Sept. 11, 1956 J. N. LAYCOCK 2,762,069

TRUSSED BRIDGE STRUCTURE

Filed May 17, 1951 3 Sheets-Sheet 1

Fig. 1

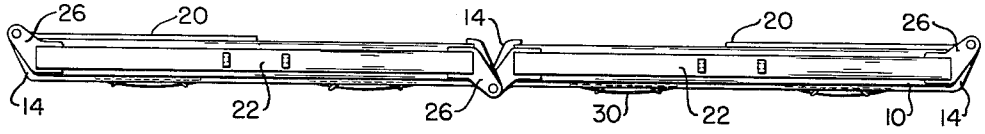


Fig. 2

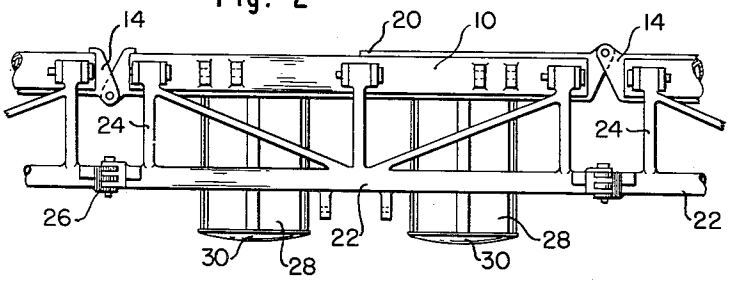
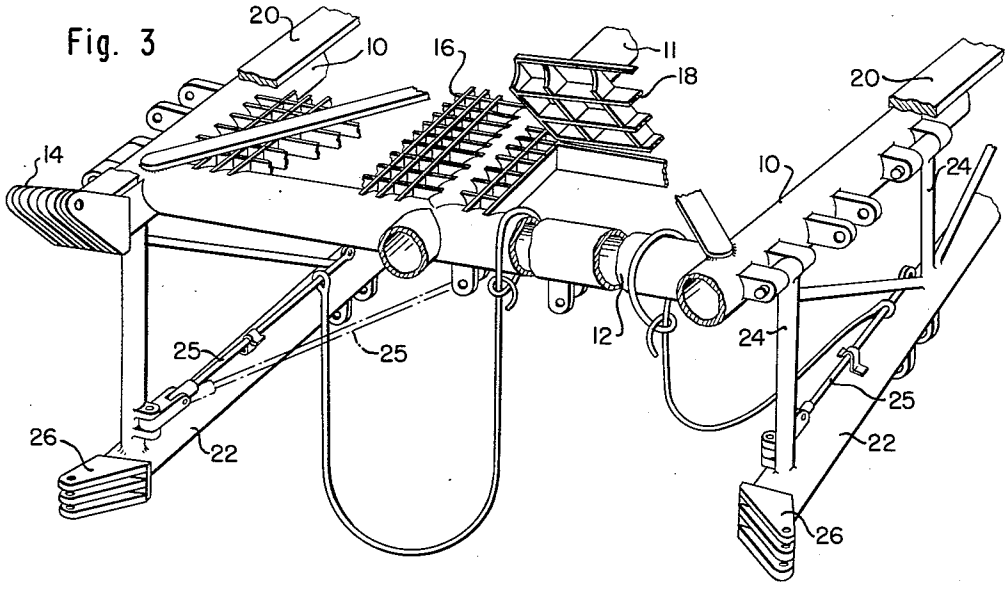


