United States Patent

Yamaso

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[54] **PREFABRICATED FRAME**

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[52] **U.S. Cl.** **52/666,** 94/8, 52/581

[51] **Int. Cl.** **E04c 2/42,** E04c 5/04

[58] **Field of Search**.....52/660, 664, 668, 666, 581; 29/160; 94/8

[56] **References Cited**

UNITED STATES PATENTS

487,585	12/1892	Schetzel	52/666
1,264,758	4/1918	Berson	29/160
1,603,678	10/1926	Furey	52/668
1,612,236	12/1926	Thomson	52/668
1,629,134	5/1927	Van Hoffen	52/666
1,733,902	10/1929	Price	52/666
1,733,903	10/1929	Price	52/666
2,283,307	5/1942	Barry et al.	52/666
2,740,335	4/1956	Greulich	52/667

Primary Examiner—Frank L. Abbott
Assistant Examiner—James L. Ridgill, Jr.
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[57] **ABSTRACT**

Prefabricated frame of truss grating type for structural uses comprising a plurality of straight longitudinal members usually made of shape steel and a plurality of zigzag lateral members usually made of band steel, the latter of which run parallel to each other but in abutting relation at the zigzag bents and engage with the former in firmly inserted relation in recesses provided along each longitudinal member.

4 Claims, 11 Drawing Figures

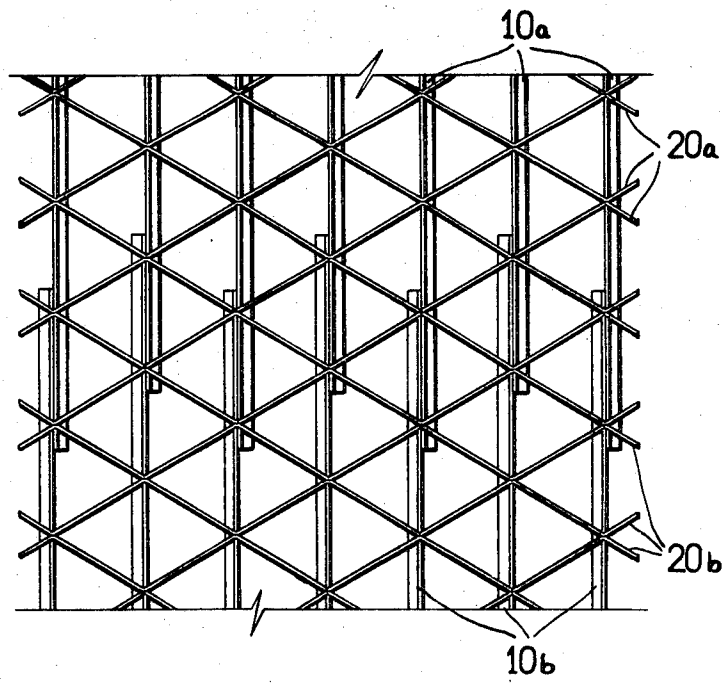

FIG.1

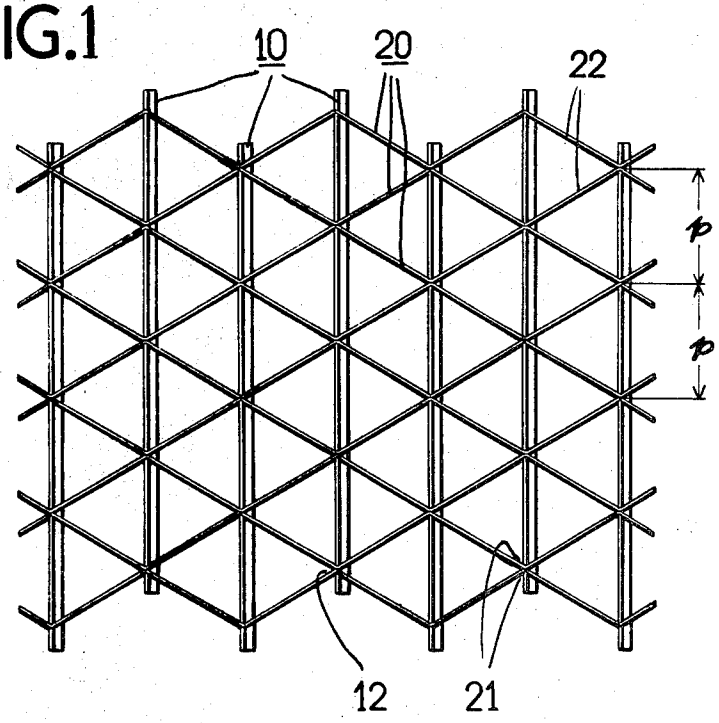

FIG.2

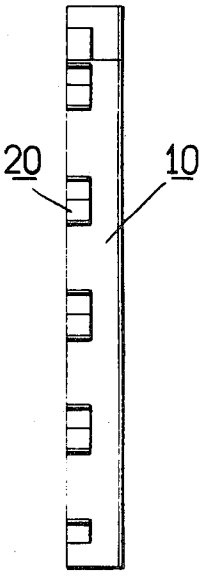

FIG.3

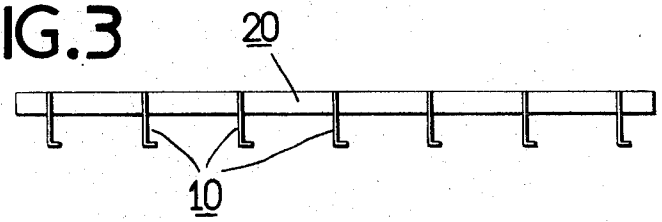

FIG.4

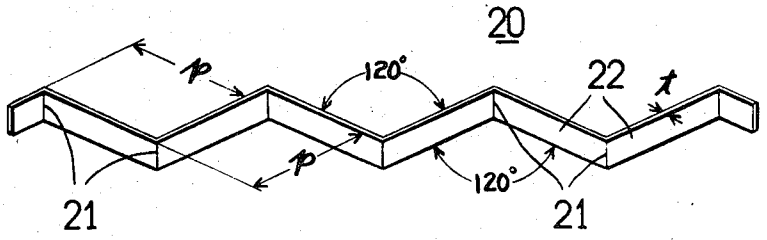

FIG.5

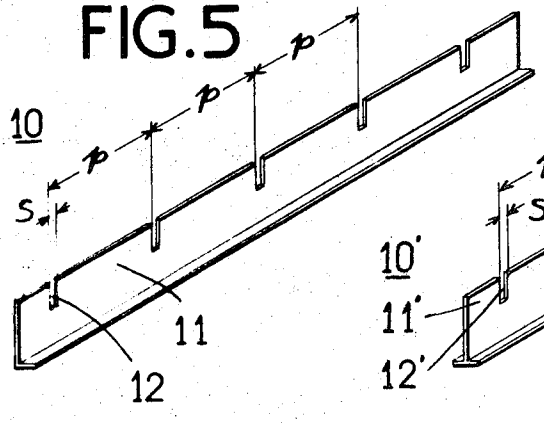

FIG.6

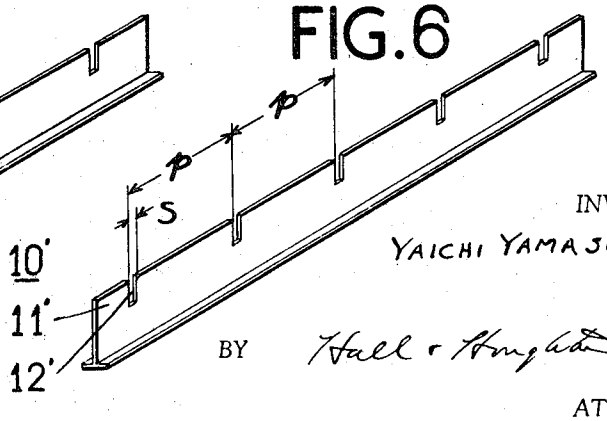

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FIG. 7

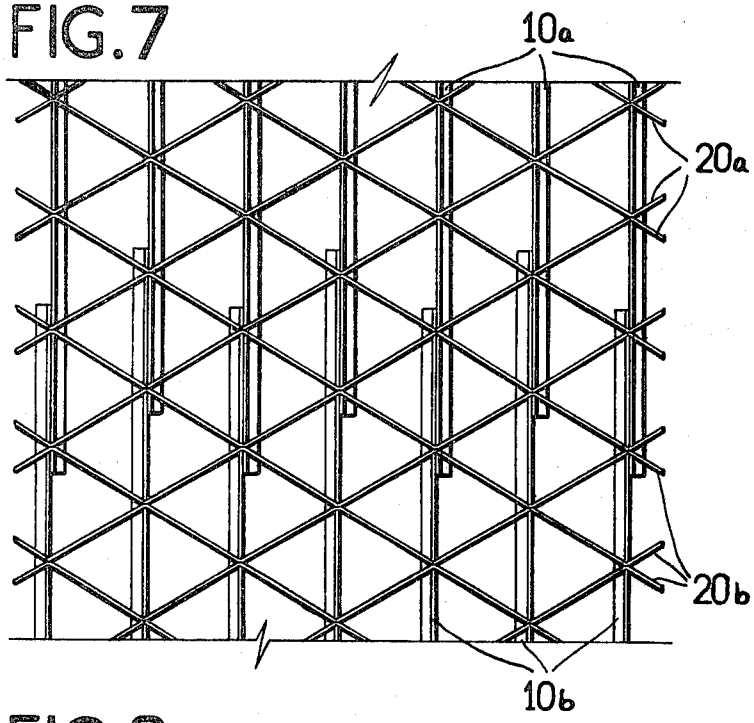


FIG. 10

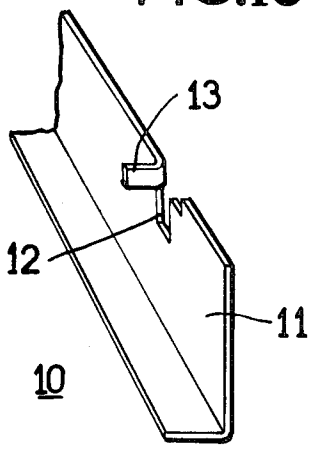


FIG. 8

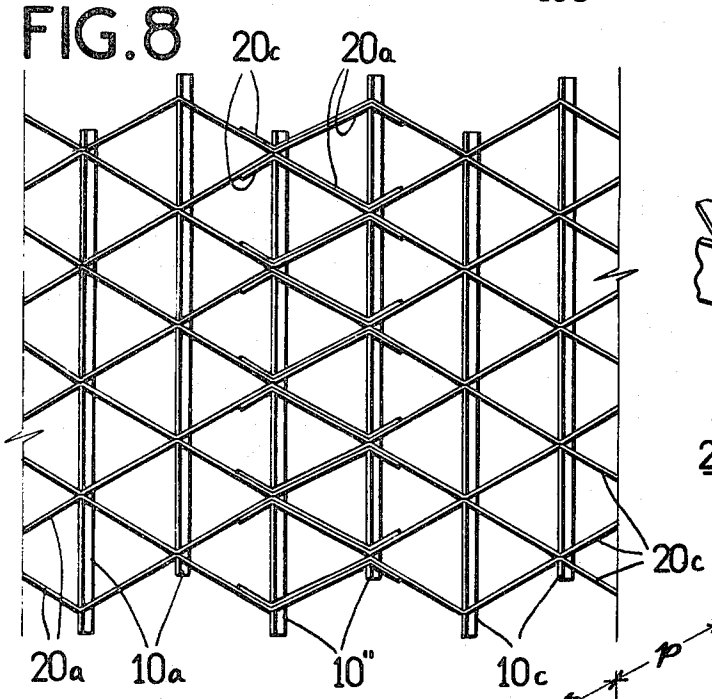


FIG. 11

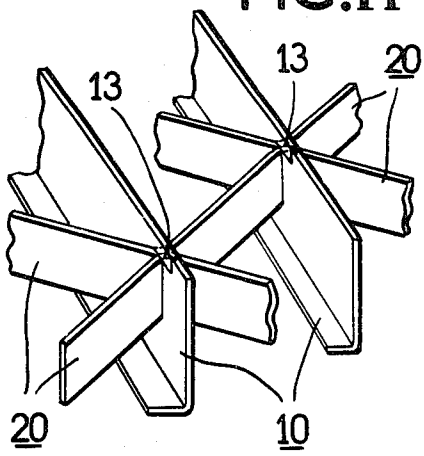
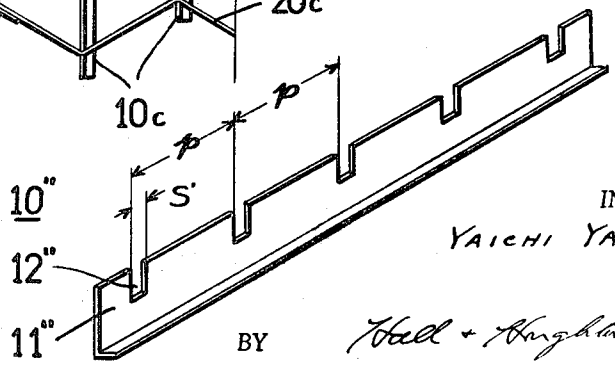


FIG. 9



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PREFABRICATED FRAME

The present invention relates to a frame, and more particularly to a prefabricated frame of grating type for structural uses, such as framework of prefabricated houses, bedding of provisional airstrips, reinforcement of concrete pavements and structures.

