

Dec. 19, 1944.

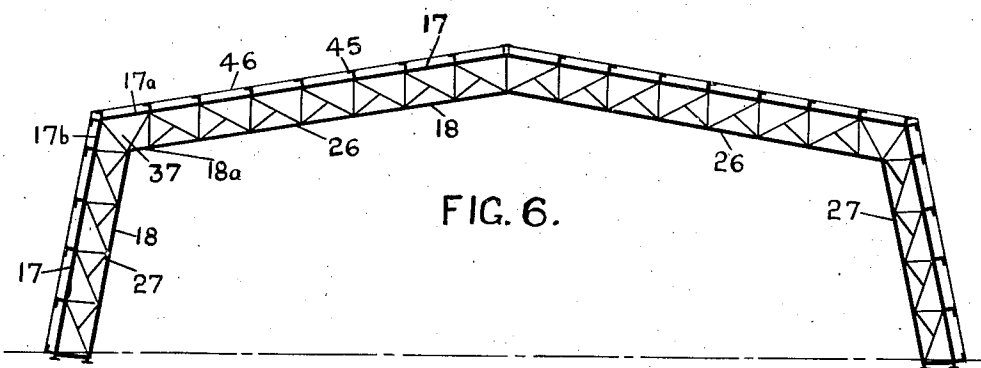
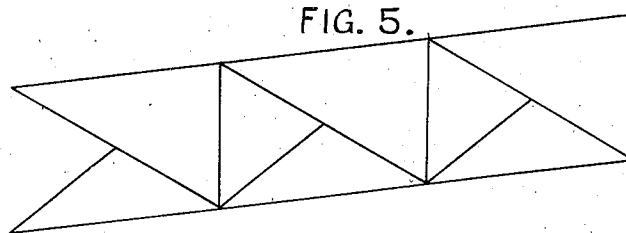
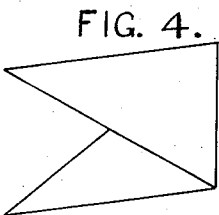
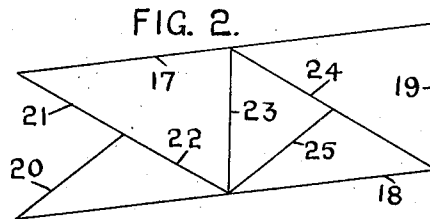
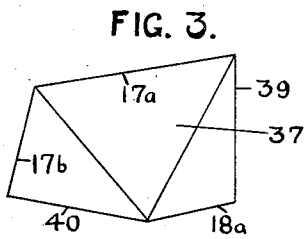
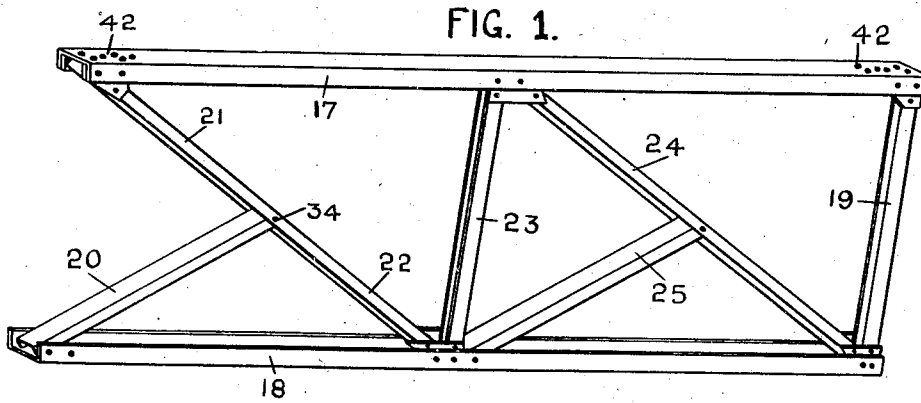
W. CRAWFORD

