Sept. 9, 1969 E. D. ROLIN 3,465,486

STRUCTURAL UNIT FOR BEAM STRUCTURES AND FLOTATION HULLS AND METHOD OF MANUFACTURE

Filed June 2, 1967 3 Sheets-Sheet 1

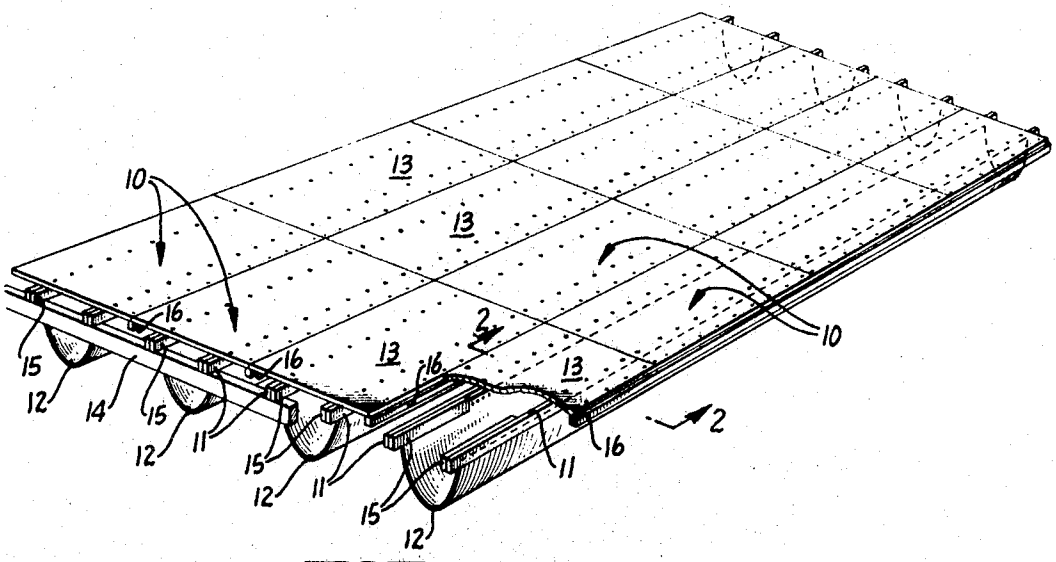


FIG. 1.

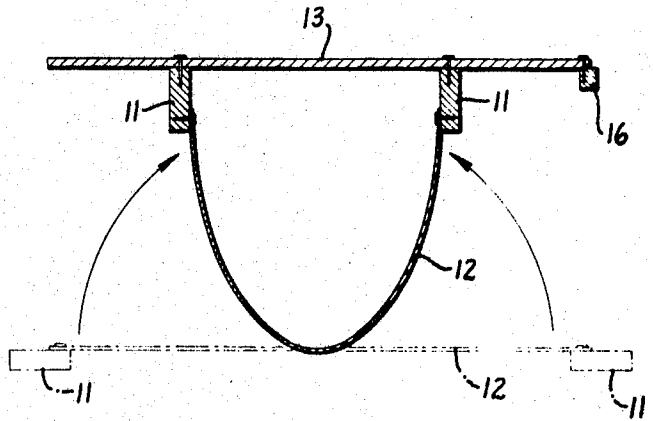


FIG. 2.

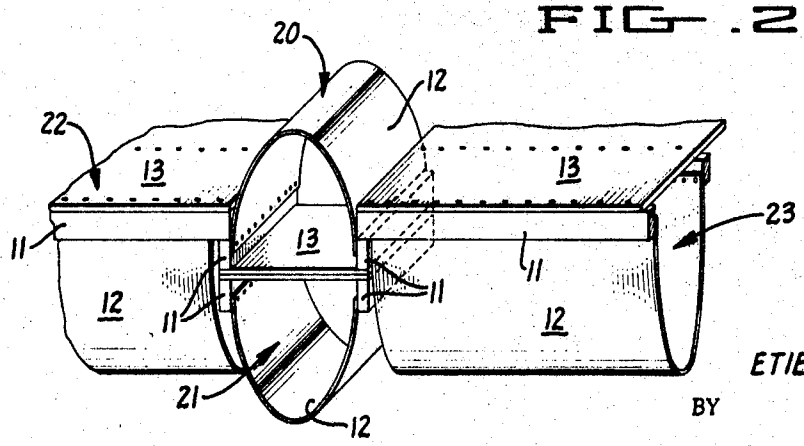


FIG. 3.