Conventional frames of grating type for such structural uses have a great disadvantage in assembling and disassembling. For instance in assembling, a number of steel bars or bands cut and trimmed in suitable lengths are initially positioned into a square grating arrangement with a required pitch, some of the bars or bands positioned diagonally over the square grating arrangement if necessary, and then each crossing portion of such grating members is knotted with wire to complete and integrate the frame. This assembling will generally take much time and labor, and considerable skill especially in knotting the crossing portions of grating members. Moreover, square gratings may usually be unable to bear multi-directional loads substantially. In general construction works frame members such as bars and plates are pre-cut into limited sizes, otherwise they will cause a considerable inconvenience in forwarding and handling. Members of limited sizes will however require to be extended by joining each other with bolts and other similar means if a substantially large frame is necessary. Bolted joints will decrease the overall strength of frame members and therefore require some particular auxiliary means to compensate the decrease of strength, resulting in increase of time and labor required for assembling or impossibility of application where such auxiliary means is not permitted.

A major object of the invention is to provide a prefabricated frame for structural uses which is easy even for unskilled laborers to assemble and disassemble.

Another object of the invention is to provide a prefabricated frame for structural uses which bears multidirectional loads substantially.

A further object of the invention is to provide a prefabricated frame for structural uses which is extendible to desired extents by joining the frame members each other without requiring bolts and any other particular joining parts.

A still further object of the invention is to provide a prefabricated frame for structural uses which facilitates forwarding and handling.

A more specific object of the invention is to provide a structural frame of truss grating type comprising longitudinal straight members and lateral zigzag members, the latter of which are engaged with the former in firmly inserted relations in recesses provided along the former.

