Feb. 12, 1957 H. HESS 2,780,842

GIRDERS

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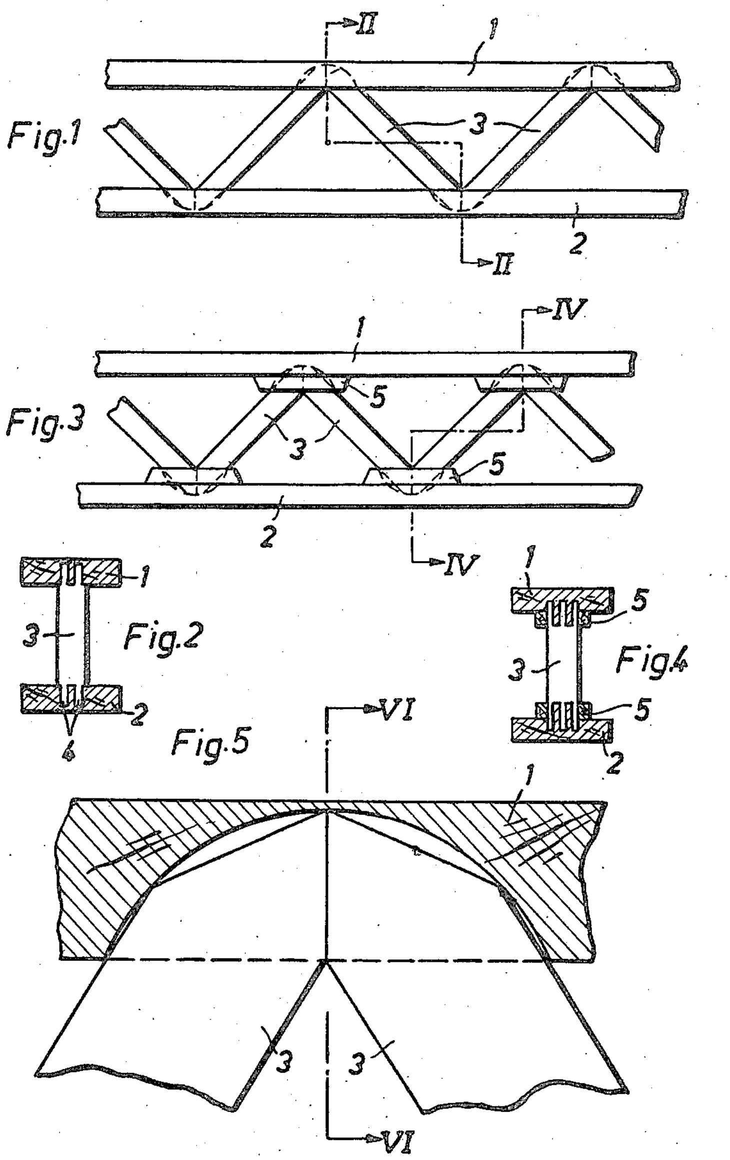

