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Guy et al.

[11] **3,779,656**

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[54] **TUBULAR JOINT**

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[73] Assignee: **Esso Production Research Company,** Houston, Tex.

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[52] **U.S. Cl.** **403/174,** 52/638

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

[58] **Field of Search** ..... 287/189.36 R, 189.36 B, 287/54 D; 52/638, 648, 655, 665, 726

[56] **References Cited**

UNITED STATES PATENTS

603,244	5/1898	Avery	287/189.36 B X
1,480,854	1/1924	Dornier	287/189.36 R
3,006,670	10/1931	Schmidt	287/189.36 R
3,596,950	8/1971	Wipkink et al.	287/189.36 R
2,738,039	3/1956	Hamilton	287/189.36 B X

FOREIGN PATENTS OR APPLICATIONS

1,363,300	5/1964	France	287/189.36 B

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[57] **ABSTRACT**

A tubular joint for framing structures, such as offshore platforms of the type used by the oil industry, in which tubular X joints are used within the structural and geometric bracing of the structures. Tubular (or cylindrical) framing members are joined together in an intersecting X shape. Wedge shaped segments of a tubular member are connected to each other and each segment is also connected to a tubular framing member and arranged so that the segments carry the axial loads of said tubular framing members in a straight line direct stress pattern across the open circular sections of said tubular framing members. The segments may be connected to two flat intersecting plates instead of to each other.

12 Claims, 7 Drawing Figures

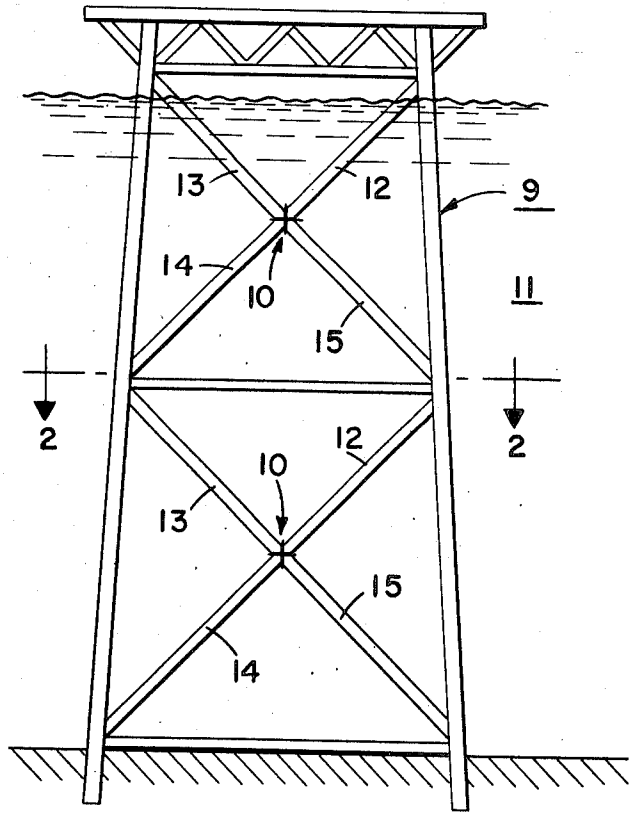

FIG. 3.

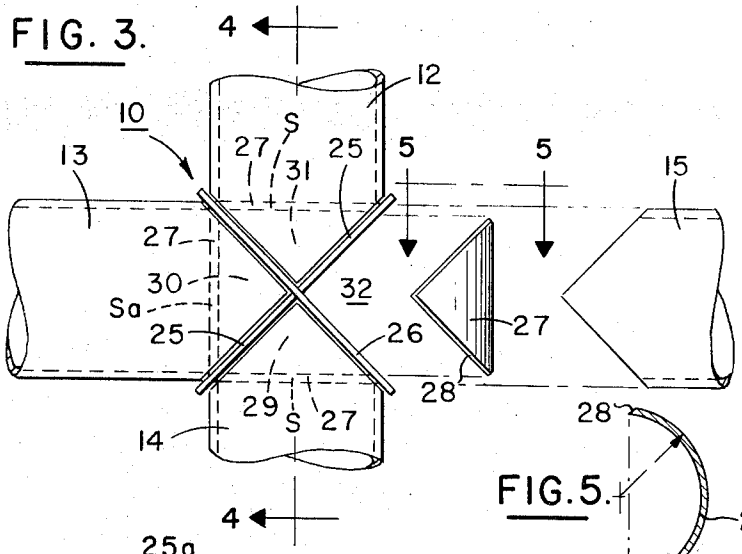

FIG. 4.

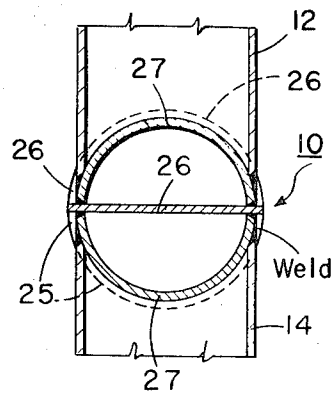

FIG. 5.

