Jan. 10, 1967 | S. LEBOWITZ | 3,296,767

TRUSS CONSTRUCTION

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FIG. 1

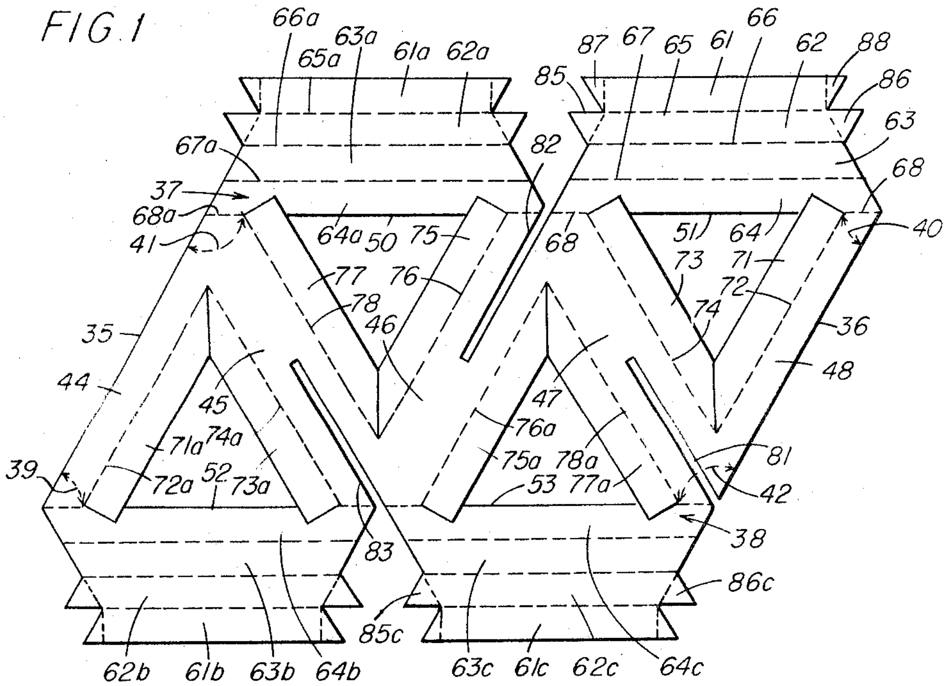

FIG. 2

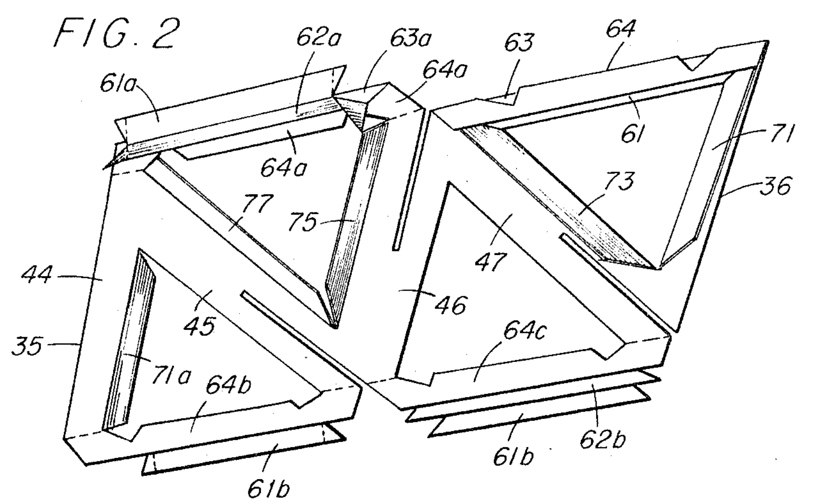

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FIG. 3

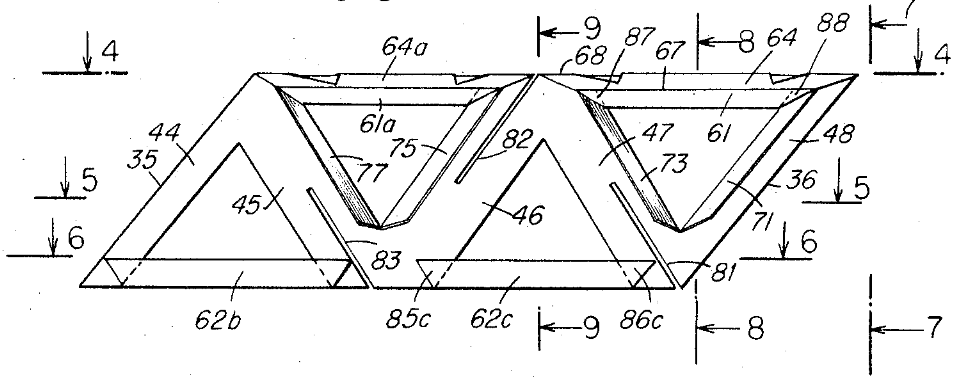


FIG. 4

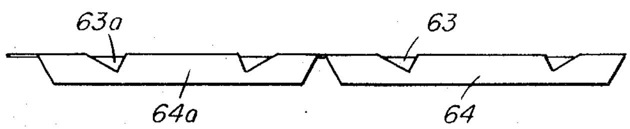


FIG. 5

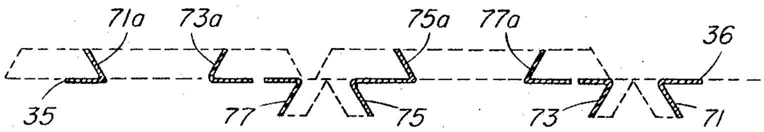


FIG. 6

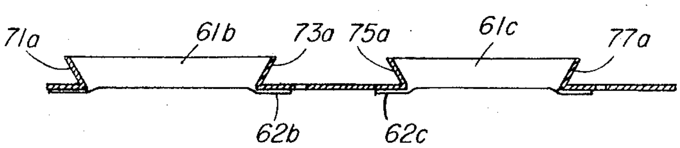


FIG. 8

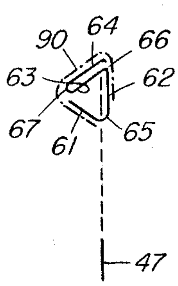


FIG. 9

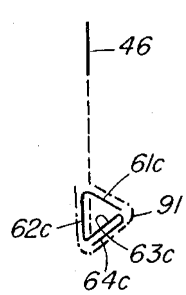
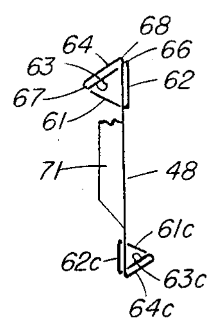


FIG. 7



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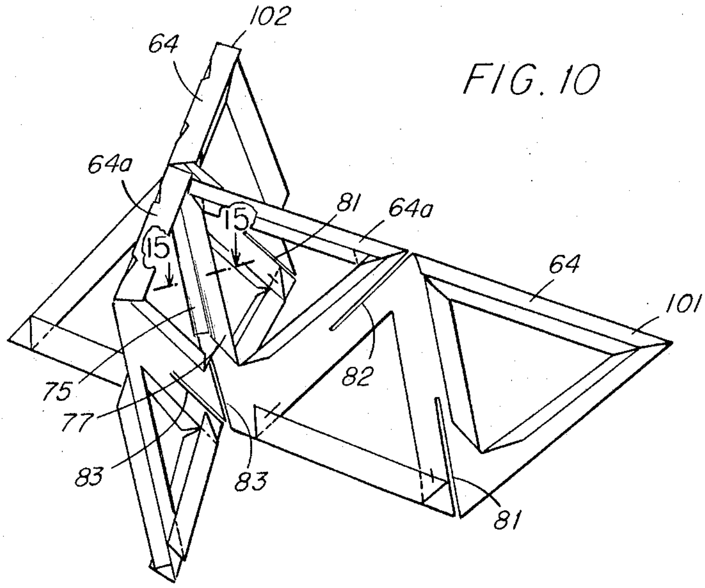

