

United States Patent

Wilson

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[45] May 9, 1972

[54] PREFABRICATED MODULAR BUILDING

[72] Inventor: Pryce Wilson, 2812 D. Street, Sacramento, Calif. 95816

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[21] Appl. No.: 12,173

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 671,707, Sept. 29, 1967.

[52] U.S. Cl. 52/81, 52/90, 52/595

[51] Int. Cl. E04b 1/32, E04b 17/02

[58] Field of Search.....52/593, 595, 92, 90, 81, 586, 52/82

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[57] ABSTRACT

A prefabricated modular building made from a plurality of panel members having the shape of an equilateral triangle and identical dimensions; and means for detachably fastening said panels together to form a building.

9 Claims, 20 Drawing Figures

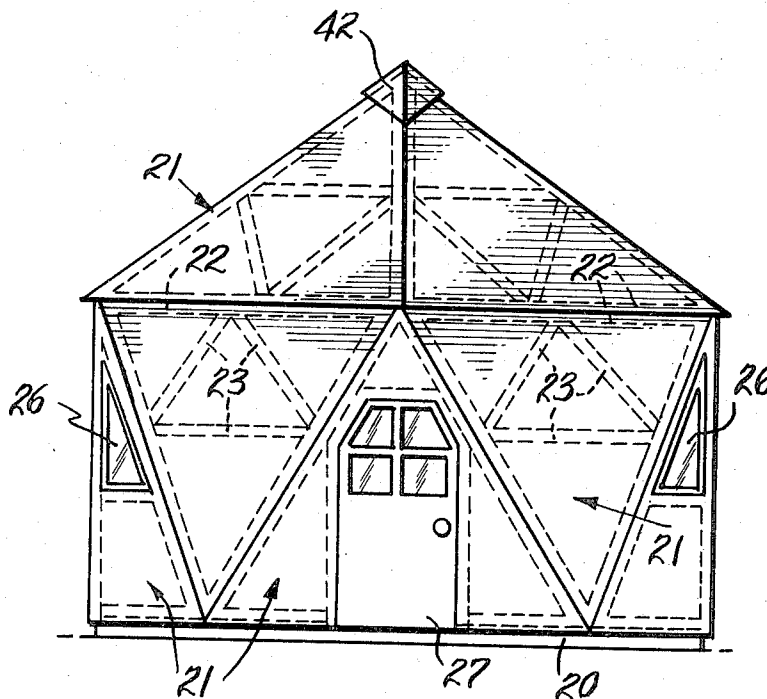


Fig. 1.

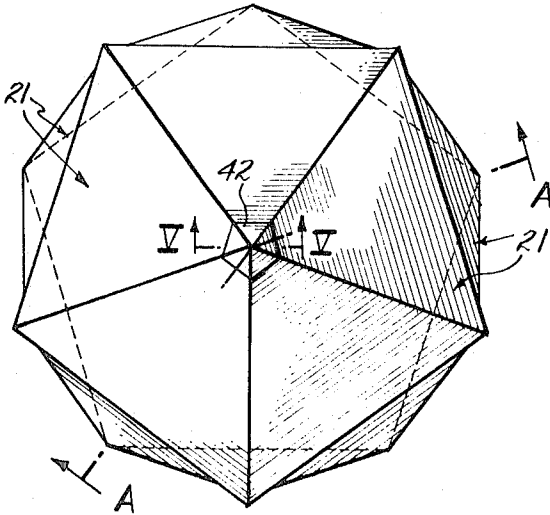


Fig. 4.

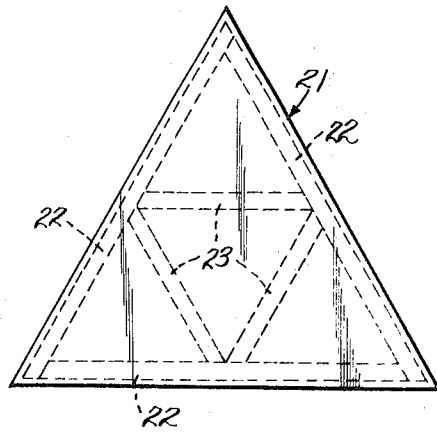


Fig. 2.

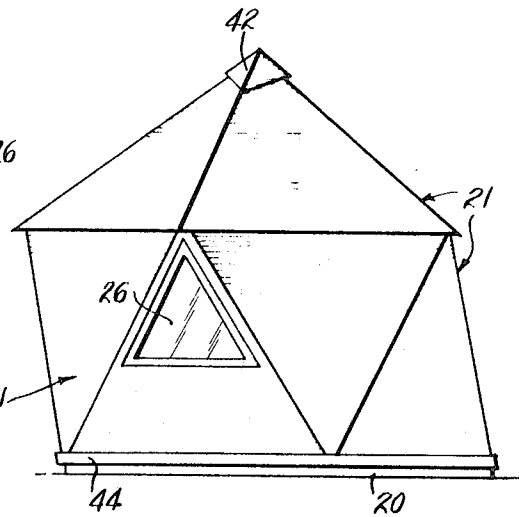
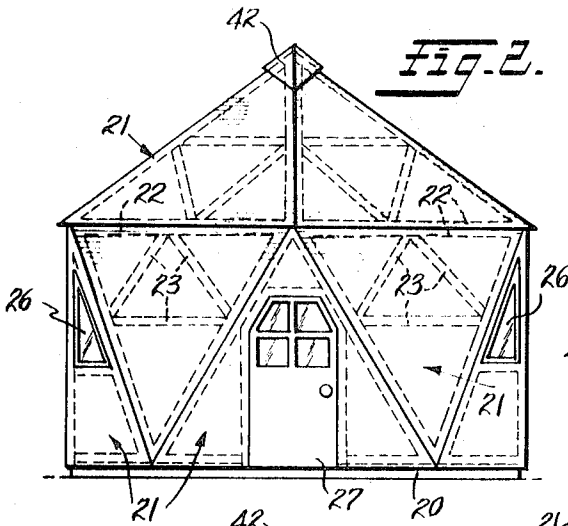


Fig. 3.

