Dec. 11, 1962 E. M. HÜNNEBECK 3,067,844

NETWORK OF SINGLE RODS WELDED TOGETHER AT THEIR JUNCTIONS

Filed March 31, 1953 2 Sheets-Sheet 1

Fig. 1

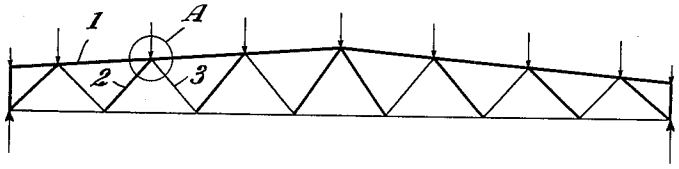


Fig. 2

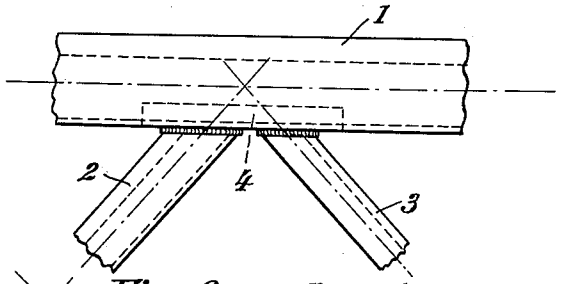


Fig. 2a Fig. 2b

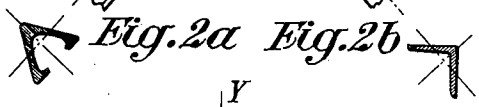


Fig. 3

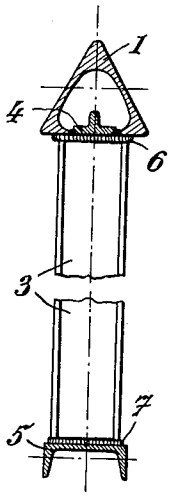


Fig. 4

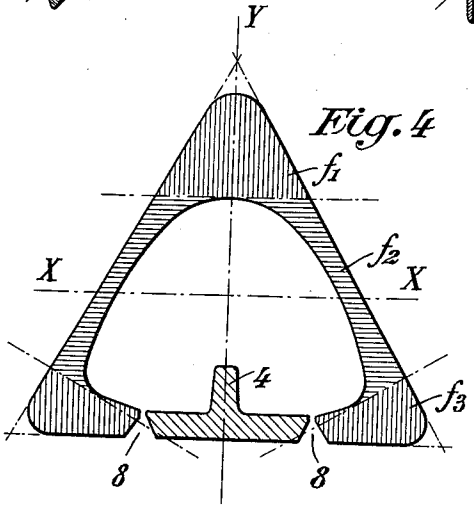
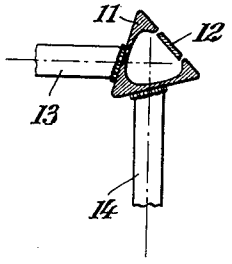