Other objects and advantages of the invention will be more fully understood from the following description of preferred forms of the invention shown by way of example in the accompanying drawings in which:

FIG. 1 is a plan view of a prefabricated frame embodying the invention;

FIG. 2 is a side view of FIG. 1;

FIG. 3 is a front view of FIG. 1;

FIG. 4 is a perspective view of a lateral member in the frame of FIG. 1;

FIG. 5 is a perspective view of a longitudinal member in the frame of FIG. 1;

FIG. 6 is a perspective view of another longitudinal member;

FIG. 7 is a plan view showing joint portions for longitudinal extension of a frame embodying the invention;

FIG. 8 is a plan view showing joint portions for lateral extension of a frame embodying the invention;

FIG. 9 is a longitudinal member employed in the joint portions of FIG. 8;

FIG. 10 is a perspective view of still another longitudinal member; and

FIG. 11 is a perspective view showing engagement of lateral members with the longitudinal members shown in FIG. 10.

The structural frame shown in FIG. 1 comprises a plurality of longitudinal members 10 and a plurality of lateral members 20. Each longitudinal member 10 is of L-steel structural shape cross section as shown better in FIG. 5. It is provided with a plurality of recesses 12 of a given width s indented along its web 11 longitudinally with a given pitch p its flange portions being continuous as shown in FIG. 5. Each lateral member 20 is of band steel and preferably of uniform height throughout its extent as shown better in FIG. 4. Its thickness is t and it is zigzaged along its whole length with a given pitch p and a given deflection 120°, thus divided into a plurality of zigzag sections 22, as shown in FIG. 4. Here s and t are determined by a relation $s = 2t$. It is noted that the lateral member 20 is zigzaged with the same pitch as the recesses 12 along the longitudinal member 10, and that each recess 12 is approximately twice as wide as the thickness of lateral member 20.

In the assembling, initially a lateral member 20 is placed on the ground as it is in FIG. 4, then a plurality of lateral members are placed similarly in parallel to the first one with their zigzag bents 21 being in such an oppositely abutting relation as to form a plurality of rhombuses, each enclosed within any four of the zigzag sections 22, and a plurality of longitudinal members 10 are engaged to the lateral members by inserting each abutting combination of bents 21 firmly into a corresponding recess 12 of longitudinal member 10, thus completing a frame of grating as shown in FIG. 1. Since it is a matter of mere insertion, any unskilled laborer can assemble the frame of the invention with considerable ease and speed. Same can be said about disassembling of the frame if such is necessary.

Since the lateral member 20 is zigzaged with the same pitch p as the recesses 12 along the longitudinal member, the assembled frame of the invention forms a truss grating of equilateral triangles, each of which comprises two of the zigzag sections 22 of lateral member 20 and one of the web portions spanning the recesses 12 of longitudinal member 10, thus closing the triangle of force completely. Since each recess 12 is approximately twice as wide as the thickness t of lateral member 20, each equilateral triangles stands substantially firm and integral at the three vertexes. Therefore compressive or tensile forces, if given to the frame in the lateral direction, will be distributed and balanced substantially in each of the equilateral triangle.

Moreover, the inclined sides of equilateral triangles are arranged in straight continuous diagonal lines of the frame and thus serve as diagonal members as well. Therefore compressive or tensile forces, if given to the frame in the diagonal direction, will be borne substantially on the secondary formed diagonal lines. Compressive or tensile forces, if given to the frame in the

longitudinal direction, will be borne substantially by the longitudinal members **10**. Since each lateral member **20** is inserted into the recess **12** of each longitudinal member **10** in the direction to aggregate the widths of both members, the thickness of frame is substantial in the direction perpendicular to the trussing plane of grating and therefore will bear compressive or tensile force substantially in the same direction. In brief, the frame of the invention is formed into a rigid body which endures multi-directional loads substantially without deformation.