Fig. 3



INVENTOR.
JOHN N. LAYCOCK

BY

Kenway, Jenney, Witter & Hildreth

ATTORNEYS

Sept. 11, 1956 J. N. LAYCOCK 2,762,069

TRUSSED BRIDGE STRUCTURE

Filed May 17, 1951 3 Sheets-Sheet 2

Fig. 4

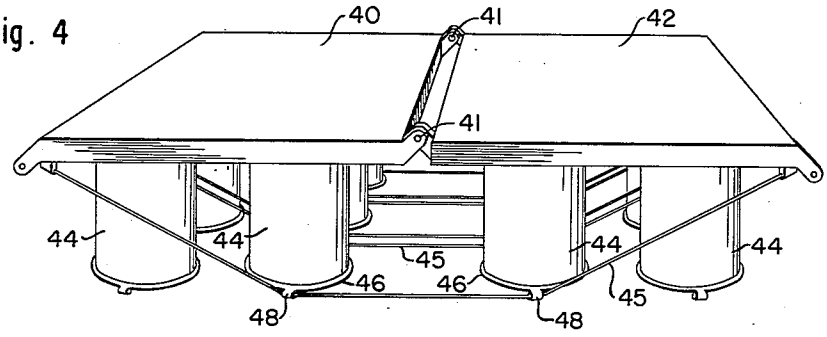


Fig. 5

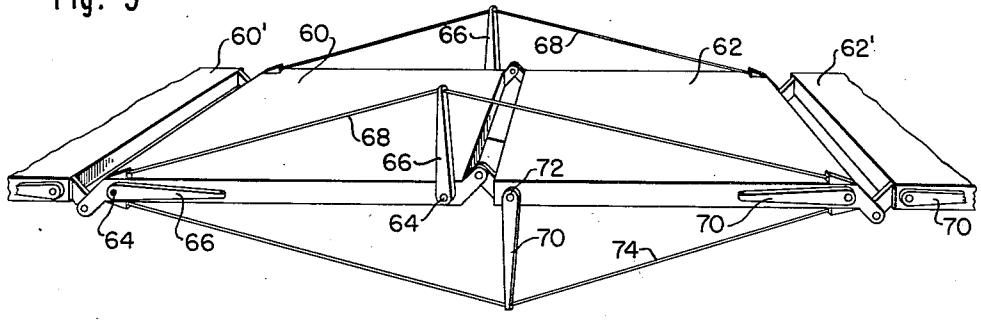
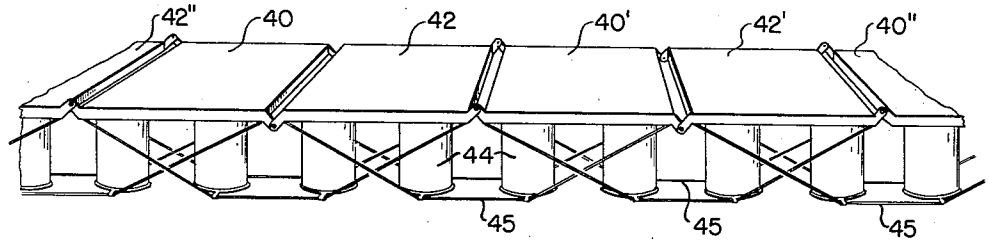


