United States Patent

Drury

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[54] STRUCTURAL SPAN

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[21] Appl. No.: **107,159**

[52] **U.S. Cl.** **14/1**, 14/19, 46/17, 59/78, 238/10

[51] **Int. Cl.** **E01d 1/00**

[58] **Field of Search** 94/4, 11, 13; 14/1, 7, 18–20; 46/17, 23; 238/14, 10; 59/78, 80; 52/690, 581

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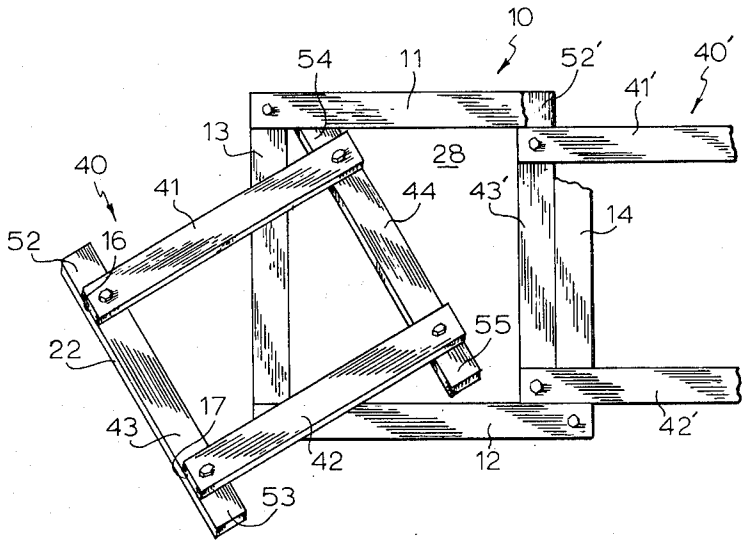
Attorney—Murphy and Dobyns

[57] **ABSTRACT**

A system for constructing a structural span comprising two types of structural components. The components of the first type each comprise a pair of first longitudinal members parallel to each other, and a pair of first transverse members connected to the bottom of the first longitudinal members. The components of the second type each comprise a pair of second longitudinal members parallel to each other and spaced to lie inside of and parallel to the first longitudinal members; and a pair of second transverse members connected to the bottom of the second longitudinal members. The second transverse members are adapted to extend underneath the first longitudinal members. The first longitudinal members and the first transverse members define an opening of a size to permit the passage of the second transverse members of each of two structural components of the second type in order to permit assembly of the span from its components.