In fact, the frame of the invention is far more capable of bearing loads than concrete reinforcements of the conventional kind, and therefore makes it possible to reduce the required thickness of concrete without decreasing the strength. This advantage may for instance be greatly appreciated in introducing a new method of revetment for river and other waterside banks. According to the new method of revetment, comparatively thin concrete plates pre-cast with reinforcement of steel frames of the present invention are placed in a line with piles along a bank of river, and then connected with each other firmly by filling concrete between each other. In this way revetting works are expedited considerably without sacrificing the strength of revetment.

The frame of the invention is extended to desired extents both longitudinal and lateral quite easily without requiring bolts and any other particular means. The longitudinal extension, is illustrated in FIG. **7**, where free longitudinal members **10***b* are additionally joined to the already framed ones **10***a* in a manner that each framed longitudinal member **10***a* overlaps a free member **10***b* by more than one pitch with their recesses **12** meeting to each other. And then free lateral members **20***b* are added to the already framed ones **20***a* in a manner similar to forming the original frame.

The lateral extension is illustrated in FIG. **8**, where free lateral members **20***c* are additionally joined to the already framed ones **20***a* by the intermediary of a pair of longitudinal members **10''** shown in FIG. **9** in a manner that each framed lateral member **20***a* overlaps a free member **20***c* by more than one pitch with the bents **21** meeting to each other. And then free longitudinal members **10***c* are added to the already framed ones **10***a* by the intermediary of the two members **10''** in a manner similar to forming the original frame. The longitudinal member **10''** shown in FIG. **9** is quite same as the member **10** shown in FIG. **5**, except that the former is provided with recesses **12''** of another given width "*s*-dash" along its web **11''** while the latter with recesses **12** of a given width *s*, both widths determined by a relation $s' = 2s$; in other words, each recess **12''** of longitudinal member **10''** is twice as wide as each recess **12** of longitudinal member **10**, thereby making it possible that each lateral member **20***a* overlaps **20***c* and two of such overlapping portions abut to each other in each recess **12''** as shown in FIG. **8**. The easy extension both longitudinal and lateral will make the frame of the invention quite suitable for bedding of provisional airstrips and reinforcement of substantially large concrete areas.

The longitudinal member of the frame may have various cross sections or structural shape other than the L-shaped one shown in FIG. **5**. For instance a longitudinal member **10'** of T-steel structural shape as shown in FIG. **6** may often be used for structural uses as well. The longitudinal member **10'** is provided with recesses **12'** of a given width *s* along its web **11'**. This one is just same as the one in FIG. **5**, except it is T-shaped in the cross section.

It may be good to sandwich the lateral members **20** with longitudinal members, so that each longitudinal line of grating has an I-shaped cross section in case a pair of T-steel longitudinal members **10'** in FIG. **6** are used to sandwich the lateral members **20** in FIG. **4**, and a channel cross section in case a pair of L-steel londitudinal members **10** in FIG. **5** are used to sandwich the lateral members **20** in FIG. **4**. The compound I-shaped or channel cross section will not only increase the strength but also offer a reliable support for plate materials which are commonly used in structural constructions. The offering of good support for plates will make the frame of the invention quite applicable to ceiling, floors, walls and various other parts of prefabricated houses.

So far the frame is assembled by mere insertion of lateral members into the recesses of longitudinal members, and this is quite sufficient in case concrete and other filling matters are cast over the frame. In case such filling matters are not cast over the frame for instance in building up prefabricated houses, there will be a possibility that the lateral members disengage themselves later from the recesses of longitudinal members however firmly inserted initially. Tongued recesses such as shown in FIG. **10** are provided in accordance with the invention to retain the lateral members in the recesses of longitudinal members assuredly.

The longitudinal member shown in FIG. **10** is of same L-steel as FIG. **4**, and the same numbers indicate same elements. The longitudinal member in FIG. **10** is provided with a tongue **13** at the upper portion of each recess **12** by leaving that part of web **11** when the recess is indented. The tongue **13** is pre-opened outward, preferably normal to the longitudinal direction of web **11**. The tongue **13** is closed after the lateral members **20** are inserted into it, as shown in FIG. **11**, thus holding the lateral members assuredly without any fear of disengagement. Since the tongues can be closed easily by simple manual bending, the frame of the invention will be assembled still by unskilled laborers with considerable ease and speed. And same can be said about disassembling, too.