FIG. 10

FIG. 11

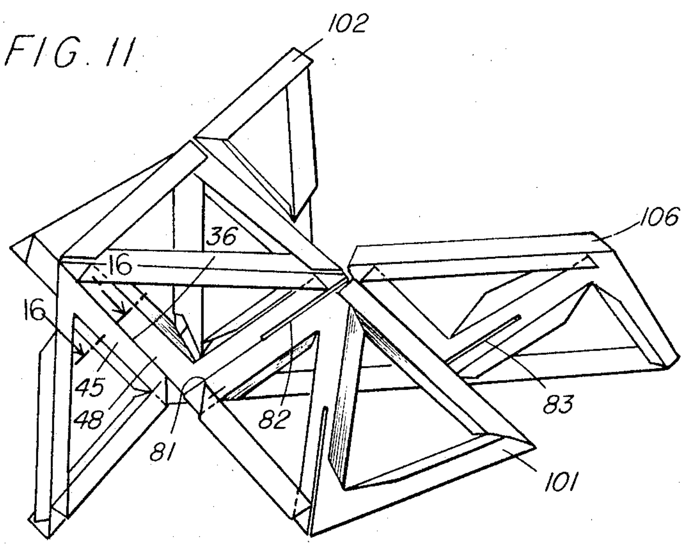

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FIG. 12

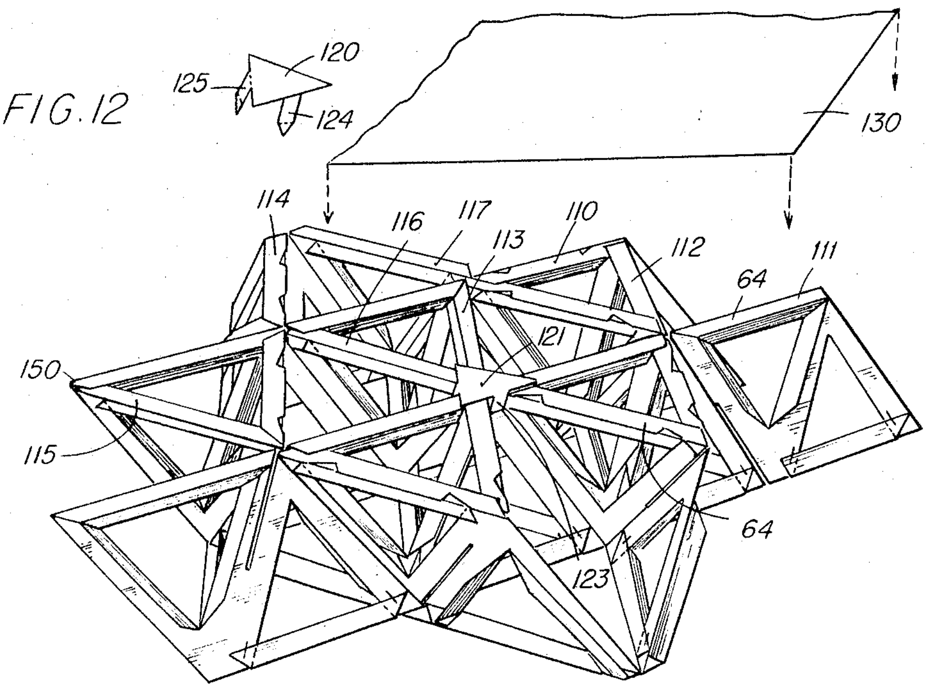

FIG. 13

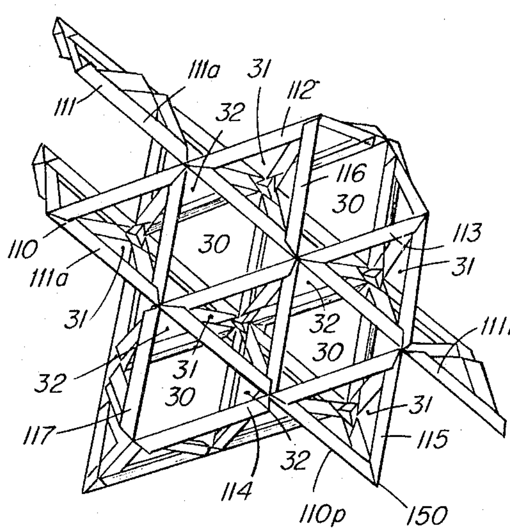

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FIG. 14

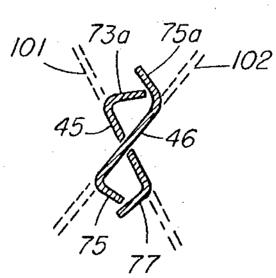


FIG. 15

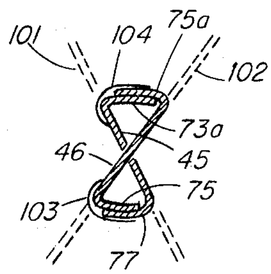


FIG. 16

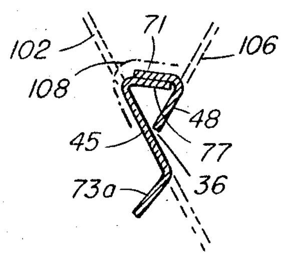
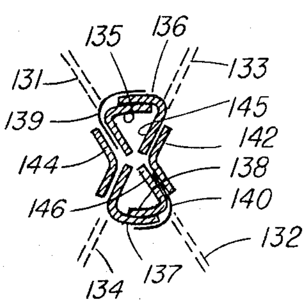


FIG. 17



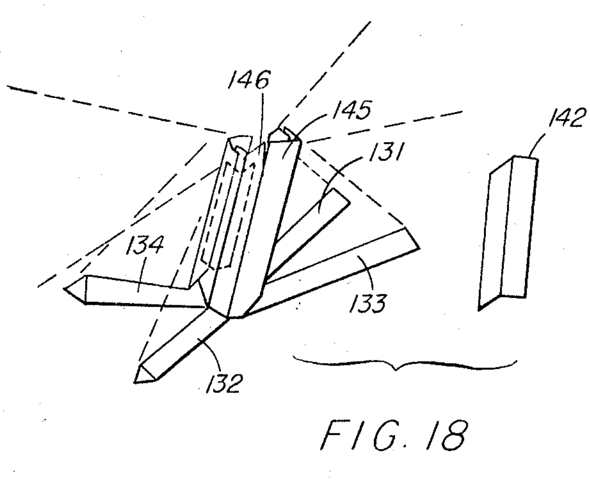


FIG. 18

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TRUSS CONSTRUCTION

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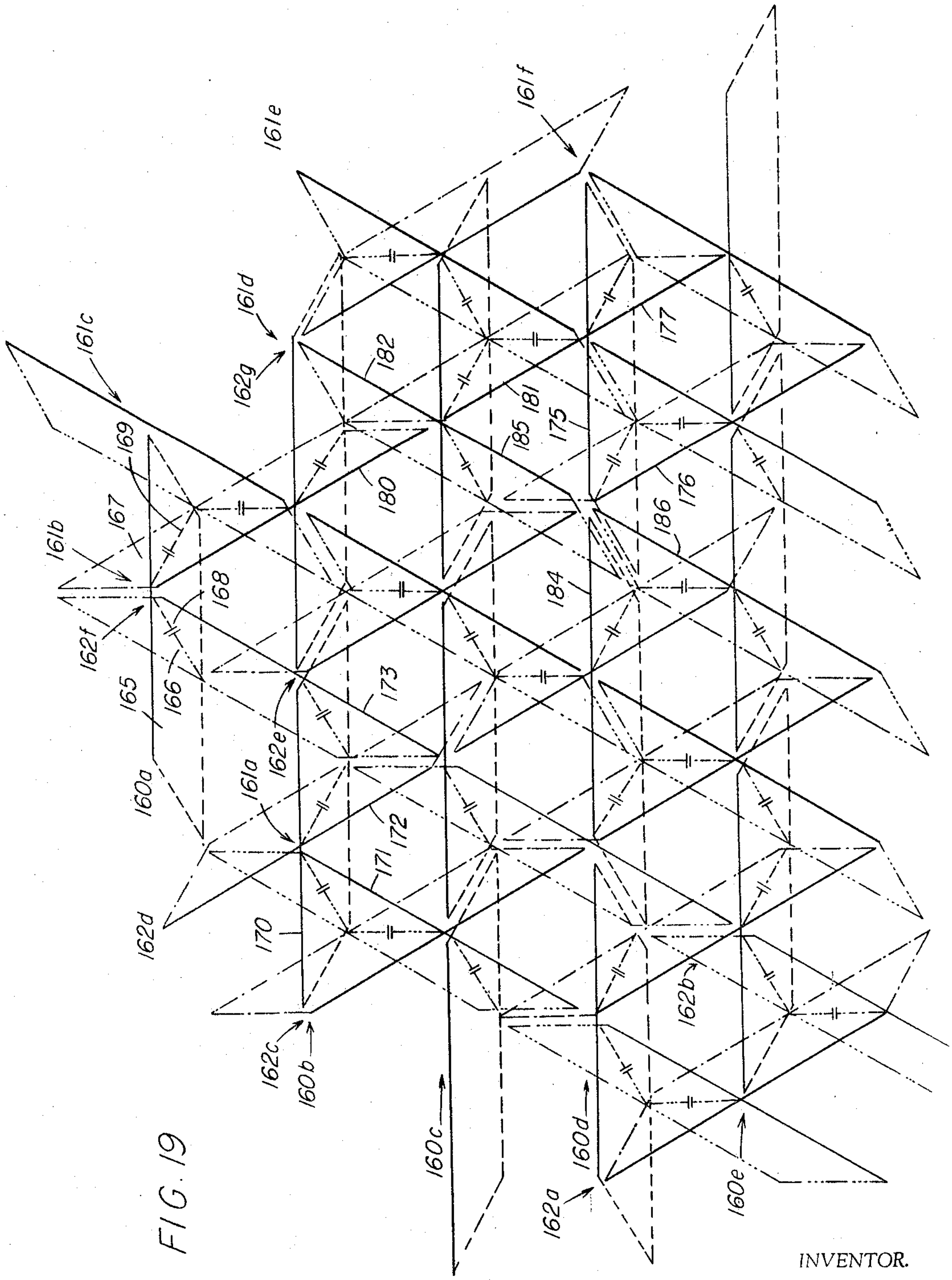

FIG. 19

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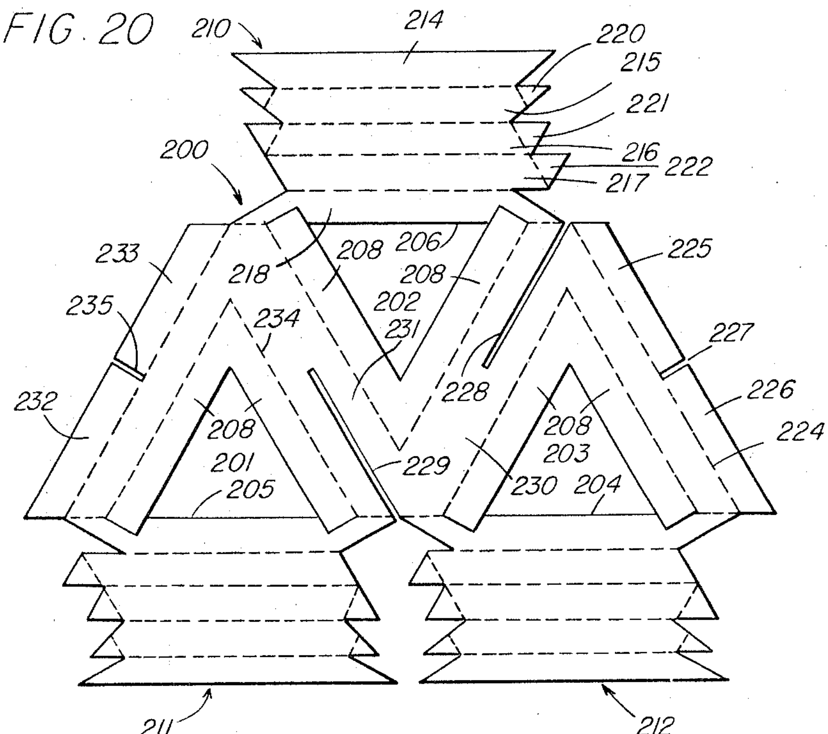
FIG. 20



