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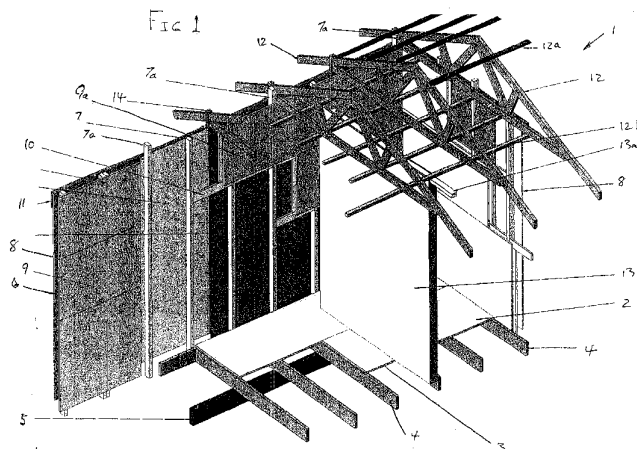
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(57) Abstract: A prefabricated modular building construction system is disclosed comprising wall panels (6) with a plurality of spaced parallel stud members (7) secured between opposing facing sheets (8, 9) with a plurality of hollow chambers or cavities (38) open at opposing ends. Some of the stud members protrude beyond upper and lower edges of the wall panel to permit, when in use, direct load bearing connection between the wall panel, adjacent lower and upper edges to a base structure and a roof structure respectively. The building construction system is preferably dimensioned to fit into a conventional shipping container.

TITLE

“MODULAR BUILDING CONSTRUCTION SYSTEM”

FIELD OF THE INVENTION

This invention is concerned with a modular construction system for
5 buildings.

The invention is concerned particularly, although not exclusively, with
a modular construction system for architecturally designed domestic
dwellings utilizing prefabricated components.

BACKGROUND OF THE INVENTION

10 During the twentieth century, as the cost of building materials and
skilled labour steadily increased, many efforts were made to reduce or at
least control the costs of dwelling construction. Cost saving proposals
included prefabrication of building structures at an automated or semi-
automated manufacturing site and subsequently transporting entire buildings
15 or building modules to a building site.

Many such proposals sought to exploit the properties of newly
developed building materials including synthetic plastics, lightweight masonry
product and composite materials over traditional building materials. Over
time, the cost of transporting large building modules has fallen into disfavour
20 and more recent developments have focussed on lightweight prefabricated
building components able to be assembled on site by less skilled labour.

Generally speaking, commoditized dwelling structures comprised of
prefabricated building components have been directed at low cost housing
projects and low cost temporary accommodation units in remote mining

villages and the like. United States Patents 3,511,000 and 7,191,571 deal with hollow masonry blocks for modular wall construction, while United States Patents 3,955,328, 4,050,215, 4,183,185, 4,655,013, 6,493,996 and 6,826,879 describe prefabricated building modules of cast concrete or moulded plastics.

Australian Patent 118357 and United States Patent 3,512,819 respectively describe the use of prefabricated modular concrete and foam plastics cored wall panels in building construction. United States Patent 3,898,779 describes the use of prefabricated composite wall and roof panels in mobile and transportable home constructions wherein the roof, walls and floor are tied together by vertical tension rods extending therebetween. United States Patents 4,031,675, 5,640,824, 6,082,066, 6,233,892, 6,412,243, 6,679,021 and 7,127,865 describe various prefabricated modular wall panels, connection systems therefor and structures embodying such wall panels.

United States Patents 4,910,932, 5,007,222, 5,687,956, 5,687,956, 6,256,960, 6,754,999, 7,155,874 and 7,243,464 deal with prefabricated structures embodying metal load bearing frames and prefabricated wall panels secured thereto.

United States Patents 4,947,615, 5,065,558 and 5,327,699 describe modular building structure systems comprising load bearing frame structures and prefabricated wall panels attached thereto.