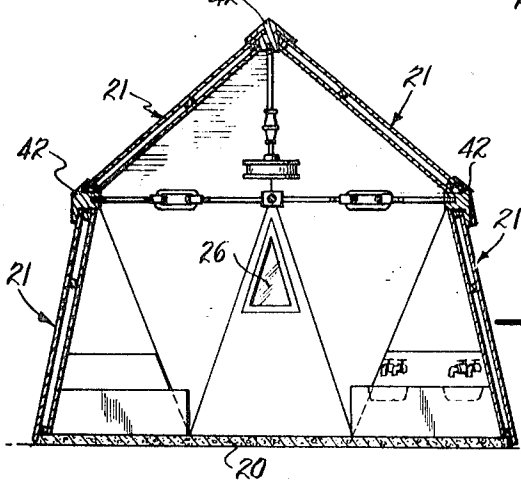


Fig. 14.

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Fig. 5.

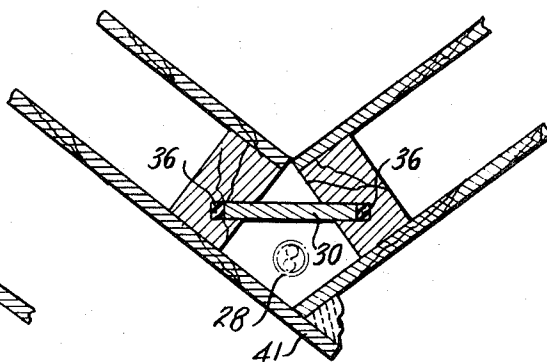
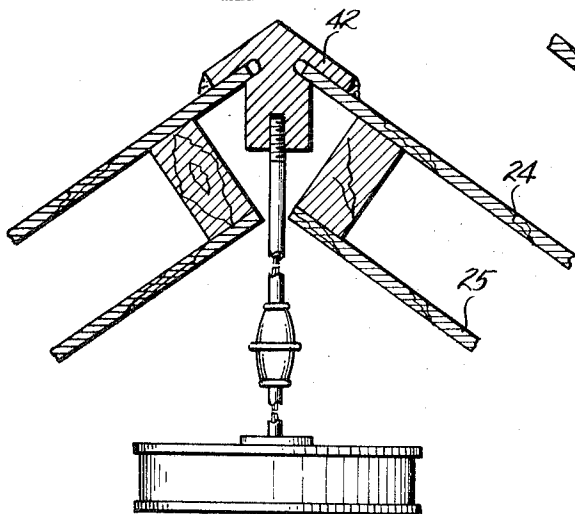


Fig. 6.

Fig. 9.

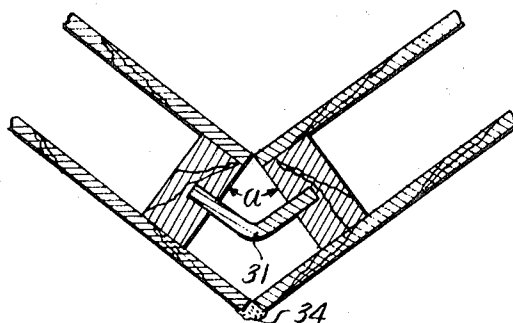
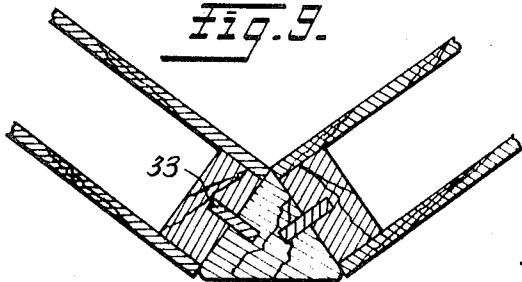


Fig. 7.

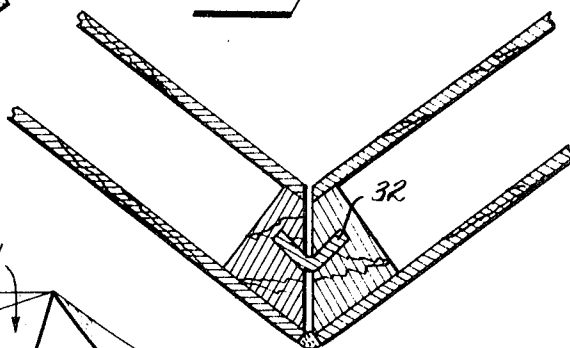


Fig. 8.

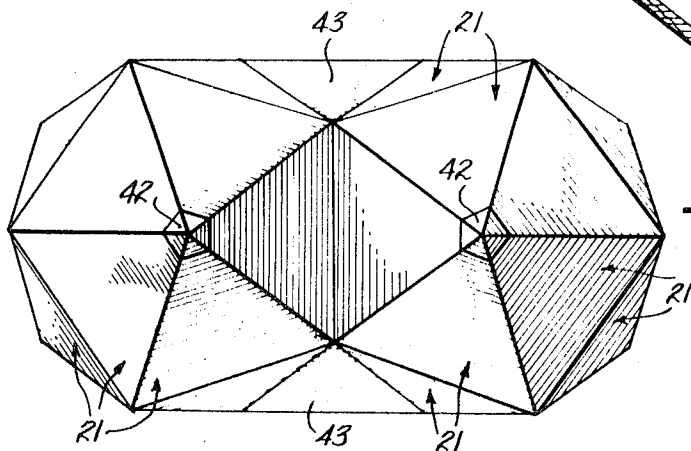


Fig. 12.

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Fig. 10.