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STRUCTURAL UNIT FOR BEAM STRUCTURES AND FLOTATION HULLS AND METHOD OF MANUFACTURE

Filed June 2, 1967 3 Sheets-Sheet 2

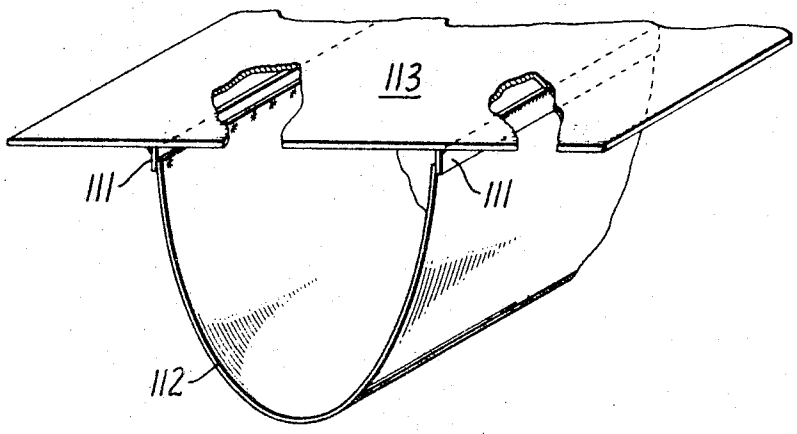


FIG. 4.

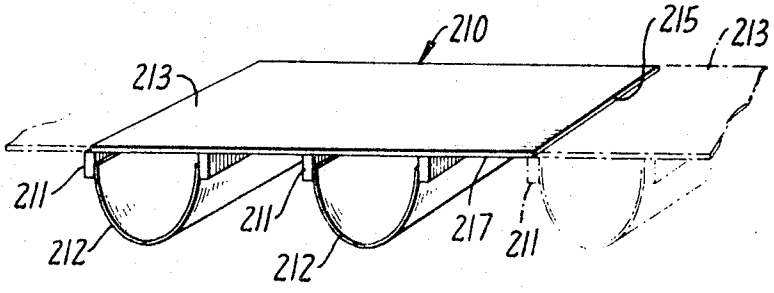


FIG. 5.