2,365,175

STRUCTURAL UNIT

Filed Sept. 17, 1942

3 Sheets-Sheet 1



Inventor:
William Crawford
By Williams, Bradbury & Burke
Attorneys

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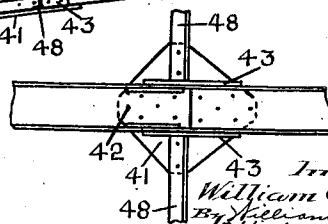
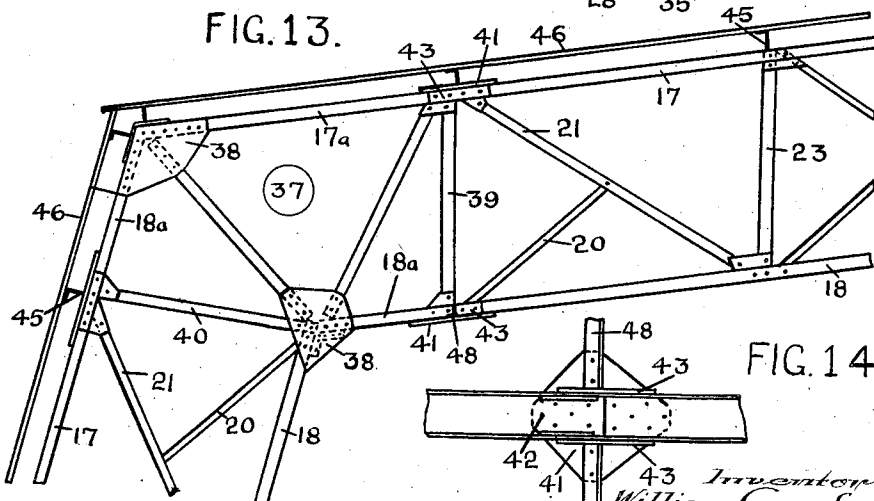
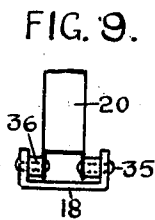
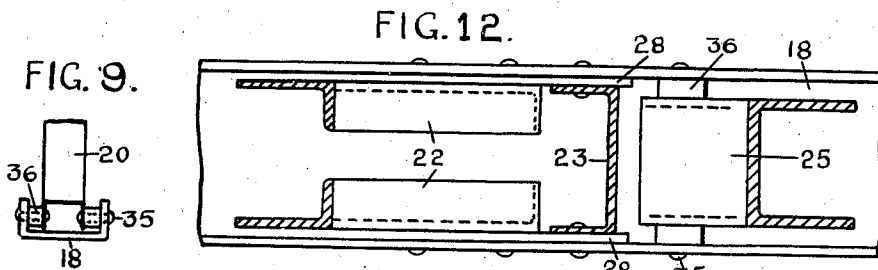
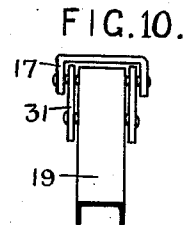
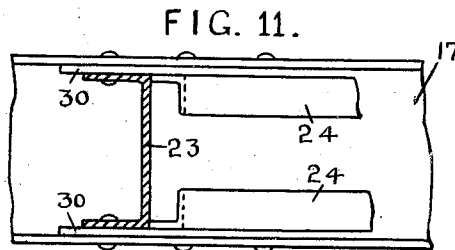
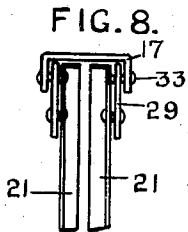
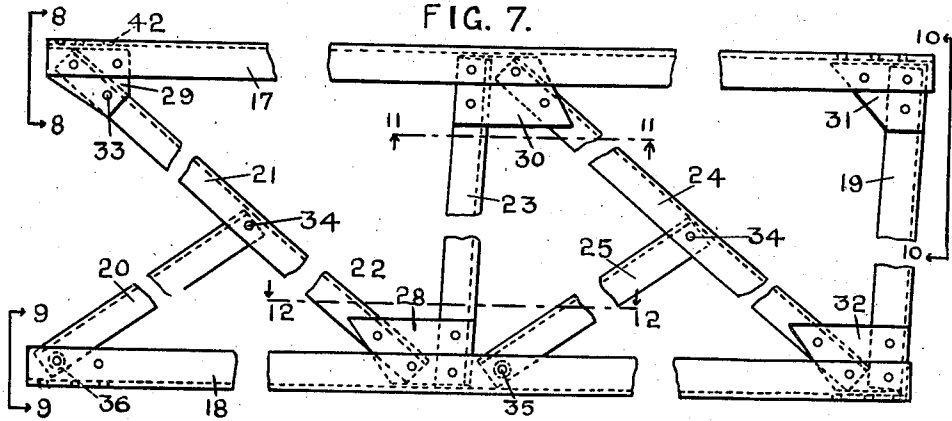
W. CRAWFORD