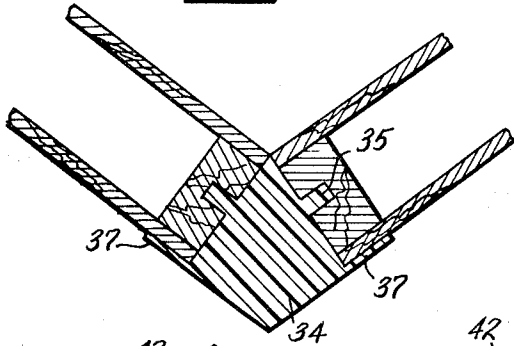


Fig. 11.

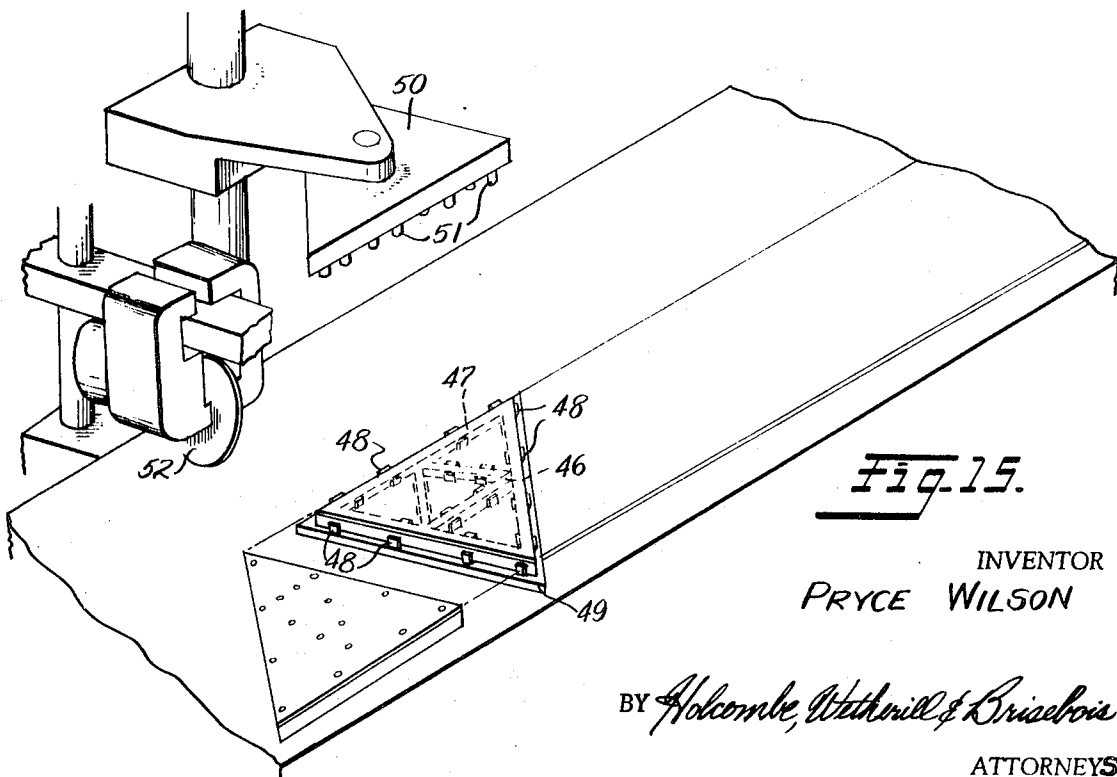
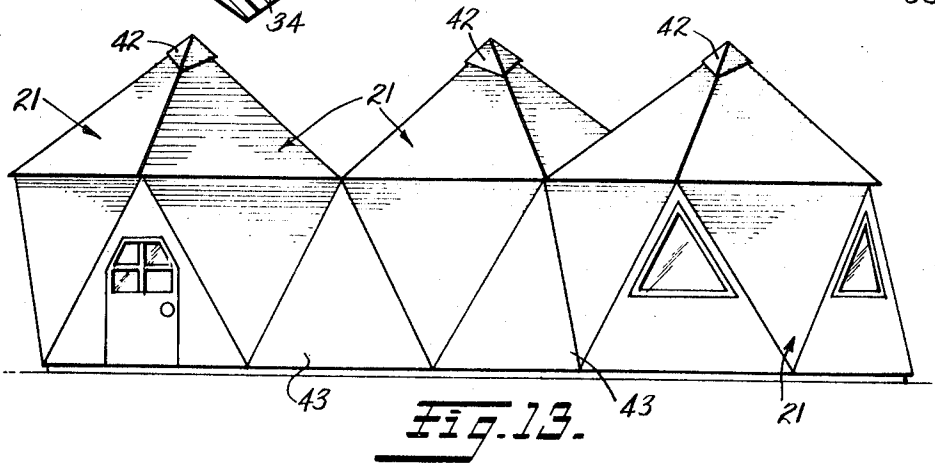
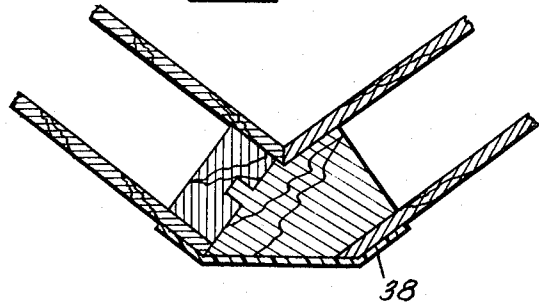


Fig. 15.