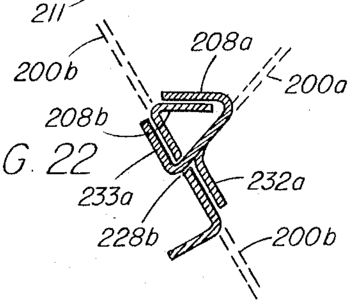


FIG. 22

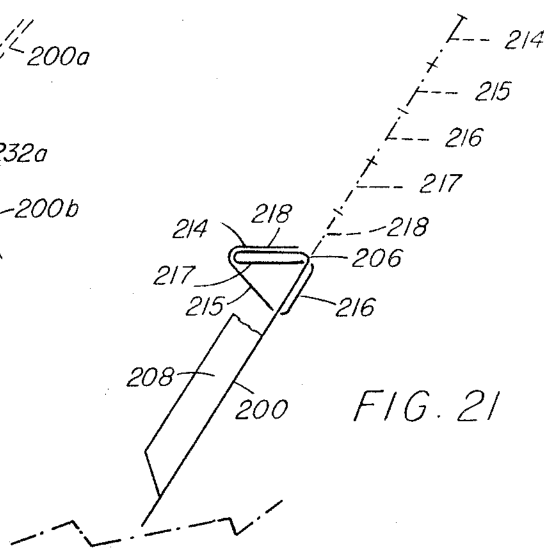


FIG. 21

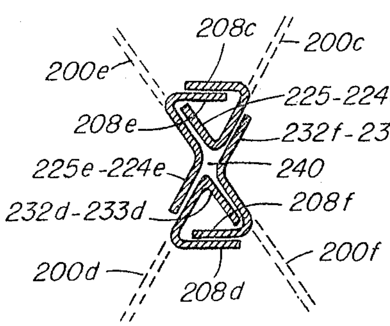


FIG. 23

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United States Patent Office

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Patented Jan. 10, 1967

3,296,767

TRUSS CONSTRUCTION

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Filed June 27, 1963, Ser. No. 290,962
11 Claims. (Cl. 52—634)

This invention relates to truss structures and in a special sense to truss structures designed to constitute a roof or the like, for buildings, e.g. a complete framework suitable for spanning areas of various dimensions, including relatively large spaces. More particularly, the invention is concerned with truss construction of the type sometimes known as an octa-tetra truss, a particular object being to provide new and unusually effective elements and combinations in such assemblies, having advantages of economy, lightness of weight, and ease of assembly or erection.

The so-called octa-tedra type of truss is well known in principle and may be described as composed of frame members arranged to define a regular assembly of octahedra and tetrahedra, i.e. in that the frame members constitute the edges of these geometrical solids. More specifically the arrangement is such that one face of each octahedron lies in one plane surface of the assembly, while the opposite, parallel face of the octahedron lies in the opposite plane surface of the truss, it being understood that as used for a roof, the framework constituting the truss has in effect upper and lower parallel faces defined by a grid of frame members arranged in abutting triangles, with transverse members extending obliquely between the two surfaces so as to outline the array of octahedra.

As will be further understood by those familiar with this type of truss, the joining of the several regular octahedra together, at the apexes of their triangular faces, also defines an array of regular tetrahedra disposed, in effect, intermediate the octahedra, with alternating tetrahedra having bases in respectively opposite surfaces of the assembly. Trusses of this type are strong and rigid, and within readily determinable limits may extend as far as desired in each lateral direction, for spanning relatively large areas with a complete framework that needs only to be carried by suitable bearing means along or beneath appropriate parts of its periphery.

In general, prior octa-tetra trusses have been constructed by assembling a multiplicity of ribs or struts or similar beam-like metal members in the combined shapes of octahedron and tetrahedron, with these members appropriately connected at their ends, i.e. at the apexes of the defined, geometrical solids. While strong trusses can be made in this way, the joining of many relatively small pieces is a costly operation for the erection of a building or similar structure, and special connecting devices or attachments are necessary in order to fit the ends of the members together in the proper angular relationship at each joint. The present invention is designed to avoid these difficulties, by providing pre-shaped sub-assemblies or units, which can be made of very lightweight, inexpensive material and which may be easily fitted together and joined with simple means, so as to afford an inexpensive light construction that will nevertheless have abundant strength and that may be erected quickly and with very little effort.

A particular feature of the invention is that the elements of the truss can be made of paperboard or equivalent board or other stiff, sheet material, for example common double-faced corrugated board such as used for heavy cartons and like packing or enclosing purposes. More generally, the structures of the invention may be defined as made of foldable board, examples of such board being corrugated carton board as explained above or boards of similar character made of plastic material, or of metal, e.g. aluminum, such as thin aluminum sheet or even relatively heavy, i.e. stiff, aluminum foil, or in some cases heavy cardboard, all to the effect of providing roof assemblies and the like which may thus be considered to be constituted of paper or its equivalent. As will be appreciated from the indicated examples of such material, the term "foldable board" is herein used as meaning stiff board material or the like (such as aluminum sheet or strip) that can be folded, i.e. bent and creased, in a relatively sharp-cornered manner whereby mutually folded portions bear an angular relation to each other, which can be permanently maintained.

Further requirements of the foldable board are that it have considerable strength in tension and that it be such that when folded, as with flaps or the like, the board may be converted into beam-like elements or ribs of polygonal cross-section, e.g. triangular. In a more general sense, this stiff material is such that when portions are folded at selected places, angular, channel or enclosed sections are achieved that have considerable strength in compression lengthwise of the fold edges. The term "fold," of course, is employed to mean a configuration reached by bending the board along a straight line so that a permanent corner or edge is in effect formed there, in a relatively sharp or creased manner.

Although for brevity of reference, the trusses made according to the invention are generally herein considered as disposed in a horizontal maner, and corresponding language of description of parts (e.g. as to upper or lower surfaces) may be used in the claim, it will be appreciated that the truss may be so organized and constituted that it can be employed in other than horizontal attitudes, and the defining terminology is intended to cover the structures however used (unless the contrary explicitly appears); for example the stated assembly may be disposed at a slope or indeed in a vertical position, where the parts or shapes defined as lying in a horizontal plane or in an upper or lower horizontal surface would in fact be located in some other plane or surface.

In a more specific sense the invention involves the provision of sub-assembly units, involving portions folded to form frame segments or ribs, the units being fashioned from sheets of board and being designed to interfit into the configuration of the octa-tetra truss. That is to say, these parts or sub-assemblies are made by cutting and appropriately scoring or creasing pieces of foldable board, and then by folding flaps from the board into hollow shapes or sections (i.e. of triangular or other polygonal cross-section), so as to constitute from each piece of board a connected assembly of triangularly arranged frame-segments or part-segments, i.e. ribs or partial ribs. Each such rib of the unit is in effect an elongated beam-like or strut-like element, having one wall that is integral at each end with one wall of at least one other rib or part-rib (in the unit) which extends at an angle thereto. In effect, each unit represents a plurality of alternately disposed triangles of which the sides are constituted to become the ribs of the truss, and which are all fashioned by simple cutting and folding operations from a sheet of the defined board.

In presently preferred forms of unit, the general shape of the pre-cut piece of board is a parallelogram having two long and two short sides, or a trapezoid having one long and three short sides, with internal angles of 60° and 120°, so that four or three alternately disposed equilateral triangles (i.e. reversely juxtaposed, in succession) are in effect encompassed by the perimeter of the unit. Flaps to constitute horizontal ribs may project from the long sides, while flaps for reinforcement of the oblique connectors or ribs may be integral with corresponding portions extending between the long sides (including the portions along the short sides). With the flaps bent or folded into place, the device provides a pre-established structural unit for building and like purposes, ready to be assembled with similar units to make the described truss.

The board units also include slots or slotted areas along some or all of the intermediate oblique rib-forming portions, arranged for interlock with like regions of other units, so that in the truss these elements may be disposed in mutually crossing relation wherever necessary, as well as in positions where end regions of the units (i.e. short sides) abut other units.

As will now be appreciated, the invention further resides in completed truss structures constituted by assembly of the units into the stated octa-tetra configuration, illustrative examples of such construction being set forth hereinbelow. In such assemblies, the folded parts of the units may be individually secured in place and also secured to each other, by simple means, such as with gummed or other adhered tape, or by stapling or other fastening appropriate for the material of the unit. By virtue of the inherent strength and rigidity of the folded sections constituting the horizontal and oblique ribs, and with the parts of the truss effectively integrated in the above manner, a novel structure results which has the defined advantages of lightness in weight, strength and substantial durability, as well as unusual economy.