9 Claims, 12 Drawing Figures



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SHEET 1 OF 2

FIG. 1

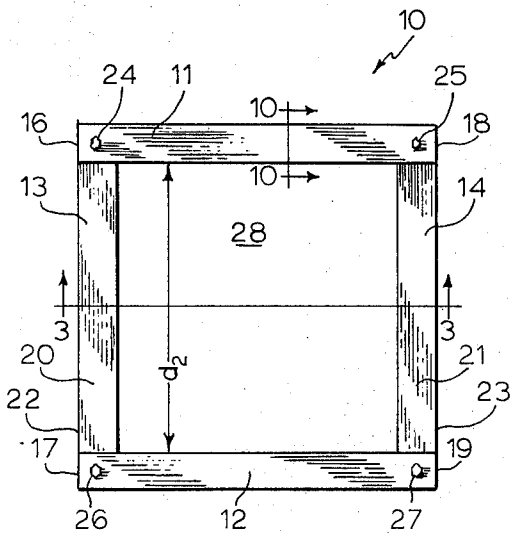

FIG. 2

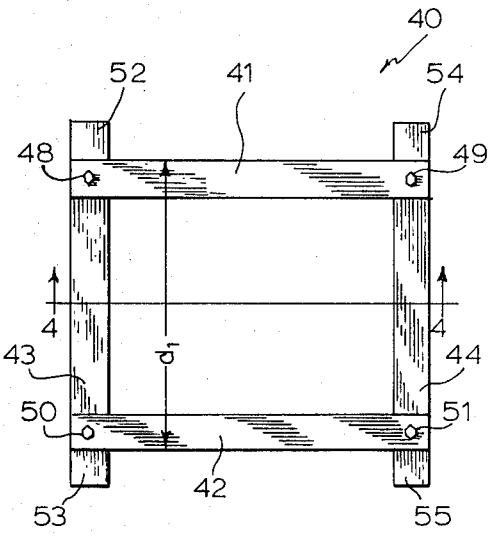

FIG. 3

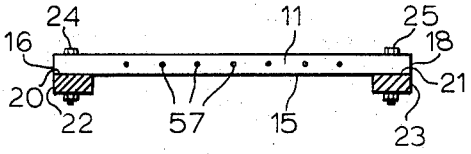

FIG. 4

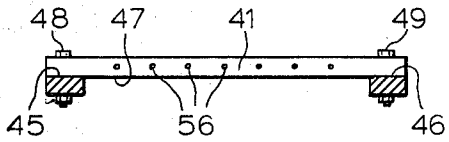

FIG. 5

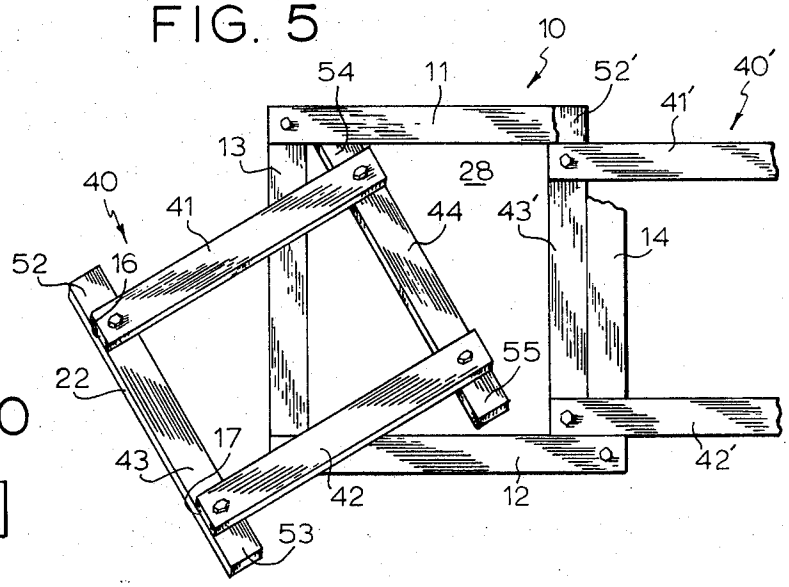

FIG. 10

FIG. 11

FIG. 12