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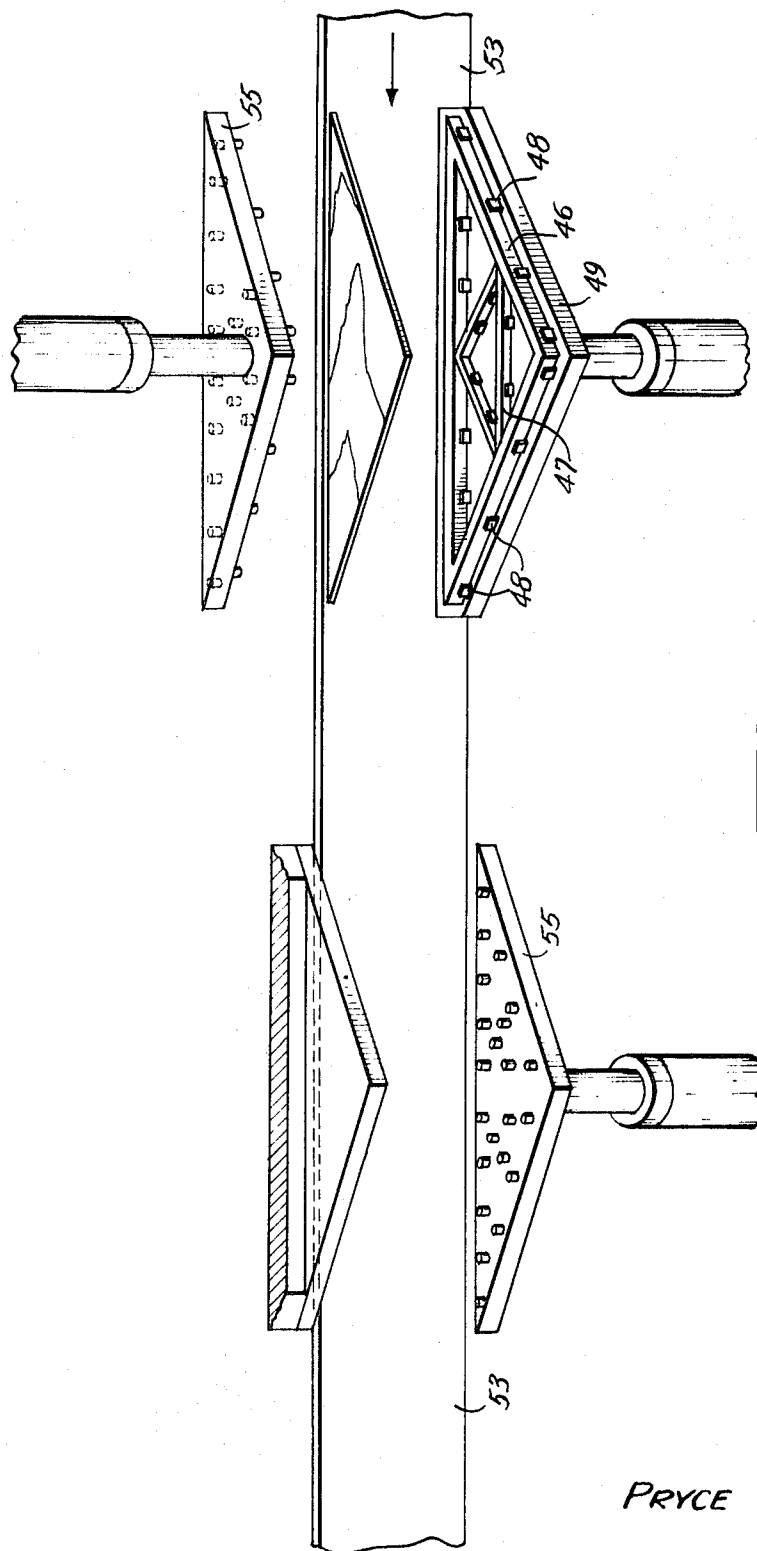


Fig. 1B.

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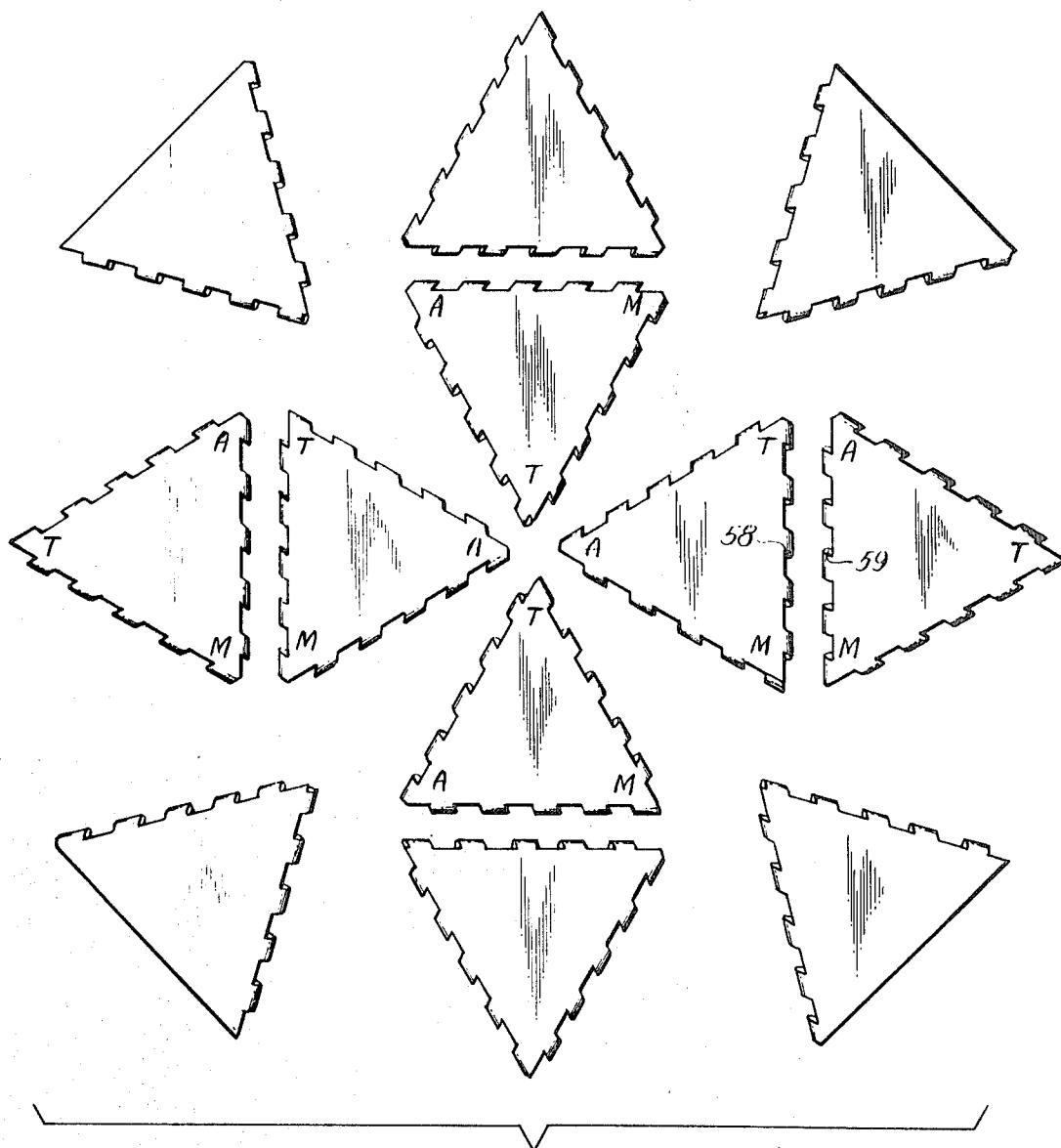


