

[54]	FRAMEWORK FOR BUILDING STRUCTURES	3,372,518	3/1968	Rensch.....52/263 X
		3,374,593	3/1968	Rensch.....52/263 X
[72]	Inventor: Eberhard G. Rensch, Lerchesberggring 24, D-6 Frankfurt am Main, Germany	3,396,501	8/1968	Tate.....52/263 X
		3,464,172	9/1969	McGee.....52/168

[22] Filed: **May 18, 1970**

[21] Appl. No.: **38,214**

Primary Examiner—Price C. Faw, Jr.
Attorney—Karl F. Ross

[30]	Foreign Application Priority Data
May 17, 1969	Germany.....P 19 25 262.1
Nov. 24, 1969	Germany.....P 19 58 878.4
Feb. 27, 1970	Germany.....P 20 09 252.8

[52]	U.S. Cl..... 52/650, 52/263, 287/54 C
[51]	Int. Cl..... E04b 1/24, E04b 5/55
[58]	Field of Search.....52/648, 650, 168, 263, 234, 52/236, 731, 732; 287/54 A, 54 B, 54 C

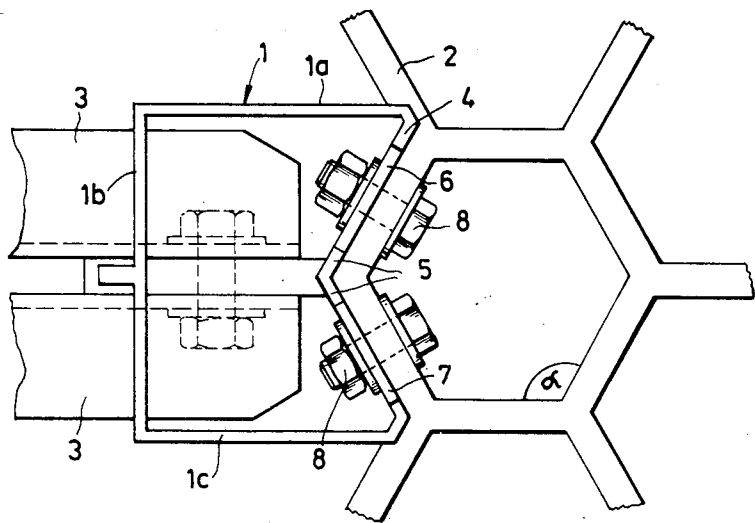
[56]	References Cited
	UNITED STATES PATENTS

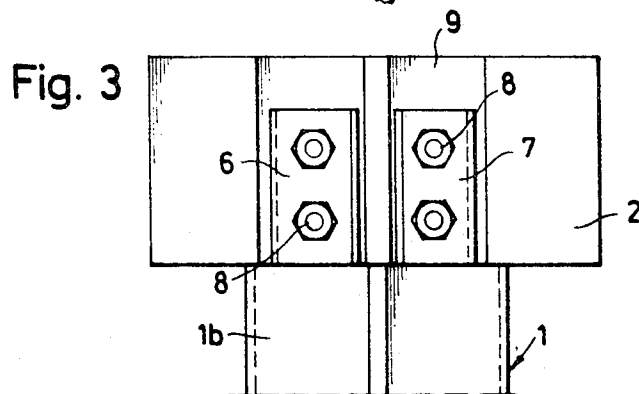
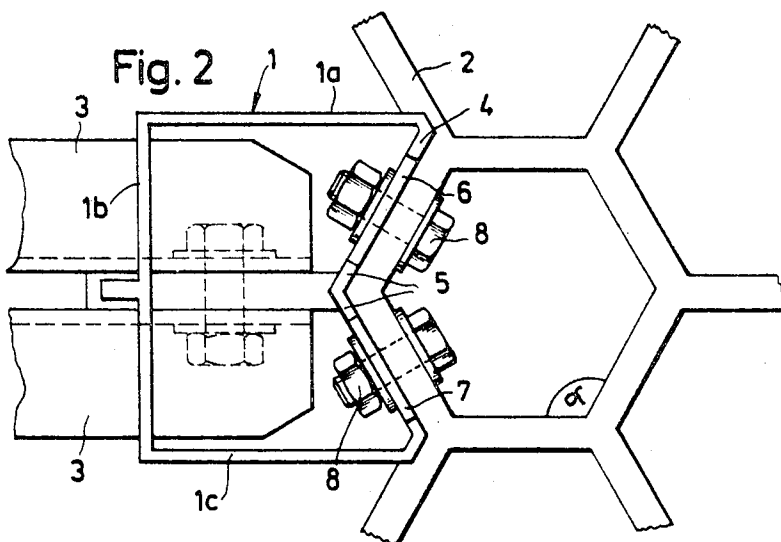
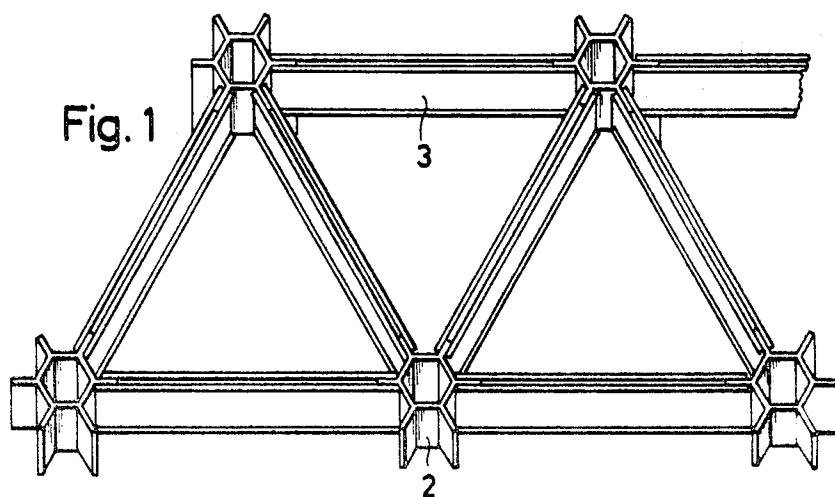
3,055,399	9/1962	Bush et al.52/732 X
-----------	--------	--------------------------

[57] **ABSTRACT**

A framework for building structures and the like in which a triangle-grid lattice is formed in a horizontal plane star-shaped junction elements having radial arms and beams and girders connecting these elements. Tubular columns join the junction elements of the vertically spaced latticework and they serve as fluid conduits.