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FIG. 6

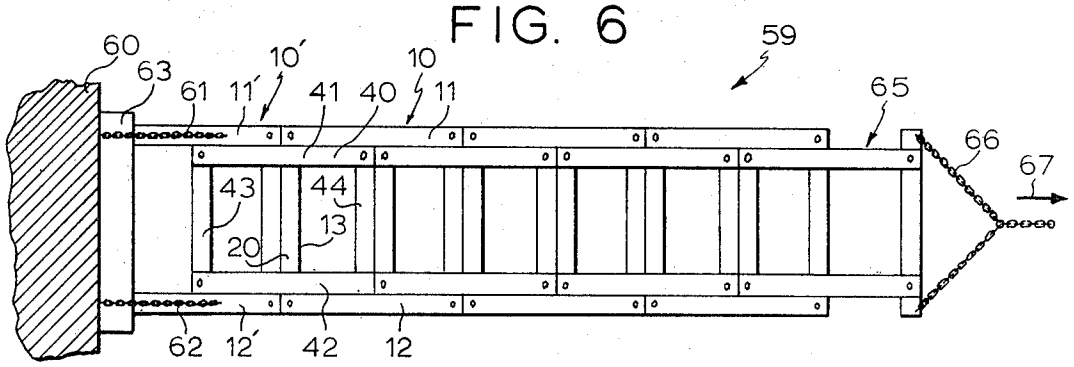


FIG. 7

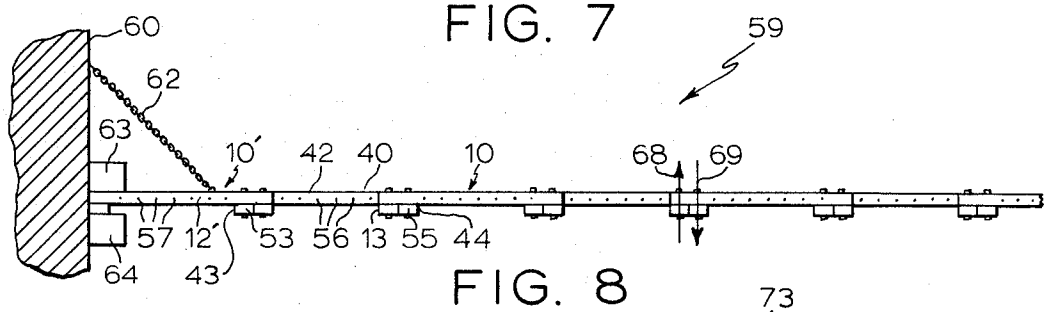


FIG. 8

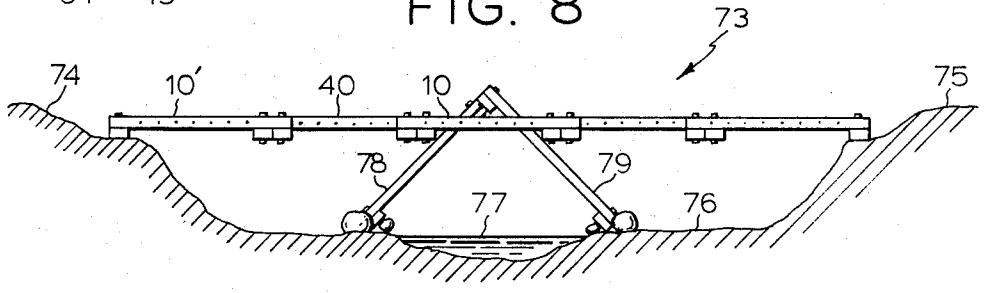
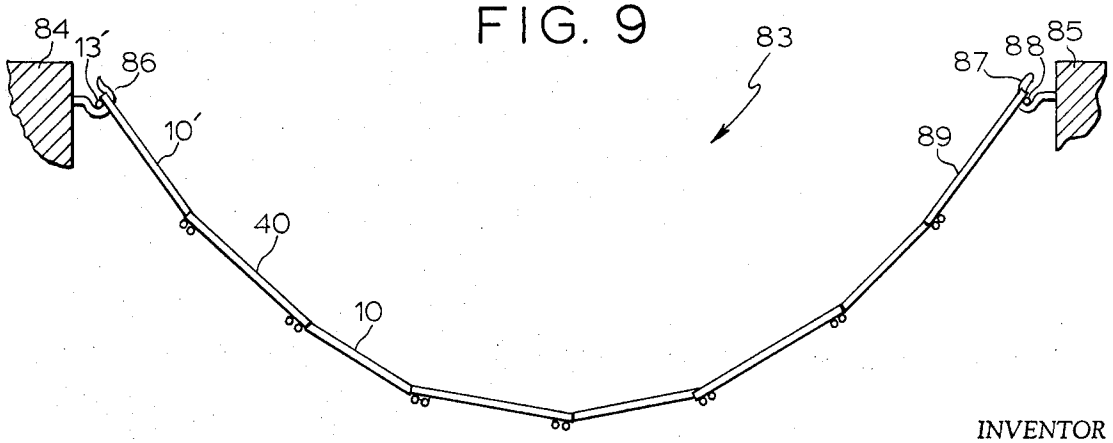


FIG. 9



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STRUCTURAL SPAN

This invention relates to a system for constructing a structural span such as a bridge.