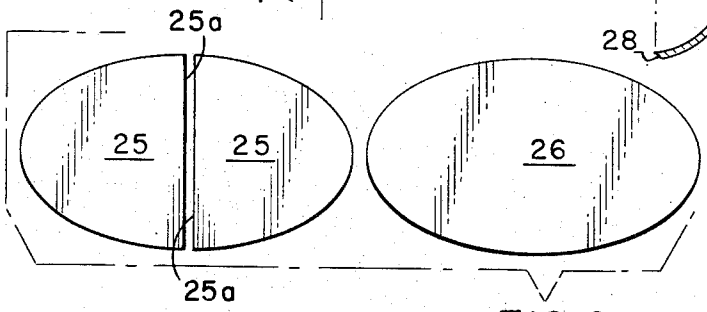

FIG. 6.

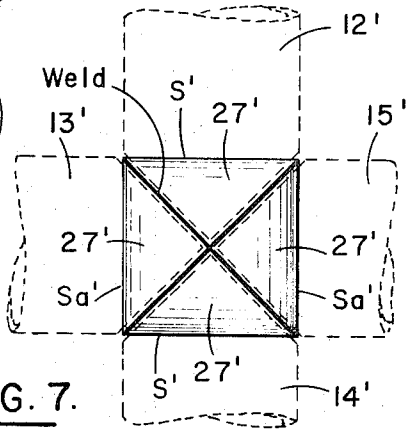

FIG. 7.

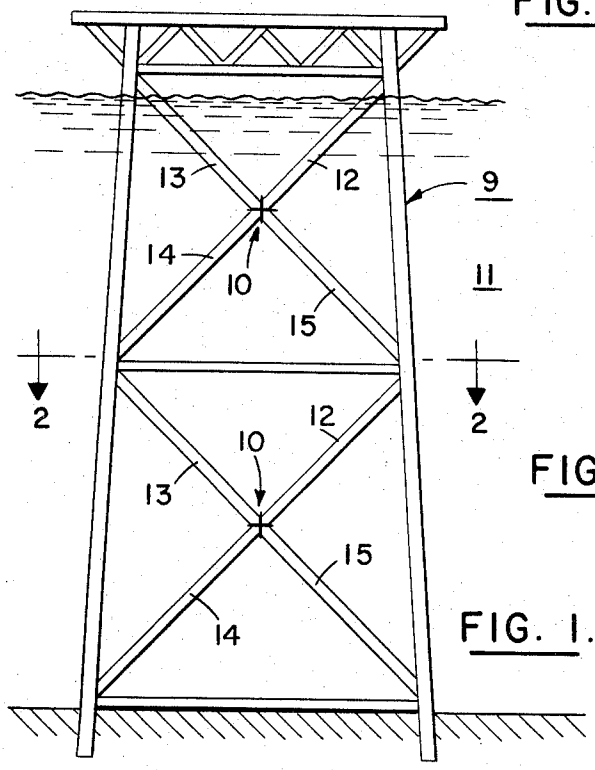

FIG. 1.

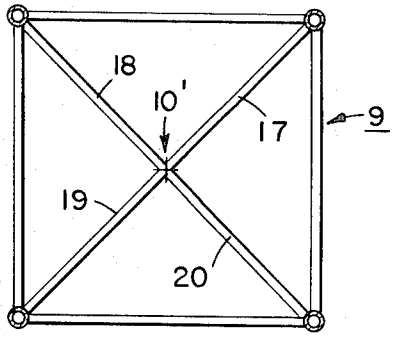

FIG. 2.

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TUBULAR JOINT

BACKGROUND OF THE INVENTION

The present invention generally concerns structural and geometric bracing used in the construction of structures such as offshore platforms.

Offshore platforms have generally been constructed of tubular members to reduce the hazards of both environmental forces and enviromental corrosion. A number of joints have been developed to join tubular members together. These joints have commonly been called by the alphabetical letter that they most nearly represent in appearance. Thus, the joints in offshore platforms are generally referred to as K, T, X and Y joints. A given platform may have one or more of these types of joints present. However, the X joint has not been used as often as the other types and is rarely used in the primary structural framing of an offshore platform. Generally, the X joint is used only in secondary geometric bracing. In an X joint one member is in tension while the other is in compression. The tension member elongates with a consequent reduction in diameter. The compression member, at the same time, presses on the sides of the tension member, further reducing its diameter. The result of these two simultaneous actions is general instability of the circular cross section of the tension member which can lead to failure at a load level less than the normal capacity of that member.