Fig. 6



INVENTOR.
JOHN N. LAYCOCK

BY

Kenway, Jenney, Witter & Hildreth,
ATTORNEYS

Sept. 11, 1956 J. N. LAYCOCK 2,762,069

TRUSSED BRIDGE STRUCTURE

Filed May 17, 1951 3 Sheets-Sheet 3

Fig. 7

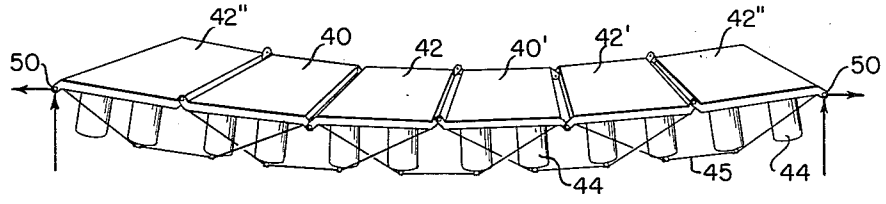


Fig. 8

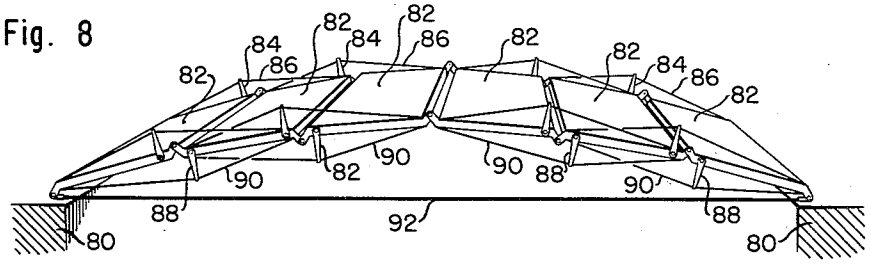
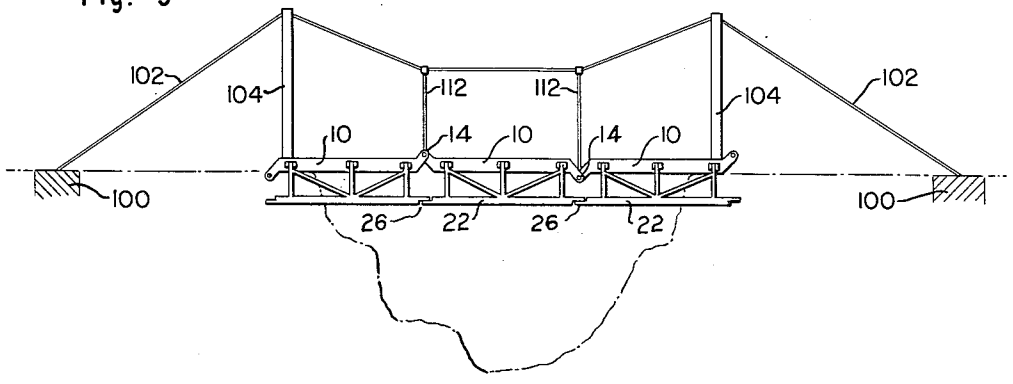


Fig. 9



INVENTOR.
JOHN N. LAYCOCK

BY

Kenway, Jenney, Witter & Hildreth

ATTORNEYS

United States Patent Office 2,762,069 Patented Sept. 11, 1956

2,762,069

TRUSSED BRIDGE STRUCTURE

John N. Laycock, Derry, N. H.

Application May 17, 1951, Serial No. 226,823

8 Claims. (Cl. 14—1)

The present invention relates to improvements in portable folding trussed craft units and, in particular, to improvements relating to the subject matter disclosed in my copending application Ser. No. 226,822, filed concurrently herewith, now Patent No. 2,669,960. Reference is made to said application for a complete discussion of the details of a trussed craft unit to which the improvements of the present invention may conveniently be applied.

The most important object of my invention is to provide conveniently operable and relatively inexpensive means for stiffening an assembly of several buoyant deck grids joined serially by hinges so that an assembly of such deck grids may be relatively rigidly held in position against articulation about the hinges when subject to load stresses of various kinds.

Another important object of the invention is to provide a plurality of hinged deck grids combined with stiffening means rendering the grids capable of being easily assembled into comparatively rigid structures useful as bridges, ramps, and the like.

These and other objects and features of the invention will be more readily understood and appreciated from the following detailed description of preferred embodiments thereof selected for purposes of illustration and shown in the accompanying drawings, in which:

Fig. 1 is a view in side elevation of a pair of deck grid sections illustrating the position of the pontoons in their collapsed state and the truss members parallel to the grid sections,

Fig. 2 is a view in side elevation of a deck grid assembly with inflated pontoons and lowered side trusses,

Fig. 3 is a view in perspective, with parts cut away for clarity, showing the construction of one form of deck grid,

Fig. 4 is a view in perspective showing rather diagrammatically one form of stiffening employed in conjunction with a pair of deck grids,

Fig. 5 is a view in perspective showing another form of cable and strut stiffening for deck grids,

Fig. 6 is a diagrammatic view in perspective showing several deck grids coupled together and stiffened,

Fig. 7 is a view similar to Fig. 6 but showing the deck grids assembled as a catenary bridge,

Fig. 8 is a view in perspective illustrating the assembly of several deck grids into an arched bridge, and

Fig. 9 is a view in side elevation showing the assembly of a plurality of deck grids as a suspension bridge.