Structural spans such as those employed in temporary bridges are well known and are frequently employed in temporary highways in expanding suburban areas and in remote areas by the armed forces. These temporary bridges suffer from a number of disadvantages such as the complicated nature of their construction and their inability to be constructed as a cantilever without being supported at both ends. Few if any of these temporary bridges can be constructed as catenary suspension bridges.

Accordingly, it is an object of the present invention to provide a structural span which is substantially free of one or more of the disadvantages of prior structural spans.

Another object is to provide a structural span which can be simply constructed into a bridge.

A further object is to provide a structural span which can be constructed in a cantilever arrangement.

A still further object is to provide a structural span which can be constructed in a catenary suspension arrangement.

Yet another object is to provide a cantilever span which can be constructed in an unexpanded state and which can be subsequently expanded to form a complete bridge.

Additional objects and advantages of the present invention will be apparent to those skilled in the art by reference to the following detailed description thereof and drawings wherein:

FIG. 1 is a plan view of a structural component of a first type employed in constructing the structural span of the present invention;

FIG. 2 is a plan view of a structural component of a second type employed in constructing the structural span of the present invention;

FIG. 3 is a sectional view taken along the line 3—3 of FIG. 1;

FIG. 4 is a sectional view taken along the line 4—4 of FIG. 2;

FIG. 5 is a partially cut away plan view showing the manner in which the components of FIGS. 1 and 2 are attached to each other to form a structural span of the present invention;

FIG. 6 is a plan view of a cantilever span constructed according to the present invention in its unexpanded state;

FIG. 7 is an elevation view of the span of FIG. 6 after it has been expanded;

FIG. 8 is an elevation view of a bridge employing the span of the present invention supported near the center thereof;

FIG. 9 is an elevation view of a suspension bridge employing the span of the present invention;

FIG. 10 is an enlarged sectional view taken along the line 10—10 of the FIG. 1; and

FIGS. 11 and 12 represent other cross-sectional forms which are alternatives to that shown in FIG. 10.

According to the present invention there is provided a system for constructing a structural span comprising two types of structural components. The structural components of the first type each comprise a pair of first longitudinal members parallel to each other and a pair of first transverse members connected to the bottoms of the first longitudinal member by high tensile strength means such as bolts. The structural components of the second type each comprise a pair of second longitudinal members parallel to each other and spaced to lie inside of and parallel to the first longitudinal members of the structural component of the first type. The structural component of the second type further comprises a pair of second transverse members connected to the bottoms of the second longitudinal members by high tensile strength means such as bolts. These second transverse members are adapted to extend underneath the first longitudinal members of the structural component of the first type in order that either the structural component of the first type or the structural component of the second type can be held in cantilever relationship to the other.

The longitudinal members and transverse members of the structural component of the first type define an opening of a size sufficient to permit the passage of the second transverse member from each of two structural components of the second type. As explained more completely below, this structural arrangement permits the assembly of the structural span of the present invention. The invention may be better understood by reference to the drawings depicting a preferred embodiment thereof.

Referring now to the drawings and in particular to FIG. 1 there is shown a structural component 10 of the first type. The component 10 comprises a pair of longitudinal members 11 and 12 and a pair of transverse members 13 and 14. The longitudinal members 11 and 12 are of equal length and have a rectangular cross-section as shown in FIG. 10. They are parallel to each other and are spaced apart from each other. Their bottom surfaces define a first plane. See the bottom surface 15 of the member 11 shown in FIG. 3. The ends 16, 17, 18, and 19 define respectively second and third planes perpendicular to the first plane.