The nature of the invention and its other features or details will be further understood from the following description and accompanying drawings of presently preferred embodiments. Referring to the drawings:

FIG. 1 is a plan view of one form of board unit, as pre-cut and as creased or scored for folding;

FIG. 2 is a like view, somewhat in perspective, of the unit of FIG. 1 with various flap means in partly folded condition;

FIG. 3 is a plan view of the unit with all flaps in folded condition as appropriate for assembly of units into a truss;

FIG. 4 is a top edge view, as if on line **4—4** of FIG. 3;

FIGS. 5 and 6 are longitudinal sections respectively on lines **5—5** and **6—6** of FIG. 3;

FIG. 7 is an end view of the unit, as if on line **7—7** of FIG. 3;

FIGS. 8 and 9 are transverse sections respectively on lines **8—8** and **9—9** of FIG. 3;

FIG. 10 is a perspective view showing two units in one mode of mutual assembly, as in the course of making a truss;

FIG. 11 is a like perspective view showing three units in assembly, i.e. as by the addition of another unit to the arrangement of FIG. 10;

FIG. 12 is a perspective view showing a multiplicity of units in assembled form, constituting a fragment of a truss, this view showing also the application of certain supplemental connectors at points of rib intersection in one face of the truss;

FIG. 13 is a plan view, as if looking down from above, of the fragmentary assembly of FIG. 12;

FIGS. 14 and 15 are transverse sections, as if on line **15—15** of FIG. 10, showing respectively the partial and completed integration of flaps of the oblique rib constituted at a locality or intersection of two units;

FIG. 16 is a view similar to FIG. 15, as if on line **16—16** of FIG. 11, showing the integration of rib-forming flaps at a locality where the end of one unit abuts an intermediate region of another unit;

FIG. 17 is a view similar to FIG. 16 showing the integration of flaps and associated reinforcing elements at a locality where the ends of four units may meet in a truss assembly;

FIG. 18 is a perspective, fragmentary, partly exploded view showing the relation of four units and supplementary reinforcement therefor, at an intersection as illustrated in FIG. 17;

FIG. 19 is a plan-type diagram illustrating one manner in which a large multiplicity of units may be assembled in truss-forming relation, i.e. as a larger truss fragment which may be continued to provide a truss of any desired dimensions;

FIG. 20 is a plan view similar to FIG. 1, of another form of board unit;

FIG. 21 is an end view of the unit of FIG. 20, similar to FIG. 7, showing the folding of the flaps along the top edge;

FIG. 22 is a view like FIG. 16, at a similar joining locality, with units as in FIG. 20; and

FIG. 23 is a view similar to FIG. 17, showing attachment of the ends of four of the units of FIG. 20.

By way of introduction, reference is first made to FIGS. 12 and 13 as showing the fundamental scheme of the octa-tetra truss. It will be readily seen that the rib-like portions (more fully described below) are in effect arranged to define an array of octahedra **30** in a regular pattern extending horizontally, with intermediate tetrahedra **31** having bases in the upper surface of the truss and further intermediate tetrahedra **32** having bases in the lower suface of the truss, the entire configuration being such that each face of the assembly constitutes a grid of equilateral triangles in regular abutment. Pursuant to the invention, the arrangement shown is an assembly of preformed units, conveniently made of paperboard or the like, each of which provides a plurality of structural ribs. This form of truss is suitable for spanning relatively large areas, e.g. of the order of 40 by 100 feet or more, and has good inherent properties of strength and rigidity.

As will be appreciated, the invention and its principles are believed to be fully demonstrated by portions of such a truss as shown in the drawings, the illustrated features being simply continued and duplicated over the desired horizontal area for a larger or more complete truss that may rest on appropriate bearing walls or equivalent supports at its peripheral regions. Inasmuch as the scale of any representation, in the drawings, of such extended truss would preclude showing anything therein beyond mere outlines, such illustration has been deemed unnecessary, it being nevertheless understood that the invention extends to and includes large truss assemblies which in all portions may be essentially as shown in the views of FIGS. 12 and 13.

Referring now to FIGS. 1 to 9 and initially to FIG. 1, one form of unit, here illustrated, is a single piece of board pre-cut in the general shape of a parallelogram having short sides **35, 36** and long sides generally indicated at the lines **37, 38,** with appropriate flap structure projecting from the long sides as explained below. Inasmuch as the preferred octa-tetra truss assembly is to involve the configurations of a regular octahedron and a regular tetrahedron having faces constituted by equilateral triangles, the angles **39** and **40** at two corners of the parallelogram are 60°, while the angles **41** and **42** at the other corners are 120°. As shown, the unit may be considered to include five alternating oblique portions **44, 45, 46, 47** and **48**, the first and last of which lie along the short sides **35** and **36** respectively, and which serve to define, in effect, four equilateral triangles (in successive, reversely juxtaposed arrangement) with two aligned bases **50, 51** in the upper long side **37** of the parallelogram and the other two bases **52, 53** aligned in the lower side **38**. The central regions of these triangular areas, for example the area defined by portions **44, 45** and base **52**, are conveniently cut away by reason of the arrangement of flaps along the sides as described below, although it will be understood that the open nature of these regions has generally no significance in the ultimate truss assembly, except for convenience in the various manual operations of construction utilizing the units.

Flap means are provided along the long sides of the parallelogram, which may be folded into polygonal section to constitute ribs in the portions that will lie in upper and lower faces of the truss. It may be noted that in FIG. 1 solid lines represent cut, i.e., fully severed boundaries in the piece of board, whereas dash lines are pre-creased areas, along which flaps are to be folded. While other arrangements of flaps may be employed, FIG. 1 shows four successively adjacent flaps **61**, **62**, **63** and **64** along the base line **51** (of one triangle) that constitutes one-half of the upper long side of the device, these flaps being an integral portion of the board and being defined by a crease line **65** between flaps **61** and **62**, a like crease line **66** between flap portions **62** and **63**, a similar crease line **67** between portions **63** and **64** and crease lines **68** between flap portion **64** and the oblique portions **47**, **48**.

Identical flap portions represented by corresponding reference numbers **61***a*, **62***a*, **63***a* and **64***a* are provided at the base line **50** in the other half of the upper long side **37**, with identical crease lines **65***a* to **68***a* inclusive. A duplication of these flap assemblies is also conveniently provided along the other long side of the device, e.g., at the bases **52**, **53** of the two lower triangles, the portions of these flap assemblies being represented by further corresponding reference numbers such as indicated by the outermost flap portions **61***b* (opposite base **62**) and **61***c* (opposite base **63**).

For ultimate conversion into oblique rib assemblies between faces of the truss, flap means are also provided lengthwise of the portions **44** to **48** inclusive of the unit, these being conveniently single flaps along the open regions of the defined triangles, although it will be understood that other and more complex flap structures may be provided, if desired, or indeed additional flap structures as at the sides **35**, **36**. The illustrated single flaps, however, are presently preferred as sufficient and conveniently simple. Thus flap **71** to be folded along a crease line **72** abuts the inner side of oblique portion **48**, while flap **73** having adjacent crease line **74** abuts the portion **47** at its side nearest the portion **48**, i.e., in the triangle constituted by portions **47**, **48** and the base **51**. Similarly flap **75**, with its crease line **76** and flap **77** with crease line **78** abut the adjacent edges of oblique portions **46** and **45** respectively, i.e., at the triangular area constituted by the latter portions and the base **50**. Like flap structures are provided for the other two triangular areas, having bases **52** and **53** respectively, viz. flap **71***a*, with crease line **72***a*, flap **73***a*, with crease line **74***a*, flap **75***a*, with crease line **76***a*, and flap **77***a*, with crease line **78***a*.

The ultimate assembly of the units into a truss will usually involve arrangements where the units intersect each other at intermediate localities, and to permit such intersection the device is provided with pre-cut slots or elongated notches **81**, **82**, **83**, respectively along the central lines of the oblique regions **47**, **46** and **45**. Thus the slot **81** extends from the corner of sides **36** and **38** at an angle of 60° half-way toward the mid-point of the side **37**, i.e., along a line which more or less precisely defines an equi-lateral triangle with the short side **36** and that half of the long side **37** which has been designated as the base **51** of such triangle. Similarly the slot **82** extends half-way from the side **37**, at its mid-point, obliquely toward the mid-point of the side **38**, again along a line defining, rather precisely, the equilateral triangle constituted by such line, the line of slot **81** and that portion of side **38** which has been designated as the base **53** of the triangle. Finally slot **83** extends from the mid-point of the side **38** toward the corner between short side **35** and side **37**, the extent of the slot being half the distance from the lower side **38** and the slope of the line being at an angle of 60° with each of the sides **35**, **37** and **38**. The line of this slot completes the definition of the two remaining equilateral triangles, the bases of which have been designated **50** and **52**.

The slots are such as to permit interlocking with like slots of identical units whereby such units may cross each other in the appropriate angular relation of 60° as required for the construction of the truss, each slot embracing the other unit along the uncut portion of the line along which the coacting slot of the other unit extends. Although by present preference the slots are pre-cut in the unit, it is conceived that the units may be made and shipped without them, leaving the slots to be cut where and as necessary at the time of assembling the truss.

The board piece indicated in FIG. 1 is conveniently made of double-faced corrugated board (for example, so-called B Flute corrugated paper), as indicated above, or other suitable material, and may have an appropriate coating, film or impregnation of plastic or like material having water-proofing or water-resistant effect, and also a lamination of metal foil, if desired, which may be such as to enhance the tensile strength. The several crease or score lines, as at **65**, **66**, **67**, **68**, **72**, **74** and elsewhere, are appropriately pre-indented or scored in the required surface of the board. For example, as seen in the view of FIG. 1, such score line may be an indentation on the side facing the viewer, if the ultimate fold is to be made by bending one portion toward the viewer. If the fold is to be made the other way, the score may be an elongated linear indentation on the opposite surface of the board. For convenience of representation, all of the crease or score lines are simply indicated by dash lines in FIG. 1, without regard to the particular face of the board in which they may appear, but the face to be selected for a given score will be readily apparent from the following description of the manner in which the several flaps are to be folded in use. Conversion of a piece of board to the article of FIG. 1 may be conveniently achieved by die stamping.

FIGS. 2 to 9 inclusive show the folding or bending of the several flap structures to complete the devices as a reinforced sub-assembly or unit, in preparation for association with other units in constructing the truss, FIG. 2 showing the various portions in partial course of folding and FIG. 3 illustrating the completed article, as also shown in the sectional or edgewise views of FIGS. 4 to 9.

