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741,501, July 1, 1968, now abandoned.

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189.36 F; 52/80, 81, 82, 86, 87, 638, 665, 669

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[54] JOINTS FOR BRACING MEMBERS
7 Claims, 6 Drawing Figs.

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287/54 A, 61/46.5

[51] Int. Cl..... F16b 7/00

ABSTRACT: A common joint assembly for a plurality of converging bracing members in an open support structure, such as an offshore drilling platform, including a polyhedral-shaped core and transition pieces for connecting each bracing member to a polygonal face of the core. Each transition piece has a larger cross section at the core than at the bracing member and has at least in part plane sides.

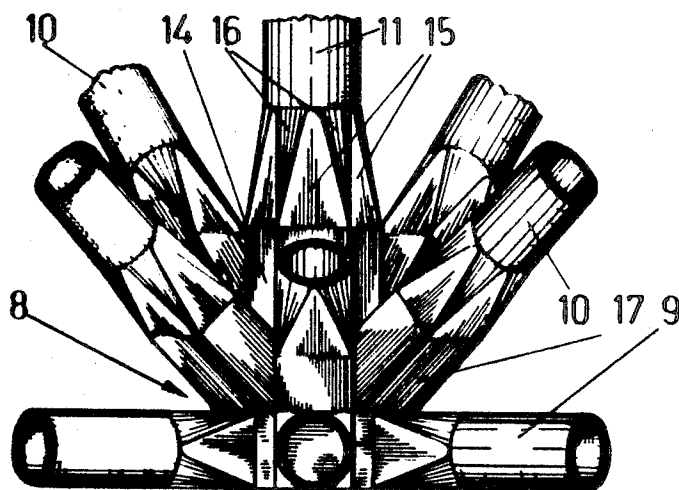


FIG. 1

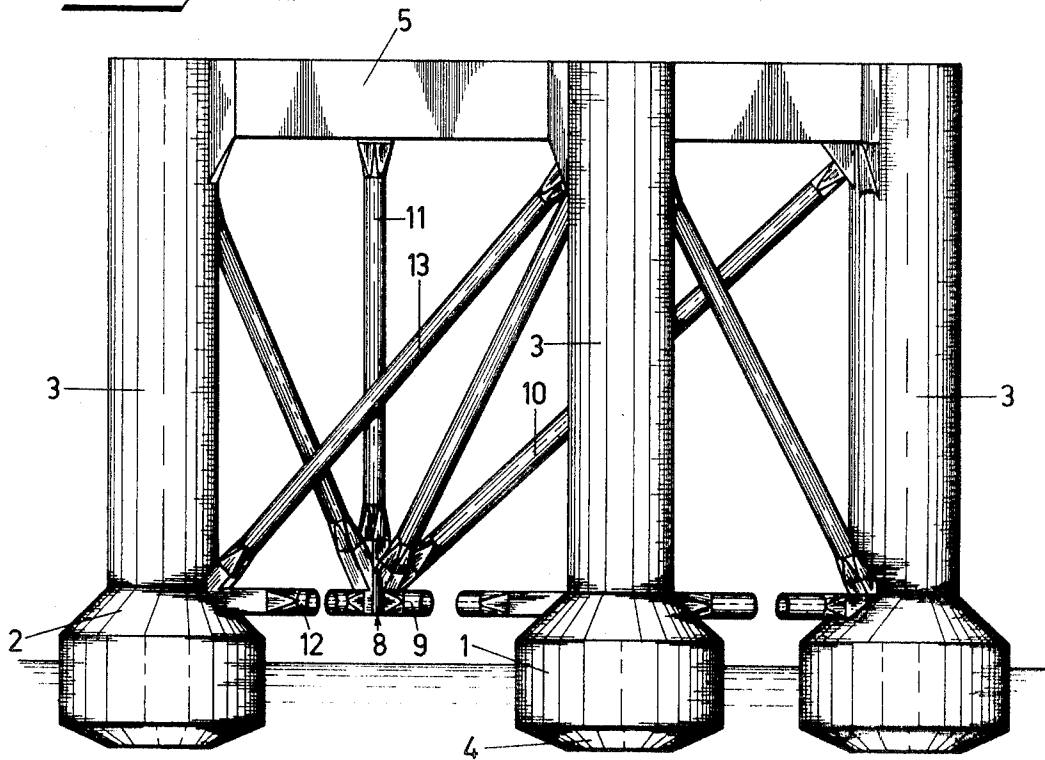


FIG. 3

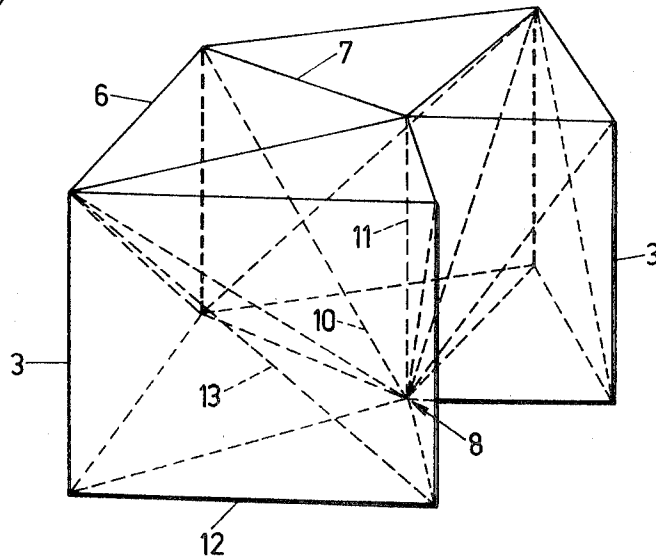


FIG. 2

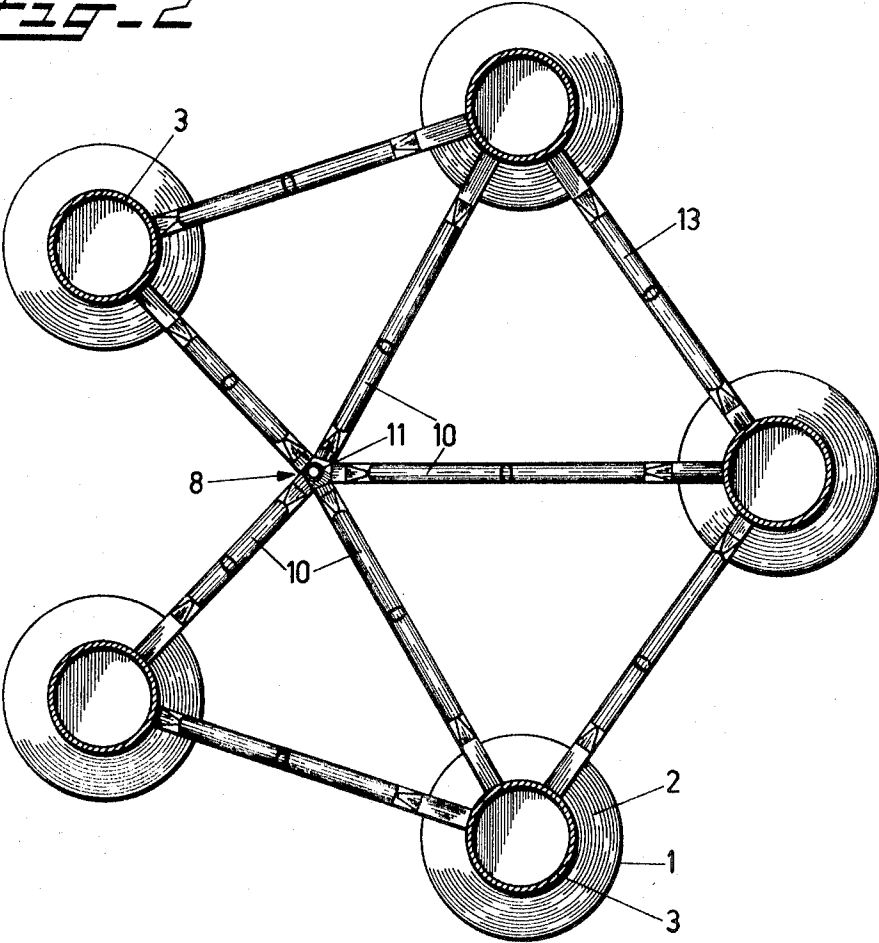
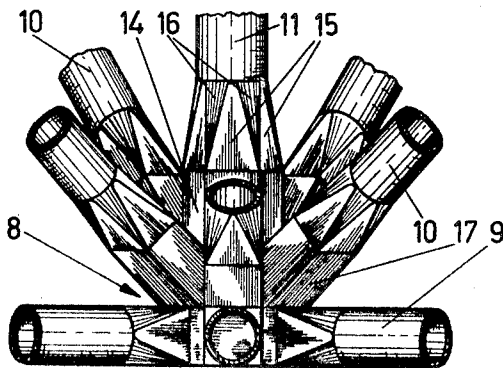