The transverse members 13 and 14 are of equal length and also have a rectangular cross-section. The members 13 and 14 are parallel to each other and are spaced apart from each other. Their top surfaces 20 and 21 lie in the above described first plane. Their outer vertical surfaces 22 and 23 lie respectively in the plane defined by the ends 16 and 17 and the ends 18 and 19. The terminal portions of the members 11, 12, 13 and 14 are held together by bolts 24, 25, 26 and 27 which extend through the members 11, 12, 13 and 14 in a direction perpendicular to the above described first plane. The members 11, 12, 13 and 14 define a square opening 28, the purpose and function of which is described more completely below.

Referring now to FIG. 2 there is shown a structural component 40 of the second type. The component 40 comprises longitudinal members 41 and 42 and transverse members 43 and 44. The longitudinal members 41 and 42 are of equal length and have a rectangular cross-section. They are parallel to each other and are spaced apart from each other a distance permitting them to lie inside the members 11, 12 while being parallel to these members 11, 12. In other words, the distance d_1 is equal to or slightly less than the distance d_2. In the embodiment shown, the members 41 and 42 have a length equal to the members 11, 12.

The transverse members 43 and 44 are of equal length and have a rectangular cross-section. They are parallel to each other and are spaced apart from each other. They have a length equal to the length of the transverse members 13 and 14. The upper surfaces 45 and 46 are attached to the lower surfaces, such as the lower surface 47 shown in FIG. 4 of the longitudinal members 41 and 42 by bolts 48, 49, 50 and 51 which extend through the members 41, 42, 43, 44 in a direction perpendicular to the first plane. By this arrangement end portions 52, 53, 54 and 55 are left projecting beyond the members 41, 42. In order to assemble the span the end portions 52 and 53 are adapted to fit underneath the members 11 and 12. The upper surfaces of the end portions are adapted to contact the lower surface 15 of the member 11. The members 41 and 42 are provided with holes 56 adapted to line up with holes 57 in the members 11 and 12. The purpose and function of these holes is described more completely below.

Referring now to FIG. 5 there is shown the preferred manner in which the components 10 and 40 are assembled. In general the transverse member 44 is passed through the opening 28 and turned such that the end portions 54 and 55 fit underneath the members 11 and 12. The component 40 is then moved outwardly until the member 44 contacts the member 13. As shown in FIG. 5, the component 10 has already received a first component 40'. The end portion 52' and 53' (not visible) of the transversed member 43' already extend underneath the members 11 and 12. Therefore it can be seen that the size of the opening which is determined by the length of the members 11 and 12 is critical. In order to continue the construction the size of the opening 28 after already having received one second component 40' must still be large enough to receive the transverse member 44 of yet another second component 40. The minimum space required is utilized when

the end portion 54 is first inserted underneath the member 11 followed by insertion of the end portion 55 under the member 12, after which the members 41 and 42 are aligned parallel to the members 11 and 12.

Referring now to FIG. 6, there is shown a cantilever span 59 of the present invention in its unexpanded form. The expanded form is shown in FIG. 7. A structural component 10' of the first type is shown in FIG. 7. A structural component 10' of the first type is supported in a cantilever fashion from a fixed mass 60 by any suitable means such as chains 61 and 62 and blocks 63 and 64 (See FIG. 7). A structural component 40 of the second type is arranged with the end portions 54 (not visible) and 55. (See FIG. 7) extending under the members 11' and 12' in the manner described above with respect to FIG. 5. Likewise the transverse member 44 of the component 40 has its end portions 54 (not visible) and 55 (see FIG. 6) extending under the longitudinal members 11 and 12 of the next adjacent component 10 of the first type. The other components of the first and second type (unnumbered) are assembled in a like manner. The last component 65 is provided with a chain 66 by which the span 59 can be expanded.