17 Claims, 21 Drawing Figures





Eberhard G. Rensch
INVENTOR

BY

Karl F. Ross
Attorney

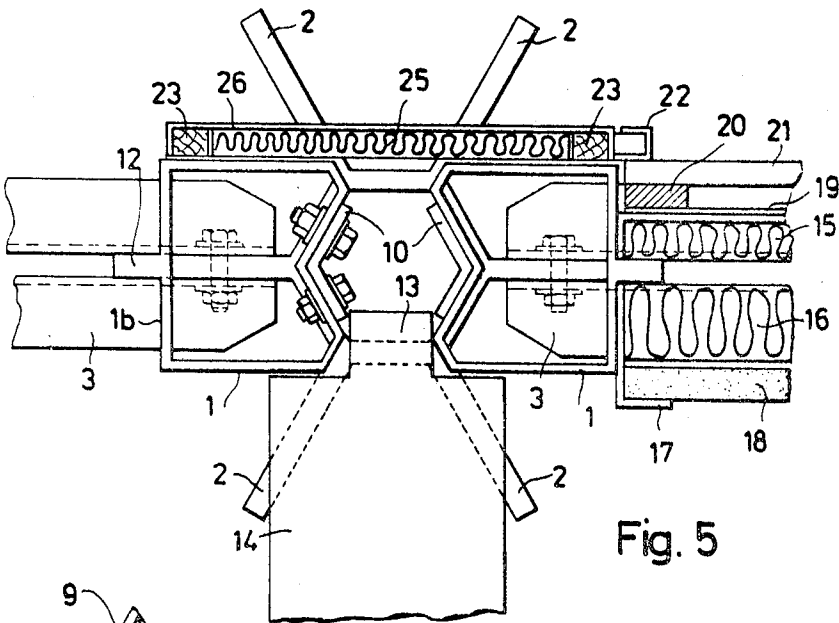


Fig. 5

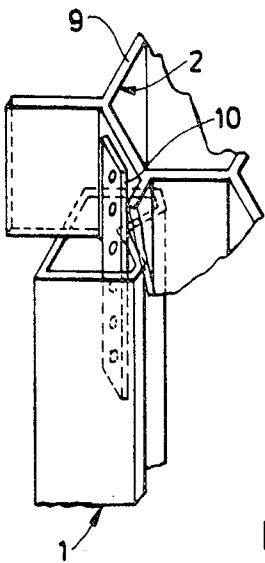


Fig. 4

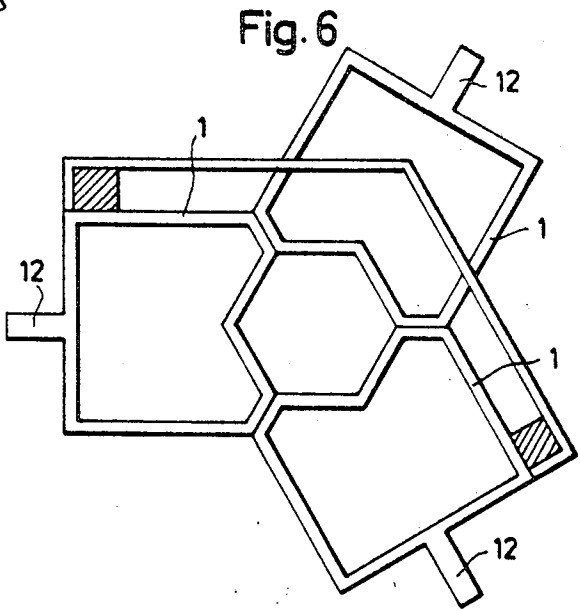
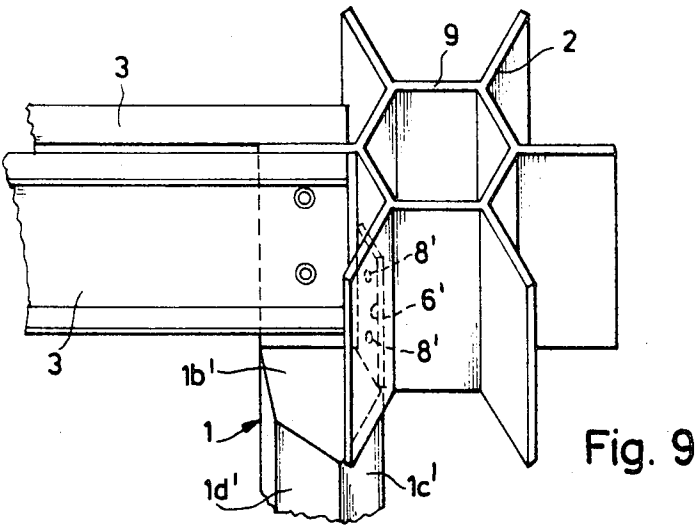
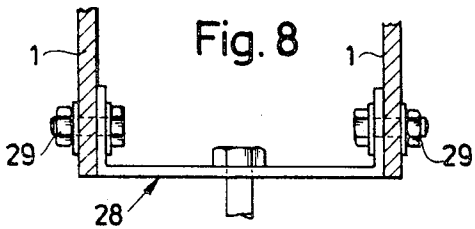
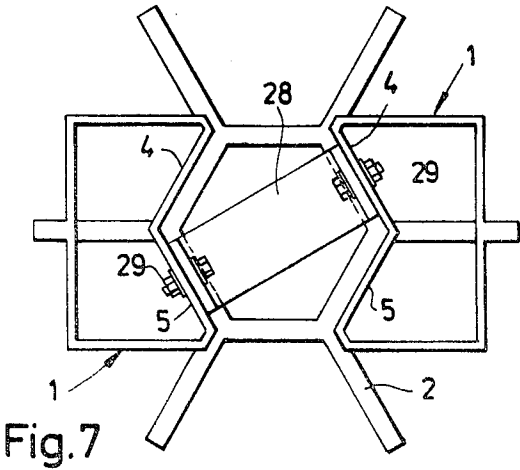