2,365,175

STRUCTURAL UNIT

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3 Sheets-Sheet 2



Inventor:
William Crawford
By *William C. Bradley*
Attorney

Dec. 19, 1944.

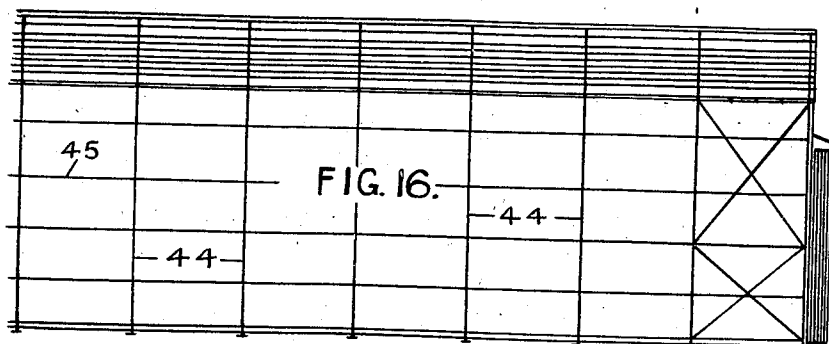
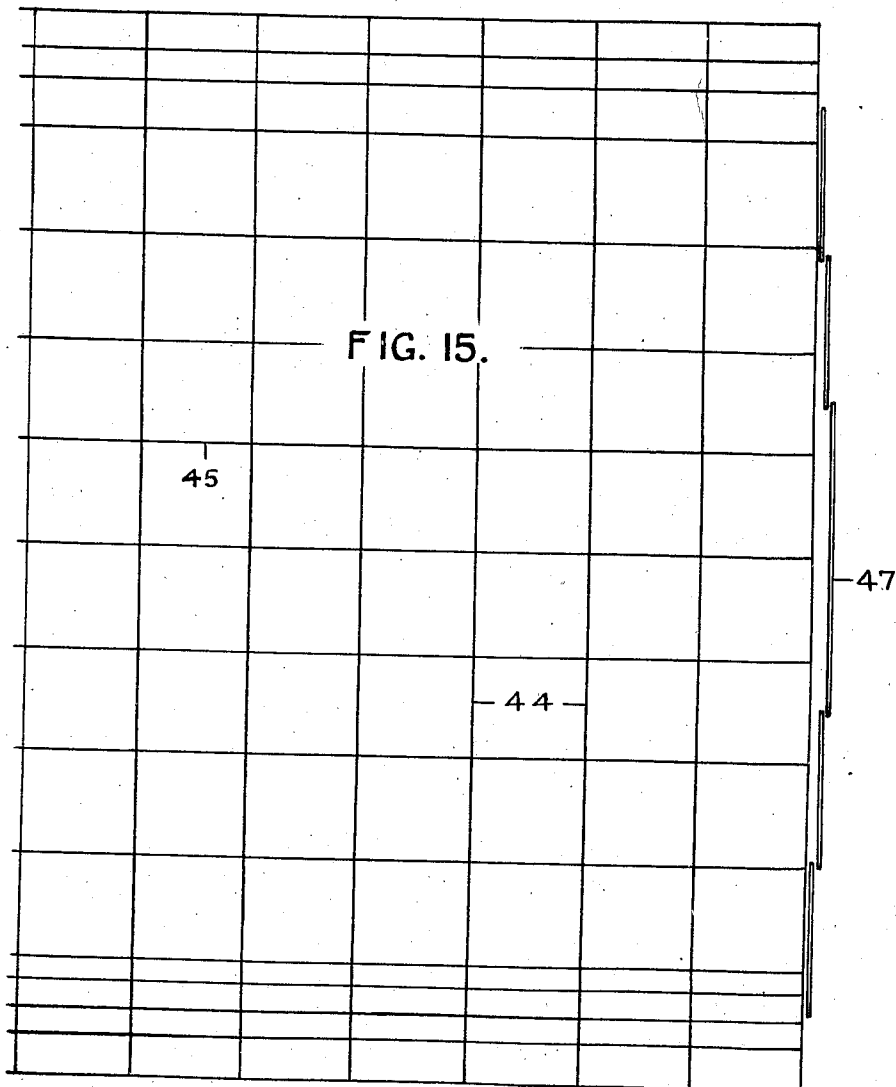
W. CRAWFORD