In order to expand the span 59, the last component 65 is pulled by the chain 66 in the direction of the arrow 67. In general, the components of the first type slide with respect to the components of the second type until the span 59 has the configuration shown in FIG. 7. More specifically, the component 10 slides for example in the direction of the arrow 67, the top surface 20 of its transverse member 13 sliding along the bottom surfaces of the longitudinal members 41 and 42 of the second component 40 until the transverse member 13 is in contact with the transverse member 44. The component 40 then slides in the direction of the arrow 67 the top surfaces of the end portions 52 (not visible) and 53 of the transverse member 43 sliding along the lower surfaces of the longitudinal members 11' and 12' of the component 10'. Of course, to increase the strength of the cantilever span 59 the sliding of the transverse members such as the members 43 and 44 in the direction of the arrow 67 can be stopped at any intermediate position where the holes 56 align with the holes 57; after which a cotter pin can be inserted in order to maintain the components in the same position relative to each other. Of course, it will be apparent to those skilled in the art that the greatest strength of the span 59 is obtained when the span 59 is in the unexpanded form shown in FIG. 6. The least strength is provided when the span 59 is in the expanded form shown in FIG. 7. This is because the twisting moment represented by the arrows 68 and 69 is greatest when transverse members of different types of components are contacting each other as shown in FIG. 7 and is least when transverse members of the same types of components are contacting each other as shown in FIG. 6. Intermediate strength can be provided by positioning the components with respect to one another at intermediate positions by the use of cotter pins through the holes 56 and 57 as described above.

Referring now to FIG. 8, there is shown a span 73 composed of components 10', 40, and 10 and so forth. The span 73 rests on a left bank 74 and a right bank 75 of a stream bed containing a small stream 77. The span 73 is centrally supported by components 78 and 79. These components can be of any design which provides support of the component 10. In the embodiment shown the components 78 and 79 are identical to the component 40 of the second type.

Referring now to FIG. 9 there is shown a span 83 in a catenary suspension arrangement. The span 83 is composed of components 10', 40, and 10 and so forth. The span 83 is suspended between fixed masses 84 and 85 by means of hooks 86 and 87. The transverse member 13' of the component 10' is held by the hook 86 whereas the transverse member 88 of the last component 89 is held by the hook 87.

Referring now to FIG. 10 there is shown the cross-sectional view on an enlarged scale along the line 10—10 of FIG. 1. In this embodiment, the cross-sectional area is rectangular having its longer dimension horizontal. Of course, the longer dimension can be vertical which will result in longitudinal members having a greater moment of inertia and therefore a greater resistance to bending. There are a number of advantages to a rectangular cross-section. The first is that wood, the least expensive material, is readily available in such a cross-section. The second is that rectangular cross-sections facilitate the sliding of one component with respect to the other when constructing a cantilever arrangement as described above with respect to FIG. 6 and 7. An alternate cross-section is the commonly used I-beam cross section shown in FIG. 11. Such a cross-section is preferred where resistance to bending must be a maximum. A large variety of materials are suitable such as steel, because of its availability and low cost, and aluminum because of the high strength to weight ratio. FIG. 12 represents a tubular cross-section which is especially preferred where the longitudinal members will be under tension as in the catenary span 83. The tubular longitudinal members can be attached to the tubular transverse members by any suitable high tensile strength means as is commonly employed in the construction of tubular scaffolding and the like.

The simplicity of construction of the components of the present invention and the ease with which they can be assembled into spans renders the construction of models quite simple. These models can be employed to test the structural soundness of any ultimate structure or can, of course, be employed simply as amusement devices.

Although the invention has been described in considerable detail with reference to certain preferred embodiments thereof, it will be understood that variations and modifications can be effected within the spirit and scope of the invention as described above and as defined in the appended claims.

What I claim is:

1. A structural span comprising:

I. a plurality of structural components of a first type each comprising:
  A. a pair of first longitudinal members:
    1. parallel to each other,
    2. spaced apart from each other,
  B. a pair of first transverse members:
    1. parallel to each other,
    2. spaced apart from each other,
    3. their upper surfaces being attached at the ends thereof to the lower surfaces of each of the first longitudinal members at the ends thereof by high tensile strength means,