Fig. 6

Eberhard G. Rensch
INVENTOR.

BY

Robert J. Ross
Attorney



Eberhard G. Rensch
INVENTOR.

BY

Karl J. Rose
Attorney

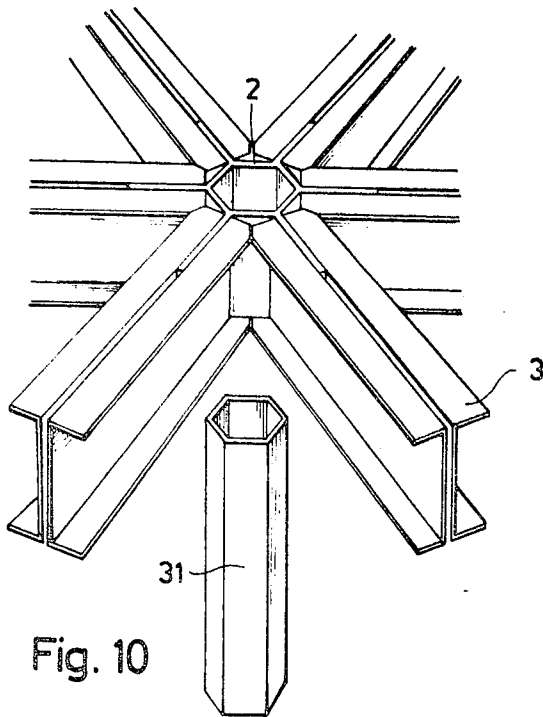


Fig. 10

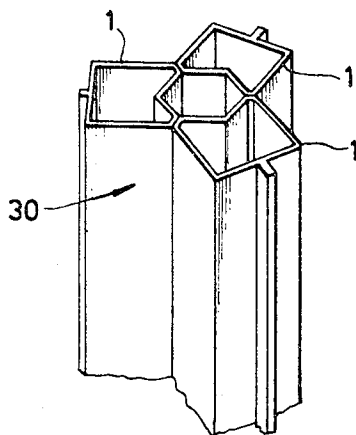
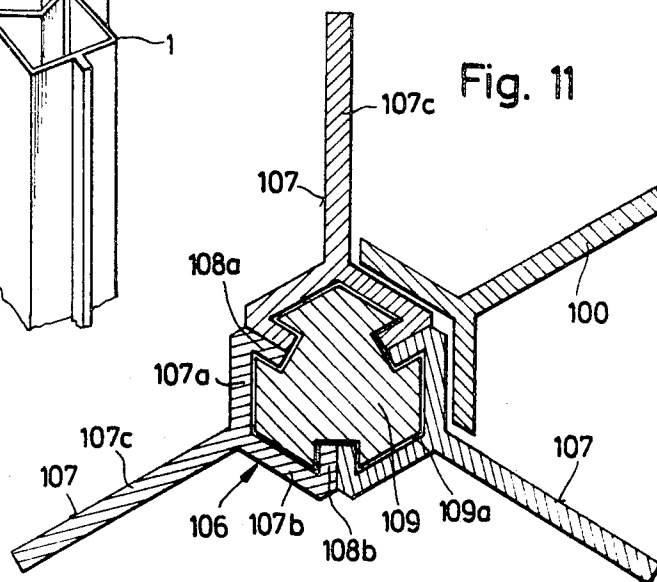