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STRUCTURAL UNIT

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3 Sheets-Sheet 3



Inventor:
William Crawford
By Williams, Bradbury & Hubbs
Attorneys

UNITED STATES PATENT OFFICE

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STRUCTURAL UNIT

William Crawford, Glasgow, Scotland

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In Great Britain July 30, 1942

12 Claims. (Cl. 189—1)

This invention has reference to an improvement in the construction of girders, beams and stanchions, and to the construction of portable structures incorporating the improved construction of girder, beam or stanchion, particularly in the construction and erection of portable buildings such as aeroplane hangars, storage sheds or the like, or in the construction and erection of walls or roofs or portable bridges or other structures adapted to resist vertical or horizontal loads or a combination thereof.

According to my invention a girder, beam or stanchion of lattice-work construction comprises a plurality of pentagonal units joined together end to end, each unit being a braced structure comprising a pair of parallel members of equal length joined together at one end by a straight end member and joined together at the other end by a pair of convergent end members forming a re-entrant angle between them.

Each unit is preferably braced by the provision between the parallel members of one or more straight transverse bracing members, preferably parallel to the straight end member and preferably equidistantly disposed or equally spaced between the ends of the parallel members, in combination with diagonal bracing.

The members of the pair of convergent end members are preferably braced by a diagonal bracing member interposed between the point of their convergence and one end of the adjacent transverse bracing member. This interposed diagonal member may be formed by an inner extension of one of the convergent members, and the diagonal bracing between the parallel members is preferably parallel to the said convergent end members.

It is preferred that each girder, beam or stanchion be built up of a plurality of similar pentagonal units of standard size and shape as aforesaid, each standard unit having a central transverse bracing member and one diagonal bracing member parallel to the extended convergent end member; said diagonal member extending between the transverse bracing member and the straight end member, an additional stay or bracing member being interposed between the said diagonal member and the inner end of the transverse member and preferably parallel to the shorter of the two convergent end members. Sub-standard pentagonal units equal in length to half of the main standard units and having no transverse or diagonal bracing members other than the diagonal extension of one of the convergent end members may be provided, and additional units

greater in length than the main standard unit and equal in length to any multiple of one-half the length of the main standard unit may be provided, each such longer unit being provided with a correspondingly greater number of transverse and diagonal bracing members.

The unit may be constructed of steel or any other material or combination of materials suitable for structural purposes.