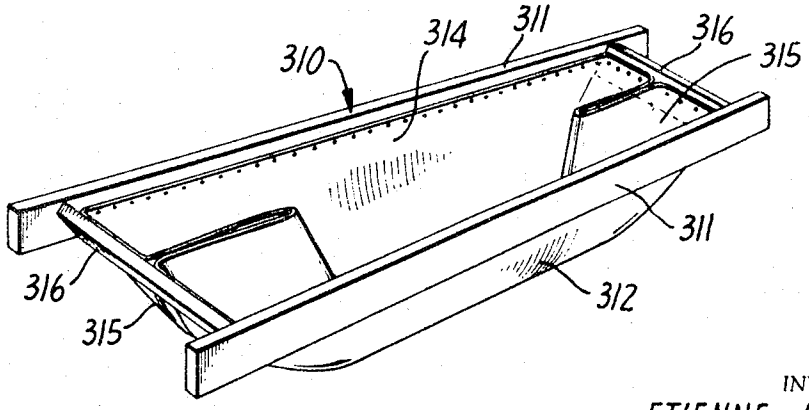


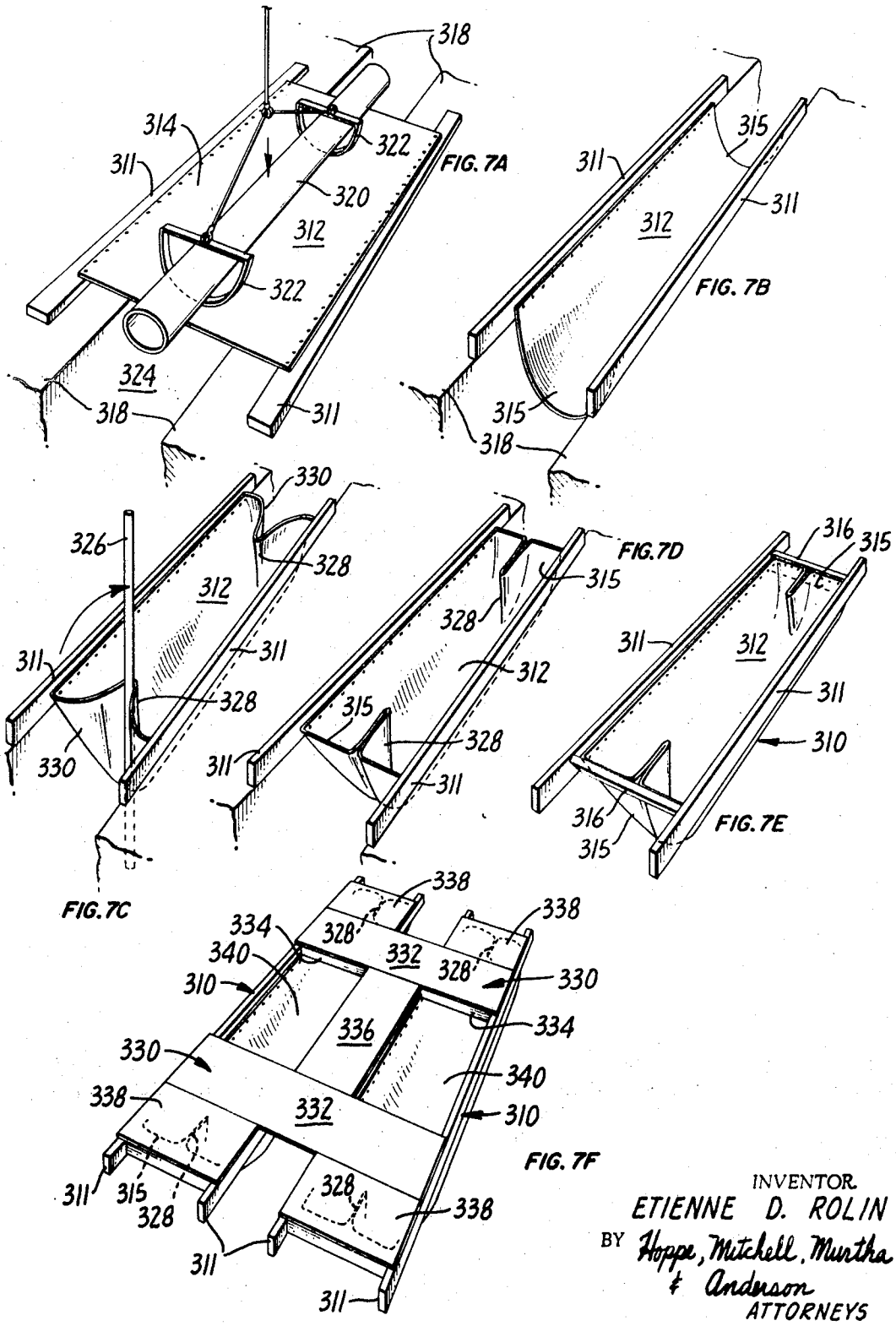
FIG. 6.

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STRUCTURAL UNIT FOR BEAM STRUCTURES AND FLOTATION HULLS AND METHOD OF MANUFACTURE

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United States Patent Office 3,465,486 Patented Sept. 9, 1969

3,465,486

STRUCTURAL UNIT FOR BEAM STRUCTURES AND FLOTATION HULLS AND METHOD OF MANUFACTURE

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Continuation-in-part of application Ser. No. 556,331, June 9, 1966. This application June 2, 1967, Ser. No. 651,085

Int. Cl. E04b *1/00*; E04c *3/02*

U.S. Cl. 52—222 7 Claims

ABSTRACT OF THE DISCLOSURE

A structural unit is formed from a sheet of flexible, high strength material, such as galvanized sheet steel, and one or more sheets of a non-flexible, rigid material, such as plywood. The flexible sheet is first secured along its longitudinal edge portions to longitudinal stringers or support members and then bowed, or otherwise flexed, into a web which is substantially U-shaped in cross-section. The rigid sheets are then secured to and across the stringers or support members to complete the beam structure. In a modification designed for use as a flotation hull the ends of the U-shaped web are folded inwardly to form a crimped section that closes off the ends without creating any seams.