The horizontal ribs are constituted by the flap structures along the long sides, for example as at **61** to **64** inclusive. While other flap structures and methods of folding or assembly may be employed, the arrangements shown here and in FIG. 20 (being a special feature of invention) are very effective, affording a resulting hollow rib of triangular cross-section having unusual strength and rigidity.

In particular, with reference to FIGS. 1 and 7, the part **63** (with associated parts **61** and **62**) may first be folded toward the viewer (FIG. 1) relative to the part **64**, and downward, until this portion approaches its ultimate position of overlying flatwise the part **64** (FIG. 7), while the part **61** is folded away from the viewer (as seen originally in FIG. 1, or toward the viewer as seen after part **63** has been folded fully downward), say preliminarily at a right angle to the part **62**, along the line **65**. The oblique flaps **71** and **73** are folded upward, toward the viewer, affording a large triangular opening beneath the indicated base line **51**. The flap **62** is also folded in the same direction as was flap **61** (i.e. away from the viewer when considered as seen in the original position of FIG. 1), relative to the flap **63** and along the line **66**, for instance preliminarily to a right angle. Thereupon the flap **64** is folded toward the viewer along the crease line **68** at the top of the portions **47** and **48** respectively (FIG. 7), carrying all of the other flap structure **63**–**62**–**61** with it, such other flap structure being thus swung around toward the viewer and downward (FIG. 1; see also FIG. 7). The flap **64** is further bent into a position sloping somewhat downwardly (FIG. 7), with the flap **63** now flatwise underlying it, folded back from the crease line **67** (now closest to the viewer, FIG. 3). At the same time, or previously, flaps

62 and 61 are bent into more acute angular relations to form with flap 63 an enclosed tube of triangular cross-section (FIG. 7). In completing these operations the flap portion 62, being the rear face of the triangular tube, is in effect pushed slightly through the upper part of the opening beneath the line 51. To allow these operations, flaps 71 and 73 may be temporarily bent flat back against regions 48 and 47, and to permit traversal of flap section 62 slightly through the opening, certain triangular corner pieces or projections 85, 86 at the ends of the section are defined by score lines as shown, so that they may be temporarily folded or bent. Thus the flap portion 62 is brought just to the rear of the board, in a position where the end projections 85, 86 may overlie the rear face, for example as will be apparent from the corresponding portions 85*c*, 86*c* at the bottom of FIG. 3.

The completed state of fold of the flap elements 61 to 64 will now be understood in FIGS. 7 and 8. The flap portion 64 extends forwardly and downwardly at a 60° angle to the face of the board, with the flap portion 63 extending against the underside of the flap 64, i.e. flatwise and thus at the same angle upwardly to the region of the fold line 68, which is the same as the base line 51 (see also FIG. 1). From the further edge (crease 66) of the flap portion 63, the portion 62 extends downwardly, in effect along the rear face of the board, with the end portions 85, 86 overlapping the rear surfaces of the portions 48 and 47 as explained above. The triangular cross-section of the hollow rib is completed by the flap 61 projecting forward and upward, again at an angle of 60°, so that its long edge meets the corner or fold line 67 between the flap portions 64 and 63. The flap portion 61 also preferably has triangular end regions 87, 88 projecting so that their sloping end edges will meet the top end edges of the flaps 71, 73 when the latter are folded into their intended place (being in effect a forward bend of 120° from their position of FIG. 1), where the latter respectively make angles of 60° with the adjacent board portions 48 and 47. If in the course of folding the upper flap sections it is found necessary at any time to have the portion 61 traverse the large triangular opening of the board, this may be facilitated by making the end projections 87 and 88 foldable temporarily, as indicated.

It will be understood that the flap sections 61*a* to 64*a* inclusive are similarly folded into a hollow triangular configuration, exactly as the flaps 61 to 64. Likewise a similar method of folding is carried out with both sets of lower flaps 61*b*, 61*c* and associated portions, the arrangement in the latter cases being such that the resulting triangular tube projects at the opposite face of the unit from the ribs fashioned at the top. These relations will be clear in FIGS. 7, 8 and 9, the result being that the uppermost and lowermost faces of the triangular-section ribs, e.g. as represented by the flap portions 64, 64*a* at the top and flap portions 64*b* and 64*c* at the bottom, lie parallel with each other and provide planes at angles of 60° with the general plane of the unit.

As indicated, the flaps 71, 73 are folded toward the viewer and likewise the flaps 75, 77, while the flaps 71*a*, 73*a*, 75*a* and 77*a* (of the lower pair of triangles) are folded reversely, i.e. away from the viewer in FIG. 1. These arrangements are all as illustrated in FIGS. 5 and 6.

The triangular box-like tubes or ribs (as at 61–64) along the upper and lower long sides of the unit may be secured in folded condition by any suitable means, such as means common to the construction or fastening of articles made of corrugated board. Thus long strips of gummed tape may be glued around each assembly, e.g. extending the entire length of each rib, as diagrammatically indicated at 90 in FIG. 8 or at 91 in FIG. 9. Alternatively, other strip or sheet material may be glued around these long faces, such as heavy fabric; or supplemental pieces of heavy paper, light board, fabric or the like may be stapled or otherwise fastened to the underlying structure, the sole requirement being that the folded triangular beam be held firmly together. For ease of illustration, the fastening means just described are omitted from FIG. 3, but will be readily apparent from the foregoing description and the illustration in FIGS. 8 and 9. In consequence, the unit, as shown in FIGS. 3 to 9 inclusive, is in effect fully prepared for assembly as a part of a truss, it being appreciated that these folding operations are essentially simple and can be performed at the time of construction. The pre-cut and pre-creased unit is thus most conveniently supplied to the builder as a flat element or blank, dimensioned with high accuracy, yet shaped and stored in a minimum of space.

The units for any desired type of roof or like construction may be of any standard size selected within a wide range of dimensions. Simply by way of example, for roofs having maximum spans of the order of say 25 to 100 feet, a useful range of unit sizes is such as to provide triangular areas (e.g. as defined by lines 36, 51 and 81 extended) having a side dimension of 3 to 3½ feet; one notably useful example of a standard unit, according to present understanding, is a board piece having a total long dimension, between its short edges (i.e. along lines 50 and 51) of 6 feet and a corresponding short oblique dimension (as along edge 35 between lines 50 and 52) of 3 feet.

The manner in which the prepared units are assembled to form the desired truss is shown in FIGS. 10 to 19 inclusive, the resulting assembly wherein the pieces are interfitted to constitute the octa-tetra configuration of ribs or connecting members being as illustrated, for instance, in FIGS. 12, 13, and 19. In essence the assembly consists of three sets of parallel rows of the units, with the units in effect abutted endwise in each row, and with the three sets of rows mutually intersecting each other at angles of 60° at apexes of the triangles constituted within the units. The assembly is further such that the top and bottom sides of the units respectively lie in upper and lower faces of the resulting truss, while the units themselves are disposed obliquely, i.e. at 60° angles to the planes of such faces. It will be seen that in this fashion, the defined triangles of the units serve to define those triangular faces of the octahedra and tetrahedra which lie between the upper and lower faces of the truss, while the triangular bases of the octahedra and tetrahedra which lie in the planes of the upper and lower faces are each defined by three rib structures of corresponding, adjoining or intersecting units (respectively in one row each, of the three sets of rows), i.e. rib structures of the long edges as constituted for example, by the flap assembly 61–64 in FIGS. 3 to 9.

In setting up the truss, successive units are simply fitted or joined together, in a progressive manner and in accordance with the defined three-row pattern, until the desired area has been filled, it being appreciated that when the truss is erected in place, as above appropriate bearing walls or the like, a light temporary scaffolding can be employed to support the units until the entirety has been completed. Alternatively, the truss can be assembled on the ground and raised into place when completed. At some localities the units cross and interlock by utilization of the slots 81, 82 or 83, whereas at other and usually the greater number of localities, the end of one unit abuts a side portion or end of another unit. As will be explained, means including the flap structures defined above are provided for securing the units together and establishing closed polygonal rib-like members which constitute the oblique connecting ribs.

In FIG. 10 there is shown the initial association of one unit with another, specifically unit 101 brought into interfitting relation with unit 102, by mutual cooperation of the slot 83 in unit 101 with slot 82 of unit 102, the latter slot being concealed in this view, but its position being recognized by the location of slots 83 and 81, in unit 102 and by comparison with FIG. 3. It will be seen at once that the two units intersect at an oblique angle, along obliquely transverse portions of the respective units, specifically the portion **45** of unit **101** and the portion **46** (see FIG. 3) of unit **102**. Furthermore, it will be noted that the upper faces **64**, **64***a* of the top ribs in the two units lie in a common plane, to which the bodies of the units are inclined at angles of 60°, it being further appreciated that the lower faces of the bottom ribs of the units likewise lie in a common plane parallel to the upper one.

With the units thus interlocked along selected transverse regions, the adjacent flaps of such regions are brought into overlapping relation to constitute elongated hollow members of triangular cross-section, joining the units and providing one of the required rib or connector structures between the top and bottom faces of the truss. FIGS. 14 and 15, being taken perpendicularly to the region of intersection in FIG. 10, further show the mode of overlap of the flaps. In FIG. 14 the units have been brought together in the above-described manner, so that flaps **75** and **75***a* project from the transverse portion **46** of unit **102**, while flaps **77** and **73***a* project from the transverse portion **45** of unit **101**. Thereupon flaps **75** and **77** are folded inward and brought together in full overlapping relation, as shown in FIG. 15 (and partly so, in FIG. 10), the same folding and lapping being effected with flaps **73***a* and **75***a*. As further seen in FIG. 10, with respect to one side of the device, the result is an elongated tubular structure of triangular cross-section at each side of the region of intersection. To fasten these parts, appropriate strips of gummed tape may be applied, as indicated at **103**, **104** in FIG. 15, thus sealing the structure together and in place, i.e. over the flap **77** and an adjacent part of the portion **46**, and likewise over the flap **75***a* and an adjacent part of the portion **45**. Alternative fastening means are also appropriate, as explained above relative to the securing of the top and bottom rib structures (FIGS. 3, 8 and 9).

