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R. E. LEE ETAL

3,193,973

METHOD OF BUILDING ERECTION

Filed Feb. 24, 1961

3 Sheets-Sheet 1

FIG. 1

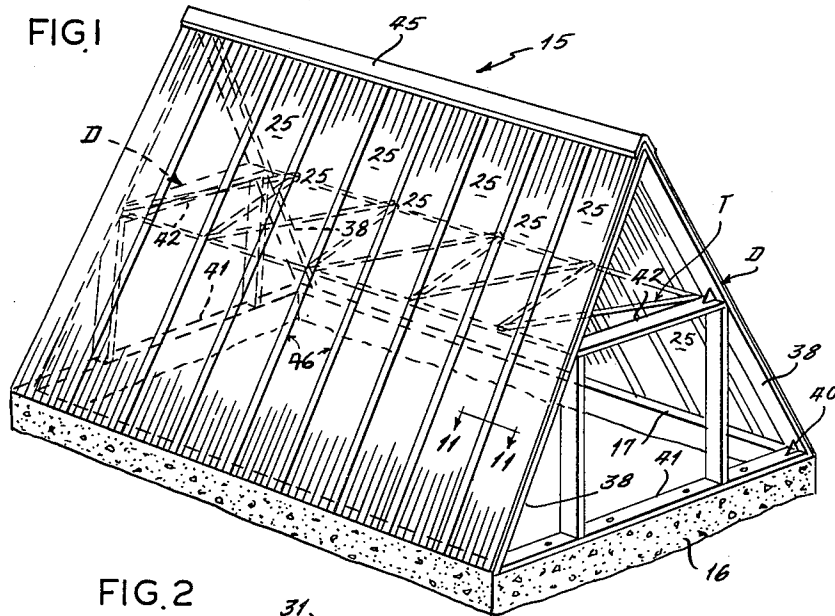


FIG. 2

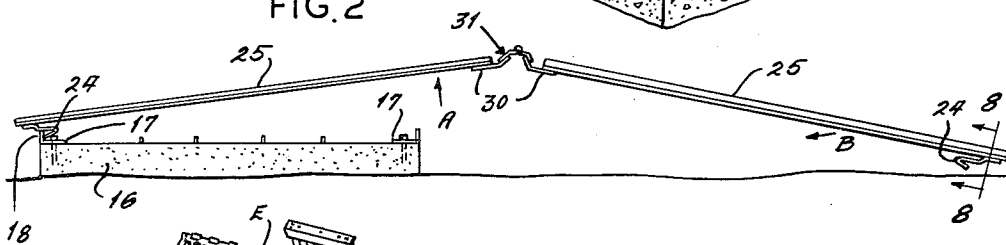


FIG. 8

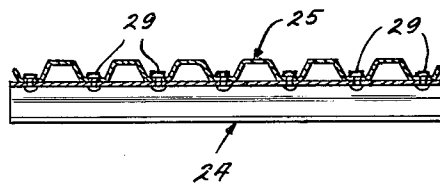
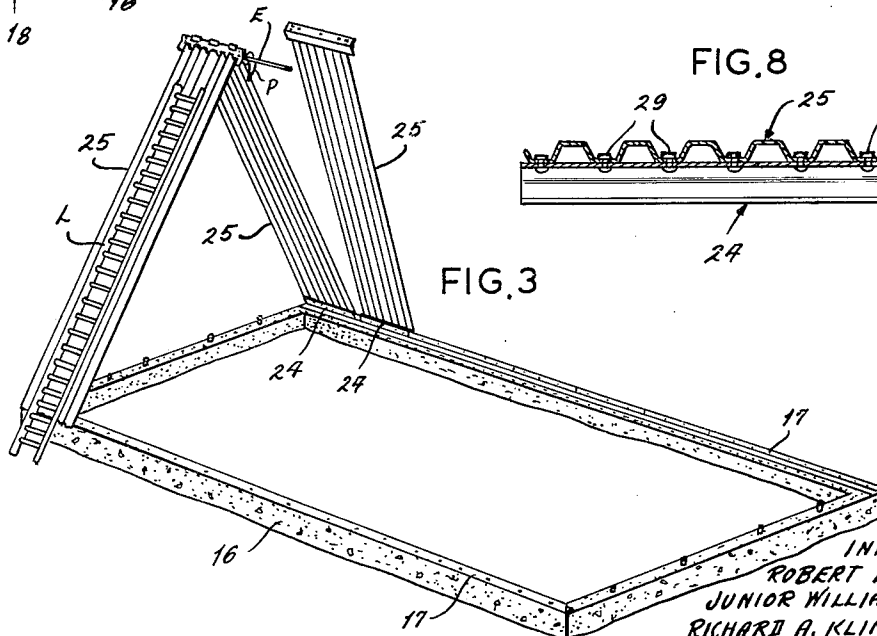