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Fig.6

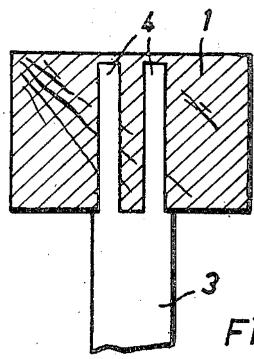

Fig.8

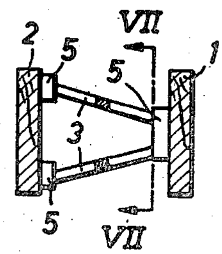

Fig.7

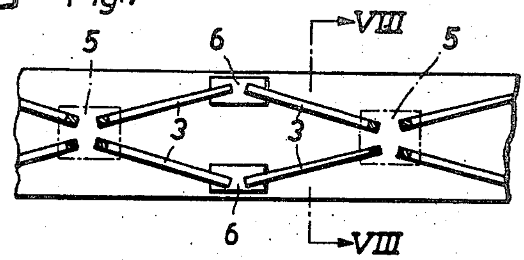

Fig.9

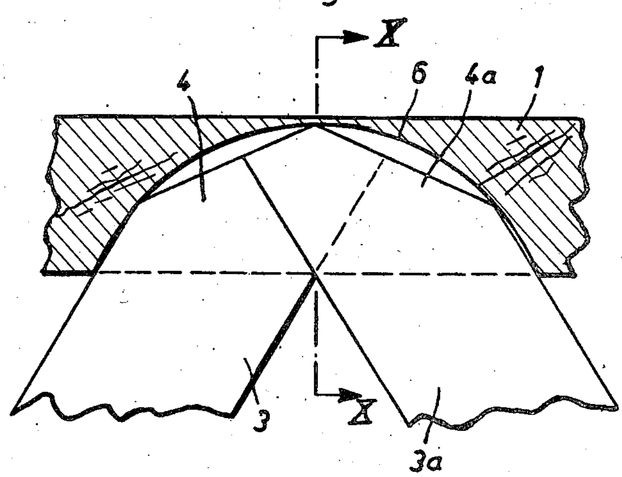

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Fig. 10

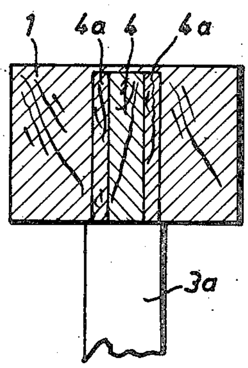


Fig. 10a

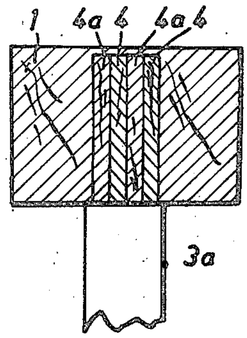


Fig. 12

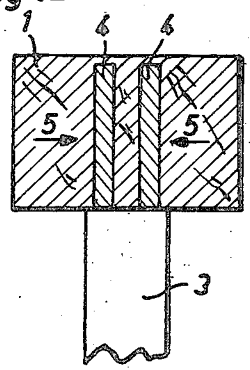
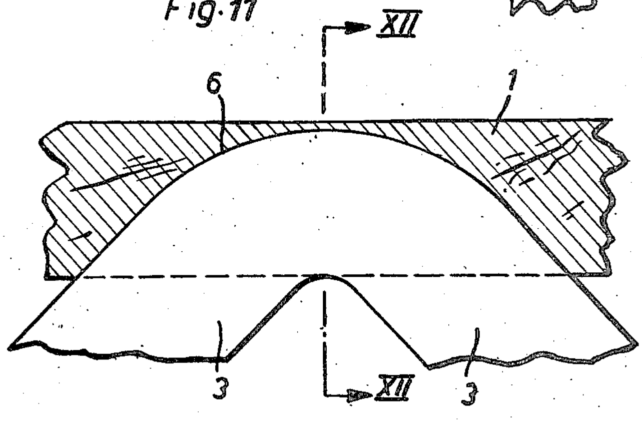


Fig. 11



Inventor

United States Patent Office

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GIRDERS

Hanns Hess, Grafrath-Unteralting, Upper Bavaria, Germany

Application October 3, 1951, Serial No. 249,419

Claims priority, application Germany October 11, 1950

7 Claims. (Cl. 20—.5)

This invention relates to non-metallic girders consisting of upper and lower booms or chords connected by bracings and is a continuation in part of my application Serial No. 219,787, filed April 7, 1951, now abandoned.

Such girders are manufactured as structural units and the makers do not necessarily know in what circumstances they may be used. Depending on these circumstances any one bracing may have to serve as a tie or a strut, that is to say it may be stressed in tension or in compression.

Such girders have been made in the past by screwing or nailing the bracings to the sides of the booms, tensions and compressions in the bracing being transmitted to the boom through shear stress in the screws or nails. Sometimes the ends of the bracings have been tenoned into the adjacent faces of the booms, that is into the lower face of the upper boom and the upper face of the lower boom; this takes care of compressive stress, but it has still been necessary to put nails or screws or transverse dowels through the boom and tenon to provide for the case of the bracing being put in tension. The holes in the booms and tenons in which these shear-stressed fastenings are received, reduce the cross section of these members, and their overall dimensions must be increased to allow for this weakening. This involves a serious increase in the weight of the booms, especially in a long-span girder, and, indeed, this increased weight must be taken into account in designing the boom dimensions. Moreover, the weakening caused by transverse holes is greater than would correspond to the mere reduction in cross section, because of the "notch" effect of the holes, material adjacent to them being unable to take its full share of stress.

Gluing has not been regarded as a practical means of joining components in structural work exposed to the weather. But of recent years glues or adhesives have been evolved, such as the casein glues and various synthetic resins, which are insoluble in water and can stand exposure. Also the shear stress per square inch which a glued joint can withstand is limited.