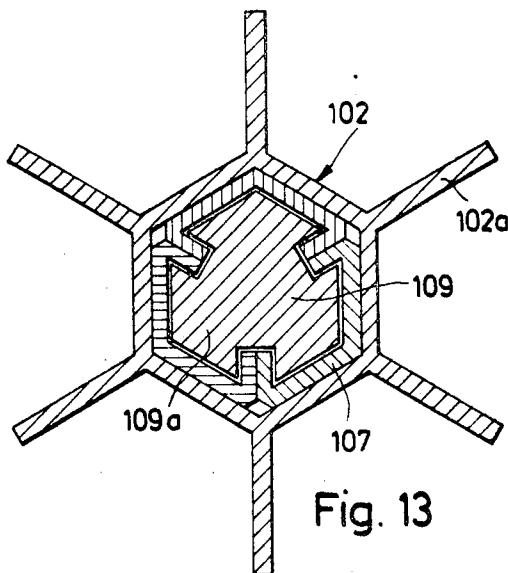
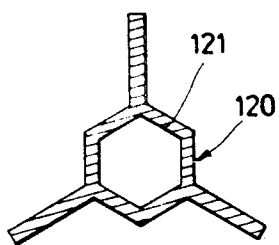
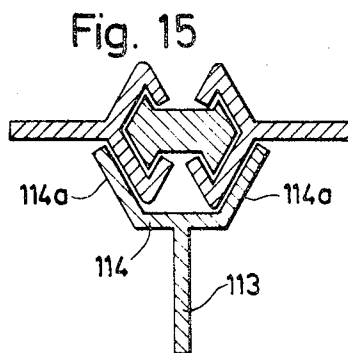
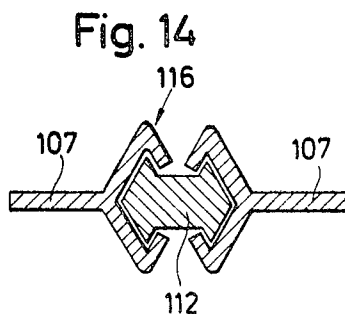
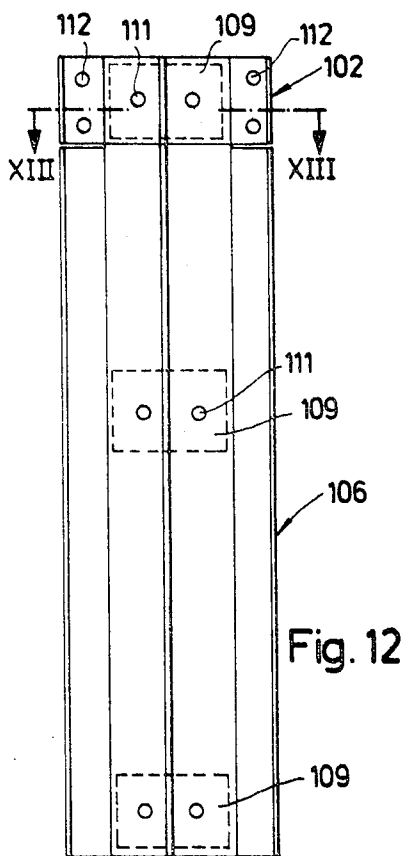
Fig. 11



Eberhard G. Rensch
INVENTOR

BY

K. J. Rensch
Attorney



Eberhard G. Rensch
INVENTOR.

BY

Karl J. Rensch
Attorney

Fig. 17

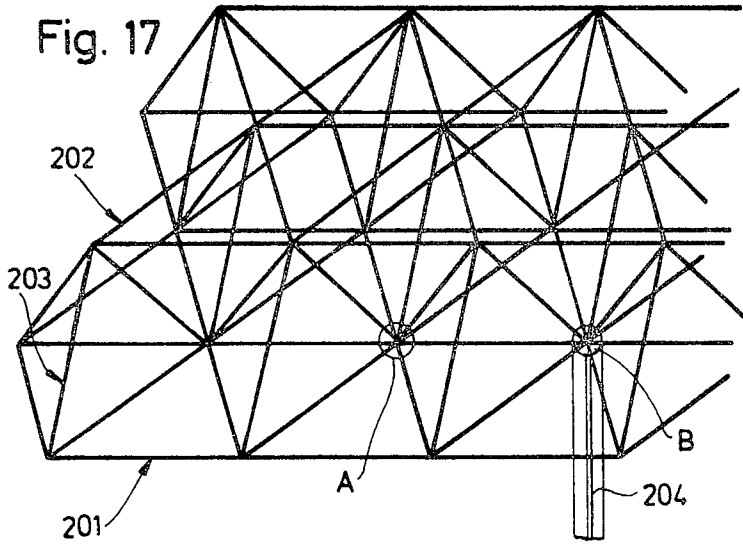
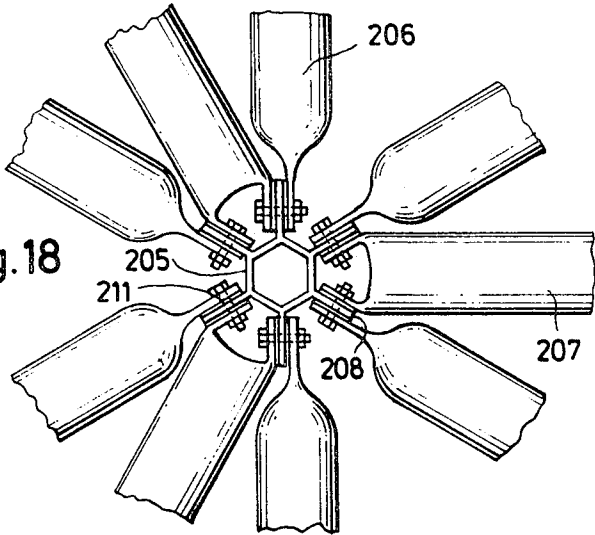