Fig. 5



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Fig. 6

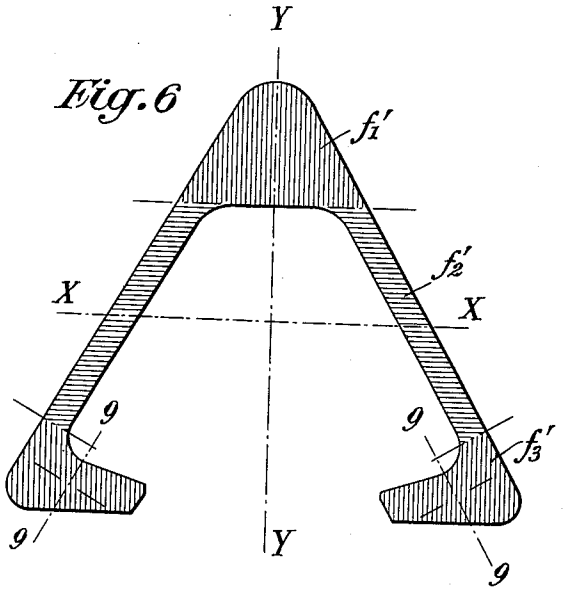
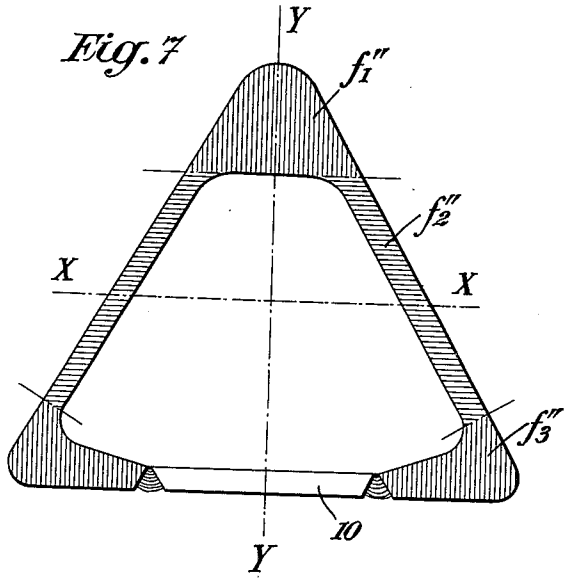


Fig. 7



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NETWORK OF SINGLE RODS WELDED TOGETHER AT THEIR JUNCTIONS

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4 Claims. (Cl. 189—37)

The present invention pertains to triangular structural hollow members and to a network of single members welded together at their junctions.

An object of the invention is to provide a triangular structural member provided with fillets within its corners.

Another object of the invention is to provide a triangular hollow structural member having one leg thereof slotted.

Still another object of the invention is to provide a triangular structural member having fillets within its corners, with one leg slotted, and having a profile mass distribution selected for optimum efficiency, while utilizing a minimum mass necessary.

Another object of the present invention is to provide a network including top members and diagonal members of the triangular hollow profile of the present invention, having a high structural strength, but requiring a lesser amount of materials than conventional up to present.

Another object of my invention is to prevent buckling of the members in any direction.

A still further object of my invention is to keep the labour expenditure low as regards both the production of the member profiles and the formation of the junctions.

Other objects and many of the attendant advantages of this invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings in which like reference numerals designate like parts throughout the figures thereof and wherein:

FIGURE 1 shows by way of example, in elevation a network having ascending and descending diagonal members;

FIGURE 2 illustrates, on an enlarged scale, in elevation, the junction shown in FIGURE 1 by the circle A;

FIGURES 2*a* and 2*b* are cross-sectional views of the diagonal members shown in FIGURE 2;

FIGURE 3 is a cross-sectional view of the top member and the connection of the tension member of FIGURE 2 to the top member and the bottom member shown in cross-section;

FIGURE 4 shows the shape of the triangular profile together with an insertion in cross-section;

FIGURE 5 shows in cross-section a junction of a spatial network and

FIGURES 6 and 7 show other shapes and sections of the triangular profile.

In the construction shown in FIGURE 1, the compression members are shown in thicker lines to differentiate them from the tension member, shown by thinner lines. Whilst the diagonal members subjected to tension have angular profiles and the bottom members have U-profiles, the members of the top member and the diagonal members subjected to compression have hollow triangular profiles. The triangular profiles have a periphery of an equilateral triangle, one side of which, is open. All three kinds of members are so arranged in the network (see

FIGURES 2 and 3) that their axis of symmetry lies in the plane of the network and their opening lies below. Thus the profiles allow the water to run away as in the case of a roof, and the danger of corrosion is reduced.

In order to connect the diagonal members **2** and **3** to the members **1** of the compression girder, the opening of the member of the compression girder is closed by an insertion **4**, welded therein. In the present case the insertion **4** has a T-profile, the web of which projects inwards. The profile of the insertion may be of a different shape, or use may be made of a simple metal sheet. This completion of the original triangular profile imparts to it an increased rigidity and permits connection of the diagonal members to flat surfaces of the members of the compression girder and of the members **5** of the tension girder having a U-profile. Thus, the incorporation of the diagonal members requires only flat sections and the welding is effected by means of seams **6**, **7** running transversely to the axes of the members. These have the advantage of avoiding the longitudinal and transverse seams which may arise without such sections and which would provide different elasticity in the same connection.