Fig. 17.

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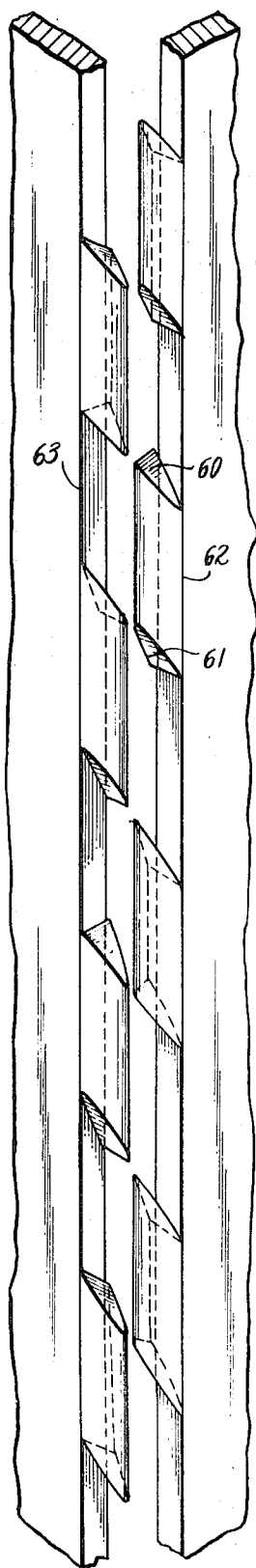


Fig. 19.

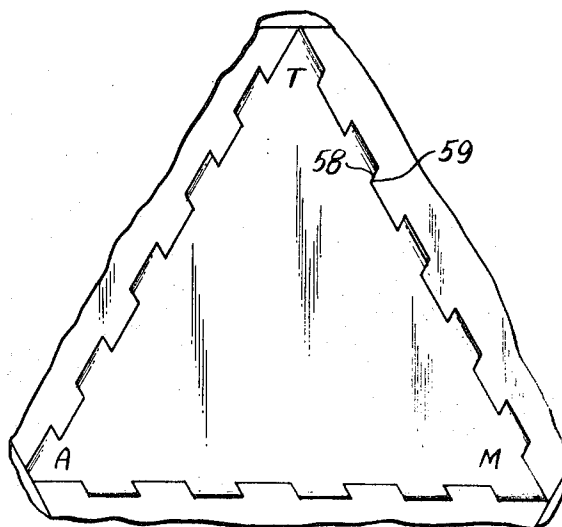


Fig. 18.

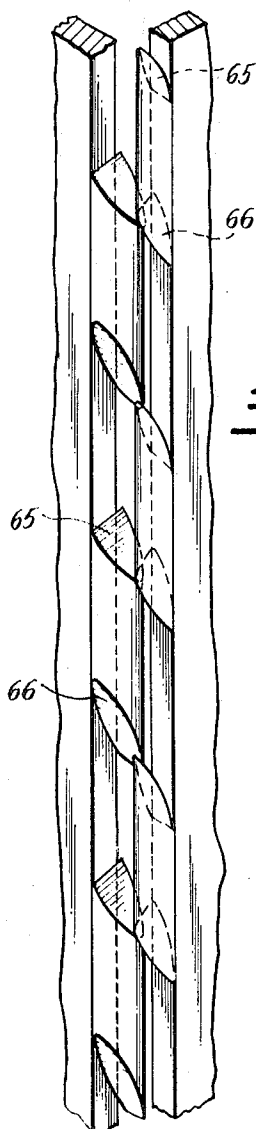


Fig. 20.

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PREFABRICATED MODULAR BUILDING

This application is a continuation-in-part of abandoned application U.S. Ser. No. 671,707 filed Sept. 29, 1967.

SUMMARY OF THE INVENTION

This invention relates to a modular building, that is a building which may be constructed from a plurality of components having identical dimensions.

The buildings according to my invention may consist of one or more basic units, each unit comprising a polygonal floor, an even number (at least eight) triangular wall panels, and half as many roofing panels, except where modified to permit another unit to be attached thereto.

All of the triangular panels are equilateral and, when 15 panels are assembled together, an individual unit has the shape of an icosahedron from which five sides which come together at a common point have been removed.