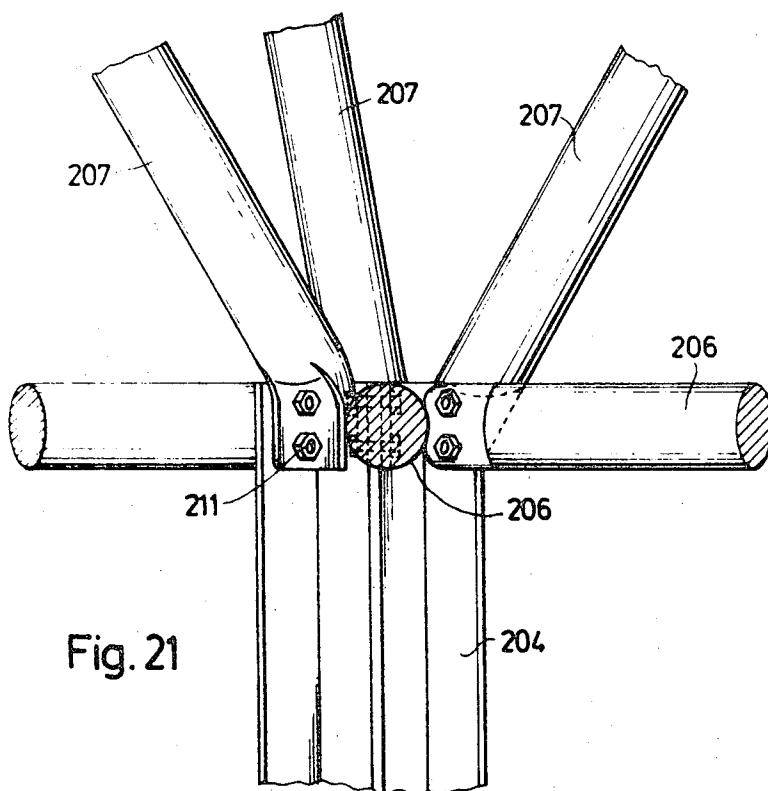
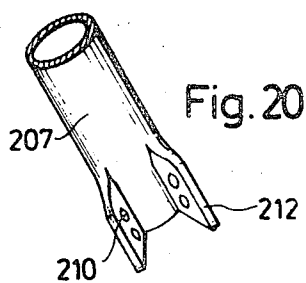
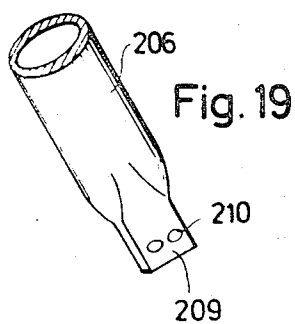
Fig. 18



Eberhard G. Rensch
INVENTOR.

BY

Karl F. Rensch
Attorney



Eberhard G. Rensch
INVENTOR.

BY

Rud. F. Ross
Attorney

FRAMEWORK FOR BUILDING STRUCTURES

1. BACKGROUND OF THE INVENTION

Latticeworks, e.g. planar latticeworks, skeletons and trestles, and also three-dimensional latticeworks, are being used to an ever-increasing extent in building work for the erection of single-story and multi-story buildings.

Planar latticeworks are known whose girders forming the horizontal plane are arranged in a 60° grid system. These girders are associated with one-piece or multi-piece supporting columns which have a star-shaped cross-section and limbs directed radially outwardly to form angles of 60° with one another. The connection of the horizontal girders is effected by means of supporting columns and at the places at which it is possible, or necessary, to dispense with a column, through the agency of junction elements. The tensile stresses which occur are taken up by the columns and the junction elements. Aluminum is preferably used as the material for this kind of skeleton or trestle, but it is also possible to use any other suitable material as long as it possesses sufficient strength. The individual parts are produced by extrusion in extrusion presses.

Three-dimensional or spatial latticeworks consist of compressional members and tensional members joined together in a triangular frame arrangement in a suitable manner through the agency of junction elements. These members arranged in a specific manner form a system which can deflect forces and span wide spaces without support. The junction elements and the connecting parts of the junction elements to the supporting piers are the most important parts of the spatial latticework.

2. SUMMARY OF THE INVENTION

The present invention has as its object the improvement of known latticeworks.

According to the invention a latticework for the erection of buildings is characterized in that the horizontal plane consists of a system of bar members or girders arranged in a triangular grid system or in a triangular frame arrangement, the connection of which is effected through the agency of junction elements with star-shaped cross-section having radially disposed arms, the columns being attached to the junction elements. The junction elements are each constructed as a simple star-shaped profile with intersecting profile arms. It is also possible to use junction elements consisting of a hollow-section or solid-section polygonal, more particularly hexagonal, core with arms which are attached to the corners and form the same angles with one another.

The latticework according to the invention affords the advantage that the tensile stresses of the skeleton or trestle are taken up only by the junction elements and the columns can be made from small sections which afford particularly advantageous connection possibilities, are advantageous from the insulation point of view, or do not require much material.

With regard to the latticework in space the system according to the invention constitutes a simplification as regards assembly, and also permits transition from the horizontal to the vertical, and vice versa, free from transition and connecting elements.

3. DESCRIPTION OF THE DRAWING

Further explanations regarding the invention will be given with the aid of the following description, reference being made to the drawings wherein:

FIG. 1 shows a perspective view of the horizontal plane of a planar framework according to the invention,

FIG. 2 shows a view of a hollow column from below in the direction towards the junction element,

FIG. 3 shows a side view of the junction element with the column,

FIG. 4 shows a modification of the column-junction element connection in perspective,

FIG. 5 shows a view corresponding to FIG. 1 but with two hollow columns,

FIG. 6 shows a column combination in the form of a closed column,

FIG. 7 shows a column combination with a base anchor

FIG. 8 shows a section through the base anchor,

FIG. 9 shows a perspective view of a junction element with a modified column form,

FIG. 10 shows an exploded view of a column, a connecting part and a junction element,

FIG. 11 shows a cross-section through the multi-part column according to the invention,

FIG. 12 shows a side view of the column according to FIG. 11,

FIG. 13 shows a sectional view along line XIII—XIII of FIG. 12,

FIG. 14, and 15 show sections through columns consisting only of two longitudinal profiles,

FIG. 16 shows a cross-section through another column construction according to the invention,

FIG. 17 is a perspective view of the spatial or three-dimensional latticework according to the invention,

FIG. 18 shows a junction point of the latticework in plan view,

FIGS. 19 and 20 show perspective views of two bar member ends and,

FIG. 21 shows a side view of a junction point.