To continue the assembly of the truss, further units are added. For instance, in FIG. 11, the above-described assembly of units **102** and **101** is extended by the addition of unit **106**, crossing unit **101** and having one end adjacent the unit **102**, this third unit being disposed in a third angular relation, whereby there are now units extending in three directions, at angles of 60° to each other. As will be apparent by comparing unit **106** with FIG. 3, this unit crosses unit **101** by mutual association of slot **82** in the latter and slot **81** in unit **106**. The mutual fastening and rib construction along this line of intersection is the same as shown and described relative to the intersection of units **101** and **102**, e.g. as in FIGS. 14 and 15. Unit **106** also engages unit **102**, i.e. along the side edge **36** of the former and the region **45** of the latter, specifically along the line which is in effect defined by slot **83** in the latter.

FIG. 16 illustrates one manner in which the connection between unit **106** and **102** is effected, i.e. by overlap of the flaps **71** of unit **106** and **77** of unit **102**. Appropriate sealing or fastening means, such as the gummed tape indicated in dotted lines **108** in FIG. 16 is employed to secure the assembly. While only a single triangular rib is afforded by this arrangement, ample strength and security of connection is nevertheless achieved, it being appreciated that in further construction of the truss, an additional unit will be used extending in line with the unit **106**, but on the other side of unit **102**. Such further connection will embrace utilization of the flap **73***a* to coact with the appropriate flap of the further unit (not shown in this view) for joining the parts and establishing an additional rib structure of triangular cross-section.

FIGS. 12 and 13 show a truss construction of a further degree of elaboration, i.e. a truss portion or fragment having more units, the mode of assembly being by intersection and abutment, as necessary, in the general manner explained above, the intersection being achieved by reason of the interfitting slots. At the several localities of intersection or abutment, the joining and completion of the necessary ribs is attained as described, e.g. as illustrated in FIGS. 14, 15 and 16. It will be apparent that there are now three sets of parallel rows of units, each obliquely disposed, at 60° angles relative to the upper and lower surfaces of the truss, and the sets of rows are mutually disposed at angles of 60° to each other, i.e. as considered from the lines of their upper or lower rib-forming structures in the respective upper or lower surfaces of the assembly. Thus specifically, there are the rows **110**, **111** parallel to each other, rows **112**, **113** and **114** likewise parallel to each other and intersecting the first pair of rows, and finally, rows **115**, **116** and **117**, again parallel to each other and crossing both of the other sets of rows. At localities of intersection or abutment the rib-forming structures are completed, with the consequence of a rigid unified structure having a high degree of strength. As preliminarily explained, the result is a desired octa-tetra configuration, involving the array of octahedra **30** and corresponding arrays of respectively reversely disposed tetrahedra **31** and **32**.

For more complete security, supplemental connector pieces in the nature of flat members **120**, **121** are preferably applied to the localities of rib intersection or joining in each of the upper and lower surfaces of the truss. These, as shown, may be flat pieces of board or like material, similar to or different from the material of the units, and are glued or otherwise appropriately secured in place to and upon the upper surface of the ribs at each juncture. While these pieces may be of other shapes, such as square, hexagonal or the like, those shown in FIG. 12 are conveniently of triangular configuration and may have coacting flaps as at **123**, **124**, **125** which are folded downwardly and may be fastened to the sides of abutting rib structures. In general, the flap members and their associated parts may be simply glued in place, or as stated, fastened in other appropriate fashion. As seen, the element **121** is shown installed, while element **120** is illustrated in exploded relation to clarify the manner of applying these parts.

In FIGS. 12 and 13 rows **112**, **113** and **114** each consist of a single unit, as likewise each of rows **115**, **116** and **117**. Row **111** consists of two units **111***a* and **111***b* while row **110** consists of a single unit **110***a* and a partial unit **110***p*, the latter consisting of essentially one-half of a single unit, for example by severing the unit of FIG. 1 along an oblique line constituted in part by the slot **82**. It will be understood that in constructing a complete roof or ceiling truss partial units of this character can be usefully employed to fill out the assembly at peripheral regions, being secured in place in the same general manner as the complete units. Indeed partial units, in effect shaped to define less than four, e.g. two, reversely juxtaposed triangular areas may sometimes have utility in other portions of the truss assembly.

The preferred configuration of folded flap structure along the long parallel edges of the board units is such that each of the resulting rib elements has one side that lies in the corresponding plane or surface of the assembled truss. Thus referring to FIGS. 3 to 9 inclusive, it will be noted that surfaces such as indicated at **64**, **64***c* of the triangular rib sections lie at angles of 60° to the plane or body of the unit, and that in consequence when the unit is disposed at a like angle of 60° (relative to the upper and lower truss faces) the stated upper and lower sides of the triangular rib sections are coplanar with the truss faces. This arrangement facilitates the application of reinforcing pieces such as indicated at **120**, **121** in FIG. 12, and also facilitates covering the completed truss with appropriate flexible, rigid, semi-rigid or other material, e.g. fabric or plastic sheet, water-proofed paperboard, composition board, roofing sheet, or the like, as indicated in exploded form at **130**.

Thus a simple manner of completing a building with the described truss as the essential roof assembly, is merely to apply a covering of sheet material **130** to the entire upper surface, either as a single piece or as overlapping strips or pieces or in other suitable arrangement, such material being conveniently secured to the exposed faces **64** and the like of the ribs. Of course, similar flexible or rigid sheet structure may also be applied to the lower or under surface of the truss, as by adhesive or other attachment, if it is desired to have a finished ceiling for the building enclosure.

In the truss assembly, as indicated above, all of the units are inclined at 60° angles to the effective planes of the upper and lower truss surfaces, so that the connecting rib structures, e.g. as shown in FIGS. 15 and 16, constitute the bounding oblique corners of the octahedra and tetrahedra. As also apparent, each of the upper and lower faces is in the form of a grid of obliquely angled figures, specifically equilateral triangles arranged in a regular pattern and defined by the rib elements along the upper edges of the three sets of parallel rows of the units.

Although at some localities of a given truss two units may intersect at intermediate regions of each so that their respective oblique slots interlock and the resulting assembly is as shown in FIGS. 14 and 15, and although at other regions there may be one or two units terminating adjacent an intermediate region of another unit (at the locality of intersection of the rows) as in FIG. 16, there may be situations where the intersection of two rows occurs at the ends of units in both rows. Such circumstance is illustrated in FIGS. 17 and 18 where units **131**, **132** lie in one row and units **133** and **134** in another row. Here it will be seen that the flaps **135** and **136** of the units **131** and **133** respectively can be overlapped into triangular configuration, and likewise the flaps **137** and **138** of the units **134** and **132** respectively, with appropriate sealing tapes or the like for fastening as at **139**, **140**, but further reinforcement and attachment may be desirable at such locality.

For this purpose, especially if the assembly of units requires numerous intersections of this nature, it is preferable to provide supplemental flaps at the oblique sides of each unit as described hereinbelow. Alternatively, for example, supplemental pieces of board **142**, **144**, may be used, elongated and centrally creased, to be bent at an angle of 120°. Such pieces may be fastened to the faces of the end oblique portions of the units, by gluing or stapling, or otherwise. For example, reinforcing piece **142** is thus secured with its wings flatwise attached to the end oblique portions **145**, **146** of the units **133**, **132** respectively. This arrangement completes a double rib structure at the defined locality, affording the desired strength and rigidity of a transverse element in the truss.

As will be apparent, the preferred structures of the invention, including units each defining in effect a plurality of reversely juxtaposed equilateral triangles, involve intersections of the rows of units at 60° slopes and at 60° angles of their face-forming ribs. At each oblique line of intersection, there are two rows crossing each other, but no more. Hence the defined flap means, e.g. as indicated in FIGS. 1 to 9, or in the further preferred examples of FIGS. 20 to 23 (described below), readily coact to provide the desired oblique or connecting rib structures, with provision for mutual connection of the quadrilateral units in various ways as set forth herein.

Whereas FIGS. 12 and 13 illustrate only a fragment of a complete truss, it will be readily apparent that by addition of further units, and indeed a large number of them, similarly arranged and interfitted, an area of any desired size may be covered. At the periphery of the entire structure, there will be a series of projecting triangular configurations, e.g. as at **150**, which may if desired be joined by fragments of units in any convenient fashion.

The bearing walls (not shown) for the periphery of the truss can have appropriate width to support a row of triangular faces, or indeed a single row of ribs, or alternatively may have a supporting plate or capital structure of rigid board or plate-like material (not shown), upon which the truss may rest. Inasmuch as these features of construction should be self-evident and are not a basic part of the invention, illustration of same is omitted from the present drawings.

As further illustration of various ways of assembling the units in trusses of extended area, FIG. 19 is a diagram of such assembly, further units being readily added to cover an area of any desired magnitude. In this figure the units are shown as simple parallelograms, and indeed wtih some dimensional and positional distortion, particularly in making most of the units a little shorter than their actual, standard size, and also in slightly displacing the interfiitting slots, so as to distinguish the individual elements more clearly.

In each unit the solid line represents the upper edge for this plan-type view, the remainder of the unit being outlined with broken lines, and having a contour as if viewed downwardly, each unit being seen at an angle of 60° to the plane of the drawing, such being also the plane of the upper surface of the truss. As previously explained, there are three sets of parallel rows of units: e.g. rows generally designated **160** and specifically ***160a***, ***160b***, ***160c***, ***160d*** and ***160e***; rows **161**, specifically marked ***161a*** to ***161f*** inclusive; and rows **162**, specifically marked ***162a*** to ***162g*** inclusive. The side and lower boundaries of the elements in rows **160** are defined by simple dash lines, those in rows **161** by dash and triple dot lines and those in rows **162** by dash and single dot lines, whereby the locations of all the several units may be readily identified.