In summary, the present invention provides a prefabricated structural frame which comprises a plurality of straight longitudinal members **10** or **10'** each having a continuous longitudinally extending flange portion, shown as extending horizontally in FIGS. **5** and **6**, and a web portion **11** or **11'** extending at right angles to said flange portion, i. e. shown as extending vertically in FIGS. **5** and **6**. The web portion **11** or **11'** of each of said longitudinal members has a plurality of recesses **12** or **12'** therein extending at right angles to said flange portion (i. e. shown as extending vertically in FIGS. **5** and **6** wherein the flange is horizontal), said recesses **12** or **12'** being enterable from the edge of said web portion **11** or **11'** remote from said flange portion (as best illustrated in FIGS. **5**, **6** and **10**), said recesses **12** or **12'** being equally spaced along the length of said web portion **11** or **11'** by a given distance or pitch *p*;

the structure further comprising a plurality of lateral members **20**, each of said lateral members, as best shown in FIG. **4**, having its length made up of a plurality of zigzag sections **22** arranged at 120° angles **21** to each other with each of said zigzag sections **22** intermediate adjacent angles **21** having a length equal to said pitch *p;* said longitudinal members **10** or **10'** being arranged in parallel spaced relation to one another as illustrated in FIG. **1**; and said lateral members **20**, as shown, each extending transversely of said plurality of longitudinal members **10** or **10'** and passing through and being engaged in the recesses **12** or **12'** in the web portions **11** or **11'** of said longitudinal members **10** or **10'** in firmly inserted relation with said web portions **11** or **11'** of said longitudinal members **10** or **10'** bisecting the 120° angles thereof as shown in FIG. **1** and forming therewith a truss grating made up of equilateral triangles lying entirely at the web sides of the continuous flange portions of said longitudinal members **10** or **10'**, with the special advantages set forth. In the form illustrated in FIG. **10** the web portion of each of said longitudinal members **11** comprises at the recesses **12** therein gate openings extending to the recesses **12** from the edge of the web portion **11** remote from the flange portion of the member **10**, through which gate openings the recesses **12** are enterable, said gate openings being wider than the recesses **12**, as shown, and said web portions **11** comprising adjacent each of a plurality of the gate openings therein a gate in the form of a tongue **13** integral with the web portion **11** and bendable to extend across said recess **12** in said gate opening for locking the structure in assembled relation. The longitudinally extended structure illustrated in FIG. **7**, as shown, comprises a pair of prefabricated structural frames, the first made up of members **10***a* and **20***a*, and the second of members **10***b* and **20***b*, each frame having its longitudinal members (**10** and **10***b*, respectively) of the L-steel shape illustrated in FIG. **5** which presents a flat web portion **11** and a flange portion entirely at one side of said web portion, the longitudinal members **10***b* of one of said frames (**10***b*–**20***b*) overlapping the longitudinal members **10***a* of the other frame (**10***a*–**20***a*) of the pair, respectively, with the web portions thereof back-to-back and the flange portions thereof extending in opposite directions, as shown in FIG. **7**, the assembly having a plurality of the recesses of each longitudinal member aligned with those of the longitudinal member overlapped thereby and having lateral zigzag members (the same as the other zigzag members **20***a* and **20***b* but common to said pair of frames) engaged in firmly inserted relation with the so aligned recesses to serve the double function of means for joining the two frames longitudinally and of transverse members common to the two frames of the longitudinally extended structure, while when the overlapped web portions at their aligned recesses are provided with gates **13** (as shown in FIG. **10**) the closing of the two gages across the common lateral members doubly reinforces the interconnection between the overlapping portions of the longitudinal members. The laterally extended structure illustrated in FIG. **8**, as shown, also comprises a pair of prefabricated structural frames, the first made up of members **10**a and **20***a*, and the second of members **10***c* and **20***c*, each frame having lengths of its lateral members (**20***a* and **20***c*) including two of the 120° angles thereof projecting beyond the longitudinal members **10***a* and **10***c*, respectively, the two 120° angles of the extending lateral members **20***a* of one frame internested with the two 120° angles of the extending members **20***c* of the other frame, respectively, as shown at the central part of FIG. **8**, and the assembly including two special longitudinal members **10''** having double width recesses S' (FIG. **9**) with the internested angles of said extending lateral members engaged therein in firmly inserted relation to serve the double function of means for joining the two frames laterally and of longitudinal members common to the two frames of the laterally extended structure.