The component parts and the joints between the component parts of each unit may be made in any known manner to provide a pre-formed unit, and the joints between pre-formed units may be effected by welding, riveting, bolting, or by the use of fish plates or other connecting members in any known manner.

A feature of the improved unit is that, when two units are assembled together with the straight end member of one unit closing the re-entrant angle formed by the convergent end members of the other unit and the two units are secured together at their junction, the straight end member of one unit acts to stiffen the support of the support of the extremities of the inner and outer members of the other unit, without necessitating the provision of additional stays or struts.

In constructing a portable building such as an aeroplane hangar or the like according to my invention, either or both the rafters and wall posts may be formed of an assembly of units as aforesaid and if the units are used only for a portion of the structure, the remainder of the structure may be constructed in any known manner.

In its preferred form, a portable building according to the invention has all the rafters and wall posts formed of an assembly of units as aforesaid, pentagonal units of suitable size and modified shape being provided for the corner joints between the wall posts and rafters. The rafters may be horizontal or inclined and the wall posts may be either vertical or splayed as desired. Variations in the dimensions of the structure may be effected by varying the number and size of standard or sub-standard units used in the construction of the wall posts and rafters or by varying the size of the units used for the corner joints.

Units according to the invention may also be used in the construction of longitudinal binders or purlins for the walls and roof of a structure.

The various units may have standardised holes for the reception of connecting bolts, rivets or other fastenings.

In order that the several units may be used in the construction of inclined rafters, it is preferred that the straight end member of each unit be secured to the inner and outer parallel members at an angle which is the complement of the desired angle of inclination of the rafter, so that the ends of the inner and outer parallel members will be vertically above each other in the assembled and erected rafter, thus providing more convenient connection to the posts or other members of the end framing of the building.

In the construction of girders, posts, purlins or other structural members, other than inclined walls and rafters, it may be convenient for each unit employed in the construction thereof to be so shaped that the extremities of the inner and outer parallel members lie at the corners of a circumscribing rectangle, that is to say, with the straight end member joining the parallel members at right angles.

The invention will be more readily understood by reference to the accompanying drawings in which:

Fig. 1 is a perspective view of a pentagonal structural unit in its preferred form.

Fig. 2 is a diagrammatic representation of the standard unit, and Figs. 4 and 5 are diagrams of sub-standard pentagonal units.

Fig. 3 is a diagram illustrating a modified pentagonal unit for corner joints.

Fig. 6 is an end elevation of an aeroplane hangar or storage shed having the wall posts and rafters built up of pentagonal structural units according to the invention.

Fig. 7 is a fragmentary side view of the unit shown in Fig. 1.

Fig. 8 is an end view on the line 8—8 in Fig. 7, Fig. 9 is an end view on line 9—9 and Fig. 10 an end view on line 10—10 in Fig. 7.

Figs. 11 and 12 are sectional views to a larger scale on lines 11—11 and 12—12 respectively in Fig. 7.

Fig. 13 is a fragmentary side view showing the junction of an inclined wall post to a roof rafter, showing also the outer covering or sheeting.

Fig. 14 is a plan view of one of the lower joints between adjacent structural units, showing the attachment of longitudinal binders and for convenience of illustration the members 20 and 39 are omitted from the view.

Figs. 15 and 16 are plan and side views respectively of one end portion of an aeroplane hangar or storage shed built up of structural units according to the invention, without the outer covering or sheeting in position.

Referring firstly to Figs. 1, 2 and 7-12, I have shown a pre-fabricated lattice-work structural unit of pentagonal form comprising parallel channel or boom members 17 and 18, an end member 19 and convergent end members 20 and 21. The outer one of the two members 20 and 21 is extended at 22 to form a diagonal bracing member. The members 17 and 18 are of equal length and are preferably braced together by an intermediate transverse bracing member 23 parallel to the end member 19 and equidistantly spaced between the ends of the unit. A diagonal bracing member 24 is fitted parallel to the member 21, 22 and a half-diagonal member 25 is fitted parallel to the member 20.