II. a plurality of structural members of a second type each comprising:
  A. a pair of second longitudinal members
    1. parallel to each other,
    2. spaced apart from each other,
    3. lying inside of the first longitudinal members,
    4. parallel to the first longitudinal members,
  B. a pair of second transverse members:
    1. parallel to each other,
    2. spaced apart from each other
    3. their upper surfaces being attached to the lower surfaces of each of the second longitudinal members at the ends thereof by high tensile strength means leaving end portions of the second transverse members projecting beyond the second longitudinal members,
    4. the end portions of each of said second transverse members extending underneath the first longitudinal members,
    5. the upper surfaces of the end portions contacting the lower surfaces of the first longitudinal members,

wherein the first longitudinal members and the first transverse members define a square opening of a size to permit the passage of the second transverse members of each of two structural components of the second type,

wherein the transverse members of the structural components of the first type and the transverse members of the structural components of the second type define;

a. a planar surface when the longitudinal members are rectilinear, and

b. a continuous curved surface when the longitudinal members are suspended as a catenary.

2. The structural span claim 1 wherein the span is centrally supported.

3. The structural span of claim 1 wherein the span is a catenary.

4. The structural span of claim 1 wherein the span is a cantilever.

5. A self supporting cantilever structure comprising:

I. a plurality of structural components of a first type each comprising:

A. a pair of first longitudinal members:

1. of equal length,
2. having a rectangular cross section,
3. parallel to each other,
4. spaced apart from each other,
5. their bottom surfaces defining a first plane,
6. their ends defining second and third planes perpendicular to the first plane,

B. a pair of first transverse members:

1. of equal length,
2. having a rectangular cross section,
3. parallel to each other,
4. spaced apart from each other,
5. their top surfaces lying in said first plane,
6. their outer vertical surfaces lying respectively in said second and third planes,
7. their upper surfaces being attached at the ends thereof to the lower surfaces of each of the first longitudinal members at the ends thereof by bolts extending through each of the first longitudinal members and each of the first transverse members in a direction perpendicular to the first plane,

II. a plurality of structural members of a second type each comprising:

A. a pair of second longitudinal members

1. of equal length,
2. having a rectangular cross section,
3. parallel to each other,
4. spaced apart from each other
5. lying inside of the first longitudinal members,
6. parallel to the first longitudinal members
7. having a length equal to the length of the first longitudinal members,

B. a pair of second transverse members:

1. of equal length,
2. having a rectangular cross section,
3. parallel to each other,
4. spaced apart from each other
5. having a length equal to the length of the first transverse members,
6. their upper surfaces being attached to the lower surfaces of each of the second longitudinal members at the ends thereof by bolts extending through each of the second transverse members in a direction perpendicular to the first plane leaving end portions of the second transverse members projecting beyond the second longitudinal members
7. the end portions of each of said second transverse members extending underneath the first longitudinal members,
8. the upper surfaces of the end portions contacting the lower surfaces of the first longitudinal members

wherein the first longitudinal members and the first transverse members define a square opening of a size to permit the passage of the second transverse members of each of two structural components of the second type,

wherein the transverse members of the structural components of the first type and the transverse members of the structural components of the second type define:

a. a planar surface when the longitudinal members are rectilinear, and

b. a continuous curved surface when the longitudinal members are suspended as a catenary.

6. A self supporting cantilever structure comprising:

I. a plurality of structural components of a first type each comprising:

A. a pair of first longitudinal members:

1. of equal length,
2. having an I-shaped cross section,
3. parallel to each other,
4. spaced apart from each other,
5. their bottom surfaces defining a first plane,
6. their ends defining second and third planes perpendicular to the first plane,

B. a pair of first transverse members:

1. of equal length
2. having an I-shaped cross section,
3. parallel to each other,
4. spaced apart from each other,
5. their top surfaces lying in said first plane,
6. their upper surfaces being attached at the ends thereof to the lower surfaces of each of the first longitudinal members at the ends thereof by high tensile strength means

II. a plurality of structural members of a second type each comprising:

A. a pair of second longitudinal members

1. of equal length,
2. having an I-shaped cross section,
3. parallel to each other,
4. spaced apart from each other,
5. lying inside of the first longitudinal members,
6. parallel to the first longitudinal members,
7. having a length equal to the length of the first longitudinal members,