FIG. 3



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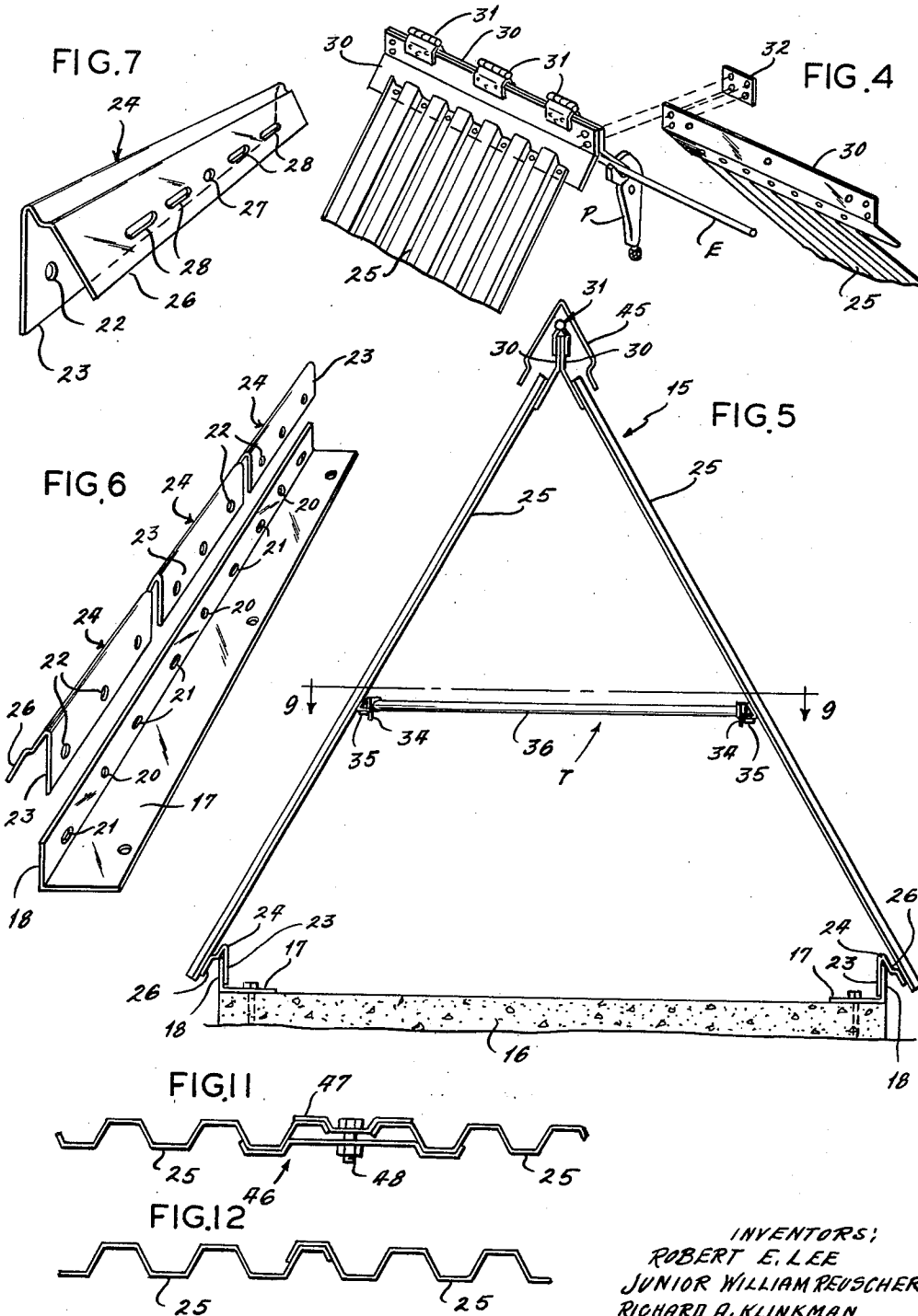
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3 Sheets-Sheet 2