This application is a continuation-in-part application of my co-pending application Ser. No. 556,331, filed June 9, 1966, now abandoned.

This invention relates generally to structural units for the construction of beam structures, flotation hulls and methods for manufacturing same. More particularly, the invention involves the manufacture of beam structures and flotation hulls from sheets of high strength, flexible material, such as rolls of galvanized sheet steel.

One object of the present invention is to provide beam structures or flotation hulls of great strength that may be made inexpensively.

Another object is to provide an inexpensive beam structure that may be used in the construction of buildings and used in large numbers to provide a continuous flooring, roofing or other load supporting structure.

It is another object of the invention to provide an inexpensive construction for beam structures or flotation hulls that can be built very rapidly using only well-known building materials.

A still further object of the invention is to provide a novel method for forming a beam structure or flotation hull using a pair of longitudinal supports, a sheet of high strength, flexible material and one or more sheets of rigid material.

Another object is to provide a girder of great carrying capacity which can be constructed rapidly at a very low cost using a pair of identically formed beam structures.

It is still a further object of the invention to provide a beam structure that may be manufactured with a modular design that allows a plurality of such beam structures to be placed side by side to form a continuous roof or flooring.

A further object of the invention is to provide a simple, inexpensive and water-tight construction for a flotation hull.

Other objects of this invention will become apparent in view of the following detailed description and the accompanying drawings.

In brief, the present invention contemplates a beam structure, or flotation hull, comprised of a pair of longitudinal support members secured in spaced relation and

having a sheet of flexible material supported therebetween, said sheet being flexed into a substantially U-shaped cross-section and having spaced-apart legs engaged flush with one support member. This beam structure may be rapidly manufactured by laying out the sheet of flexible material in a plane, securing the support members along parallel longitudinal edges of the sheet, moving the longitudinal support members generally toward one another while bowing or otherwise flexing the sheet into a substantially U-shaped cross-section, and then securing the support members to a rigid sheet while maintaining the flexible sheet material in its flexed condition.

In the drawings forming a part of this application and in which like parts are identified by like reference numerals throughout the same:

FIGURE 1 is a perspective view of a support and flooring comprised of beam structures made in accordance with the teaching of this invention;

FIG. 2 is a partial vertical section of the flooring shown in FIG. 1, taken on lines **2—2** thereof, broken lines being used to indicate the manner in which each beam structure is manufactured;

FIG. 3 is a perspective view showing a girder constructed with a pair of beam structures, one superimposed above the other, and also showing a second pair of beam structures supported from the girder;

FIG. 4 is a perspective view of a modified form of the invention;

FIG. 5 is a partial perspective view of a modular unit constructed in accordance with the teachings of the invention;

FIG. 6 is a perspective view of a flotation hull made in accordance with the teachings of the invention; and

FIGS. 7A–7F are a series of perspective views showing the manner in which a flotation hull may be formed and how a pair of flotation hulls may be joined together to form a raft, bridge pontoon, dock, catamaran hull or other floatable structure.

Referring to FIG. 1 in particular, there is illustrated a plurality of beam structures **10**, each comprised of a pair of longitudinal stringers or support members **11**, a sheet of flexible, high-strength material **12** flexed into a substantially U-shaped cross-section, and a sheet of rigid material **13** secured across the pair of longitudinal stringers or support members **11**. The flooring structure as a whole is supported at either end by a beam **14**.

An inexpensive although rigid construction may be made using wooden 2 x 6's for the support members **11**; galvanized steel or other sheet metal for the flexible material **12**; and standard sheets of plywood for the rigid sheets **13**. Using these materials, the support members may be secured to sheet members **12** and **13** (and the beam structures assembled) by using common building nails. The width and thickness of the various materials used would, of course, be determined by an engineering analysis and selected to meet the span and loading requirements for the intended use. However, 18 gauge galvanized steel of 4-feet width has been used for the flexible material in applications having spans up to 47 feet. Greater spans are possible in roofing applications. Standard 2 x 6 pieces of number have been used as support elements **11** in combination with 4 x 8 sheets of ½", ⅝", or ¾" plywood as the rigid sheet material **13**.