B. a pair of second transverse members:

1. of equal length,
2. having an I-shaped cross section,
3. parallel to each other,
4. spaced apart from each other
5. having a length equal to the length of the first transverse members,
6. their upper surfaces being attached to the lower surfaces of each of the second longitudinal members at the ends thereof by high tensile strength means leaving end portions of the second transverse members projecting beyond the second longitudinal members
7. the end portions of each of said second transverse members extending underneath the first longitudinal members,
8. the upper surfaces of the end portions contacting the lower surfaces of the first longitudinal members

wherein the first longitudinal members and the first transverse members define a square opening of a size to permit the passage of the second transverse members of each of two structural components of the second type,

wherein the transverse members of the structural components of the first type and the transverse members of the structural components of the second type define:

a. a planar surface when the longitudinal members are rectilinear, and

b. a continuous curved surface when the longitudinal members are suspended as a catenary.

7. A method of constructing a span comprising in sequence the steps of:

I. supporting in cantilever relationship o a fixed mass, a structural component of a first type comprising:

A. a pair of first longitudinal members parallel to each other,

B. a pair of first transverse members connected to the bottom of the first longitudinal members by high tensile strength means, said first longitudinal members and said first transverse members defining an opening;

II. providing a structural component of a second type comprising:

A. a pair of second longitudinal members parallel to each other spaced to lie inside of and parallel to the first longitudinal members,

B. a pair of second transverse members connected to the bottom of the second longitudinal members by high tensile strength means said second transverse members adapted to extend underneath the first longitudinal members

III. positioning the structural component of the second type in engagement with the first type of structural component with one second transverse member in contact with the bottom of the first longitudinal members and the second longitudinal members in contact with the top of one first transverse member;

IV. positioning a second similar structural component of the first type in engagement with the structural component of the second type, the other second transverse member of the structural component of the second type in contact with the bottom of the longitudinal members of the second structural component of the first type;

V. repeating steps II, III, and IV, to complete the span,

wherein the transverse members of the structural components of the first type and the transverse members of the structural components of the second type define:

a. a planar surface when the longitudinal members are rectilinear, and

b. a continuous curved surface when the longitudinal members are suspended as a catenary.

8. The method of claim 7 wherein the span is first constructed in an unexpanded manner and then expanded in a longitudinal direction.

9. A structural span comprising:

I. a plurality of structural components of a first type each comprising:

A. a pair of first longitudinal members:

1. parallel to each other,

2. spaced apart from each other,

B. a pair of first transverse members:

1. parallel to each other,

2. spaced apart from each other,

3. their upper surfaces being attached at the ends thereof to the lower surfaces of each of the first longitudinal members at the ends thereof by high tensile strength means,

II. a plurality of structural members of a second type each comprising:

A. a pair of second longitudinal members:

1. parallel to each other,

2. spaced apart from each other,

3. lying inside of the first longitudinal members,

4. parallel to the first longitudinal members,

B. a pair of second transverse members:

1. parallel to each other,

2. spaced apart from each other,

3. their upper surfaces being attached to the lower surfaces of each of the second longitudinal members at the ends thereof by high tensile strength means leaving end portions of the second transverse members projecting beyond the second longitudinal members,

4. the end portions of each of said second transverse members extending underneath the first longitudinal members,

5. the upper surfaces of the end portions contacting the lower surfaces of the first longitudinal members,

wherein the first longitudinal members and the first transverse members define a square opening of a size to permit the passage of the second transverse members of each of two structural components of the second type,

wherein the spacing of the longitudinal members of the structural member of the second type are spaced to fit into the space between the longitudinal members of the member of the first type with the upper surfaces in the same plane,

wherein the transverse members of the structural member of the second type extend beyond the longitudinal members to contact the underside of the longitudinal members of the structural member of the first type, a succession of such pairs of members being connected to form a bridge.

* * * * *