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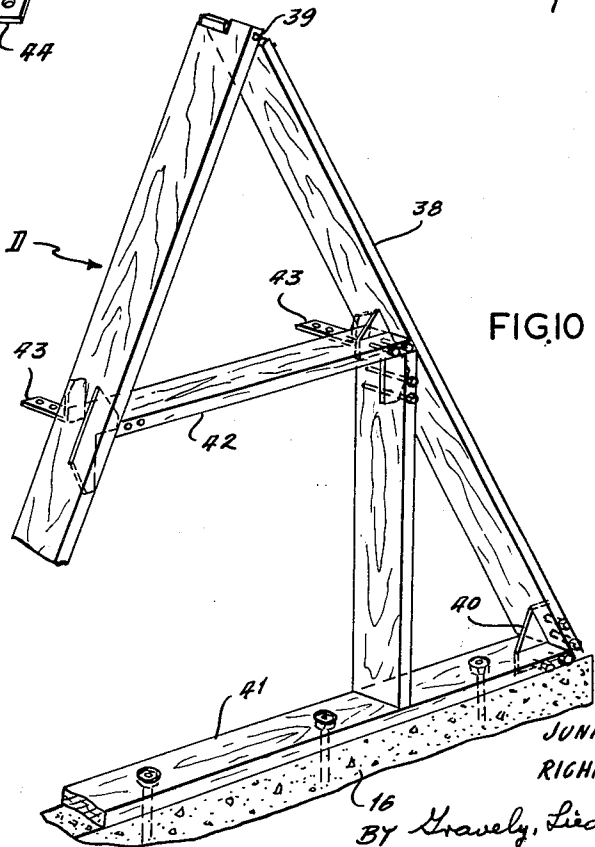
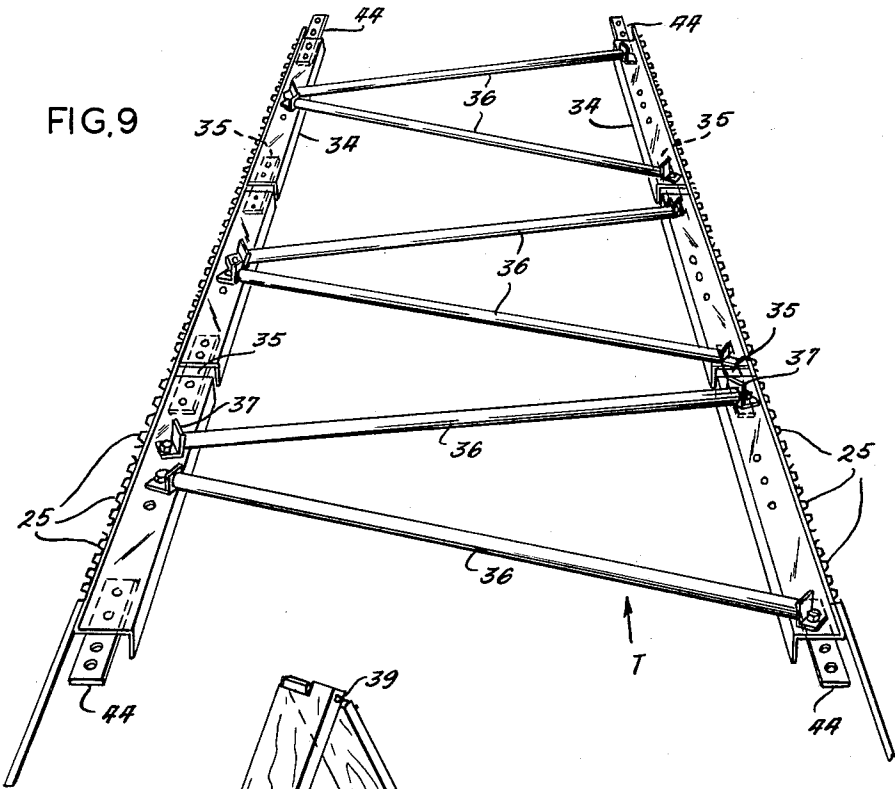
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3 Sheets-Sheet 3



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METHOD OF BUILDING ERECTION

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2 Claims. (Cl. 50-531)

This invention relates to improvements in building constructions and to a method of erecting the same.