The problem can be moderated in a practical way by improving the tension member's ability to transfer the compression load across its open circular section. Several techniques can be used to improve the X joint in this manner. The wall thicknesses of both the tension and compression members can be increased at the joint to improve stiffness and thus ring stability, or internal ring stiffness can be added to bridge the open circular section and thus improve both ring stability and load transfer, or a combination of these techniques can be used to improve overall performance. Even with these techniques available, however, there has been a reluctance to use the X joint in principle structural framing.

With the advent of deep water platforms, dynamic wave excitation became an important design parameter. To moderate dynamic amplification, it is necessary to reduce the platform's natural period which can best be accomplished through structural stiffness. On a cost and weight basis an X braced structure is a very efficient way to frame a structure for maximum stiffness and use of the X braced structure would be preferred provided the aformentioned deficiencies were overcome.

The X joint of the present invention overcomes the deficiencies in all previous X Joints. The present invention provides a most effective means of transferring the compression member's load across the tension member's open circular section; it provides complete ring stability; and it permits rational analysis. In effect, it creates a joint that permits both the tension member and the compression member to act as though they were isolated individual members.

SUMMARY OF THE INVENTION

Briefly, the present invention involves structural framing apparatus which comprises tubular framing members to be joined together in an intersecting X form; and means connected to the tubular framing members at their intersection to carry the axial loads of the tubular framing members in a straight line direct stress pattern across the open circular sections of the tubular framing members. The means for carrying the axial loads across the open circular sections preferably comprise four wedge shaped segments of a tubular member connected to each other and to the tubular framing members.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows an offshore platform having the improved X braced framing constructed in accordance with the present invention;

FIG. 2 is a sectional view taken along the lines 2—2 of FIG. 1;

FIG. 3 is an enlarged partly exploded view illustrating one embodiment of the improved X joint in accordance with the present invention;

FIG. 4 is a view taken along the lines 4—4 of FIG. 3;

FIG. 5 is a view taken along the lines 5—5 of FIG. 3;

FIG. 6 illustrates elliptically shaped plates or diaphragms which form part of the improved X joint in the embodiment of FIGS. 3–5; and

FIG. 7 is a view illustrating another embodiment of the improved X joint in accordance with the present invention.

DETAILED DESCRIPTION OF THE INVENTION

An offshore platform **9** located in a body of water **11**, is illustrated in FIG. **1**. The principle structural framing of platform **9** is composed of tubular members **12, 13, 14** and **15** joined together at their intersection by the X joint designated **10.** As seen in FIG. **2** the secondary geometric bracing is composed of tubular members **17, 18, 19** and **20** joined together at their intersection by X joint designated **10'**. As shown in FIGS. **3–6** two semi-elliptically shaped plates or diaphragms **25** and an elliptically shaped plate or diaphragm **26** are welded together so that the flat edges **25***a* of plates **25** abut the opposite flat sides of plate **26** forming thereby open quadrants **29, 30, 31** and **32.** A segment **27** of a tubular or cylindrical member (pipe), wedge shaped in elevation as seen in FIG. **3** and semi-circularly shaped as seen in FIG. **5** and having a flat tapered edge portion **28** is fitted into each of the open quadrants **29, 30, 31** and **32,** the flat tapered edges fitting against the flat surfaces of plates **25** and **26.** Segments **27** are welded to plates **25** and **26.** Tubular members **12, 13, 14** and **15** and segments **27** are of the same initial diameters and each tubular member is welded to the segment **27** with which it is associated and to the plates **25** and **26** in the quadrant with which the particular tubular member is associated. Segments **27** when in position transfer axial compression loads across the open circular cross sections formed by the intersecting tubular forming members **12, 13, 14** and **15.** The double dotted lines indicated by S in FIG. **3** show the straight line direct stress pattern across the open circular sections of the tubular framing members **13** and **15** whereas the double dotted lines indicated by S_a show the straight line direct stress pattern across the open circular sections of tubular framing members **12** and **14.**

Tubular members **12, 13, 14** and **15** may be either short pieces of pipes or tubular members that the principle members are welded to or they may be the principle tubular members themselves. The improved X joint may be appropriately prefabricated for assembly in the construction of the main offshore platform.

The modification of the X joint shown in FIG. 7 comprises four segments 27' similar to segments 27 described above. However, segments 27' are welded or otherwise connected directly to each other resulting in the configuration shown in FIG. 7. Tubular members 12'13'14' and 15'shown in dotted lines in FIG. 7 are welded to segments 27' as previously described (except of course the tubular members would not be welded to the diaphragm or plate members). The straight line direct stress pattern across the open circular sections of tubular members 12' and 14' are indicated at S' and the straight line direct stress pattern across the open circular sections of the tubular members 13' and 15' are indicated at S'*a*.

