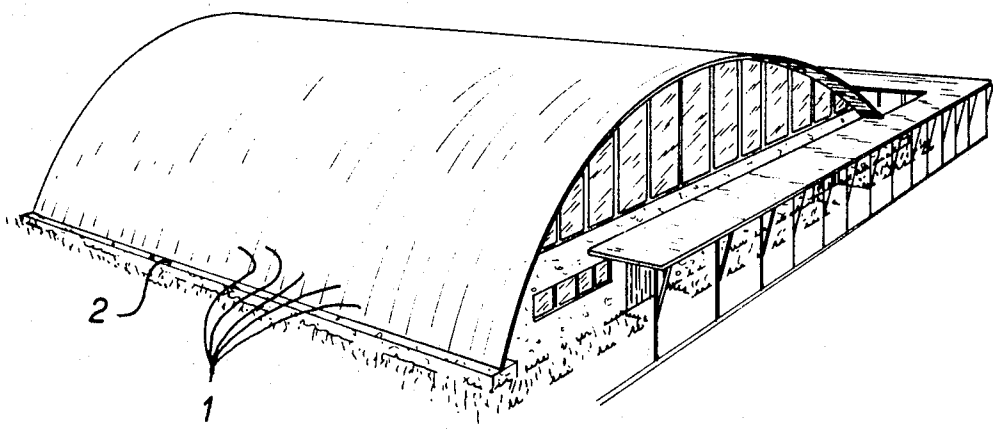


FIG.1

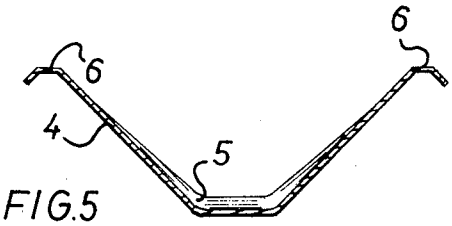


FIG.5

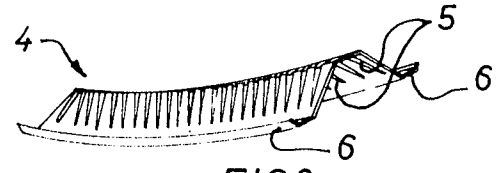


FIG.3

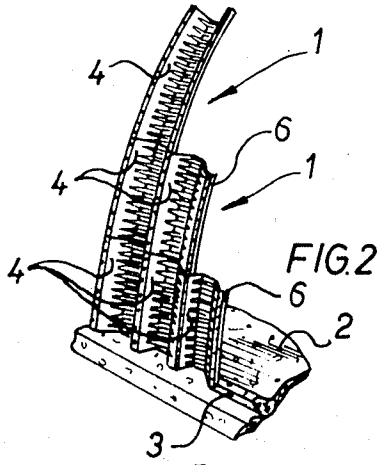


FIG.2

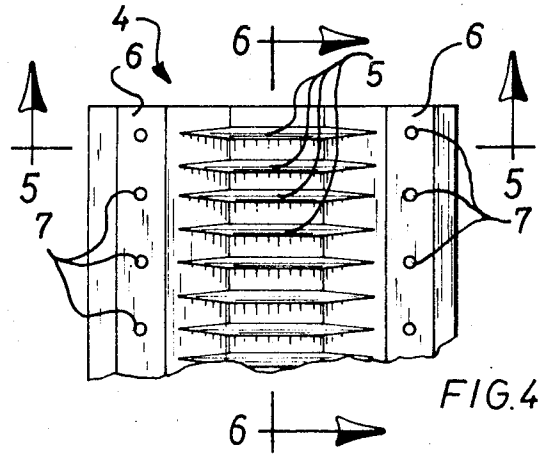


FIG.4

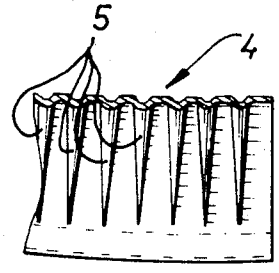


FIG.6

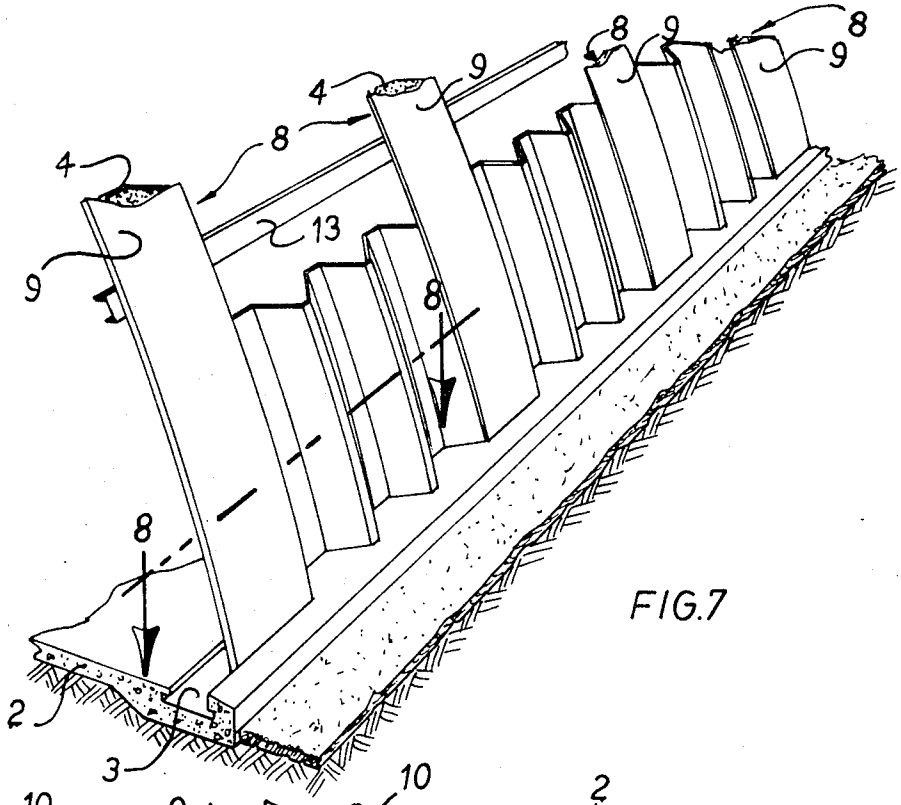


FIG.7

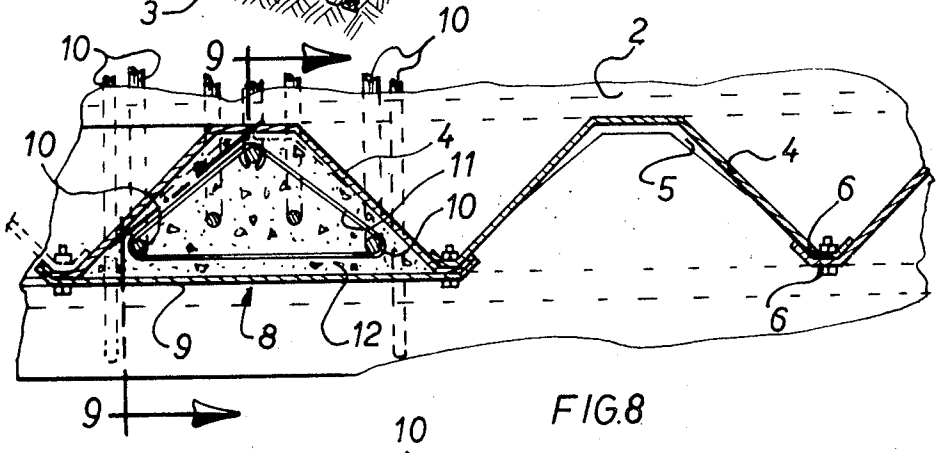


FIG.8

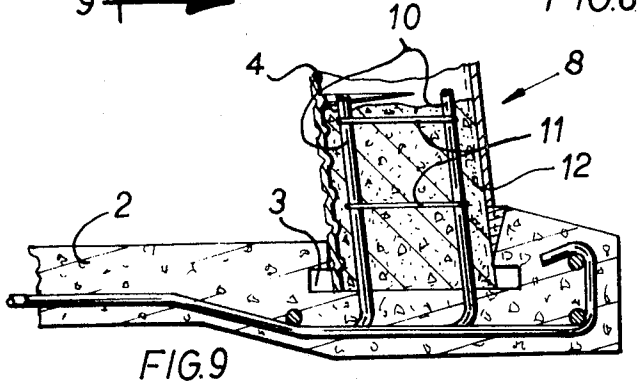


FIG.9

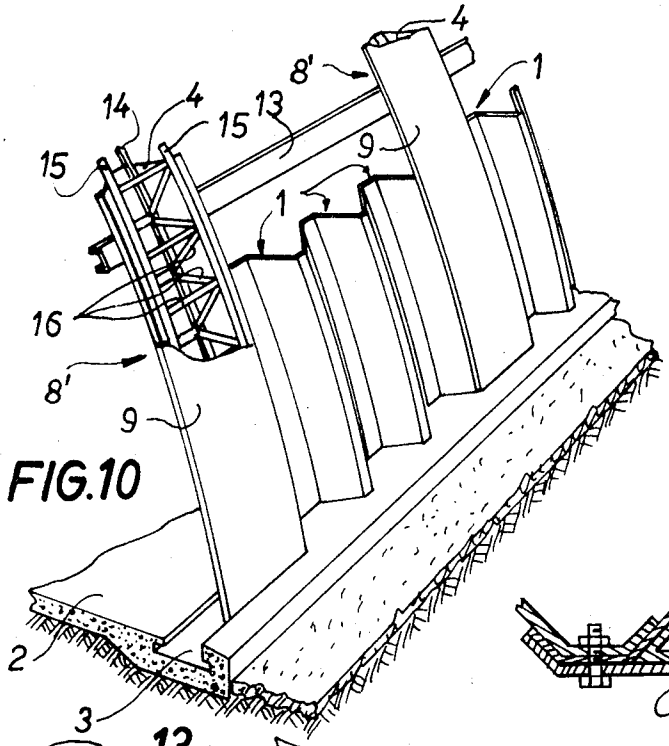


FIG.10

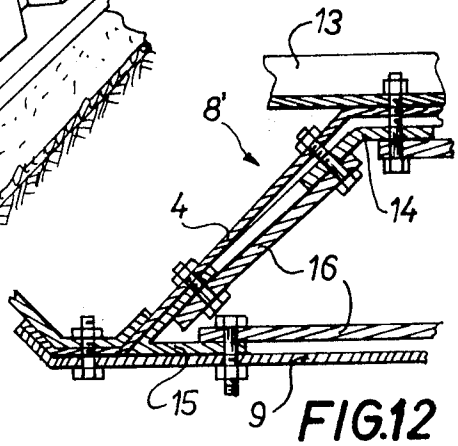


FIG.12

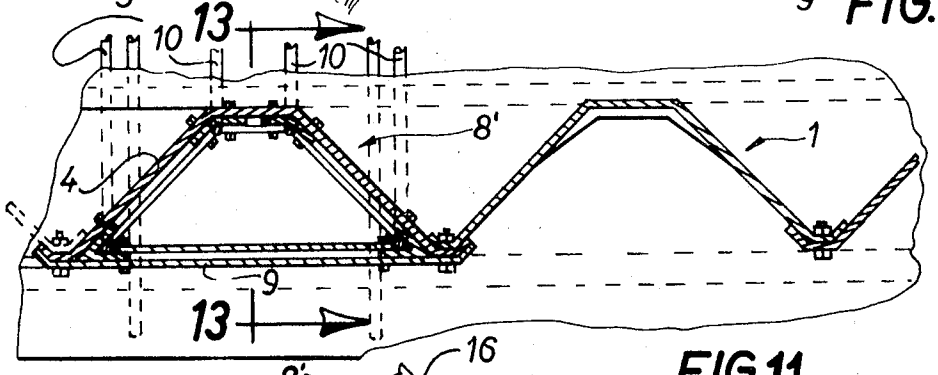


FIG.11

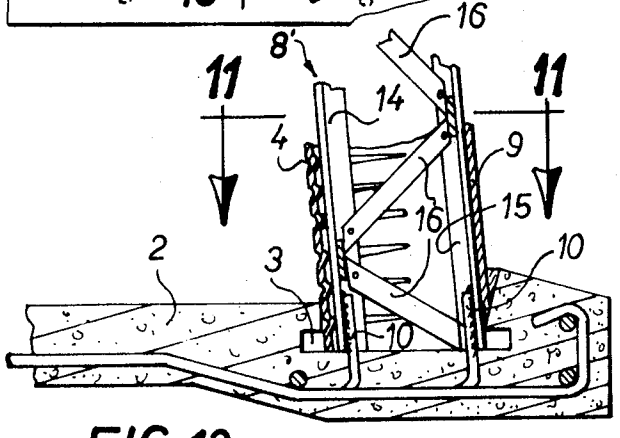


FIG. 13

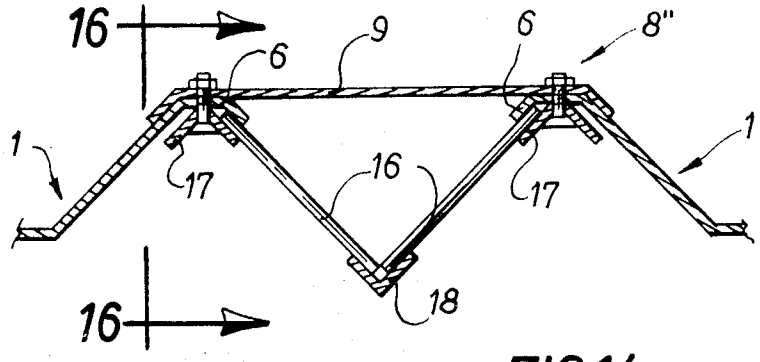


FIG. 14

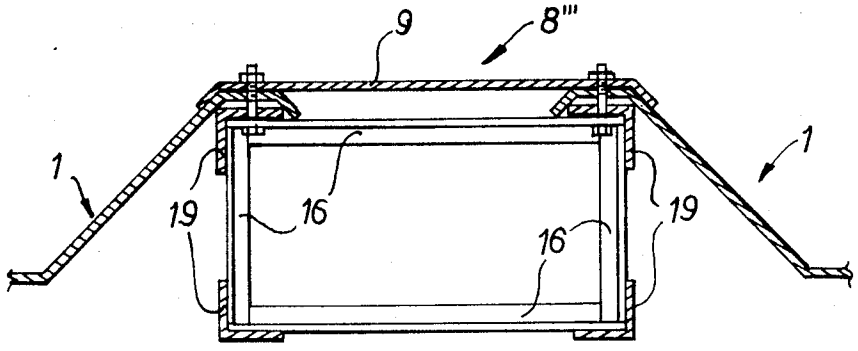


FIG. 15

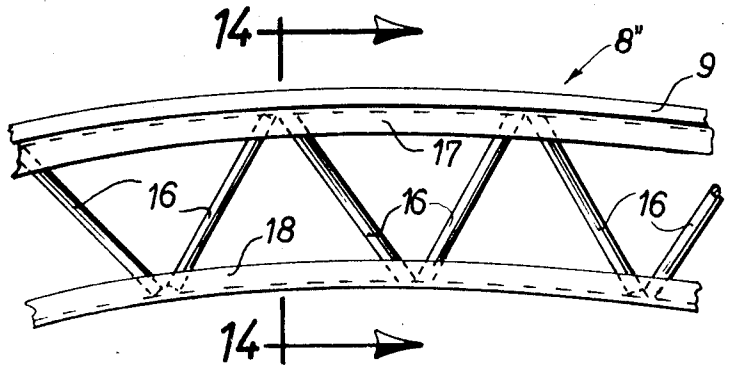


FIG. 16

BUILDING STRUCTURE WITH COMPOSITE ARCHED UNITS AND METHOD OF CONSTRUCTION THEREOF

The present invention relates to buildings and, more particularly, to a building structure of the type including a plurality of prefabricated structural arched units which are assembled side by side and to a method of strengthening anyone of the arched units.