The art of construction and erection of houses, buildings, and the like has shown very little progress over methods used in the past, and very little has been done for simplifying the fabrication and construction of the many components, sub-assemblies and even major assemblies of pre-fitted components. Likewise, this art has always and still does require a large number of workers to perform the erection work. This invention is not concerned with conventional steel, reinforced concrete, brick, masonry or wood construction. It is, however, directed to moderate size constructions for houses, buildings, utility structures and the like in which the components are prefabricated, light weight parts which are fitted at the job-site by one or two workers using simple hand tools and portable ladders, and in which scaffolding or temporary supports are not necessary or need be provided.

It is, therefore, an important object of this invention to provide an erection method or procedure for houses and the like composed of simple and lightweight parts whereby economies in labor may be realized.

It is an object of this invention to provide pre-fabricated construction components utilizing simple fastening means and to teach an improved and economical procedure for erecting the components.

Another object of this invention is to provide a building erection procedure in which certain components are utilized as a starting frame for subsequent components whereby scaffolding and temporary supports can be dispensed with.

A further object of this invention is to provide a building construction in which side walls and roof sheets are combined with a horizontal truss assembly so that vertical and horizontal loads are efficiently distributed and the assembly is aligned and rendered quite rigid.

It is a further object of this invention to provide certain components in a building assembly of improved utility as temporary supports for other components during erection of the assembly and to subsequently transform the temporary supporting function of these components into an integrated portion of the assembly.

Other objects and advantages of this invention will appear as the description of the selected embodiments proceeds, reference being directed to the accompanying drawings, wherein:

FIG. 1 is a perspective view of a house construction embodying the improvements of the present invention;

FIG. 2 is a diagrammatic illustration of an early stage of the erection procedure herein preferred;

FIG. 3 is a further illustration in perspective of another stage in the erection procedure;

FIG. 4 is a greatly enlarged and fragmentary perspective view of certain components shown in FIG. 3;

FIG. 5 is an end elevational view of a building making use of the principles of this invention;

FIG. 6 is a greatly enlarged perspective view of components of the assembly of FIG. 5;

FIG. 7 is a further perspective of a component of FIG. 6, but seen from the reverse side;

FIG. 8 is an enlarged sectional elevational view taken along line 8-8 in FIG. 2;

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FIG. 9 is a perspective view from the end of another component in the assembly of FIG. 1, the view being at the elevation 9-9 in FIG. 5;

FIG. 10 is a perspective view of a further component of the assembly of FIG. 1;

FIG. 11 is an enlarged sectional view taken at line 11-11 in FIG. 1; and

FIG. 12 is a sectional view of an alternate assembly detail.

The invention contemplates the erection of a building of considerable height without the use of scaffolding or other temporary supporting means so as to allow for economical and speedy erection. This erection procedure is based upon the use of hinged connections at both ends of the sheet and a restraining means at the base so that the sheets and the base form a stable triangle.

Considered in its simplest form, this invention contemplates a construction in which a series of side sheets are joined at a ridge line and anchored at a base line, thereby providing a shell or form for the support of a horizontal truss within the sheets to stiffen the sheets against horizontal loads and leave substantially only vertical loads for the sheets to resist or withstand. It also contemplates completing the construction by the placement of tie down diaphragms or frames at the ends of the combined sheets and truss. A novel and unique improvement is that the uniting of the components provides a three-dimensional structure in which no individual section can be considered functionally load resistant by itself. The vertical loads of this three-dimensional structure are carried by the action of the side sheets. The side sheets are so proportioned that they are designed to be self-supporting but not of sufficient strength to carry normal vertical loads when first erected. The horizontal truss so stiffens the sheets that the vertical loads can be functionally carried by the action of the side sheets. The horizontal loads are carried by the joint action of the side sheets and the horizontal truss. The truss reaction from the horizontal loads is transferred to diaphragms at the ends and thence to the ground. The horizontal truss therefore performs a dual function and thus eliminates the need for a separate transverse structural member, as found in conventional practices.

Another feature of this invention is the construction of a building in which there are no vertical or other framing members between the end diaphragms of the building other than a horizontal truss used to stiffen the sheets.