As can be seen from FIGURE 4, the edges of the triangular profile and of the insertion **4** lying opposite each other are so bevelled that grooves **8** are formed for V-shaped welding seams. The three corners of the profile are strengthened inwards by the formation of approximately triangular surfaces in the corners of the profile. In this way the cross sectional surface is divided into three different kinds of surfaces, as indicated by different hatchings. f_1 is a surface containing the reinforcement of the upper edge, f_3 are the two surfaces containing the reinforcement of the lower corners, and f_2 are the remaining surfaces of the sides of the triangle. The boundary lines between the surfaces are constituted by tangents to the hollow space of the profile, which are perpendicular to the axis of symmetry of the same or perpendicular the outer surface of the sides. X and Y are the two main axes of inertia of the profile.

Numerous tests have been carried out in order to obtain a profile which will combine the smallest cross-section, and therefore the minimum consumption of material, the highest resistance to buckling of the member in the case of mere bending or of torsion of the member axis. In the prior art, these two requirements could not be satisfied by the same means. As regards the first requirement, the profile is the more economical the greater its moment of inertia with respect to the surface of its cross-section. However, this requirement for thinness of profile contradicts the requirement for a great wall thickness as a security against torsion.

Experiments were made which show that these two requirements can be fulfilled satisfactorily if use is made of an open triangular profile according to the invention, the cross-section of which follows a definite rule. Thus, it has been found that a strengthening of the corners of the profile towards the inside is of special importance; moreover, the surface f_1, the two surfaces f_2 taken together, and the two surfaces f_3 taken together have to amount each to approximately $\frac{1}{3}$ of the total surface of the profile. An optimum of the bearing strength can be obtained if, over a length ten times their thickness the sides of the triangular profile have parallel boundary sur-

faces (FIGURE 6), and if the greatest radius of gyration with respect to the axis 9—9 of one of surfaces f_3' is one quarter of the smallest radius of gyration of the whole profile. Under this condition, one can obtain a profile value

$$\frac{F}{\text{Min } i2}$$

of only 1.75, which may be improved to 1.4, if the thickness of the sides is reduced to 1/15 of their length (f_2'' in FIGURE 7); where F is the cross section area of the profile but in that case the open triangular profile must be closed in the middle of the member, or by means of two metal sheets **10** arranged at distances of 1/3 of the profile length. In this case also the surfaces f_1'' and f_3'' are slightly smaller than in FIGURE 6.

The junction of the spatial network (FIGURE 5), for instance a four-legged grid mast, shows a vertically placed triangular profile **11**, which is closed in the region of the junction by a welded-in insertion **12**, whereby it is ensured against any change of shape. The stays are welded on to the surfaces of the triangular rod in the planes **13** and **14**.

The buckling process of open profiles having a minimum mass is very complicated. The buckling due to the bending of the member axis, as previously calculated, is initiated earlier owing to too small resistance against deformation and torsion of the member. It would be difficult to ascertain by calculation these influences dependent upon the shape of the profile. The rules above indicated with respect to the form of the cross-section of the triangular member therefore could be determined only by a series of tests. Moreover, in the form of the cross-section according to the invention, the moments of inertia related to the main axes X and Y are nearly equal to each other, so that one can obtain the full bearing strength with the smallest cross-section, whilst avoiding buckling in any direction.

The amount of labour used is small, since the triangular profiles can be obtained by the usual drawing processes, and since the connection of the stays to the chords is simpler, the flat sections being provided on the stays, than in the case of sections which are not even, or when the spatial curved sections of tubes are used.

The formation of the junctions may be easily adapted, by the welding-in of more or less thick metal sheets or T-profiles, to the forces arising in the rods.

It should be understood, of course, that the foregoing disclosure relates to only preferred embodiments of the invention and that it is intended to cover all changes and modifications of the examples of the invention herein chosen for the purposes of the disclosure, which do not constitute departures from the spirit and scope of the invention set forth in the appended claims.