The channel members 17 and 18 have their channels opposed to one another. The end channel member 19 and intermediate member 23 are preferably inclined at an angle to the members

17 and 18 which is the complement of the desired angle of slope of the roof, if the units are to be assembled together to form sloping roof rafters as shown at 26 in Fig. 6, but the members 19 and 23 may be at right angles to the members 17 and 18 or at any other desired angle if the units are to be assembled together to form horizontal or vertical girders, beams or stanchions, or inclined wall posts illustrated at 27 in Fig. 6.

As shown more particularly in Figs. 7 to 12, the channel members 19, 21, 22, 23 and 24 preferably have an external width less than the internal width of the channels of the members 17 and 18, so that the ends of the intermediate members fit within the channels of the members 17 and 18 and permit of the insertion of gusset plates 28 to 32 between the outer faces of the flanges of the members 19 and 21-24 and the inner faces of the flange of the members 17 and 18. These gusset plates are secured to and between the overlapping flanges by rivets 33 or by means of bolts or welding. In order that the upper ends of the half-diagonal members 20 and 25 may fit within the channels of the members 21, 22 and 24, the members 20 and 25 have an external width equal to the internal width of the channels of members 21, 22 and 24, so that they may be secured thereto by rivets 34 or by bolts or welding. As the lower ends of the members 20 and 25 are substantially narrower than the channel of the member 18 into which they fit, the connection of the lower ends of members 20 and 25 to the member 18 is effected by rivets or bolts 35, and distance pieces, washers or sleeves 36 are fitted on the rivets or bolts 35 between the flanges of the members 20 and 25 and the flanges of the member 18, as seen more clearly in Figs. 9 and 12.

On the drawings I have shown the members 17, 18, 19, 20, 23 and 25 as consisting of single rolled steel or pressed steel channels, whereas the members 21, 22 and 24 each consist, as seen more clearly in Figs. 8, 11 and 12, of a pair of angle bars having opposed aligned webs. Obviously the members 21, 22 and 24 might consist of rolled or pressed steel channels like the members 17 and 18, or the members 17-20, 23 and 25 might consist each of a pair of angle bars like the members 21 or 24, but in such case it will be understood that the angles of the members 17 and 18 must be butt-welded together or have their aligned webs secured together by web members.

Figs. 4 and 5 diagrammatically illustrate how sub-standard pentagonal units may be constructed, Fig. 4 showing a unit equal to half the length of the standard unit shown in Fig. 2, and Fig. 5 showing a unit equal to one and one half times the length of the unit shown in Fig. 2. In this manner, sub-standard units equal in length to any multiple of the unit shown in Fig. 4 may be constructed.

Fig. 3 illustrates a modified form of pentagonal unit 37 for use at corner joints, such as where roof rafters spring from wall posts, as shown at 37 in Figs. 6 and 13. The corner unit 37 may be built up in any suitable manner of channel members 17a, 17b and 18a, end members 39 and 40 and intermediate bracing members, gusset plates 38 being secured at the inner and outer angles as shown in Fig. 13. It will be observed from Figs. 6 and 13 that the structural units of the roof rafters are disposed with the channel members 17 uppermost and that the structural

units of the wall posts have the channel members 17 on the outside. The members 17a and 18a of the corner unit are aligned with and joined to the members 17 and 18 of the adjacent roof unit, and the member 17b of the corner unit is aligned with and joined to the member 17 of the adjacent wall post unit.