FIG. 4

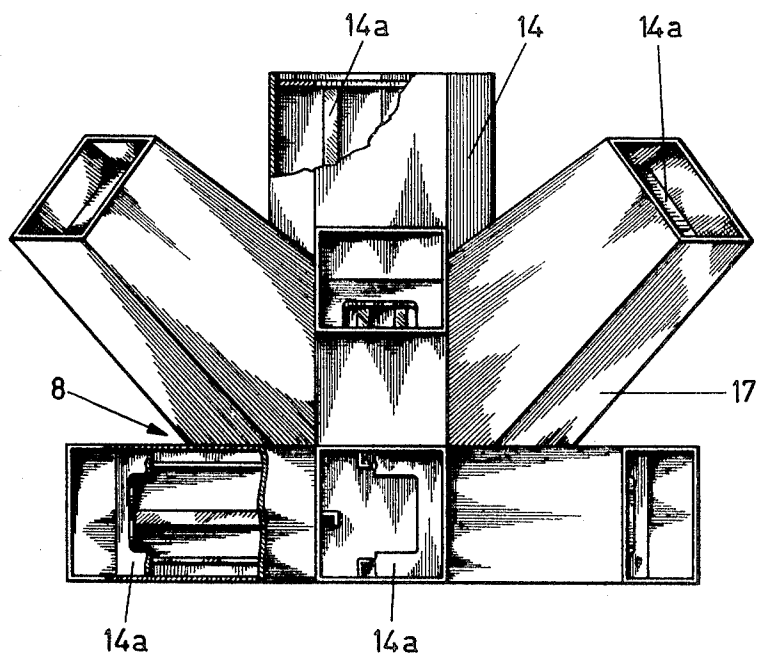


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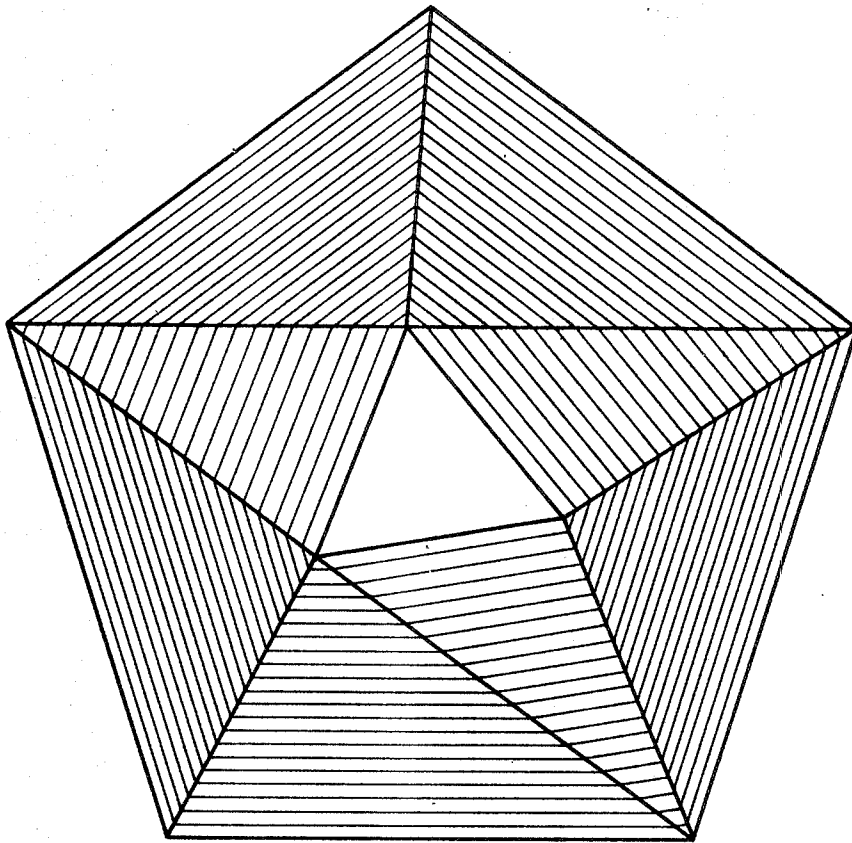


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Fig. 5



JOINTS FOR BRACING MEMBERS

This application is a continuation-in-part of application, Ser. No. 741,501, filed July 1, 1968, and now abandoned.

BACKGROUND OF THE INVENTION

This invention relates in general to joints for the bracing members of open structures.

SUMMARY OF THE INVENTION

This invention is particularly, although not exclusively, applicable to joints for the bracing members of an open structure such as a floating sea platform, the platform comprising a number of vertical columns carried by floaters at their lower ends, which columns carry a horizontal work deck and are kept in relative position by means of a number of horizontal and/or inclined bracing members between adjacent columns. In such a structure it is of vital importance that the joints between the bracing members should be designed and constructed in accordance with high standards, and that the material stresses in the bracings should be transmitted to other bracing members without producing high local stress concentrations.