In assembling the structure, the units are successively put in place in one or another of the defined rows, with appropriate intersecting or abutting relation to the units of crossing rows, and with endwise abutment to the adjoining units of the same row. For simplicity, the slots of the intermediate oblique portions of the units are only shown at those localities where there is actual interlock or interfitting with a similar slot of another unit. For example, the unit **165** in row ***160a*** crosses unit **166** of row ***161b*** and unit **167** of row ***162f***, the slotted areas of unit **165** coacting with corresponding areas of units **166**, **167** along the lines **168**, **169** respectively, it being further noted that the slots in the unit **165** are identified by dash lines, the coacting slot of unit **166** by a dash and triple dot line and that of unit **167** by a dash and single dot line. Other examples of units intersecting by virtue of the slotted construction will be apparent throughout the figure, as for instance between unit **170** in row ***160b*** and units **171**, **172** and **173** in rows ***161a***, ***162d*** and ***161b*** respectively. Likewise unit **175** in row ***160d*** intersects units **176** and **177** in the respective rows ***162e*** and ***162f***. For distinction from terminal edges of units in this diagram, the lines representing localities of interfitting slots are each designated by the symbol of a pair of short transverse lines, i.e. to symbolize the ends of the respective slots.

At many localities, the end of one unit abuts an intermediate region of a unit in a crossing row, as for example where units **180** and **181** in row ***162f*** meet a transverse portion of unit **182** in row ***161d***. At some localities convenience of assembly may dictate that four units of two intersecting rows terminate at the line of intersection, one such example being at the crossing region between rows ***160d*** and ***161d***. Here units **184** and **175** of row ***160d*** meet endwise along the oblique connecting line where units **185** and **186** of row ***161d*** likewise meet at the same line.

The actual structure of individual units is, as explained, omitted in the diagram of FIG. 19, but it will be understood that each may be characterized by rib-forming parts of the nature shown in other views, and that connection or interconnection of units along the defined oblique lines of crossing of the rows may be effectuated as has been set forth hereinabove, or as in further examples described below. The scheme shown in FIG. 19, or similar modes of relating the units to each other, may be continued to provide a truss of any desired shape and size, e.g. having an essentially rectangular outline, or having a peripheral contour of other character, as circular, hexagonal or the like, or indeed of non-symmetrisal shape, whatever the requirements of the roof or other building use may ditcate.

A modified and presently preferred form of unit **200** is shown in FIGS. 20 and 23 inclusive, and is designed to constitute three rather than four equilateral triangular areas **201**, **202** and **203** which are reversely juxtaposed in a manner generally similar to FIG. 1. Thus the device of FIG. 20 has primarily the shape of a trapezoid with one parallel side constituted by the bases **205** and **204** of the triangles **201**, **203**, while the other, shorter parallel side is the base **206** of the triangle **202**. The oblique sections joining the parallel edges are provided with interior flaps generally designated **208** and corresponding to the flaps **71**, **73**, etc. in FIG. 1, with like function and effect in ultimate assembly of a truss structure.

The rib-forming flap structures **210**, **211** and **212** at the parallel sides respectively corresponding to the triangle bases **206**, **205** and **204**, are modified by including a fifth flap. Thus for example, the flap assembly **210** includes flap sections, all parallel to the line **206**, respectively designated in sequence from the outermost downward as flaps **214**, **215**, **216**, **217** and **218**. As explained in connection with parts **85** to **88** inclusive of FIG. 1, flaps **215** to **217** inclusive may include small triangular end portions as shown at **220**, **221** and **222**, which are temporarily foldable for convenience in assembling the parts into the triangular tube configuration of the rib.

FIG. 21 illustrates diagrammatically the manner of folding the five-flap assembly into the rib structure, it being noted that the arrangement is similar to the four-flap assembly of FIG. 7, except that the outermost or fifth flap is arranged to overlie the top or uppermost face of the triangular tube as seen in these views. Thus specifically the ultimate configuration is such that flap **218** is folded forward at a 60° angle to the main body of the unit **200**, with the next flap **217**, folded rearwardly and flatwise under the flap **218**. The next outer flap **216** is folded downward, in the plane of the unit, from a line essentially located at the upper edge boundary **206**. The flap **215** is then folded upward and forwardly, i.e., toward the outer corner that joins flaps **217** and **218**, while the fifth or outermost flap **214** is folded rearwardly to overlie the flap **218**. The entire assembly is then sealed as with adhesive tape or other means in the manner explained above, affording a rigid and relatively strong rib structure, even further reinforced as compared with the arrangements in FIGS. 1, 3 and 7.

As indicated by way of alternative in reference to other embodiments above, the unit may, and in FIG. 20 does, include supplemental flap structure along the side or lateral oblique edges. Thus along the edge line **224** there is flap structure consisting of portions **225** and **226** separated by a slot **227**, each of these elements covering one-half of the edge **224** and being dimensioned, lengthwise of the edge, to fit within an oblique slot of another unit, i.e., such as one of the other of slots **228** and **229** that are cut in the intermediate oblique portions **230** and **231** in similar fashion to the slots **81**, **82** and **83** of FIG. 1. A like pair of endwise adjacent flaps **232** and **233** are carried by the opposite oblique edge region **234** of the unit and similarly separated by a short slot **235**.

It will be readily appreciated that the assembly of units, such as shown in FIG. 20, into a complete truss is achieved in basically the same fashion as explained above regarding the units of FIG. 1, especially in that the design is such as to provide rib assemblies bounding equilateral triangles, both in the units themselves and as the units are aligned and joined in three sets of parallel rows. Where an intermediate oblique portion of one unit actually intersects a corresponding portion of another unit, mutual attachment and construction of a rib assembly is achieved exactly as shown in FIGS. 10, 14 and 15. The oblique slots in the two units are respectively interlocked with the non-slotted portions of each other, along the slot lines, and the adjoining flaps **208**, corresponding to flaps **75**, **77** and others in the earlier views, are overlapped and fastened to complete the oblique rib of the truss at the locality of intersection.

Where a lateral end of one unit (e.g., **224** or **234** of FIG. 20) abuts an intermediate, oblique portion of another unit, in a manner similar to the abutment illustrated in FIG. 16 and also shown at the locality of FIG. 11 to which FIG. 16 relates, the mutual attachment is effected as shown in FIG. 22. Here it will be understood, by comparison with FIGS. 11 and 16, that one end of one unit **200*a*** is arranged to meet an intermediate, oblique portion of another unit **200*b***, and the internal flaps **208*a***, **208*b*** of the adjoining parts of the units are overlapped in the same manner as flaps **71** and **77** in FIG. 16. The outer end flaps of the unit **200*a***, which may for example be flaps **233*a*** and **232*a*** (corresponding to similarly numbered parts in FIG. 20) are also utilized. Thus one of these flaps, for instance flap **233*a***, is passed through the oblique slot, e.g., slot **228*b*** of the unit **200*b***, and is folded to overlap an adjoining part of the oblique portion of unit **200*b***. Likewise the other flap, e.g., flap **232*a*** is folded to overlap another part of the same oblique portion (i.e., on the other side of the line of the slot **228*b***), all as clearly shown in FIG. 22. These supplemental flaps **233*a***, **232*a*** are secured to the faces of the unit **200*b*** in appropriate fashion, as by overlapping tape or preferably by direct adherence (using an adhesive) or with staples or like fastening elements. In consequence, a particularly strong and rigid connection is achieved.

For those regions of the truss assembly where the ends of four units come together, e.g. as explained above in connection with FIGS. 17 and 18, and as also illustrated in FIG. 19 at the juncture of units **184**, **175**, **185** and **186**, the provision of lateral end flaps in the unit **200** of FIG. 20, affords special cooperation to effectuate a secure attachment without supplemental reinforcing pieces. Thus in FIG. 23 (as will be understood by reference also to FIGS. 17, 18 and 19), two units **200*c*** and **200*d*** of one row meet endwise at the locality **240** and likewise units **200*e*** and **200*f*** of another row meet similarly endwise at the same locality **240**. As in the case of the flaps **135** to **138** of FIG. 17, the internal flaps **208*c*** and **208*e*** of units **200*c*** and **200*e*** are folded across each other, while flaps **208*f*** and **208*d*** of units **200*f*** and **200*d*** are similarly folded and overlapped (see the correspondingly numbered parts in FIG. 20), with these parts appropriately secured, as in the manner explained for FIGS. 15 through 17.

In addition, the adjacent set of end flaps of each unit is folded into abutment with a face of an end oblique portion of another unit, in order to complete the mutual joining of all four elements. For instance, end flaps **232*f***, **233*f*** of unit **200*f*** are folded into abutment with a face of the end oblique portion of unit **200*c***. Likewise end flaps **232*d***, **233*d*** of unit **200*d*** are folded to overlap a face of the end oblique portion of unit **200*f***. Similarly end flaps **225*e***, **224*e*** of unit **200*e*** are brought into overlapping relation to a face of the end oblique portion of unit **200*d***, while similar end flaps **225*c***, **224*c*** of unit **200*c*** are folded against a face of unit **200*e***. As thus shown in FIG. 23, there is an effective interconnection among all four units, the supplemental end flap sets being fastened in any of the ways described above, although preferably by adhesive attachment or like direct fastening means. The resulting assembly, i.e. at a locality where four units meet endwise, is firmly joined together, with a strong rib-forming structure constituted by the several described flaps and associated oblique body portions of the units.