Each beam structure **10**, it has been found, can be rapidly manufactured by first laying out the flexible sheet material **12** on a flat surface as indicated in FIG. 2. Longitudinal stringers or support members **11** are then secured to parallel longitudinal edges of the sheet **12**, after which support members **11** are brought upwardly and together (as indicated in FIG. 2) bowing or bending the sheet into a U-shaped cross-section. Next, members **11** are

brought together until they are approximately two feet apart on center, and then they are secured in spaced relation by affixing the rigid sheet **13**, as by nailing.

It has been observed that by providing a linear distance between the longitudinal stringers or support members **11** which is approximately one-half the arcuate length of the flexible sheet **12** produces a U-shaped bend having leg portions that are nearly vertical and, therefore, flat on the longitudinal support members **11**. This minimizes the twisting of the members and a pulling out of nails which may be used in the construction.

Again referring to FIG. 1, an auxiliary support member **15** may be secured to the ends of support members **11** on the inside of the beam section, the lateral edge of flexible material **12** being sandwiched between members **11** and **15**. The use of auxiliary supports is particularly desirable to provide additional strength for wooden support members at points where the shear load normally sustained by the flexible sheet **12** is transferred into support members **11**.

Adjacent beam structures **10** are interconnected by longitudinal ribs or stiffeners **16** placed on the edge and underneath rigid sheet members **13**. One stiffener is mounted along one edge of each sheet **13** and located so as to receive thereon the sheet **13** of an adjacent beam structure. After the beam structures have been placed in side-by-side relation as shown in FIG. 1, sheets **13** may be nailed or otherwise secured to the stiffening rib that is supported by the adjacent beam structure. This produces a rigid, continuous flooring comprised wholly of beam structures.

Referring to FIG. 3, there is shown an assembly of beam structures, each constructed in the manner described above. In particular, it will be noted that a beam structure **20** is superimposed above a second beam structure **21**, the U-shaped cross-section of the uppermost sheet **12** being inverted. Beam structures **20** and **21** are connected as by nailing or bolting the rigid plates **13** of both beam structures together. The pair of beam structures **20** and **21** form a girder of great strength that can be used to hold transverse beam structures, such as **22** and **23**. The support members **11** of inverted beam structure **20** provide ledges along which support members **11** of beams **22** and **23** can be selectively positioned.

It will be apparent that the beam structures described herein can be used for floors and roofs of buildings wherever a long span, flat or slightly pitched surface is desired, and without intermediate supports. A sloped roof of any desired pitch can be constructed simply by varying the height of the end supports. Also, a desired camber can be obtained by positioning the longitudinal members **11** on a slope with respect to the top or longitudinal edges of the flexed sheet **12**. As indicated above, a typical beam structure constructed as described herein can be used for supporting roofs with spans up to 47 feet and for floors with spans up to 30 feet. Of course, modifications, such as by using thicker gauge metal, can provide for even larger spans. The beam structure can also be placed in a vertical position where it may act as a bearing wall. It can also be used for disposal chutes for construction debris or for transporting fluid concrete.

In the modification shown in FIG. 4 an all metal beam structure is shown. In this form of the invention the rigid sheets of plywood are replaced by steel deck plates **113** and the longitudinal stringers or support members comprise flat bars **111** that are welded to the under side of the steel deck **113**. The sheet metal web **112** is then spot welded to the stringers or support members **111**. While this construction is more costly and heavier than that shown in FIGS. 1–3 it has the advantage that it is noncombustible, and, hence, is suitable for use in buildings where resistance to fire is a prerequisite.

FIG. 5 illustrates a modular unit **210** constructed in accordance with the teachings of the invention. In this unit, the rigid plywood sheets **213** are offset with respect to the flexible webs **212** so that one edge **215** of the plywood sheet terminates in the middle of one of the longitudinal stringers or support members **211**. As distinguished from the form of the invention shown in FIGS. 1–3 the standard plywood sheet is disposed with its greater length transverse to the flexible web **212** so that the sheet spans two such parallel webs set on four foot centers. This spacing results in an overhang **217** to the right of the right hand web (as viewed in FIG. 5) that reaches to the middle of the stringer or support member **211** of the next adjacent marginal unit (shown in phantom outline in FIG. 5). This arrangement of the plywood sheets eliminates the need for the longitudinal ribs or stiffeners **16** shown in FIGS. 1–3. It also eliminates the need for any lateral bracing of the beam structures during storage since each modular unit comprises a pair of webs that give the beam structure unit a stability not possessed by the single unit type construction shown in FIGS. 1–3.