According to the present invention a joint between the ends of a number of bracing members of a structure is composed of a core of polyhedral shape having at least as many faces as there are bracing members leading to the joint. Each bracing member is connected to a polygonal face of the core through a transition piece being in line with the bracing member to which it is connected. These transition members each have, at the end thereof connected to the core, a polygonal cross section complementary at least in one direction to the polygonal shape of the face of the core to which it is connected. Moreover each transition member has at least as many plane faces as there are sides in said polygonal cross section, of which the sides each form an edge of one of said plane faces. The cross section of the transition members at the end connected to the core is larger than at the other end, where the cross section is equal to that of the adjacent part of the bracing member.

A bracing member having a polygonal cross section can always be connected to a cross section of different polygonal shape by means of flat faces. To join a member having an n -sided polygonal cross section to a member having an m -sided polygonal cross section requires $n+m$ triangular plane faces to obtain a completely closed surface of the transition piece. In order to connect a circular bracing member to a polygonal cross-sectional member, the number of flat faces corresponds with the number of sides of the polygon, this number being increased by the same number of faces of part-conical shape between the flat faces to complete the transition piece. Of course, the length of the transition piece has to be chosen sufficiently long to ensure a uniform distribution of the stresses.

In the case of a structure in which a vertical central bracing member is joined to five pairs of inclined bracing members located in vertical planes which connect the joint to higher and lower points of the structure, the core may advantageously have the shape of a vertical prism having a regular five-sided cross section. The transition members for the inclined bracing members may immediately be connected to a vertical face of such a prism or the core could have extended or protruding parts of polygonal cross section extending from said vertical faces of the core and connected at their other ends to upwardly inclined transition members.

Conveniently the core may be composed of flat plates, thereby keeping its construction simple.

Furthermore, the core may be provided with stiffening plates, with or without recesses, to provide a greater stiffness to the core. If the angle between an incoming bracing and the faces which have to take up the stresses becomes too large, diagonal stiffening plates are particularly advantageous to secure a best possible transmission of the stresses.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention may be carried into practice in various ways, but one specific embodiment will now be described by way of example with reference to the accompanying drawing, in which:

FIG. 1 is a side view of a floating platform;

FIG. 2 shows a horizontal section and top view of the lower part of this platform, the work deck and corresponding girders being left out;

FIG. 3 is a diagram in perspective of the center lines of the bracings forming the spatial trussing;

FIG. 4 shows a side view of a joint according to the invention;

FIG. 4a is a view similar to FIG. 4 but of the core only, in a somewhat different embodiment and sectioned and cut away in part to show the interval structure of the joint, and

FIG. 5 shows a top view of a transition piece between bars of three- and five-sided cross sections respectively, for use in a modified form of the joint of FIG. 4.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The floating platform shown in FIG. 1 derives its floating ability substantially from floaters 1 of circular cross section connected to columns 3 through a conical transition 2. The lower side of each floater 1 has the shape of a truncated cone 4.

On top of the columns 3 is mounted a deck structure 5 which may be composed of a single deck or a number of decks. Preferably, the number of decks is three for a floating drilling platform to provide room for crew accommodation, storage spaces for material, and spaces for machinery and the like.

In the deck structure lie deck edge girders 6 and radial girders 7, as shown in FIG. 3.

A joint 8 is provided at a lower level, which lies above the water surface when the platform is to be towed. From this joint 8 bracings 9 radiate in a horizontal plane, inclined spatial bracings 10 radiate to the upper ends of the columns, and a vertical bracing 11 extends upward to the deck.

Furthermore, circumferential bracings 12 are provided in the horizontal plane at the level of the joint 8. One diagonal bracing 13 is mounted in each side face of the structure between the columns.

As seen in FIGS. 2 and 3 there are no bracings between the two columns bordering one vertical face of the structure, so that a wedge-shaped opening results at that location. A drilling rig is mounted above this opening which, thus, can be brought freely over a well of which the casing may extend above water.

Including the five stabilization columns 3 the whole structure has 33 bars, whereas 30 bars are needed for a statically determined framework. These additional three redundant bars could for instance have been left out of the diagonal bracings in the side faces of the spatial framework, and thus constitute a safety margin for the structure.

The location of the joint 8 does not coincide with the center of the circumscribed circle of the regular pentagon on the corners of which the columns are located. The location of joint 8 is eccentric, being shifted to the side of the drilling rig location for a more favorable load distribution to accommodate the heavy load of the drilling rig on one side of the structure.