The diaphragm or plate members illustrated herein may have shapes other than elliptical, as for example square or rectangular shapes. Other changes and modifications, such as the angle between intersecting members may be more or less than the 90° illustrated, may be made in the specific illustrative embodiments of the invention shown and/or described herein without departing from the scope of the invention as defined in the appended claims.

Having fully described the nature, operation, advantages and apparatus of our invention,

We claim:

1. Structural framing apparatus comprising:

four tubular members, each being substantially the same cross-sectional size, arranged and interconnected in an intersecting X-form and having open and spaced apart ends;

means connected to said open ends of said tubular members closing off said open ends thereof and forming an enclosure in the space between said tubular members and extending each two aligned tubular members coaxially across the open ends of said other two aligned tubular members to form effectually a continuous tubular member of said two aligned tubular members to aid in transferring axial loads across said open ends.

2. Structural framing apparatus as recited in claim **1** wherein said means connected to said open ends of said tubular members comprise four wedge-shaped segments connected together to form said enclosure, each segment being connected to and closing off the end of a different one of said tubular members; and

each two opposing wedge-shaped segments extending each two aligned tubular members across the open ends of said other two tubular members.

3. Structural framing apparatus as recited in claim **2** wherein said tubular members are circular in cross section, substantially the same diameter in cross section.

4. Structural framing apparatus as recited in claim **3** wherein each segment includes a flat tapered edge portion, said edge portions being connected together to form said enclosure.

5. Structural framing apparatus comprising:

four tubular members, each being substantially the same cross-sectional size, arranged in an intersecting X-form and having open and spaced apart ends;

means connected to said open ends of said tubular members closing off said open ends thereof and forming an enclosure in the space between said tubular members and extending each two aligned tubular members across the open ends of said other two aligned tubular members to aid in transferring axial loads thereacross;

said means connected to said open ends of said tubular member comprising:

two flat intersecting plate members arranged in an X-form, said intersecting plate members being at least equal in size to the diameter of said largest tubular member at the intersection of said tubular members; and

four wedge-shaped segments, each segment having a radius substantially equal to the radius of said aligned tubular members and being arranged in a quadrant of said intersecting plate members and being connected thereto and being connected to and closing off the end of a different one of said tubular members;

each two opposing wedge-shaped segments extending each two aligned tubular members across the open ends of said other two tubular members.

6. Structural framing apparatus comprising:

four tubular members arranged in an intersecting X-form and having open ends and being spaced apart at said open ends;

four wedge-shaped segments, each segment having a radius substantially equal to the radius of said aligned tubular members and being connected to a different one of said tubular members at said open end of said tubular member closing the end thereof, each of said wedge-shaped segments being connected along its edges to adjacent wedge-shaped segments, thereby enclosing the space between said open ends of said tubular members; and

each two opposing wedge-shaped segments extending each two aligned tubular members across the open ends of said other two tubular members to aid in transferring axial loads thereacross.

7. Structural framing apparatus comprising:

a first tubular framing member;

a first wedge segment joined to the end of said first tubular framing member;

a second tubular framing member;

a second wedge segment joined to the end of said second tubular framing member;

a third tubular framing member;

a third wedge segment joined to the end of said third tubular framing member;

a fourthe tubular framing member;

a fourth wedge segment joined to the end of said fourth tubular framing member;

said wedge segments having radii substantially equal to the radii of said aligned tubular framing members and being connected together edgewise and said first and second wedge segments being opposed and said third and fourth wedge segments being opposed;

said first and second wedge segments extending said first and second tubular framing members across the open ends of said third and fourth tubular framing members; and

said third and fourth wedge segments extending said third and fourth tubular framing members across the open ends of said first and second tubular framing members.

8. Structural framing apparatus as recited in claim **7** in which said tubular members are circular and substantially the same diameter in cross section.

9. Structural framing apparatus as recited in claim **8** in which each of said segments has flat tapered edges,

said edges of said segments being connected together to form said enclosure.

10. Structural framing apparatus comprising:

four tubular members arranged in an intersecting X-form and having open ends and being spaced apart at said open ends;

two flat intersecting plate members arranged in an X-form and extending across the space between said tubular members, said intersecting plate members being at least equal in size to the diameter of said largest tubular member at the intersection of said tubular members;

four wedge-shaped segments, each segment having a radius substantially equal to the radius of said aligned tubular members and being arranged in a different quadrant formed by said intersecting plate members and connected to said plate members and to the open end of a different one of said tubular members closing said open ends thereof, each of said wedge-shaped segments being connected along its edges to said plate members, thereby enclosing the space between said open ends of said tubular members; and

each two opposing wedge-shaped segments extending each two aligned members across the open ends of said other two tubular members.

11. Structural framing apparatus as recited in claim **10** in which said tubular members are circular and substantially the same diameter in cross-section.

12. Structural framing apparatus as recited in claim **11** in which each of said segments has flat tapered edges, said edges engaging said plate members.

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