4. SPECIFIC DESCRIPTION

FIG. 1 shows the planar latticework according to the invention, which consists of a network of preferably U-shaped girders 3 arranged in a 60° grid pattern, which are connected through the agency of junction elements 2 which in profile or cross-section are hexagonal with radially disposed arms attached to the corners. The core of these junction elements is illustrated as being hollow, but it may also be solid. The columns according to the invention are connected to these junction elements.

The proposal, according to the present invention, of a horizontal planar structure comprising a network of girders preferably of equal length which are arranged in a triangular grid pattern and are connected through the agency of junction elements, and wherein the network is supported by means of column elements attached to the junction points, also affords advantages as regards possible variations in space distribution and prefabrication and also the advantage that the columns or column parts can be formed of small section members or section-member parts, since the tensile stresses are taken

up by the junction elements. Thus the columns can be produced in extrusion presses such as are generally used in the metal and plastics industry. The column constructions discussed hereinafter show various possibilities as to how the column sections can be constructed subject to the given requirements.

FIG. 2 shows a column part according to the invention which is connected to a junction element, as viewed from below in the direction towards the junction element and the girders of the horizontal plane. The hollow column is designated as 1, the junction element as 2 and the U-shaped girders as 3. The hollow column has sides 1a, 1b and 1c which are arranged at right angles to one another, whereas the fourth side 4 has a recess or indentation owing to an angular inclination of the two limbs 5. The limbs 5 are arranged at an angle of 120°. This angle corresponds to the angle α of a junction element corner, so that the straps 6, 7 projecting beyond the column body abut the webs of the junction-element core 9 (FIG. 3) and are fastened thereto by means of the bolts 8. Junction element and column parts are conveniently so dimensioned that the junction elements are not only bolted to the column parts but also bear thereon.

The side view in FIG. 3 shows clearly the two straps 6, 7 which project beyond the column body and which are secured to the column core by means of the bolts 8. The U-shaped girders 3 have been omitted to facilitate easier understanding of the drawing. The column has been broken off a short distance below the junction element. Instead of straps formed on the column body, it is also possible to use separate connecting straps 10, possibly bent over at an angle of 120°, which are bolted on the one hand to the limbs of the side 4 of the column and on the other hand to the column core as shown in perspective in FIG. 4. If necessary the strap 10 can also abut externally on the column part and on the inner wall of the core 9.

FIG. 5 shows a plan view according to FIG. 1, but in a detailed representation, namely in conjunction with various wall elements. In this illustration the junction element is again provided with the reference numeral 2. To this junction element 2 two diametrically opposite hollow columns 1 are connected through the agency of angled connecting straps 10. The U-shaped girders forming the horizontal grid and bolted to the arms of the junction element 2 are again designated by the reference numeral 3.

Formed centrally on the longitudinal sides 1b are ledges 12 which serve for the abutment of wall parts or as a tongue of a tongue-and-groove connection between the wall elements and the columns. The gap remaining between the hollow columns 1 thus serves in the illustrated example as a groove for the engagement of the tongue 13 of the wall part 14 which is connected at right angles to the course of the girders 3. The construction of a sandwich wall connected to the right-hand hollow column is shown in FIG. 5. At both sides of the ledge 12 there are provided panels 15, 16 for thermal insulation. Towards the inside, a plasterboard 18 is secured simply by means of a holding section member 17. Towards the outside the insulating panel 15 is first of all covered with a moisture-proof insulation 19 on which a spacer 20 is arranged for forming a ventilatable intervening space and an outer skin 21

held preferably by means of a profiled strip 22. For the external covering of the gap remaining between the hollow columns 1 opposite the tongue 13, there are arranged at the columns at both sides of the gap, bars 23 preferably made of hardwood, between which an insulating panel 25 can also be provided. A section member (profile) 26, preferably made of aluminum can be applied as an outer skin through the agency of the bars 23.

Within the hollow space or chase formed by the column parts it is possible to arrange supply lines of all kinds. In the case of considerable static loads, the hollow columns may also be filled with a cast composition.

FIG. 6 shows in a diagrammatic view the arrangement of three hollow columns according to the invention which are arranged at an angle of 120° relatively to one another, and which abut on one another without leaving any joint gap, forming a hexagonal hollow space. If only two columns forming an angle of 120° are provided, an outer cladding can be provided which in principle corresponds to that shown in FIG. 5, but is appropriately angled.

To adjust and connect the columns at the base, U-shaped anchoring parts can be provided as shown in FIGS. 7 and 8. The anchoring part 28 engages between the columns 1, the limbs 4 or 5 of the columns 1 being connected by bolts 29. The base of the anchoring part 28 is bolted to the foundation. This method of connection can also be used in the case of column parts which are arranged at an angle of 120° relatively to one another, since in that case each two column limbs 4, 5 are situated opposite one another.

FIG. 9 shows a modification of the hollow column 1 in a perspective view with the junction element 2 and the girders 3 forming the horizontal framing. The column 1 is so constructed that it is given a U-shaped cross-section with outwardly inclined limbs in accordance with the individual junction element sectors, the base of the U corresponding to one side of the column core. For better stability, the limbs are connected to one another by the walls 1d'. Connection need not be effected at the limb ends. Conveniently the limbs 1b', 1c' form an angle of 60° so that the junction element arms can abut on the columns. The strap 6' formed on to the base side is connected by means of bolts 8' to the junction elements 2 as in the constructional arrangement shown in FIG. 2. The column construction is also suitable for combination with one or more of the same type in dependence on static requirements and those due to the configuration of the walls.