There are presently known building structures of the above type which are particularly adapted for warehouses, hangars, or public buildings such as arenas, civic centers and the like. The prefabrication and clear span features make such building structures attractive for the above applications wherein the building structures are usually required to carry only limited loading.

The present invention proposes to increase the utility of a building structure of the above type by strengthening at least one of the arched units thereof, such as to increase the load supporting capability of at least a section of the building structure and to also increase the maximum allowable clear span thereof.

It is a general object of the invention to provide a building structure of the above type with at least one strengthened arched unit.

It is a more specific object of the invention to provide a building structure of the above type having at least one composite arched unit which is strengthened by combining a concrete arched beam therewith.

It is another object of the invention to construct building structures of the above type and to strengthen existing ones by forming one or more concrete arched beams in situ therewith.

Other objects and advantages of the invention will become apparent in the light of the following detailed description of preferred embodiments of the invention which are illustrated, by way of example only, in the accompanying drawings, in which:

FIG. 1 is a perspective view of a building structure of the above type, as known in the prior art;

FIG. 2 is a partial perspective view of structural arched units constructed and arranged as known in the prior art;

FIG. 3 is a perspective view of a section or panel arranged to form part of a structural arched unit, as known in the prior art;

FIG. 4 is a front view of one end of a section or panel as shown in FIG. 3;

FIGS. 5 and 6 are cross-sectional views as seen along lines 5—5 and 6—6 respectively in FIG. 4;