The invention comprises various labor-saving methods of constructing the triangular panels, and it is a particular advantage of the completed building that it is quick and easy to assemble, and that because the walls and roof are substantially self-supporting when assembled, the building requires only the simplest type of connecting means at the joints.

While primarily designed for use as buildings, it will be appreciated that sets of scaled-down triangular panels with suitable connectors, make attractive toys. Similarly, while in the preferred embodiments which will be hereinafter described the triangular panels are made principally of plywood, other sheet material may be used, and suitable triangular panels may be molded as monoliths from concrete, plastic, metallic, or foamed material.

Turning now to the drawings, it will be seen that,

FIG. 1 is a top plan view showing a building unit embodying the invention;

FIG. 2 is a front elevation of the same building unit;

FIG. 3 is a side view of the building unit of FIGS. 1 and 2;

FIG. 4 is a plan view of one type of triangular panel suitable for use constructing the building unit of FIG. 1;

FIG. 5 is a detail view, in vertical section, taken through the peak of the roof of the building along the line V—V of FIG. 1;

FIGS. 6, 7, 8, 9, 10 and 11, show various methods of connecting the triangular panels together;

FIG. 12 is a top plan view showing two units connected together;

FIG. 13 is an elevational view showing three units connected together;

FIG. 14 is a vertical sectional view taken along the line A—A of FIG. 1 and showing part of the interior of one of my units;

FIG. 15 is a perspective view showing one arrangement of equipment which may be used to manufacture the individual triangular panels from which my modular building is constructed;

FIG. 16 is a perspective view of a second arrangement of equipment which may be used to manufacture such panels;

FIG. 17 is an exploded developmental view showing the various panels of a building having a square floor plan utilizing the present invention;

FIG. 18 is a plan view showing one of the panels of FIG. 17 in greater detail while connected to three adjacent panels;

FIG. 19 is a vertical elevational view showing the edges of two adjacent panels partially assembled, said panels being connected by an especially useful interlocking means; and

FIG. 20 is a similar view showing less complex interlocking means.

Like reference numerals denote like parts throughout the several views.

Turning now to FIG. 2, it will be seen that the building is preferably built on a pentagonal base 20, which may be provided from concrete in situ, or constructed in situ from lumber, or constructed in advance, either entire or in five identical triangles, and brought to the site.

The walls consist of ten triangular panels, 21, which are in fact equilateral, although this is not apparent from the

drawings, due to their angular position. Half of these triangular wall panels have one side resting on the base 20, with the opposite corner at the top, and lean slightly outward, as best seen at the left of FIG. 3. The other five wall panels rest on one corner, have their opposite sides at the top, parallel to the ground, and lean slightly inward. The roof comprises five more panels, of identical shape and dimensions, with one side of each roof panel resting on the upwardly positioned sides of the five inwardly inclined wall panels, and their opposite corners coincident to form a central peak. The floor is pentagonal and may be made of any suitable material. Preferably, however, it is made in five triangular sections and its outer edges are formed for attachment to the bottoms of the outwardly leaning panels in much the same way that adjacent panels are attached to each other.

In a preferred embodiment of the invention, as best seen in FIG. 4, each panel is formed from three outer frame members 22 braced by an inner triangle formed by three inner frame members 23. The frame formed by these members may be faced on one or both sides with plywood or other sheet material. Ordinarily the outer sheet 24 will be weatherproof, while the inner sheet 25, if any, may be of a decorative material. The space between the sheets may or may not be filled with insulating material, depending on the purpose for which the building is to be used. Windows 26 may be set into one or more panels, as best seen in FIGS. 2 and 3. The edges of these windows may be seated in slots in the inner edges of the frame members 21 and one of the braces 23. This eliminates the need for sashing. At least one panel will be fitted with a door 27. The windows and doors will ordinarily be mounted in the outwardly leaning panels.

It will be appreciated that each panel is positioned at an angle of about 140° with respect to each adjacent panel. In other words, if the edges of a panel are perpendicular to their main surfaces, there will be an angle α (see FIG. 7) about 40° between the edges of each pair of adjacent panels. A portion of the resulting space may be used to contain water, gas, and electric lines, as shown at 28 in FIG. 6.

It will also be appreciated that the roof panels and the five inwardly leaning wall panels form a self supporting arch-like structure which is held together by its own weight, so that there is little need to urge the edges of adjacent members toward each other. It is only necessary to prevent relative movement in a direction transverse to the principal planes of the panels, and the construction is such that even that type of movement is greatly inhibited by the weight of the panels themselves.

As best seen in FIGS. 6-11, suitable connecting means include various combinations of elongated rigid strips 30, 31, 32, 33, 34, and mating grooves in the edges of the panels. The panel edges may be cut at 90° to their main faces, as in FIGS. 6 and 7, or at half the angle α as in FIG. 8. Alternatively, some of the edges may be cut at the full angle α and the others at 90°, as shown in FIG. 11.

While the connecting members have been shown in FIGS. 6-9, as thin strips having edges seated in slots in the panel edges, these connecting members may also take the form of solid wedge-shaped members 34 made of metal, wood, or plastic, and provided with tongues 35 seating in mating grooves in the panel edges. Alternatively, the panel edges may carry the tongues, while the members 39 are grooved. In either case the grooves may be provided with resilient sealing strips 36 of rubber or the like so as to form a weather-tight seal. Alternatively, the tongues may consist of a series of longitudinally spaced teeth and the grooves may be in the form of a series of short mating slots. The connecting members may have an integral outer portion 37 lapping over the edges of the adjacent panels, or may be covered by an adhesive weather-proof tape 38 such as the fiber-glass reinforced tape produced by the Minnesota Mining and Manufacturing Co. This solid, double-sealing type of joint is particularly useful in assembling roof panels, since the space between the edges of roof panels is not ordinarily needed for utility lines, and the double seal is more important at this point.