United States Patents 6,253,498, 6,907,695 and 7,100,332 describe prefabricated structures that fold compactly for shipping but unfold to form a

modular building structure.

United States Patent 4,161,089 describes a modular building structure system which may be rapidly constructed or demounted. The system employs load bearing panelized members having an internal frame with interior and/or exterior surface skins mounted in abutting relationship by
5 tension rods and fractionally interfitting slip pin members. Wall panel members are inserted into channels mounted on a foundation slab.

While generally satisfactory for their respective intended purposes, all suffer from one or more shortcomings including difficulty and cost of
10 transportation, requirement for skilled labour to manufacture components and to erect structures, requirement for specialized and thus expensive fittings for construction, rigid limitation of component dimensions utilizing standard components to minimize cost and generally lack of flexibility in the design of the final building construction. Limitations such as those
15 aforementioned have generally restricted such prefabricated modular building systems to low cost housing and the like where cost rather than function or aesthetics dictates the ultimate building design.

Accordingly it is an aim of the present invention to overcome or alleviate at least some of the shortcomings associated with prior art
20 prefabricated modular buildings systems or otherwise to provide consumers with more convenient choices.

Throughout this specification, unless the context requires otherwise, the words "comprise", "comprises" and "comprising" will be understood to imply the inclusion of a stated integer or group of integers but not the

exclusion of any other integer or group of integers.

BRIEF SUMMARY OF THE INVENTION

According to one aspect of the invention there is provided a prefabricated modular building construction system for a building structure,

5 said system comprising:-

a plurality of wall panels adapted for interlocking edge to edge abutment, said wall panels each comprising a plurality of spaced parallel stud members secured between opposing facing sheets to define a plurality of parallel hollow chambers, open at opposing ends thereof, said wall panels
10 characterized in that at least some of said stud members protrude beyond upper and lower edges of said wall panel to permit, in use, direct load bearing connection between said wall panel adjacent lower and upper edges thereof to a base structure and a roof structure respectively.

If required each said wall panel may have an outer facing sheet
15 applied after erection of said wall panel.

Preferably said wall panel is prefabricated with inner and outer facing sheets.

The base structure may comprise a precast concrete slab with fixing beams secured about a perimeter thereof, said fixing beams, in use, forming
20 an anchor structure for fasteners extending through protruding lower ends of joint members of said wall panels.

Alternatively said base structure may comprise a plurality of floor panels supported on spaced bearer members, said floor panels each comprising an inner facing sheet with a plurality of spaced parallel joist

members secured thereto, said base structure including fixing beams extending about a perimeter thereof, said fixing beams, in use, forming an anchor structure for fasteners extending through protruding lower ends of stud members of said wall panels.

5 If required said roof structure may comprise a plurality of spaced truss members extending between opposed walls of said building structure, said truss members, in use, being secured directly to respective protruding upper ends of said stud members of said wall panels by fasteners extending therebetween.

10 Alternatively said roof structure may comprise a plurality of edge to edge abutting roof panels, said roof panels each comprising a plurality of spaced parallel rafter members secured between opposing facing sheets to define a plurality of parallel hollow chambers, open at opposing ends thereof, an inner side of an eaves region of each said roof panel being exposed to
15 permit, in use, direct connection between rafter members and respective protruding upper ends of said stud members of said wall panels by fasteners extending therebetween.

 Preferably said roof structure is supported on fixing beams extending adjacent an outer upper edge of opposed walls of said building structure.

20 If required, said roof structure may be secured to said fixing beams by mounting brackets.

 Suitably said parallel hollow chambers of said wall panels communicate with a ceiling cavity of said roof structure whereby in use a wall of said building structure facing solar radiation is cooled by a convection

current generated by heating of air within said parallel hollow chambers.

Preferably heated air accumulating in said ceiling cavity is exhausted via opposite ends of a ridge cap extending along the ridge of a gabled roof structure.

- 5 Throughout this specification, unless the context requires otherwise, the words "comprise", "comprises" and "comprising" will be understood to imply the inclusion of a stated integer or group of integers but not the exclusion of any other integer or group of integers.