The invention may also be employed to provide a simple, inexpensive and water-tight construction for a flotation hull. Such a hull **310** is shown in FIG. 6. The method of forming the hull and combining two such hulls into a floatable structure is illustrated in FIGS. 7A–7F.

As seen in FIG. 6 the hull **310** comprises longitudinal stringers or support members **311** and a sheet of flexible, high-strength material **312** which has been nailed to the support members along its outer edge portions **314**. The sheet material, preferably galvanized sheet steel, has been flexed into a substantially U-shaped cross-section and the opposite ends thereof **315** have been folded inwardly and upwardly to form closures for what otherwise would be the open ends of the U-shaped web of sheet material. End braces **316** join the stringers or support members **311** and the folded ends **315** of the web **312** are nailed thereto. This construction results in a seamless, water-tight hull structure which may then serve as the basic unit for rafts, docks, bridge pontoons and other like structures. As in the case of the beam construction the support members **311** may be made from standard lumber sizes such as 2 x 6's, 2 x 8's and other sizes as desired. The web **312** may be made from any suitable sheet material but galvanized sheet steel is preferred.

Such a hull may be fabricated easily and inexpensively by first unwinding a desired length of sheet from a coil of galvanized steel. The sheet may then be laid out on spaced parallel flat surfaces **318** with the opposite sides **314** of the sheet overlaid on longitudinal stringers or support members **311**. The edges of the opposite sides **314** are then nailed to the supports **311** and the galvanized sheet is then bowed or flexed into a U-shaped web **312**. One method of flexing or bowing the web **312** is shown in the drawings. A heavy weight is first lowered onto the galvanized sheet at the center where the sheet is not supported from underneath. As shown in FIG. 7A, a large diameter length of pipe **320** may be used as the weight. This has the advantage of disposing the weight evenly along the longitudinal axis of the web. The pipe **320** is suspended between U-shaped straps or hangers **322** which, by reason of their configuration, facilitate the shaping of the web into its U-shaped form as the web is bent downwardly. Downward movement of the web **312** during the bowing operation causes the stringers or support members **311** to assume a vertical position and at the end of the web-forming operation the bowed sheet and the stringers appear as shown in FIG. 7B. Preferably the spacing **324** between the two supporting surfaces **318** is substantially equal to the width of the desired hull dimensions as this simplifies the proper sizing of the web during the forming operation.

After the web **312** is formed the open ends **315** are folded inwardly and upwardly to close off the web and to form a water-tight hull. A simple method of doing this is to block or otherwise fix the lower end of a long bar **326** underneath the web **312** and to pivot the upper end of the bar **326** upwardly and inwardly against the open edge

is to block or otherwise fix the lower end of a long bar **326** produces an inwardly extending crimp **328** in the web and, at the same time, bends the adjacent portions **330** of the web upwardly at a slanting angle so as to close off the open ends of the web (FIG. 7C). With the bar **326** removed the crimped portions **328** of the web are bent and shaped together to form a neater appearance (FIG. 7D) and then the outer edge portions **315** of the crimped web are nailed to angled cross-braces **316** positioned between the support members **311** (FIG. 7E). In this manner a simple, inexpensive and water-tight flotation hull is constructed. One advantageous feature of the construction is the lack of any seams at or below the water line. Since the construction is seamless no caulking is required.