FIG. 7 is a partial perspective view of a building structure constructed according to a first embodiment of the invention;

FIG. 8 is a cross-sectional view as seen along line 8—8 in FIG. 7;

FIG. 9 is a cross-sectional view as seen along line 9—9 in FIG. 8;

FIG. 10 is a partial perspective view of a building structure constructed according to a second embodiment of the invention;

FIG. 11 is a cross-sectional view as seen along line 11—11 in FIG. 13;

FIG. 12 is an enlarged partial view of FIG. 11;

FIG. 13 is a cross-sectional view as seen along line 13—13 in FIG. 11;

FIG. 14 is a cross-sectional view as seen along line 14—14 in FIG. 16 of a third embodiment of the invention;

FIG. 15 is a cross-sectional view of a fourth embodiment of the invention; and

FIG. 16 is a side view of the third embodiment of which FIG. 14 is a transverse cross-section thereof.

Reference will first be made to FIGS. 1 to 6 inclusive for a description of a structural arched unit according to the prior art, to which the present invention is applied.

The building structure of the above type, usually the outside shell of a building, as shown in FIG. 1, includes a plurality of elongated arched units 1 erected side by side in contiguous relationship and having opposite ends firmly supported, preferably by a concrete base 2. The latter is provided with a channel 3 into which the structural arched units 1 rest endwise.

Each structural arched unit 1 is formed from a number of sections or sheet metal trough members 4 assembled end to end in overlapping relationship to form a structurally sound joint. Each trough member 4 is longitudinally arc shaped to ultimately form an arched unit when assembled end to end to other similar trough member. Each panel 4 is transversely formed, such as by folding, bending or stamping, to define a generally V-shaped cross-section with a transversely flat bottom and diverging wings each having a laterally outwardly protruding flange at its outer edge. The bottom of the trough members is disposed on the inside of the arched unit 1.