BRIEF DESCRIPTION OF THE DRAWINGS

- 10 In order that the invention may be fully understood and put into practical effect, reference will now be made to preferred embodiments illustrated in the accompanying drawings in which:-

FIG. 1 shows schematically portion of a building structure utilizing the modular prefabricated system according to the invention;

- 15 FIG. 2 shows a partial side elevation of a wall structure;

FIG. 3 shows a phantom view of a wall structure;

FIG. 4 shows a partial cross-sectional view of a transverse facing sheet joins;

FIG. 5 shows a top plan view of a joint between adjacent wall panels;

- 20 FIG. 6 shows a top plan view of a corner joint between adjacent wall panels;

FIG. 7 shows the mounting of a wall panel to a concrete slab base;

FIG. 8 shows the mounting of a wall panel to a floor panel supported on a bearer and stump base;

FIG. 9 shows the mounting of a truss roof structure to a wall panel;

FIG. 10 shows the mounting of a rafter structure to a wall panel; and

FIG. 11 shows a part cross-sectional view of a building structure embodying the system of the invention wherein a convection cooling system is illustrated.

For the sake of simplicity, like reference members are employed for like features where appropriate in the drawings.

DETAILED DESCRIPTION OF THE DRAWINGS

FIG. 1 shows schematically portion of a building structure embodying the prefabricated modular components of the system according to the invention.

The structure 1 comprises prefabricated floor panels 2 each having a sheet of flooring grade reconstructed timber particle board 3 secured by screws and glue to timber joists 4, typically spaced at 600 mm centres. The floor panels 2 may be supported on bearers 5 of a conventional bearer and stump floor structure or a cast concrete slab as later described.

A wall panel 6 comprises a plurality of timber parallel stud members 8 spaced at 600 mm centres secured by screws and glue to opposing facing sheets comprising an outer skin 8 and an inner skin 9 and for the sake of clarity certain portions of inner skin 9 are omitted. Outer skin 8 may be weatherproof or marine grade ply, fibre reinforced cement or the like while inner skin 9 may be 19 mm sheets of particle board. As shown, the inner skin sheets 9a may be staggered to avoid long unsupported vertical joints. The joints may be supported by thin splicing members 10 secured to abutting

sheets 9a and extending within the hollow cavity formed between the studs 7.

5 A timber eave beam 11 is secured on the outer skin 8 at the upper edge thereof by screws extending into studs 7 and it will be noted that in the embodiment shown certain of the studs 7a protrude beyond the upper edges of the inner and outer skins 8,9 while all studs protrude below the lower edges of the outer and inner skins 8, 9 respectively.

10 Supported on the eave beam 11 and secured by screws or bolts to the protruding top ends 7a of studs 7 are roofing trusses 12 supporting roof and ceiling battens 12a, 12b respectively, the latter also providing a fixing point for the top plate 13a of a non-load bearing interior wall 13. Where roof trusses 12 are secured to the building structure intermediate upwardly protruding studs 7a, they are secured to eave beam 11 by a steel truss bracket 14.

15 The wall and floor panels (as well as roof panels when used) are conveniently prefabricated in a jig which locate the structural stud, joist (and rafter) members respectively in an upright position at a predetermined spacing while the outer and or inner sheets are secured thereto by screws and glue. Each of the wall and floor panels (and roof panels where used), the fixing beams, floor joists, roof trusses and the like are all designed to fit
20 within a standard (20/40) foot container such that the structure and cladding of a complete building structure can be delivered on site as a complete prefabricated kit of parts for easy assembly by relatively unskilled labour.