One way in which a pair of such hulls may be combined is shown in FIG. 7F. A pair of hulls **310** are disposed parallel to each other and are joined together by transverse deck sections **330** adjacent to the ends of the hulls. The deck sections **330** may be formed of plywood planks **332** to which downwardly depending stiffeners or blocks **334** of 2 x 4's, or other similar lumber, are nailed. The length of the stiffeners or blocks **334** is such as to make a tight friction fit with the support members **311** of the respective hulls. Each transverse plywood deck section **330** has parallel pairs of such blocking appropriately spaced to fit within the hulls and the insertion of the blocking **334** into the hulls when the decks are laid results in a rigid joining together of the hulls. Similar longiudinal stiffeners or blocking (not shown) are provided on a central deck section **336** which is placed over the opening between the hulls intermediate the transverse deck sections **330**. The blocking on the longitudinal deck section **336** forms a friction fit with the transverse deck sections and provides further stiffening to the assembly. Similar removable deck sections **338** may also be provided to overlie the crimped ends of the hulls. A pair of hulls, when so joined together, may serve as a raft, dock section or catamaran hull. If used as a boat hull the central sections **340** of the hulls **310** may be left open to form cockpits. If it is not desired to have these open spaces they may be enclosed with further decking as desired.

What I claim and desire to secure by Letters Patent is:

1. A girder comprised of at least a pair of structural units each unit comprising a pair of longitudinal support members, means for securing said support members in spaced relationship, a sheet of resilient and flexible material flexed into a substantially U-shaped cross-section having spaced-apart legs engaged with one of said support members, respectively, and means for securing each leg of said sheet to the support member with which it is engaged; one structural unit being superimposed above the other, the U-shaped cross-section of the uppermost sheet being inverted; and further comprising means for securing said structural units together.

2. A method for forming a beam structure with a sheet of resilient flexible material and a pair of elongated support members extending generally parallel to the longitudinal axis of the finished beam comprising the steps: supporting said sheet with one surface thereof facing and in spanning relationship to an opening defined by a support, said opening having a length at least as great as said sheet and a width of the desired size for the beam that is to be formed; fixedly securing parallel longitudinal edges of the sheet to said elongated members, respectively; applying a force against the opposite surface of said sheet to thereby flex said sheet through said opening until it assumes a substantially U-shaped cross-section; then securing said elongated support members in spaced relation to retain the sheet material in its flexed condition.

3. A method for forming a girder using a pair of structural units, each unit being formed with a sheet of resilient and flexible material and a pair of longitudinal support members by securing parallel longitudinal edges of the sheet to said longitudinal members, respectively; flexing the sheet into a substantially U-shaped cross-section; then securing said longitudinal members in spaced relation while maintaining the sheet material in a flexed condition; and further superimposing one structural unit above the other while inverting the U-shaped cross-section of the uppermost structural unit, and securing one structural unit to the other.

4. A structural unit comprising:

a pair of longitudinal support members; a sheet of flexible material flexed into a substantially U-shaped cross-section having opposite ends and spaced-apart edge portions, said edge portions being engaged with said longitudinal support members, a pair of transverse support members; said opposite ends of the flexible material being folded inwardly to form closed end portions, said end portions being engaged with said transverse support members; and means for securing said edge and end portions to said longitudinal and transverse support members respectively.

5. A floatable structure comprised of at least two structural units as defined in claim **4**, and a plurality of deck sections, said deck sections having depending portions fitting between and engaging said longitudinal support members.

6. A floatable structure as set forth in claim **5** wherein said structural units are spaced from each other and said deck sections extend transversely to and removably engage said longitudinal support members, and at least one longitudinal deck section covering a portion of the spacing between the structural units.

7. A method for forming a floatable structural unit from a sheet of flexible material, a pair of longitudinal support members and a pair of transverse support members comprising the steps of:

securing parallel longitudinal edges of the sheet to said longitudinal members, respectively; flexing the sheet into a substantially U-shaped cross-section; folding the unsecured opposite ends of the sheet inwardly to close off the ends thereof; securing said transverse support members between and to said longitudinal members; and securing said opposite ends to said transverse support members.

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PRICE C. FAW, JR., Assistant Examiner.

U.S. Cl X.R.

9—6; 52—731, 741; 114—.5, 61

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,465,486 September 9, 1969

Etienne D. Rolin

It is certified that error appears in the above identified patent and that said Letters Patent are hereby corrected as shown below:

Column 2, line 62, "number" should read -- lumber --. Column 5, line 1, "is to block or otherwise fix the lower end of a" should read -- portions 315 of the web. The pivoting of the --.

Signed and sealed this 21st day of April 1970.

(SEAL)
Attest:

Edward M. Fletcher, Jr.
Attesting Officer

WILLIAM E. SCHUYLER, JR.
Commissioner of Patents