As seen in FIG. 3, the joint between the horizontal girders 7 in the upper face or deck is located vertically above joint 8, but this is not essential for the reliability of the structure.

FIG. 4 shows the joint 8 in detail. This joint has a central core consisting of parts 14 and 17. Part 14 is in the shape of a vertical-axis prism of pentagonal cross section of which the angles between the sides may be adapted to the angles at which the bracings meet. In vertical projection, these angles are supplementary to each other. In a case of not too large deviations from symmetry a regular pentagonal cross section will fully suffice. The prismatic part 14 may be made of flat

plates joined together at their edges, and internal stiffening plates 14a as shown in FIG. 4a with or without apertures in them may be built into this part if necessary in order to increase its rigidity.

The bracings 9, 10 and 11 leading to the joint are of circular cross section in FIG. 4 and the connection between the vertical bracing 11 and the part 14 of the core is formed by a transition piece composed of converging flat faces 15 and part-conical faces 16. Thereby, an advantageous transmission is ensured of the stresses in rod 11 to the face of core 14.

As seen in the drawings, the number of flat faces 15 of the transition piece equals the number of sides of the prism 14, and in between the flat faces 15 lie an equal number of part-conical faces 16.

In connecting an inclined spatial bracing 10 to a vertical side face of the core part 14, the bracing 10 is connected to a core part 17 of square cross section through a transition section similar to that just described, the part 17 being welded to the corresponding face of the part 14 to form the core.

FIG. 4a shows a core with parts 14 and 17 being almost identical to the core of FIG. 4, but with the parts 17 for the inclined bracings 10 being frustopyramidal and not prismatic as in FIG. 4.

The usual and most preferred way of designing and manufacturing the joint of this invention is by welding plates together for the core and the transition members and by welding such parts and the bracing members together to form a unitary rigid structure with a good guiding and distribution of stresses. The bracing members are preferably circular tubes as commercially available.

FIG. 5 shows by way of example how a triangular bracing can be connected to a pentagonal face of the core. The number of flat faces required in the transition section equals the sum of the number of sides of both areas to be connected, i.e., in the present case, $3+5=8$.

When forming a joint according to the invention, the centerlines or axes of the bracing members meet at and pass through a common point of intersection to maximize the strength of the joint and provide uniform stress distribution.

It will be apparent that the application of such a joint is not limited to an application in floating platforms, but may be useful in other open support structures in general, such as bridge trusses, heavy construction frameworks, etc.

While the invention has been particularly shown and described with reference to a preferred embodiment thereof, it will be understood by those skilled in the art that various changes in form and details may be made therein without departing from the spirit and scope of the invention.

What we claim is: claim:

1. A common joint structure for joining the converging ends of a plurality of bracing members comprising:

a. a polyhedral-shaped core having at least as many faces as there are bracing members leading to the joint,

b. a plurality of transition members connecting each bracing member to a polygonal face of the core,

each transition member being in line with the bracing member to which it is connected, the transition members each having at the end thereof connected to the bracing member a cross-sectional area equal to that of the adjacent part of the bracing member and smaller than the cross-sectional area of the transition member at the other end thereof where it is connected to the core and where this cross-sectional area is polygonal and at least in one direction equal in linear dimension to the linear dimension in the same direction of that face of the core to which the transition member is connected, each transition member having a number of plane faces at least equal to the number of sides of said polygonal cross section of the transition member at the end connected to the core, each side of said polygonal cross section being the edge of one of said plane faces.

2. A common joint structure as set forth in claim 1, wherein:

a. the bracing members have circular cross sections, and

b. the plane faces of the transition members are each alternated by part-conical faces.

3. A common joint structure as set forth in claim 1, wherein the core is formed by a plurality of flat plates and is provided in its interior with a plurality of stiffening plates to add greater rigidity to the core.

4. A common joint structure as set forth in claim 1, wherein the core has a vertical part of polygonal cross section from which transition members extend in an upwardly inclined direction, in a horizontal direction and one in a vertically upward direction.

5. A common joint structure as set forth in claim 4, wherein parts of polygonal cross section of the core extend in an upwardly inclined direction from the walls of the said vertical part of the core and are connected at their outer ends to the said upwardly inclined transition members.

6. A common joint structure as set forth in claim 4, wherein:

a. the vertical part of the core has the shape of a vertical prism with a pentagonal cross section, and

b. there are five pairs of horizontal and inclined bracing members lying in vertical planes and converging at the joint.

7. A common joint structure as set forth in claim 1, wherein the bracing members are hollow.