For the details of construction of one form of deck grid, or trussed craft unit, suitable for use in conjunction with the present invention the reader is referred to my copending application, but I have shown in Figs. 1–3 the essential elements thereof, and an inspection of these figures will show that each deck grid or trussed craft unit is composed of a tubular skeleton frame including two long side tubes **10**, a central longitudinal tube **11** and shorter end tubes **12**. The area within

the outer tubes may conveniently be covered by a grating **16** in which is included a removable manhole section **18**; or the deck may be a solid sheet of wood or steel or other suitable material. The ends of the side tubes **10** and the center tube **11** are provided with heavy hinge plates **14** which are offset vertically and arranged in alternation so that at one end of each unit the hinge plates **14** extend downwardly, while at the opposite end they extend upwardly. Consequently a plurality of deck grids may be hinged together in series and folded in accordion fashion to form a compact stack. A stout stiffening strap **20** extends from each hinge plate casting along the top or bottom of the longitudinal tubes of the frame. Hinged to each of the side tubes **10** are heavy bars **24**, the outer ends of which are secured to long tubular members **22** at the end of each of which are hinge plates **26** and which may be swung down at right angles to the deck section and secured in place by hinged struts **25** to serve as side trusses lending strength and rigidity to the deck grid.

Beneath each deck grid is a number of rows of cylindrical collapsible inflatable pontoons or bags **28**, to the bottom of each of which is secured a metal shoe **30**. At its upper end each bag is suitably secured to the deck in any convenient manner, as recited in my above-named co-pending application. The pontoons **28** collapse for storage and rest within the deck grid as shown in Fig. 1, while upon inflation they extend down into the position shown in Fig. 2. I contemplate the provision of as many as **24** pontoons with each deck grid, but for the sake of clarity in the drawings I have shown each deck grid as provided only with six pontoons **28** in a manner similar to that shown in Fig. 4. The principle of operation, however, is the same, regardless of the number of pontoons. I provide means (not shown) for inflating the pontoons, the description illustrative of the inflating means being omitted here because it has been fully and entirely explained in my copending application above identified. Moreover, the inflating means per se forms no part of this invention as claimed. Although for many uses sufficient rigidity is incorporated into a string of deck grids by means of the side truss members **22** and their associated hinges and struts, I have devised a less cumbersome and expensive method of trussing a plurality of units as shown in Figs. 4 and 5 where vertical struts are served by longitudinally running cables. In the embodiment shown in Fig. 4 there is included a pair of deck grids **40** and **42** (shown diagrammatically) hinged at **41**, each grid being provided with six pontoons **44**. Each pontoon has at its bottom a metal shoe **46** suitably secured to the body of the pontoon and provided at each side with an eye **48**. There are six cables **45**, each of which is secured at one end to the end of the deck grid and runs down beneath both of the grids **40** and **42**, being secured at the far end of the adjacent deck grid. Each cable passes through two of the eyes **48** on the pontoon shoes **46**, skipping the row of pontoons nearest the far ends of the two sections **40** and **42**. In Fig. 6 I have shown six deck grids, **40**, **40'**, **40''**, **42**, **42'**, and **42''**. It will be observed that each end of each deck grid is served by cables but that they are arranged in alternation so that each cable spans two deck grids. While the cables, as shown in the drawings, span but two grids, it is contemplated that each cable may span more than two grids, since the principle of operation is not affected by the number of grids served by each cable.

When the pontoons are collapsed, the cables **45** are slack; thus the deck sections may be folded into a stack without interference from the cables. However, when the stack is unfolded and the pontoons are inflated, the

cables are placed under tension and the pontoons, or rather the confined air columns within them, serve as vertical struts said pontoons and confined air columns within them acting as compression members in the trussing system. An advantage of this form of stiffening is the fact that the inflated pontoons **44** are not incompressible. Consequently if an unduly heavy load is suddenly applied, the deck grids will articulate to a limited extent about the hinges and the cables will not snap. There is the further advantage that as the pontoons are compressed in response to the action of the cables under these circumstances, the resistance increases because the pressure within each pontoon increases simultaneously under compression. As soon as the unduly heavy load has been reduced, the action of the pontoons and cables is to restore the deck grids to level position. It should be pointed out that each pontoon is served by cables running along both sides, the result being that there is no tendency to displace the pontoons laterally, each being held securely between two cables. The normal tendency of a load on a string of deck grids is to push down the hinges, but the upward pressure of the flexible air-filled pontoons against the underside of the deck structure will be beneficial in counteracting such transverse sagging.