The assembly of units **200** (FIG. 20) into a complete truss structure is accomplished in the same manner as illustrated in FIGS. 10 to 13 and in FIG. 19 (with special reference to the latter), and separate illustration of such assembly seems unnecessary. The elements are aligned endwise in three sets of parallel rows, the upper and lower edges of the sets of rows intersecting each other at 60° angles so as to provide the triangular grid configurations in the upper and lower faces of the truss. Inasmuch as the units **200** are constituted as assemblies of reversely juxtaposed equilateral triangles, like the unit of FIG. 1, the asembly of these units in the mutual configuration illustrated by FIG. 19 affords the desired octa-tetra truss. The ribs constituted in the upper and lower faces of the truss and the ribs or struts extending obliquely between such faces are fashioned in a similar way by folding and mutual attachment of the flaps of the respective units, and result in defining areas of octahedral and tetrahedral shape, in exactly the same regular array through the truss assembly.

The trapezoidal units **200** of FIG. 20 are presently believed to afford greater ease of assembly into a desired truss structure, e.g. as compared with the units of FIG. 1, although the latter are quite satisfactory for use in making up the described trusses. It will be understood, of course, that units of both types may be employed in a single truss assembly, inasmuch as all intersections and localities of meeting are effected along the same kind of 60°, oblique lines, but in many cases convenience of manufacture is served by providing only one type of unit.

In all cases of truss assemblies as described hereinabove, the resulting structure is not only securely interlocked, but effectively reinforced by the rib-forming portions, both horizontally and in the oblique connecting areas, to serve the principles of octa-tetra truss design. By the employment of units embracing at least a plurality of triangular areas, simplicity of construction is achieved, and ease of assembly, all without the need of making separate connections among individual rib sections or lengths and without special joint elements as usually required for such connections.

As in the example of FIG. 1, unit **200** of FIG. 20 may be dimensioned to suit the requirements of use, within a rather wide range of sizes. For instance, one appropriate embodiment of unit **200** to be employed for roof trusses of considerable area, may have one edge length **206** of 3 to 3½ feet, an opposite parallel edge length **205–204** of 6 to 7 feet, and correspondingly side edge lengths **224** and **234** of 3 to 3½ feet. These units can be employed with either parallel edge uppermost in the assembled truss; indeed (as with the units of FIG. 1 and the structure of FIG. 19), convenience of assembly will usually dictate the employment of some units with the short edge uppermost and of some units with the long edge at the top.

Although the principles of the units as herein described may be usefully applied to elements of material other than foldable board, i.e. other than stiff foldable sheet (alternatives being, for instance, preformed, ribbed elements of other appropriate materials such as fully rigid substances, and even cast plate-like units of metal or plastic), there are very special advantages in the foldable board construction. The latter type of element is conveniently made as a flat piece (whether corrugated paperboard, or metal or the like) and may be so shaped and stored, yet the operations of folding and securing, e.g. as to the various flap means, are easily performed as and when the units are employed in building a truss. The paperboard or like material can be very inexpensive, and the manufacturing operations likewise, yet the final structure is effective, and indeed is characterized by great facility of assembly.

In many cases, it will be desirable to coat or impregnate the material of the units with suitable water-proofing or water-resistant substances, e.g., where corrugated board or similar paper structure is utilized. As alternative to original coating or impregnation, such treatment can be applied, if desired, to the finished truss, for instance by spraying. One presently preferred type of board is, as indicated above, double-faced corrugated paper, e.g., constituted of two sheets of heavy kraft or other paper or board joined by an intermediate layer of board in corrugated configuration. As apparent, the entire structure is very light, yet it is fully strong enough to span relatively broad areas, and to carry necessary loads, such as heavy snowfall or other expected roof loading.

It is to be understood that the invention is not limited to the specific forms of devices herein shown and described, but may be carried out in other ways without departure from its spirit.

I claim:

1. An octa-tetra truss composed of a multiplicity of structural units, each unit comprising structure defining a plurality of reversely juxtaposed, coplanar triangular areas, arranged so that the bases of the triangular areas lie in respectively opposite parallel edges of the unit, said triangular areas being defined by structural portions in each unit extending obliquely between the parallel edges, said units being engaged with each other along said oblique portions, and being arranged in a plurality of sets of parallel rows, each row consisting of endwise successive units disposed obliquely between the upper and lower faces of the truss, with the parallel edges of each unit respectively lying in said faces, and the aforesaid sets of rows being arranged to intersect each other along oblique portions of the units so that the parallel edges of the units define obliquely-angled grid patterns in the faces of the truss.

2. An octa-tetra truss composed of a multiplicity of structural units, each unit comprising structure defining a plurality of reversely juxtaposed, coplanar equilateral triangular areas, arranged so that the bases of the triangular areas lie in respectively opposite parallel edges of the unit, said triangular areas being defined by structural portions in each unit extending obliquely between the parallel edges, said units being engaged with each other along said oblique portions, and being arranged in three sets of parallel rows, each row consisting of endwise successive units disposed obliquely between the upper and lower faces of the truss, with the parallel edges of each unit respectively lying in said faces, and the three sets of rows being arranged to intersect each other along the oblique portions of the units so that the parallel edges of the units intersect at angles of 60° to define triangular grid patterns in the faces of the truss.

3. A truss as defined in claim **2**, in which each unit comprises a piece of stiff foldable sheet having flap means along each parallel edge folded into angular cross-section to constitute rib structure for the truss, each of said oblique portions including flap means folded into angular cross-section in coaction with the oblique portion of another unit engaged therewith, to constitute connecting rib structure of the truss.

4. A truss as defined in claim **3**, in which the folded flap means along each edge has a triangular cross-section having one side coplanar with the face of the truss in which such edge lies, and in which the coacting flap means of the engaging oblique portions are arranged in overlapping relation to constitute, with said last-mentioned portions, rib structure of triangular cross-section.

5. An octa-tetra truss composed of a multiplicity of structural units, each unit comprising a piece of stiff foldable sheet, of quadrilateral contour, defining a plurality of reversely juxtaposed, coplanar triangular areas, arranged so that the bases of the triangular areas lie in respectively opposite parallel edges of the unit, flap means along each of said edges folded into rib-forming configuration, said

triangular areas being defined by structural portions in each unit extending obliquely between the parallel edges, said units being engaged with each other along said oblique portions, flap means constituted along the oblique portion of at least one unit at each locality of engagement, said last-mentioned flap means being folded in rib-forming configuration for coaction with the oblique portion of the other unit at such locality to constitute a connecting rib of the truss, said units being arranged in three sets of parallel rows, each row consisting of endwise successive units disposed obliquely between the upper and lower faces of the truss, with the parallel edges of each unit respectively lying in said faces, and the three sets of rows being arranged to intersect each other along the oblique portions of the units so that oblique connecting ribs are formed at each place of intersection and so that the ribs constituted in the parallel edges of the units define triangular grid patterns in the faces of the truss.

6. A truss as defined in claim **5**, in which each unit is shaped to define at least three reversely juxtaposed, equilateral triangular areas arranged so that the bases of two triangles lie in one edge and the bases of at least one other triangle lie in the other edge of the unit, each of the oblique portions of each unit having flap means folded into rib-forming configuration in coaction with an oblique portion and its flap means of one other unit at the locality of engagement of the last-mentioned two units.

7. A truss as defined in claim **6**, in which a plurality of units in each row respectively intersect a plurality of other units of another row along respective oblique portions, said last-mentioned portions at each intersection having slots respectively along complementary portions of their lengths, arranged in mutually interfitting relation at the place of intersection.

8. A structural element for assembly with like elements to form an octa-tetra truss, comprising a piece of stiff foldable sheet having a pair of parallel opposite edge portions one of which is provided with two endwise aligned sets of flap parts foldable into polygonal cross-section to constitute, respectively, two endwise aligned rib structures for one face of the truss, the other of said edge portions having one set of flap parts foldable into polygonal cross-section to constitute a rib structure for the other face of the truss, said piece having transverse portions extending obliquely between said edge portions to define a plurality of reversely juxtaposed triangular areas such that each set of rib-forming flap parts of an edge portion has a triangular area with its base adjacent thereto, said transverse portions having rib-forming flap structure foldable along lines lengthwise of said portions, and each of said transverse portions being constructed and arranged to fit with an oblique transverse portion of another element to constitute therewith a transverse rib of the truss.

9. A structural element as defined in claim **8**, wherein the transverse portions include outer portions each having a pair of endwise-aligned flaps foldable for rib-forming coaction with transverse portions of other elements, and wherein the remaining transverse portions of the defined element extend in successively opposite oblique directions from one of the first edge portions to the other, each of said remaining transverse portions having a slot opening at one of said first-mentioned edge portions and adapted to interfit with a like slot of another element.

10. A structural element for assembly with like elements to form an octa-tetra truss which has upper and lower faces wherein the edges of the elements collectively define a grid consisting of triangles having sides of equal predetermined length, comprising a unit having a pair of parallel edges and shaped to define a plurality of reversely juxtaposed, coplanar triangular areas, arranged so that bases of adjacent triangles lie in opposite parallel edges of the unit and are dimensioned to constitute sides of the first-mentioned triangles of the surface grids of the truss, said unit having a quadrilateral contour which extends around the perimeter of the juxtaposed triangles and includes the aforesaid parallel edges, and has side edges joining the parallel edges, said unit having intermediate oblique portions defining intermediate sides of the juxtaposed triangular areas, and said intermediate portions having slots adapted to interfit with like slots of similar units.

11. A structural element for assembly with like elements to form an octa-tetra truss, comprising a unit having structure defining three successively reversely juxtaposed, coplanar triangular areas each consisting of an equilateral triangle, said areas being arranged so that the bases of two triangles constitute one horizontal edge of the unit and the base of the other triangle constitutes the other horizontal edge of the unit, parallel to the first-named edge, said triangular areas being defined by structural portions extending obliquely between said parallel edges, including portions which constitute outer lateral edges of the unit and portions which constitute intermediate oblique connections, the portions constituting said intermediate oblique connections being slotted to be capable of interfitting with like slotted portions of similar elements.

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