Another possible method of connecting a junction element 2 to a closed support 30 formed of three hollow columns 1 is shown in FIG. 10. The connecting part is a hexagonal-section rod 31 which is hollow or solid and is dimensioned for engagement in the hollow space of the junction element 2 and that of the support 30. The rod 31 is bolted or adhesively secured to the junction element core and/or the hollow columns 1.

The column constructions described hereinbefore permit right-angled connections and constitute an insulation owing to the hollow construction. In addition they offer the advantage of smooth outer surfaces. In contrast, hollow section members are difficult to produce and also cannot be produced on all extruders.

Therefore, a further feature of the present invention is the simplification of the section members by dispensing with complicated intermediate elements and reducing the column to three wall connection limbs. FIG. 11 shows a cross-section through a column 106 according to the invention of three longitudinal section members 107 which are Y-shaped in cross-section and wherein the two limbs 107a, 107b combined to form the column core are made shorter in the limb direction than the third, radially disposed limb 107c.

The ends 108a, 108b or the shorter limbs 107a, 107b are bent at an angle of 60° relatively to one another. These bent-over portions 108a and 108b of the three longitudinal section members 107 forming a closed column abut on one another and can be connected to one another by adhesive securing of the abutting surfaces. Another method of connection consists in arranging a tongue or locking element 109 which has rhombus-like projections 109a for engagement in the grooves which are formed by the longitudinal section members and are open towards the interior of the column. If the connections formed by the limbs 107c of the longitudinal section members are not adequate, an additional Y-section longitudinal section member 100 can be provided which is adapted to be bolted to the column.

FIG. 12 shows a side view of the column shown in FIG. 11. In conjunction with FIG. 13 it will be clearly seen that the radially disposed limbs 107c are cut out in accordance with the junction element height and the core of the column engages in the junction element 102 so that the limbs 102a of the junction element 102 rest on those of the supporting column 106. The length of the radially disposed limbs 107c of the longitudinal section members is adjusted to that of the junction element 105. As FIG. 12 shows, three locking or tongue elements 109 are received in the column and bolted at 111 to the longitudinal section members. The girders forming the horizontal plane are attached at 112 to the limbs of the junction elements.

FIG. 13 shows clearly how the junction element 102 engages about the girder end. The tongue or locking element 109 can be made from aluminum or another suitable material, and it is not necessary for the tongue element 109 to fill the entire hollow space of the column, and instead it is sufficient if the rhombus-shaped portions 109a engage in the grooves of the longitudinal section members and are connected to one another by webs.

A column 116 consisting of only two longitudinal section members 107 is shown in cross-section in FIGS. 14 and 15. The two section members 107 are situated diametrically opposite and are connected by means of a locking element 112 which at opposite ends is rhombus-shaped for engagement in the grooves of the longitudinal section members. FIG. 15 shows a longitudinal section member 113 which is to be arranged, and which is T-shaped in cross-section, the ends 114a of the transverse web 114 being bent-over upwards at an angle of 120°. The arrangement of this longitudinal section member permits right-angled connection to the longitudinal section members 107. The supporting columns 116 engage in a junction element 102 in a similar manner to that described in connection with FIGS. 12 and 13.

In FIG. 16 there is shown in cross-section a column 120 which has a hexagonal core 121 with three radially disposed limbs 122 which form an angle of 120° with one another. The construction represents the one-piece form of the column 106. The one-piece column 120, like the multi-piece column 106, engages at its ends in the junction element 202, appropriate cutaways being made in the limbs. It is true that the one-piece column 120 requires larger presses for manufacture, but a considerable saving of material is achieved. It is possible according to the invention to provide no limb or only one limb, two limbs, four limbs, five or six limbs, instead of three.

FIG. 17 shows a perspective view of the latticework in space. The lower 60° triangular grid is designated as 201 in the drawings, whereas the upper grid is designated by the reference numeral 202. These two grids are connected by way of struts 203 which extend at an angle of 60° both to the members of the upper grid 202 and of the lower grid 201, so that an ordered plane latticework of tetrahedrons and half-octahedrons is formed. The columns 204 attached to the junction points of the members are shown diagrammatically in the illustration.

Nine members meet at each junction point of the latticework in space, as the perspective view of the latticework in space in FIG. 17 shows clearly.

FIG. 18 shows a plan view on to a junction point corresponding to point A of FIG. 17, which consists of the junction elements 205 and the compressional or tensional bar members which are bolted thereto and which are designated as 206 or 207 depending on the construction of the connecting flanges.

The junction element 205 consists of a star profile with six radially disposed profile arms 208 which form equal angles to one another. The illustrated junction element 205 has a hollow core in the illustration.

The members 206 and 207 (see FIGS. 19 and 20) are generally tubular, but may also be solid. The ends of the members 206 are formed to constitute a flange 209 which is provided with holes 210 for the insertion of screw bolts 211. The members 207 on the other hand are provided with two flanges 212 which form an angle of 60° in accordance with the angle between the neighboring profile arms 208 of the junction element 205. The holes for the screw bolts also have the reference numeral 210'.

The ends of the members 207 engage between two neighboring limbs of the junction element star profile and abut on the one opposite side of the limbs 208. The members 206 on the other hand are arranged on the free limb side. The flanges of members attached near one another which abut on the two sides of a limb are bolted jointly. As FIG. 17 shows clearly, in the described constructional arrangement a member 207 with double flange arrangement alternates with two members 206 with single flange arrangement. Nine members can be connected to a six-arm junction element.

The height of the junction elements is dependent on the static conditions and also the thickness of the members. The members 206 in FIG. 17 are all situated in a single plane, whereas the members 207 extend at an angle of 60° upwards. In order to achieve this inclination, the member ends with the flanges are bent-over

relatively to the members themselves (see FIG. 21). The bent, over members 207 correspond to the struts 203 in FIG. 17.