The frame of the invention will facilitate forwarding and handling considerably because both lateral and longitudinal members are bundled compactly when disassembled, because both members are minimized in the original unit lengths due to the easy extendibility on later necessary occasions, and because the longitudinal members are made of light shape steel.

It will thus be seen that the prefabricated structural frame in accordance with the invention is easy to assemble and disassemble, endurable of substantial multidirectional loads, extendible desiredly without requiring particular joining parts, and minimal of carrying inconveniences.

Since certain changes and modifications may be made in the invention, some of which have been herein suggested, it is intended that the foregoing shall be construed in a descriptive rather than in a limiting sense.

What I claim:

1. An assembly of a plurality of prefabricated structural frames, each of said structural frames comprising a plurality of parallel longitudinal members of L-shape steel each presenting a flat web portion and a flange portion entirely at one side of said web portion, the longitudinal members (**10***b*) of one of said frames overlapping the longitudinal members (**10***a*) of the other frame of said pair, respectively, with the web portions thereof back-to-back and the flange portions thereof extending in opposite directions, the web portion of each of said longitudinal members having a plurality portion and enterable from the edge of said web portion remote from said flange portion, said recesses being equally spaced along the length of said web portion by a given distance or pitch (*p*), each of said frames further comprising a plurality of lateral members, each of said lateral members having its length made up of a plurality of zigzag sections arranged at angles to each other, and said lateral members each extending transversely of said plurality of longitudinal members and passing therethrough and being engaged in the recesses in the web portions of said longitudinal members in firmly inserted relation, with said web portions bisecting the angles thereof and forming therewith a truss grating made up of triangles lying entirely at the web sides of the continuous flange portions of said longitudinal members, the assembly having a plurality of the recesses of each longitudinal member aligned with those of the longitudinal member overlapped thereby and having lateral zigzag members common to said pair of frames engaged in firmly inserted relation in the so aligned recesses.

2. An assembly as claimed in claim **1**, wherein the zigzag sections of said lateral members are arranged at

120° angles to each other with each of said zigzag sections intermediate adjacent angles having a length equal to said pitch (*p*), whereby the truss grating formed by the bisection of said angles by said web portions is made up of equilateral triangles.

3. An assembly of a plurality of structural frames according to claim **15**, each of said structural frames having lengths of its lateral members (**20***a* and **20***c*) including two of the angles thereof projecting beyond the longitudinal members (**10***a* and **10***c*) respectively engaged therewith, the two angles of the extending lateral members (**20***a*) of one frame being internested with the two angles of the extending members (**20***c*) of the other frame, respectively, and the assembly including two special longitudinal members (**10''**) having recesses of double width with the internested angles of said extending lateral members engaged therein in firmly inserted relation.

4. An assembly as claimed in claim **3**, wherein the zigzag sections of said lateral members are arranged at 120° angles to each other with each of said zigzag sections intermediate adjacent angles having a length equal to said pitch (*p*), whereby the truss grating formed by the bisection of said angles by said web portions is made up of equilateral triangles.

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