Each trough member 4 is provided with transverse corrugations 5 to increase the transverse buckling resistance thereof. The lateral flanges 6 of each trough member 4 are provided with holes 7 and are formed for overlapping engagement and securement of one flange of one panel 4 with one flange of an adjacent similar trough member 4, as can be seen in FIG. 8.

The invention will now be described in details and consists in reinforcing or strengthening a building structure by at least one elongated composite arched unit including an elongated reinforcing beam structure joined to at least one adjacent arched unit.

In the preferred embodiment of the invention which is illustrated in FIGS. 7, 8 and 9, the invention consists in forming at least one composite arched unit 8 including, and more precisely enclosing an elongated reinforcing arched beam or beams of concrete in a building structure of the above type. The composite arched unit 8 is produced by fixing a rectangular transversely flat sheet metal cover panel 9 to confining the opposite lateral flanges 6 of the series of panels 4 forming a structural arched unit 1. The cover panel 9 is composed of a single piece or of a series of interconnected sections, not shown, arranged in end-to end relation. The assembly of a cover panel 9 with an arched unit 1 defines a completely confined arch shape space, as can best be seen in FIG. 8.

Reinforcing bars 10 are positioned inside the above arch shape space lengthwise thereof and are retained together by transverse wires 11 or the like. Bars 10 are preferably disposed above and below the transverse neutral axis of the trough member 4. Concrete 12 is poured into and fills the above arch shape space to form a concrete arched beam inside the latter. Preferably, the bars 10 extend into the base 2 to firmly anchor

the arched beam, as is well known in the construction field.

Whether for strengthening an existing building structure of the above type or upon construction of such building structure, the following methods are adapted to form concrete arched beam or beams.

Reinforcing bars **10** are positioned into the trough of the structural arched unit which it is desired to strengthen. The sections of a plate **9**, for instance of galvanized steel, are successively fixed against the opposite lateral flanges **6** of the series of trough members **4** forming the selected structural arch unit **1**. An opening is left at the uppermost point of the concerned unit **1** for access into the otherwise completely confined arch shape space defined by the plate **9** and the arched unit **1**. Concrete is poured into that space to completely fill the same whereby, upon solidification of the concrete, forms an arched beam.

As an alternative method, the reinforcing bears **10** are positioned and, thereafter, the concrete is poured by sections in a vertically progressing sequence following the similar sequence of erection of the selected arched unit **1** and fixing of sections of the plate **9** thereto.

The number of composite arched units (arched beams) **8** and the spacing thereof may be selected to suit any particular application. Generally, a building structure will, as shown in FIG. **7**, include a plurality of strengthened or composite arched units spaced from each other and separated by at least one non-strengthened or regular arched unit **1**. A brace or stiffener member **13**, in such case, preferably connects the intermediate arched units **1** to the composite arched units **8**.

Particular reference will now be made to FIGS. **10** to **13** inclusive to describe another embodiment of the invention comprising composite arched units **8'** each including an elongated reinforcing beam made with trussing, arranged to be laterally joined to at least one adjacent arched unit and having, like the other reinforcing beams Of the invention, a transverse cross section forming a closed plane figure, as best seen in FIG. **11**.

As for the case of the previous embodiment, the composite arched units **8'** are laterally juxtaposed to other arched units such as the arched units **1** and preferably interconnected by longitudinal braces or stiffeners **13** while erected endwise into the channel **3** of a concrete base or slab **2**. The latter is in this embodiment also preferably provided with reinforcing bars **10** having a free end extending upright into the channel **3** for fixing the arched units **1** and **8'** thereto. The composite arched unit **8'** includes an elongated arched panel structure made of a single panel or a plurality of sections **4** and an exterior panel or sections **9** as for the reinforcing beam of concrete previously described.

Within the arch shape space defined by the panels **4** and **9**, an elongated reinforcing beam of trussing is positioned and joined to the adjacent or juxtaposed arched units **1**, as shown in FIGS. **11** and **12**. The trussing includes longitudinal members **14** and **15** which are interconnected by transverse members **16** crisscrossing intermediate thereof and such as to form a polygonal cross section with the members **14** and **15** along the angles of the polygon and the members **16** along the sides of the latter.