FIG. 21 shows a side view of the point B in FIG. 17, which represents a connection point of members 206 and 207 through the agency of a junction element prolonged to form a column 204. At the upper end of the column 204, corresponding to FIG. 18, six members 206 are arranged in a plane of which only three are visible. The other three members 207 extend at an angle of 60° upwards and form parts of the strut means 203. The length of the column 204 is to be adapted to particular requirements. With the use of star profile junction elements according to the invention, which when prolonged can be used as columns, the additional arrangement of connecting part is not necessary. But the other multi-piece and single-piece columns already described within the framework of the invention can also be used.

In the case of the insertion of walls, instead of the members it is also possible to use C-shaped or O-shaped girders in the lower grid in accordance with the course of the walls. By this exchange, there are obtained together with the profile limbs of the columns, right-angled horizontal and vertical abutments and thus frames which have hitherto not been known in latticeworks in space and which make possible the arrangement of prefabricated wall elements without additional holding parts.

The columns constructed with a hollow core can be connected to the water mains, either in such an arrangement that water is introduced into the column interior or pipelines can be arranged within the column. The possibility of introducing water if necessary will cool the columns in the case of fire, when there is no loss of load-bearing ability. For example the supports can be perforated at the upper end for the outflow of water. The control of water entry into the piers can be effected for example by temperature-sensitive elements.

By connecting the hollow column interiors or the pipelines at the upper and lower end by additionally arranged pipelines it is possible to achieve physically a circulation system which with the action of heat acts as a cooling arrangement in accordance with the laws of gravity heating. These possibilities with the latticework in space according to the invention in conjunction with practical experience with the latticework, which shows that the latticework does not collapse in the case of non-uniform damage but gaps simply form which are compensated within the structure by the many supporting directions, afford considerable advantages in the event of a fire.

I claim:

1. A building structure comprising a horizontal latticework including a plurality of spaced-apart junction elements having angularly spaced outwardly extending arms, and beams connecting arms of the spaced junction elements and defining with one another triangles having said junction elements at the vertices thereof; and columns connected with the junction elements of the latticework and perpendicular thereto for vertical positioning of the latticework, each of said junction elements being of a star profile with at least some of the arms thereof being angularly offset from other arms by about 120°, said columns flanking said junction elements and being laterally connected thereto.

2. The building structure as defined in claim 1 wherein said elements are solid-cross-section profiles formed unitarily with said arms.

3. The building structure as defined in claim 1 wherein said junction elements are hollow profiles formed unitarily with said arms.

4. The building structure as defined in claim 1 wherein said junction elements are generally prismatic and are formed with said arms at vertices of the prism.

5. The building structure as defined in claim 1 wherein said columns are each composed of several column portions joined at the respective junction elements.

6. The building structure as defined in claim 5 wherein said column portions extend outwardly from the junction elements and are inclined angularly to one another so as to include angles of substantially 120° between them, said column portions each being formed with an outwardly extending ledge.

7. The building structure as defined in claim 1 wherein said columns each have a flank confronting the respective junction element and indented complementarily to a vertex thereof.

8. The building structure as defined in claim 1 wherein said columns are each formed from a plurality of sections having inwardly turned tongues, said tongues being adhesively secured together.

9. The building structure as defined in claim 1 wherein said junction elements rest vertically upon said columns, further comprising a core element traversing each junction element and the respective column.

10. The building structure as defined in claim 1 wherein said beams are formed with bent ends having angles corresponding to those of the arms.

11. The building structure as defined in claim 1 wherein said beams are angle-section girders.

12. The building structure as defined in claim 1 wherein said columns are hollow and are connectable to a water-supply line thereby enabling water to traverse said columns.

13. The building structure as defined in claim 12 wherein said columns are perforated at their upper ends.

14. The building structure as defined in claim 12 further comprising duct work interconnecting the interior of the columns and their upper and lower ends.

15. A building structure comprising a horizontal latticework including a plurality of spaced-apart junction elements having angularly spaced outwardly extending arms, and beams connecting arms of the spaced junction elements and defining with one another triangles having said junction elements at the vertices thereof; and columns connected with the junction elements of the latticework and perpendicular thereto for vertical positioning of the latticework, each of said junction elements being of a star profile with at least some of the arms thereof being angularly offset from other arms by about 120°, said elements being hollow and of polygonal cross-section, said columns having complementary cross-sections and being received within said junction elements.

16. A building structure comprising a horizontal latticework including a plurality of spaced-apart junction elements having angularly spaced outwardly extending arms, and beams connecting arms of the spaced junction elements and defining with one another triangles

having said junction elements at the vertices thereof; and columns connected with the junction elements of the latticework and perpendicular thereto for vertical positioning of the latticework, each of said junction elements being of a star profile with at least some of the arms thereof being angularly offset from other arms by about 120°, said columns each being composed of three generally Y-shaped sections having inwardly turned tongues including angles of 120° with one another, and a core of generally hexagonal configuration formed with grooves angularly offset through 120° to receive said tongues and clamp said Y-shaped sections together.

17. A framework for a building structure, comprising:

a horizontal latticework including a plurality of spaced-apart junction elements having angularly spaced outwardly extending vertical arms and vertical webs between said arms, and beams connecting arms of the spaced junction elements together and defining triangles having said junction elements at the vertices thereof;
vertical columns independent of but laterally affixed to the webs, said junction elements and extending vertically perpendicular to the latticework for vertical positioning thereof; and
means for attaching wall-forming members to said columns.

* * * * *

15

20

25

30

35

40

45

50

55

60

65