Adjacent standard units are assembled together so that the end member 19 of each unit closes the re-entrant angle formed by the end members 20, 21 of the adjacent unit. Similarly the corner unit 37 (Fig. 3) is assembled so that the members 39 and 40 close the re-entrant angles formed by the end members 20 and 21 of the adjacent units of the wall posts and rafters, as clearly apparent from Fig. 13. It will also be understood that the members 17 of adjacent units are aligned with one another and that the members 18 are also aligned with one another. When so assembled, adjacent units are permanently or detachably secured together at their junctions such as by the use of fishplates 41 (Figs. 13 and 14) bolted to the abutting members 17 or 18, the ends of the webs of the members 17 or 18 being provided with bolt holes 42 (Figs. 1 and 7) for this purpose. Additional fishplates 43 may also be used for connecting the flanges of adjacent members 17 or 18. Obviously adjacent units may be joined together by welding or by riveted or bolted joints in place of or in addition to the fishplates 41 and 43 if so desired. Fig. 14 shows one of the lower joints between the units. The upper joints are similarly effected by means of fishplates 41 and 43.

It will be apparent that, when the units are assembled together, the end member 19 of one unit acts to stiffen the support of the outer extremities of the members 20 and 21 of the adjacent unit and that the members 39 and 40 similarly stiffen the support of the extremities of the members 20 and 21 of the adjacent roof and wall units.

In the construction of portable buildings such as aeroplane hangars or portable sheds, transverse frames as illustrated in Fig. 6 may be built up of pentagonal units according to my invention and the wall posts may be either vertical or splayed. Similarly, the roof rafters may be either inclined as in Fig. 6 or horizontal, in which latter case it will be understood that the members 19 of the units will be at right angles to the members 17 and 18. As shown in Figs. 15 and 16, these transverse frames (designated 44 in Figs. 15 and 16) may be suitably spaced apart and connected by longitudinal binders or purlins 45 to which external sheathing 46 (Figs. 6 and 13) may be secured. Doors 47 (Figs. 15 and 16) of any convenient type may be fitted to either or both ends of the building.

As shown in Figs. 6 and 13, the purlins 45 are of angle section metal, but for buildings which require to withstand heavy loads, the purlins may be of any section or built up of pentagonal units assembled and connected together end to end in a manner similar to the roof rafters and wall posts.

The lower joints between adjacent structural units may be longitudinally braced together by means of longitudinal binders 48 secured at their ends to the fishplates 43, as shown in Fig. 14.

I claim:

1. A prefabricated structural unit of pentagonal form comprising a pair of parallel members of equal length joined together by a straight transverse end member, a diagonal bracing mem-

ber between one end of said parallel members and the junction between the opposite parallel member and said transverse member, and a sub-diagonal member extending from an intermediate point in the said diagonal member to one end of said last mentioned parallel member.

2. A prefabricated structural unit of pentagonal form comprising a pair of parallel members of equal length joined together at one end by a straight end member, a straight intermediate bracing member secured to said parallel members equidistantly between their ends and parallel to said end member, a main diagonal bracing member secured between the end of one of said parallel members and the junction of said intermediate bracing member with the other parallel member, and a sub-diagonal member extending from an intermediate point in said main diagonal member to one end of said last mentioned parallel member.

3. A structural unit as claimed in claim 2 including diagonal bracing between the junctions of the parallel members with the end and intermediate members.

4. A prefabricated structural unit of pentagonal form comprising a pair of parallel members of equal length joined together at one end by a straight end member, a plurality of straight intermediate bracing members secured in spaced relationship between said parallel members and in parallel relationship to said end member, a main diagonal bracing member secured between the end of one parallel member and the junction of the other parallel member with the intermediate member most remote from said end member, a sub-diagonal bracing member extending from an intermediate point in said main diagonal member to the end of said last mentioned parallel member and diagonal bracing members between said intermediate members and between said end member and the adjacent intermediate member.

5. A structural unit as claimed in claim 1 in which the straight end member is inclined to the parallel members.

6. A prefabricated structural unit of pentagonal outline and comprising five substantially co-planar members outlining the unit, two of said members being parallel and of channel section, and the other three of said members being of smaller width than the width between the flanges of said channel section members, distance members inserted between the ends of the said three members and the inside faces of the flanges of said channel section member, and means securing said members and distance pieces together so that the parallel members are joined together at one end by a third member, while the fourth and fifth members extend diagonally, one from one end of one parallel member and the other from one end of the other parallel member, the fourth member extending diagonally between and joining the parallel members and the fifth member extending between and joining one parallel member to an intermediate point in the fourth member.