A principal object of this invention is a non-metallic girder built of upper and lower chords or booms and bracings connecting them in which weakening of the booms by transverse shear-stressed fastenings is wholly avoided, so making possible a substantial reduction in the cross section of the boom, due to the saving of the loss of cross section occasioned by such fastenings, to the avoidance of notching effect and to the reduction in the weight of the booms arising from these two causes.

More specifically the object of the invention is a non-metallic girder built of upper and lower booms connected by bracings tenoned into them and secured by gluing with an adhesive insoluble in water, such as those above mentioned, each bracing having at least two tenons to afford an adequate area of glued joint. Any one bracing may consist of two or more braces set side by side and not necessarily parallel to each other or to the mid longitudinal plane of the girder.

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A further object of the invention is a girder of this kind in which mortises are machined in the booms with rounded bottoms, and the tenons are correspondingly shaped, to a sufficient degree of approximation to permit of the ends of the tenons being glued to the bottoms of the mortises.

Yet another object of the invention is a girder of this kind in which the booms are reinforced at the joints by glued-on blocks through or into which the bracings are tenoned, thereby reducing the depth of the necessary mortises in the boom itself or altogether dispensing with them.

A still further object of the invention is a girder with upper and lower booms interconnected by braces tenoned into them, two or more adjacent braces being made of a single piece of material formed with a knee at the joint or at each joint, the tenons being cut from the knee or knees of the combined brace.

Another object of the invention is a girder with upper and lower booms interconnected by braces, adjacent bracings being tenoned into each other as well as into the booms.

These and other objects of the invention will be more fully understood from the following description of examples of girders built according to the invention and shown in the drawings.

Fig. 1 is an elevation of part of a girder constructed according to the invention, and

Fig. 2 a cross section of it on the line II—II of Fig. 1;

Fig. 3 shows a similar girder with reinforcements at its joints, and

Fig. 4 is a cross section of it on the line IV—IV of Fig. 3;

Fig. 5 is a longitudinal section on a larger scale of one of the joints of the girder of Fig. 1, and

Fig. 6 a cross section of it on the line VI—VI of Fig. 5;

Fig. 7 is a sectional plan on the line VII—VII of Fig. 8, and

Fig. 8 a cross section on the line VIII—VIII of Fig. 7 showing a girder having double braces;

Fig. 9 is a longitudinal section through a joint at which the brace tenons are overlapped or tenoned one into the other;

Fig. 10 is a cross section of this joint on the line X—X of Fig. 9 with one form of tenon;

Fig. 10*a* is a similar section of the joint with another form of tenon;

Fig. 11 is a longitudinal section through a joint with a bowed brace member, and

Fig. 12 is a cross section of it on the line XII—XII of Fig. 11.

The upper chord or boom 1 and the lower chord or boom 2 are connected by brace means extending in zig-zag arrangement substantially in the longitudinal plane of these chords. The brace means according to Figures 1 to 6 comprise oppositely inclined and converging brace portions 3 ending in groups of at least two transversely aligned tenons 4 (Fig. 4) engaging correspondingly arranged groups of aligned mortices which are provided in respectively opposite faces of the upper chord 1 and lower chord 2. These groups of aligned mortices are spaced apart longitudinally of the chords. The tenons 4 are glued in the mortices by means of a glue which is insoluble in water. In the girder shown in Figs. 3 and 4 reinforcing blocks 5 are glued to the inner faces of the booms, and the tenons 4—here three in number—extend through the reinforcements 5 into the boom 1 or 2. But the mortises in the booms are of less depth than in Figs. 1 and 2. If the boom section is not to be reduced at all the tenons should be mortised into the reinforcement only. The cross sections through the mortices in the chords are oblong, whereby suitably the longer sides of the mortices extend substantially in the direction of the chords. As appears especially in Fig. 5 it is of advantage to curve the bottom of the mortise, which is easily done with a rotary cutting tool. But as it would be difficult to shape the end of the tenon to a curve, the end is made polygonal i. e., has a multi-cornered face having as close an approximation to the curve as is convenient. The tenons having complementary shape to the mortices fit into the latter suitably with a clearance of less than 0.2 mm., whereby the multi-cornered ends of these tenons conform to the round contour of the bottoms of the mortices. Fig. 5 shows the ends of the tenons of neighbouring braces abutting in a plane VI—VI at right angles to the length of the girder.