It will also be readily seen that the resistance of the cables **45** and their trussing comes into play gradually with some small motion at the hinge so that the two deck grids will be heeled toward each other. This flexibility which permits the slight heeling of the deck grids thus brings into play the natural resistance of these sections to heeling, i. e. the metacentric stability of the buoyant structure. Furthermore if there are more than two grids, as shown in Fig. 6, they also will normally be heeled by the heeling of the two grids bearing the load, and these other grids will contribute further to the stability of the string. Consequently the forces which the cable and strut elements have to carry are reduced.

In Fig. 5 there is illustrated another form of the invention in which the pontoon struts are replaced by entirely rigid strut members. In this instance there are shown two deck grids **60** and **62**, with portions of adjacent grids **60'** and **62'** hinged thereto. The grid **60** is provided at its four corners with studs **64** on which are pivoted sturdy bars or struts **66** in the end of each of which there is a through-and-through hole for the passage of a cable **68** running from the outer end of the grid **60** through the upwardly extending struts **66** and to the far end of the grid **62**. The grid **62** is similarly provided with pivoted strut members **70**, two being shown in the flat storage position and two others being swung downwardly to receive cables **74** which span the grids **60** and **62**. Thus, the two grids **60** and **62** are trussed against articulation either up or down, the cable **74** serving to prevent a depression of the hinge and the cable **68** with the struts **66** serving to prevent upward articulation about the hinge joining the two grids. When it is desired to fold the grids into a stack, the struts **66** and **70** are swung parallel with the decks and the cables thus slackened sufficiently to permit folding. If desired the struts may be pinned in either position to prevent accidental displacement thereof.

In Fig. 7 there are six hinged deck grids hung like a suspension chain between two abutments indicated at **50** and capable of providing the horizontal and vertical forces needed to keep the bridge deck in this suspended position when subjected to its intended live loads. The cable and strut construction is of the type shown in Figs. 4 and 6, which is adequate to insure adequate local distribution of concentrated loads so that the local bending of the deck structure at its various hinged joints is kept within limits sufficient to prevent interference with the movement of traffic over the bridge. The action of the cable and strut elements reduces the horizontal forces applied to the abutments.

In Fig. 8 the cable and strut construction of Fig. 5 is shown as applied to six grids assembled to form an arch bridge. The six deck grids are divided into units of three, each unit being provided with trussing both below and above the deck. Furthermore there is provided a pair of tie cables **92** joining the ends of the arch to reduce the thrust upon the abutments **80**. In this form each unit consists of three grids **82** provided with upwardly extending struts **84** served by cables **86** and downwardly extending struts **88** served by cables **90**.

For a short span the whole length may be trussed as a single unit, just as each half is trussed in Fig. 8.

In Fig. 9 there is shown a suspension bridge formed from three units of the type shown in Figs. 1–3. This bridge includes a pair of cable anchors **100** which serve one of the two main suspension cables **102**, each of which runs to a pair of posts **104** mounted in position on the opposite ends of the bridge. The bridge is composed of three deck grids **10** hinged at **14** and provided with side truss members **22** hinged together as shown diagrammatically at **26**. Suspender cables **112** connect the main suspension cable **102** with the bridge deck at the hinge points **14**. Although the suspension bridge has been shown as constructed of deck grids with the rigid side truss elements as shown in Fig. 2, such a bridge may be constructed with equal facility from deck grids provided with the strut and cable stiffening shown in Fig. 4 or 5.

In any application of the cable and strut stiffening to folding bridge decks, the deck structure may either be floated into place or transported by rail, overhead cables, or the like. If it is to be floated into position, the necessary buoyancy is provided in the grids themselves, the tubular frames thereof, or by pontoons or auxiliary floats. This is also true when the structure is used as a barge, lighter, floating or beached causeway, dry dock, or other waterborne device.