In FIGS. 1 and 5, the assembly of components results in the construction of a building 15 upon a base 16 which may be a wall (shown) or a platform, or slab, or may be a section of prepared ground. The base 16 carries a pair of angle members 17 which are anchored along opposite margins, and have outer upstanding flanges 18 (FIG. 6). The flanges 18 are prepunched with apertures 20 and slots 21 to cooperate with apertures 22 formed in the fulcrum legs 23 of anchors 24 (FIGS. 6 and 7) for side sheets 25, there being nine such sheets at each side of the building illustrated, but the number of sheets may be more or less. Each anchor 24 has an angular support leg 26 suitably punched with an aperture 27 and slots 28. The anchors 24 (FIG. 8) are attached to the inner side of the side sheets 25 by threaded or bolt means 29 inserted in the aperture 27 and slots 28, the aperture being the locating means for the sheet and the slots providing allowances for production tolerance. While means 29 is shown as a threaded means it is understood that other means could be employed.

Referring now to FIGS. 1, 2, 3 and 4, it is seen that the building is formed by side sheets 25 rising to a ridge line and that there are, in the example shown, nine side sheets on each side. Beginning with the most leftward

side sheets 25, and observing FIGS. 2 and 3, the sheets 25 are each provided with anchors 24 adjacent the base ends, and are hingedly joined at the adjacent ends by ridge flanges 30 having cooperating leaf hinges 31 (FIG. 4). One anchor 24 (the left one in FIG. 2) is set with its fulcrum leg 23 against the inside of the flange 18 so that the sheet 25 lies over the base 16 and the cooperating sheet 25 extends rightwardly from the base. A worker, or a worker and helper, is able to lift the sheet 25 at arrow A thereby pulling the other sheet 25 in the direction of arrow B. By combining the lift at A and push at B the two sheets 25 are raised to the position of FIG. 3 in which the anchors 24 are engaged in the members 17 and the hinged connected ridge flanges 30 are folded to start the formation of a ridge member. These two sheets constitute the starting side sheets and are structurally stable enough because of the triangulated relation with base 16 and attachment at flanges 18. In FIG. 6 it is seen that the flange 18 is formed with a guide aperture 20 and slots 21 at each side, and that the anchor 24 has apertures 22 which align with the flange aperture 20 and slots 21 to receive bolts or other suitable securing means (not shown).

Once the starting pair of side sheets 25 has been erected (FIG. 3) and attached to the base 16 as described, the worker can place a ladder L on a side sheet and climb to the ridge flange 30 to place an erection bar E (FIGS. 3 and 4) in extended position by clamping it to a portion of one of the ridge flanges 30 by a clamp or gripping pliers or the like P. The bar E then becomes the temporary support for the next side sheet 25 which is provided with a ridge flange 30. No hinges are needed other than for the starting sheets to allow these sheets to be raised and support themselves during construction. After the third side sheet is placed against the erection bar E, a fourth sheet (not shown) is then erected for cooperation with the third sheet and the ridge flanges are attached to each other. A connector plate 32 is then applied to unite the ridge flanges of the four side sheets. The erection bar E is moved to the next position and the same procedure is followed each time until the full set of said sheets has been raised and interconnected. Up to this stage of the construction the tools used are wrenches for the bolts, a ladder, the erection bar E and pliers P. If two people work together, one can straddle the ridge flanges while the other can lift the side sheets into position, using the erection bar E as a guide. Obviously each side sheet 25 has an anchor 24 attached thereto, and these may be close to the lower ends, as in FIG. 5, or they may be located farther up on the side sheets 25 to afford greater overhang. As seen in FIG. 1, the pairs of side sheets are spaced from each other to leave gaps which are closed by a batten arrangement to be referred to later.

The foregoing procedure is followed by the construction of a horizontally disposed truss T in the interior and upon the sheets at some preselected elevation. The truss is best seen in FIGS. 5 and 9, and comprises a series of Z-bars 34 which are attached to the side sheets and in this embodiment, span three side sheets. The Z-bars 34 at each side are connected by splice members 35 so that the bars 34 and splice members 35 at each side form the chord members of the truss T. The web of the truss T is formed of a number of diagonally directed members, in this embodiment consisting of tubes 36 and attachment angles 37 at the opposite ends thereof. The horizontal leg of the angles 37 are bolted or secured to the Z-bars 34 in the pattern illustrated in FIG. 9, but no limitation is to be imposed by this arrangement. The erection of the truss T is carried out part by part on the side sheets until completed, after which the side sheets carry the vertical loads and the truss resists side loads and stiffens the side sheets in the mid-span zone. Depending on the height a step-ladder may be required for this procedure and wrenches are again used.