As is shown in Figs. 7 and 8 a bracing may be made up of a plurality of braces **3**, **3** lying side by side, and not necessarily parallel to the mid plane of the girder and each other. The reinforcements **5** on which the braces abut are in the mid plane of the girder on one boom and displaced outward on the other, so that the braces are at an angle to the vertical mid plane of the girder.

In Figs. 9 and 10 the two braces **3** and **3***a* abut. But their tenons **4** and **4***a* are so made that they in part overlap, and can be glued together over the area of overlap. In Fig. 10 the brace **3***a* has two tenons **4***a* which receive between them the single tenon **4** of brace **3**. In Fig. 10*a* both braces have two tenons which mesh together.

In Fig. 11 the brace bar **3** is formed with a knee at the joint and the two tenons **4** are milled out of the round of the knee. These enter mortises in the boom **1**. As appears from Fig. 11 the tenons wholly fill the mortises, so that there is no space between the bottom of the mortise and the knee of the brace, and their surfaces can be glued together.

As above indicated, mortises and tenons are machined so accurately that only thin films of glue can be left between them. In Fig. 12 the arrows **5** indicate the direction of the pressure exerted by the boom **1** upon the tenon pressed into it, due to its own transverse strength and elasticity; the exertion of this pressure while the glue is setting ensures thorough adhesion of the glued surfaces. Because of this elastic pressure it is not necessary to put the work in a clamp while the glue sets, and that saves not only an additional step in manufacture, but also clamps and especially space in the factory.

The examples show that at the joints the brace and boom together present a structure analogous to a piece of plywood, having a corresponding strength. No sort of fastenings are used which could be stressed in shear. Warping or other distortion of the booms or twisting of the girder under load is practically prevented by the mortising of the braces into the booms and their thorough binding together.

I claim:

1. A non-metallic lattice girder comprising upper and lower chords, and braces extending from the one chord to the other and tenoned into both, the tenons of neighboring braces following each other lengthwise of a chord being tenoned into each other.

2. A non-metallic lattice girder comprising upper and lower chords, and braces extending from the one chord to the other and tenoned into both, the tenons of neighbouring braces following each other lengthwise of a chord overlapping and being glued to each other as well as to the chord.

3. A non-metallic lattic girder comprising upper and lower chords, groups of transversely aligned mortices in respectively opposite faces of said upper and lower chords, said groups being spaced apart longitudinally of said chords, said mortices having oblong cross sections with the longer sides of said mortices extending substantially in the direction of said chords, said mortices having bottoms rounded in the longitudinal plane of said chords, brace means joining said upper and lower chords and extending substantially in the longitudinal plane of said chords in zigzag arrangement, said brace means including oppositely inclined brace portions converging at said groups of mortices, each of said brace portions having a group of tenons which are transversely aligned and fit into the aligned mortices of the corresponding groups of mortices, the ends of said tenons conforming to the contour of said bottoms, said tenon groups being glued in the mortices in the respective groups by means of a glue insoluble in water.

4. A non-metallic lattice girder comprising upper and lower chords, groups of transversely aligned mortices in respectively opposite faces of said upper and lower chords, said groups being spaced apart longitudinally of said chords, said mortices having oblong cross sections, one of the sides of said cross section extending substantially in the direction of said chords, said mortices having bottoms rounded in the longitudinal plane of said chords, brace means joining said upper and lower chords and extending substantially in the longitudinal plane of said chords in zigzag arrangement, said brace means including oppositely inclined brace portions converging at said groups of mortices, each of said brace portions having a group of tenons which are transversely aligned and are of complementary shape to said mortices and fit into the aligned mortices of the corresponding groups of mortices, the ends of said tenons conforming to the contour of said bottoms, said tenon groups being glued in the mortices of the respective groups by means of a glue insoluble in water.

5. A non-metallic girder according to claim 4, wherein the clearance with which said tenons are fitted into said mortices amounts to less than 0.2 mm.

6. A non-metallic girder according to claim 4, wherein reenforcing blocks are glued on said upper and lower beams at the entrances of said mortice groups, said brace means passing through said blocks, said tenon groups extending through said blocks into said mortices and said blocks also being glued to said brace means.

7. A non-metallic girder according to claim 4, wherein said tenons have end portions with multi-cornered faces, the corners of said faces fitting the rounded bottoms of said mortices.

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