I claim:

1. A compression member for a network of members welded together at their junctions, of one piece and hollow and of a cross section bounded exteriorly by an equilateral triangle, one triangle side having a slot and the surfaces of the hollow at the corners being concave and more distant from the external surface than at the middle of two sides, a bridging plate at spaced intervals along the length of said slot, and secured to the edges thereof, the cross section of the compression member being divided into five parts, the cross section part lying opposite the slot and bounded by parts of the outer triangle sides and a tangent to the concave surface of the hollow normal to the axis of symmetry, two equal cross section parts each bounded by one of the first named triangle sides, the third triangle side and by the tangent to the concave surface of the hollow normal to the one of the first named triangle sides, two equal parts each lying between the first tangent and one of the second tangents, and wherein the first cross section part and the sum of the second cross section parts and the sum of the last cross section parts each equals one third of the entire cross sectional area.

2. A compression member for a network of members welded together at their junctions, of one piece and hollow and of a cross section bounded exteriorly by an equilateral triangle, one triangle side having a slot and the surfaces of the hollow at the corners being concave and more distant from the external surface than at the middle of two sides, a bridging plate at spaced intervals along the length of said slot, and secured to the edges thereof, wherein the cross section part bounded by the tangent to the concave surface of the hollow normal to the axis of symmetry, the two cross section parts each bounded by a tangent to the concave surface of the hollow normal to one of the closed triangle sides, and the two remaining cross section parts are so related that the last named cross section parts have each a length equal to fifteen times their thickness and the largest radius of gyration of one of the cross section parts adjacent the slot is about one fourth of the smallest radius of gyration of the entire cross section.

3. A compression member for a network of members welded together at their junctions, of one piece and hollow and of a cross side having a slot and the surfaces of the hollow at the corners being concave and more distant from the external surfaces than at the middle of two sides, a bridging plate at spaced intervals along the length of said slot, and secured to the edges thereof, the cross section of the compression member being divided into five parts, the cross section part lying opposite the slot and bounded by parts of the outer triangle sides and a tangent to the concave surface of the hollow normal to the axis of symmetry, two equal cross section parts each bounded by one of the first named triangle sides, the third triangle side and by the tangent to the concave surface of the hollow normal to the one of the first named triangle sides, two equal parts each lying between the first tangent and one of the second tangents, and wherein the first cross section part and the sum of the second cross section parts and the sum of the last cross section parts each equals one third of the entire cross sectional area and wherein the cross section part bounded by the tangent to the concave surface of the hollow normal to the axis of symmetry, the two cross section parts each bounded by a tangent to the concave surface of the hollow normal to one of the closed triangle sides, and the two remaining cross section parts are so related that the last named cross section parts have each a length equal to fifteen times their thickness and the largest radius of gyration of one of the cross section parts adjacent the slot is about one fourth of the smallest radius of gyration of the entire cross section.

4. A compression member for a network of members welded together at their junctions, of one piece and hollow and of a cross section bounded exteriorly by an equilateral triangle, one triangle having a slot and the surfaces of the hollow at the corners being concave and more distant from the external surfaces than at the middle of two sides, a bridging plate at spaced intervals along the length of said slot, and secured to the edges thereof, the cross section of the compression member being divided into five parts, the cross section part lying opposite the slot and bounded by parts of the outer triangle sides and a tangent to the concave surface of the hollow normal to the axis of symmetry, two equal cross section parts each bounded by one of the first named triangle sides, the third triangle side and by the tangent to the concave surface of the hollow normal to the one of the first named triangle sides, two equal parts each lying between the first tangent and one of the second tangents, and wherein the first cross section and the sum of the second cross section parts and the sum of the last cross section parts each equals one third of the entire cross sectional area, and wherein the cross section part bounded

by the tangent to the concave surface of the hollow normal to the axis of symmetry, the two cross section parts each bounded by a tangent to the concave surface of the hollow normal to one of the closed triangle sides, and the two remaining cross section parts are so related that the last named cross section parts have each a length equal to fifteen times their thickness and the largest radius of gyration of one of the cross section parts adjacent the slot is about one fourth of the smallest radius of gyration of the entire cross section, the slot being bridged by a plate closing the partly open triangle side in the middle of the compression member length.

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