The next structural component is the end diaphragm or frame D, shown in FIGS. 1 and 10. The frame D takes the lateral loads from the truss T and carries the loads therefrom into the base 16, thereby relieving the side sheets. In its simplest form, the frame D consists of two diagonal struts 38 pin-connected at the top or ridge apex at 39 and anchored by members 40 at the base 16. A base plate or still 41 may be employed for this purpose. If not then the anchor 40 is carried by the base 16. The struts 38 carry a horizontal element 42 at the elevation of the truss T, and connectors 43 extend therefrom to connect to the truss element 44. Either the elements 44 or 43 may be eliminated if desired and the other elements used to make a direct connection.

The construction is substantially completed, as to its more important components, by placement of the ridge cover 45 over the ridge flanges 30, and by assembly of the batten members over the gaps in the side sheets. The batten is shown in FIG. 11, and includes an exterior elongated structural shape 46 and an interior holder 47 secured together by means 48 spaced along the length thereof. The interior holder is made in two pieces divided at the elevation of the truss T for convenience. It is not necessary in all cases that the side sheets 25 be spaced apart, and in FIG. 12 the sheets 25 are illustrated in overlapped or interlocked arrangement so that no batten assembly is required. This can be applied in the construction of FIG. 1 by shortening the length of the ridge flanges 30 so that there is no interference when the sheets are interlocked.

In the foregoing disclosure reference has been made to structure which has the function of a truss, or shear frame, or diaphragm. These terms are used to describe a component of the present assembly and has the following meaning: a structural diaphragm may be defined as a relatively thin structural element, that is, one where the thickness to depth or width relationship of the assembly is small. It is usually conceived as flat and of rectangular shape capable of resisting shear parallel to its edges. In the broadest sense a diaphragm is defined by two faces and a plurality of edges and is attached to adjacent elements along two or more edges. A trussed diaphragm differs from a solid or sheathed diaphragm by virtue of the elimination or omission of that material not used to diagonally direct the shear forces to a diaphragm attached edges. Effective diaphragm action requires sufficient strength to withstand shear and moment in its plane and sufficient rigidity to limit horizontal deflection. It resembles conventional beam and girder action in general concept but differs greatly in behavior because the span-depth ratio is usually less than four and the web thickness is comparatively very small. Consistent shear stresses and shear deformation or skewing greatly predominate over bending stresses and deflection. Specifically the properties of solid diaphragms are largely dependent on the nailing of the laminations. The properties of sheathed diaphragms depend principally on the effectiveness of the sheathing and the properties of truss and pressure diaphragms depend largely on the diagonal.

What is claimed is:

1. A method of erecting the opposite side sheets for a slant-sided building structure which includes hingedly interconnecting the adjacent ends of a first pair of opposed, self-supporting side sheets, raising the hingedly connected ends of the first pair of side sheets into the position of use, temporarily attaching an elongated erection member to the hingedly interconnected adjacent ends of the first pair of side sheets such that the erection member projects outwardly in space with a portion of its length free, utilizing the self-supporting character of the first pair of side sheets and the free length of the erection member to support the next pair of opposed, self-supporting side sheets, placing the said next pair of side sheets with raised ends supported on the erection member and interconnecting

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such raised ends to fix the same in position of use, and progressively moving the elongated erection member to a new temporary attachment at the interconnected ends of the last raised set of opposed side sheets until the slant-sided building structure is complete.

2. A method of erecting self-supporting side sheets for a slant sided building which comprises forming a first set of sheets for opposite surfaces of the slant sides by hingedly connecting adjacent ends of the first set of sheets, raising the first set of sheets by elevating the hingedly connected ends to the position of use, fixing the opposite lower ends of the first set of sheets against spreading, removably attaching to a portion of the raised hingedly connected ends of the first set of sheets an erection member which projects outwardly from a portion of the hingedly connected ends, raising a second set of sheets in position with adjacent elevated ends resting on the erection member, fixing the opposite lower ends of the second set of sheets against spreading and in positions to match the slanted position of the first set of side sheets, connecting the elevated adjacent ends of the second set of sheets to fix the position of use thereof, removing the erection member and removably attaching it to a portion of the connected ends of the second set of sheets to project outwardly as before, and repeating the sequence of raising and connecting the adjacent raised ends of sub-

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sequent sets of sheets into slanted positions while supported by the erection member until the slant sides of the building are completed.

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