It will be evident that if the effective length of the outboard edge of each side truss panel, of the type shown at **22** in Fig. 2, is the same as the effective length of the deck grid to which it is attached, the deck will be stiffened in a straight or plane form, but if the outboard edge of the truss is longer or shorter than the effective length of the deck grid to which it is connected, the latter will not lie in a plane but will approximate a curved surface, the surface curving one way or the other depending upon whether the effective length of the truss is shorter or longer than that of the deck grid. This fact may be taken into account in constructing arched and catenary forms of deck bridges as shown in Figs. 7 and 8.

Although in Figs. 6 and 7 to promote clarity of presentation only one row of pontoons has been illustrated, it is to be understood that the arrangement is to be the same as that shown in Fig. 4. Obviously the exact number of pontoons to be employed will be dictated by the application intended for the appliance. As indicated above, the use of as many as 24 pontoons with each grid is contemplated.

Moreover, although the structure illustrated in Fig. 9 does not carry pontoons, it may prove desirable to employ pontoons if the structure must be floated to the particular site of use. After the structure is secured in position, the pontoons may be removed or collapsed and retained in place to reduce wind loading. The latter is particularly desirable if the bridge is to be later moved to another site.

Having now described and illustrated a preferred embodiment of my invention, what I claim as new and desire to secure by Letters Patent of the United States is:

1. A trussed structure comprising a plurality of deck grids hinged in series, a plurality of inflatable members secured beneath each deck grid, and a plurality of cables, each cable being secured to one end of one of said deck grids, engaging a plurality of said inflatable members under at least two deck grids and being secured at its other end to the end of another deck grid, whereby inflation of said member will tension said cables.

2. A trussed structure comprising a plurality of deck grids hinged in series, a plurality of rows of inflatable members disposed beneath each of said deck grids, a shoe secured to the bottom of each of said members, and cables secured to the far ends of adjacent grids and engaging the shoes on at least one of said inflatable members under each grid.

3. A trussed structure comprising a plurality of deck grids, fastening means fixed to the ends of each of said grids for joining said grids in series relationship, cables spanning two grids and secured at their ends to said grids adjacent said fastening means, and collapsible compression members projecting from said grids and engaging said cables.

4. A trussed structure comprising a plurality of buoyant deck grids, fastening means fixed to the ends of each of said grids for joining said grids in series relationship, cables spanning two grids and secured at their ends to said grids adjacent said fastening means, and collapsible compression members projecting from said grids and engaging said cables.

5. A trussed structure comprising a plurality of deck grids, fastening means fixed to the ends of each of said grids for joining said grids in series relationship, a plurality of inflatable collapsible pontoons disposed beneath each grid, and a cable spanning at least two of said grids, secured to alternate ends of adjacent grids adjacent said fastening means and engaging said pontoons.

6. A bridge comprising a plurality of deck grids hinged in series, a first cable spanning the entire series and connected to the end of the series, said cable being shorter than said series, pivotally mounted strut members secured to each of said grids movable to a substantially vertical position, and a plurality of cables spanning at least two of said grids secured to alternate ends of adjacent grids and engaging said strut members to stiffen said grids in arched position.

7. A trussed structure comprising a plurality of deck grids hinged in series, a plurality of cables secured at each end to and running longitudinally along said grids beneath said series of grids, and inflatable collapsible members secured to said grids and to said cables intermediate the ends of said cables, said members being inflated to tension said cables.

8. A trussed structure comprising a plurality of deck grids hinged in series, a plurality of cables spanning two adjacent grids and running longitudinally along said series, and movable struts secured to said grids and to said cables positioned to tension said cables and being adapted to be moved to a position to permit relative pivotal movement of said grids.

References Cited in the file of this patent

UNITED STATES PATENTS

41,719	Perry	Feb. 23, 1864
511,472	Sumovski	Dec. 26, 1893
1,115,775	Bisbach	Nov. 3, 1914
1,415,554	Hatch	May 9, 1922
1,640,980	Caroni	Aug. 30, 1927
1,788,264	Wilson	Jan. 6, 1931
1,973,584	Tatter et al.	Sept. 11, 1934
2,480,144	Laycock	Aug. 30, 1949

FOREIGN PATENTS

4,093	Great Britain	Feb. 28, 1884
4,224	Great Britain	Feb. 23, 1903
264,872	Germany	Sept. 29, 1913
65,502	Austria	Jan.. 15, 1914