The longitudinal members **14** and **15** are preferably angle-shaped in cross section such as to substantially match the internal angles formed by the panels or sections **4** and **9**. The members **14, 15** and **16** are preferably assembled by nuts and bolts, as illustrated, and may be advantageously prefabricated for quick erection on the site. It must be also noted that the trussing defined by the members **14, 15** and **16** are bolted or otherwise joined to the adjacent arched units **1**, as shown in FIGS. **11** and **12** to transmit rigidity and anti-buckling resistance thereto.

As can be seen, the above defined reinforcing trussing is particularly advantageous to strengthen or reinforce an already erected building since it can be readily added thereto without substantially altering the basic structure. For instance, the trussing is merely added into the fold of every fourth, fifth, sixth ordinary or standard arched unit **1**, or as desired for the particular application.

In the further embodiment of FIGS. **14** and **16**, the combined arch unit **8''** includes the exterior panel or sections **9** but does not include the panel or sections **4** as in the previous embodiments. In such case, a trussing of greater depth or cross section may be joined laterally to adjacent arched units **1**. In this embodiment, the elongated reinforcing beam structure is defined by the trussing which has a transverse cross section forming a closed plane figure or polygon with the panel **9** forming one side thereof. The other sides of the polygon are formed by the transverse members **16** which are crisscrossing intermediate longitudinal members **17** and **18**. It may be noted that the members **17** and **18** can be similar and that the transverse members are clamped against the folded portion of the lateral edges **6** by the longitudinal members **17** secured by bolts or the like, as shown in FIG. **14**.

In FIG. **15**, a still further embodiment of the invention is illustrated showing a composite arched unit **8'''** including the exterior panel or sections **9** but no panel or sections **4** as in the embodiment of FIGS. **14** and **16**. The combined arched unit **8'''** includes an elongated reinforcing beam structure formed of trussing having a rectangular cross section. The rectangular trussing still includes transverse members **16** crisscrossing along the sides of the rectangle between the longitudinal members **19** at the four angles thereof.

It must be noted that the trussing is always joined to the laterally adjacent arched units by bolts in order to provide for easy installation while any angle of the trussing which does not engage the adjacent panels or units may be either bolted or welded and preformed.

Obviously, any trussing according to the invention may be advantageously pre-assembled to cut down the erection time on the site and disruption of the normal activities when strengthening an occupied building structure.

I claim:

1. An arched building structure comprising a plurality of similar elongated arched units disposed side by side in adjoining relation to form a continuous shelter membrane, each arched unit composed of a plurality of similar sheet metal trough members secured to each other in end-to-end relation and in alignment, each trough member having a generally V-shaped cross-section with a transversely flat bottom and diverging side wings and a laterally outwardly protruding flange at the outer edge of each wing, each trough member being longitudinally arched, the bottom of the trough member being on the inside of the arched unit, said

bottom and side wings being corrugated transversely of the trough member, the flanges of the trough members of any arched unit being directly secured in overlapping relationship to the side flanges of the trough members of adjacent arched units, at least some non-adjacent arched units being strengthened, said strengthened arched units further including a series of transversely flat rectangular sheet metal cover members secured to said flanges and extending across the top of said trough members being in end-to-end alignment over the entire length of said arched unit, said cover members closing the top of said trough members and defining a closed space in said strengthened arched unit, concrete filling said space, and armature rods embedded in said concrete and extending longitudinally of said strengthened arched unit.

2. In a building structure as claimed in claim **1**, wherein each trough member has a transverse neutral axis intermediate its bottom and said lateral flanges, some of said armature rods extending above and others of said armature rods extending below said neutral axis.

3. In a building structure as claimed in claim **2**, wherein said strengthened arched units are separated laterally from one another by at least one non-strengthened arched unit.

* * * * *