7. A prefabricated pentagonal unit for a structural member of assembled unit construction comprising five substantially co-planar elements of which two are parallel boom elements of equal lengths and the others are bracing elements, one bracing the boom elements together at one end, another being a main diagonal bracing the other end of one boom element to the opposite boom element, and the third being a sub-diagonal con-

necting one end of said last mentioned boom element to an intermediate point in the main diagonal, thereby to form a re-entrant brace between the boom elements on one end thereof.

8. A pre-fabricated structural unit of pentagonal form comprising a pair of parallel members of equal length joined together at one end by a straight end member and joined together at their other ends by a pair of convergent end members forming a re-entrant angle between them, one of said convergent members being extended beyond the point of convergence inwards to one of the parallel members so that it forms a diagonal connection between the two parallel members, a straight transverse bracing member parallel to the straight end member and secured to said parallel members equidistantly between their ends and to the junction of one of said parallel members with said extended member of the convergent end members, a diagonal bracing member between the said transverse member and the straight end member and parallel to said extended member of the convergent end members, and an oppositely inclined diagonal member parallel to said other convergent end member and extending from one end of the transverse member to the diagonal member which extends between said transverse member and the straight end member.

9. A structure comprising a plurality of pentagonal units joined together end to end, each unit comprising a pair of parallel members of equal length joined together at one end by a straight end member and joined together at their other ends by a pair of oppositely inclined diagonal members of different lengths forming a re-entrant angle between them, the longer diagonal member joining the end of one parallel member to an intermediate point in the other parallel member, and the shorter diagonal member joining the end of said last mentioned parallel member to an intermediate point in the longer diagonal member, said units being assembled to cause the straight end member of one unit to close the re-entrant angle formed by said diagonal members of the adjacent unit, so that when the two units are secured together at their junctions, the straight end member of one unit stiffens the support of the extremities of the adjacent unit.

10. A pre-fabricated pentagonal structural unit comprising a pair of parallel boom members of channel form in section and of equal length and having their channels opposed, an end channel

member joining said boom members together at one end, a transverse channel member joining said boom members together and disposed equidistantly between their ends, a pair of main diagonal bracing members connecting said boom members together, said diagonal members being parallel to one another and at opposite sides of said transverse member, one of said diagonal members connecting one end of said end member to the opposite end of said transverse member, and the other diagonal member connecting the other end of said transverse member to the end of the opposite boom member, and each diagonal member consisting of a pair of angle members having one pair of webs aligned, and a pair of short oppositely inclined diagonal members connecting the main diagonal members to one of said boom members, said short diagonal members being of channel form in section.

11. A transverse frame for a portable building comprising a plurality of pentagonal units assembled together to form roof rafters and wall posts and said rafters being joined to said wall posts by pentagonal corner units, each of the rafters and wall posts comprising a pair of parallel members of equal length joined together at one end by a straight end member and joined together at their other ends by a pair of convergent end members forming a re-entrant angle between them, said units being assembled to cause the straight end member of one unit to close the re-entrant angle formed by the convergent end members of the adjacent unit, so that when the two units are secured together at their junctions, the straight end member of one unit stiffens the support of the extremities of the adjacent unit and the end members of each pentagonal corner unit close the re-entrant angles formed by the convergent end members of the adjacent units of the wall post and rafter.

12. A lattice-work structure comprising a multiplicity of exactly similar braced pentagonal units as specified in claim 1 joined together end to end, said units being assembled to cause the straight end member of each unit to close the re-entrant angle formed by the convergent end members of the adjacent unit, so that when adjacent units are secured together at their junctions, the straight end member of one unit stiffens the support of the extremities of the adjacent unit.

WILLIAM CRAWFORD.