The outer sheets of the panel will ordinarily be cut a little larger than the inner sheets so as to cover the space caused by the angle 60. These outer sheets may overlap the frame uniformly on all sides, as shown in FIGS. 7 and 8, in which case the overlaps on adjacent panels will meet in a butt joint, as shown in FIG. 7, and may be sealed by a strip of caulking compound 40, or may be covered by a strip of waterproof tape 38 adhesively secured to the panel edges, as previously described.

It will be appreciated that if the connecting strips 30, 31, 32 or the slots in which they seat are coated with a resilient sealing material, such as rubber, and said strips run the full length of the panel edges, the joints are double-sealed, once by the connecting strips 30, 31, 32 and once by the strip of caulking compound 34.

In an alternative embodiment the overlap on the lower edge of each roof panel and each outwardly inclined panel is made a little longer than necessary to produce a butt joint, and the overlap on the upper edge of the inwardly sloping panels is made a little shorter than would be necessary to produce a butt joint. This produces an overlapping joint like that shown in FIG. 6 between the roof and the inwardly inclined wall panel, so that the longer surface 41 functions as an eave. The outwardly inclined wall panels will likewise have the edges with the longer overlap down, so that they overlap the base 21, thus preventing a drafty floor. The inwardly inclined wall panels will be positioned with an edge carrying a shorter overlap up, to fit under the eaves. The overlaps on the two remaining edges of the inwardly inclined wall panels may then be dimensioned either to produce butt joints, or joints in which the edges of the inwardly sloping panels overlap those of the outwardly sloping panels. Similarly, the upwardly inclined edges of the roof panels may be dimensioned to produce either butt or lapped joints. It will be appreciated that if all the panels are manufactured with one short and two long overlaps, it will simply be necessary to trim one of the long overlaps on each of the outwardly inclined panels to the short length at the factory, to produce a structure in which all of the joints are of the overlapping type.

The peak of the roof may be sealed by a metallic or plastic member such as 42, FIG. 5, which is simply dropped in place, and may be used to support a chandelier or other convenience fixture. The joint between the roofing panels may be sealed with waterproof tape, or by strips of extruded plastic or metal provided with oppositely disposed tongues positioned at an angle of 130° with respect to each other as shown in FIG. 10 and coated with a resilient sealing material, or slipped on to the edges of the panels after an adhesive sealing coat has been applied thereto.

While various types of separable joints have been shown, since such joints facilitate disassembly, it will be appreciated that in a crude version, wooden wedges may be inserted at the joints, and nails driven into these wedges. The panels may also be connected by means of interengaging metallic catches.

As shown in FIGS. 12 and 13 a plurality of units may be connected together to form a multi-room structure. This necessitates the provision of special panel members 43, FIG. 11, but poses no other problems. As many units may be connected together as desired, by eliminating three adjacent wall panels from each unit.

If desired a member such as 42 may be mounted at each of the upper corners of the building and connected to a central point by a system of wires or bars and turnbuckles, two of which are shown in FIG. 14. If a strip of metal 44 is then wound around the bottom, and its ends fastened to the door jambs, an exceptionally strong and rigid structure is produced.

The interior of the building is particularly adapted to the provision of furniture and equipment shaped to conform to the building contours or take advantage of its structural peculiarities. Note the bench, sink, and chandelier seen in FIG. 14.

Turning now to FIG. 17 it will be seen that my new building need not have a pentagonal floor plan. It may have any even number of sides, so long as its maximum diameter is less than twice the length of a panel edge. FIG. 17 is an exploded

developmental view showing a building according to my invention using eight side panels and four roof panels, and having a square floor plan.

This view has been used to illustrate another method of connecting adjacent panels, which method may be used in connection with a building having a pentagonal as well as one having a square floor.

As shown in FIG. 17, the edges of each panel are provided with projections which may be metal plates, wooden wedges, or even pairs of pins which define a plane. The essential point is that these projections have mating surfaces 58, 59 which intersect a plane containing the principal surfaces of the panels at an acute angle to the horizontal when in assembled position and used as wall panels, with the end of the projection remote from the panel edge highest.

The consequence is that the weight of the roof acts to jam the edges of adjacent panels together, using the principle of the inclined plane. The resulting friction between adjacent panels is so great as to prevent outward movement of the outwardly inclined panels, since these panels are only slightly inclined, and consequently only a relatively small component of the roof weight urges the outwardly inclined panels outwardly, while a relatively large component increases the frictional resistance to such movement. Outward swinging of the inwardly leaning panels is directly prevented by the weight of the roof, which would have to rise to permit such movement, and inward movement of any panels is prevented because this would require compression or displacement of adjacent panels. It may however, be desirable to have at least some of the mating surfaces of the projections positioned to intersect a vertical plane perpendicular to the plane of the panels, at an angle to the horizontal. This arrangement is shown in FIG. 19, in which it will be seen that the surfaces 60 and 61 are visible in the elevational view. Surface 60 prevents horizontal movement of edge 62 toward the viewer with respect to edge 63, and surface 61 prevents horizontal movement of edge 62 away from the viewer with respect to edge 63, so that separation requires movement having a vertical component.

A simpler arrangement is shown in FIG. 20. The projections in this embodiment have parallel upper and lower surfaces 65, 66 so that transverse movement of adjacent panels is possible, if the weight factor is overcome.

But the construction of the building is such that any vertical movement is resisted by the weight of the roof. The building is consequently held together by its own weight and the restriction of movement resulting from the angular positions of the wedge surfaces 58-61. For convenience in assembly, it may be desirable to provide one of the inwardly leaning side wall panels, and the adjacent edges of the two adjacent side wall panels with projections having edges which are perpendicular to the plane of said one panel. This panel then serves as a key and is put in place last. The key panel may also overlap the adjacent edges of both panels, in order to facilitate its insertion as the last component. The weight of the building will still hold it together, since the top of the inwardly leaning panel would have to rise before it could swing outward. One of the panels forming the roof may be modified in like manner, for similar reasons.

A detailed consideration of FIG. 18 will show that in each panel the mating surfaces of two edges slope toward an apex T; the mating surfaces on two edges slope away from the apex A, and the mating surfaces along one edge leading to the apex M slope away from that apex, while the mating surfaces on the other edge slope toward that apex. It will also be observed that the distance from the apex A to the nearest projection is the same on each side thereof. This is also true of apex T, but in the case of apex M, such is not the case. The projections from two adjacent edges may occupy substantially the entire space between said edges, but this is by no means essential, and the central projections may be omitted in most cases.

This building possesses many very important practical advantages.

In the first place, it may be assembled very quickly by unskilled labor, without the use of any nails, screws, or the like, so that the cost of erection is very low.

As a corollary, since there need be no nails or screws, the building may be readily taken apart by simply peeling off any tape applied and withdrawing the connecting members. The components may then be loaded on a truck, moved to another location, and reassembled. This makes the invention particularly suitable for use in providing temporary housing for construction workers, temporary concession stands, offices for vacant lots being temporarily used as parking lots, vacation homes, etc., etc.

In the second place, because the panels are all of identical dimensions, no hand shaping or cutting is required at the site and all the panels may be mass produced at the factory on an assembly-line basis at a very low labor cost per panel, and to very close tolerances.

In one approach, illustrated in FIG. 15 the plywood or other facing material, and the frame members are initially cut or formed to the desired size and shape. The frame members 46, 47 need be of only two lengths, and are all cut at the same angle. These frame members are simply dropped into the clamps 48 carried by a jig 49 and a facing sheet positioned thereon. A power-actuated frame 50 carrying a plurality of staple guns 51, welding guns, or the like, is mounted above the jig and when actuated drops down and fastens the facing sheet to the frame members at as many points as there are guns. It will be appreciated that if welding guns are used and the frame and facing sheets are made of wood, the frame members will have those of their surfaces facing the sheet coated with a suitable heat-responsive adhesive before the facing sheet is applied, and it is this adhesive, well known in the industry, which will be activated by the welding guns. After one facing sheet has been attached, the panel may be simply flipped over, manually or automatically, so as to fall beneath another power actuated gun-carrying frame, and a second facing sheet is fastened to its opposite in like manner.

It will be appreciated that many modifications of this basic method may be devised. For instance, the facing material may be fed to the assembly point in continuous strips instead of pre-cut triangles. In this case, the jig holds the frame members required to form two panels, and the strip is intermittently advanced over the jig. When the jig is covered, the guns are brought down, and then the saws 52 are brought down to sever the resulting panels from the strip and each other. Since the saws always travel in the same path, their operation may be made automatic upon pressing of a button. In another variation, a plurality of jigs may be mounted on chains, and advance the frame members from a first position beneath the gun frame 50, to a second position over the end of a second strip sheet material above a second upwardly acting gun frame. The chain may reciprocate the jig between the two positions or carry several jigs and travel around drive wheels, like the treads of a tractor.

In another arrangement, illustrated in FIG. 16, the jig is vertical and the frame members are inserted horizontally into the clamps 48 which extend over a conveyor belt 53. A vertical sheet is then positioned against the frame members and a gun frame 54 moved horizontally to attach the sheet to the frame

members. The jig is then withdrawn and the panel, the lower edge of which now rests on the conveyor belt 53, is advanced to a second position in alignment with a gun frame 55 on the opposite side of the panel from the first gun frame. A second triangular piece of sheet material is then applied to said opposite side of the panel frame, and the second gun-frame actuated.

What is claimed is:

1. A demountable building comprising a roof and side walls, said side walls consisting essentially of an even number of panels in the shape of equilateral triangles having substantially identical dimensions, with said side wall panels leaning alternately inward and outward, and said roof comprising half as many panels as said side walls meeting at a common apex, each panel comprising a triangular frame and a sheet covering at least one side of said frame, said frames constituting the principal load-bearing support for the building, and said side wall panels being assembled alternately so that the base portion of at least two side wall panels lie in a horizontal plane along the bottom of said building with a third intermediate side wall panel nested therebetween having its base portion in a horizontal plane along the upper edge of the wall of said building, said three side wall panels being interlocked by interfitting means, said interfitting means comprising a plurality of mating surfaces which abut each other along the adjacent edges of adjacent panels whereby the weight of said intermediate panel gives a wedging effect between said mating surfaces.
2. A building as claimed in claim 1 in which said interfitting means comprise connecting members positioned between the panels, the edges of said panels and said connecting members being formed with interfitting tongues and grooves.
3. A building as claimed in claim 1 in which the edges of said panels lie in planes making an angle of about 20° with the planes of said sheets.
4. A building as claimed in claim 3 in which said interfitting means comprise interfitting tongues and grooves formed in the edges of said panels.
5. A building as claimed in claim 1 consisting essentially of fifteen panels interconnected to form a structure having the shape of an icosahedron from which five sides having apices at a common point have been removed.
6. A demountable building as claimed in claim 1 in which said interfitting means are projections extending from the edges of the panels at an acute angle to said edges.
7. A demountable building as claimed in claim 6 in which said projections have surfaces mating with surfaces on adjacent panels and extending transversely with respect to a horizontal line lying in either the principal plane of its panel or in a plane perpendicular thereto.
8. A building as claimed in claim 1 in which at least some of said panels have a discrete first sheet covering one side of the panel frame and having its edges substantially flush with those of said frame, and a discrete second sheet covering the opposite side of said frame, at least one of the edges of said second sheet projecting beyond the edge of said first sheet.
9. A building as claimed in claim 1 having eight sidewall panels and four roofing panels.

* * * * *