Being architect designed, the building structure is designed primarily for functionality and flexibility in design rather than with rigid dimensional

limitations of "standard" modular components which impose severe constraints on building designs and their functionality. While generally speaking, the height of a prefabricated wall panel is limited either to the internal height or width of a shipping container, this is the only real design
5 constraint as prefabricated panels up to six metres in length can easily fit into a shipping container in an upright or flat position.. The simplicity of the panel assembly procedure enables a set of prefabricated wall, floor and roof panels to be assembled for a particular house design, which, along with other structural elements may be loaded directly into a shipping container as
10 they are produced. While some standardization of panel dimensions is possible it is not a necessity with the system according to the invention.

Building structures permissible with the system according to the invention allow a wide range of housing designs to suit all tastes and otherwise allow great flexibility in floor plans to achieve optimum functionality.

15 FIG. 2 shows schematically a part front elevational view of a wall panel according to one aspect of the invention.

As shown, wall panel 15 comprises window and door apertures 16, 17 respectively formed during panel construction. If required, a window and a door may be fitted during the panel construction. The broken line 18 may
20 represent a joint between adjacent panels 15a, 15b.

FIG. 3 shows, in phantom, a configuration of facing sheets applied to a wall panel.

Typically, a wall panel 6 comprises a plurality of timber wall studs 7 at 600 mm intervals sheeted on the outside with a weatherproof plug such as

marine ply, fibre reinforced cement sheet or the like while the inner side is sheeted with reconstructed timber panelling such as particle board or medium density fibreboard (MDF) or the like. As shown the upper and lower sheeting panels 20, 21 are standard 1200 mm by 2400 mm sheets while the intermediate sheet 22 measuring 600 mm by 2400 mm has a joint seam 23 staggered with respect to joint seams 24 between the upper and lower sheets 20, 21. It is to be understood that any variation known to a skilled addressee may be used. For example, sheet sizes of 1200 mm x 3600 mm and 800 mm x 3600 mm may be applied as appropriate.

Clearly visible in FIG. 3 are the protruding upper and lower ends 7b, 7c respectively wall studs 7. Also visible are the joint splicing members 10 which may be positioned in alternating cavities between adjacent studs 7 to support horizontal joint seams 25. Joint seams 23, 24, 25 may be finished with a weatherproof jointing and taped prior to finishing the wall.

FIG. 4 shows an enlarged cross-sectional view in the direction A-A in FIG. 3.

The wall section shows a stud 7, an outer skin 8 and inner skin sheets 20 and 22 forming a joint 25 supported by a splicing member 10 to which sheets 20 and 22 are screwed and glued. If required a waterproofing and/or insulating membrane 26 may be located between studs 7 and outer skin 8 during fabrication of the wall panel. The interior cavity between adjacent studs and inner and outer sheets is continuous from the top to the bottom of a wall panel and this facilitates easy connection of utilities such as power, gas and water to desired locations within the building structure after the main

structure is erected.

FIGS. 5 and 6 respectively show top plan views of the configuration of intermediate and corner wall joints.

In FIG. 5, a socket and spigot joint is formed between adjacent panels 5 6a, 6b by positioning end stud 7d so that portion of stud 7d protrudes to form a spigot which occupies a socket-like recess formed by locating an opposite side wall stud 7e in a recessed position as shown. The joint is simply glued and screwed for strength and weather resistance.

For a corner joint, a corner panel 6c is formed with a recessed end 10 stud 7e and outer skin 8 terminates beside recessed stud 7e. The corner joint is formed by fixing the protruding flange 28 of inner wall sheet 9 to the end of end stud 7 of an adjacent wall panel 6. After fixing the corner joint a corner trim 29, is fixed to the corner region.

FIG. 7 shows the attachment of a wall panel 6 to a precast concrete 15 slab base 30.

A timber fixing beam 31 is secured or otherwise formed about the periphery of the slab 30. A support ledge 32 formed from a strip of material having the same thickness as inner wall lining sheet 9 is secured to fixing beam 31. Support ledge 32 serves to support the mass of a wall panel 6 20 while fixing screws 33 are inserted via the lower protruding ends of studs 7 into fixing beam 31.

A decorative trim panel 34 of folded sheet steel covers the protruding lower ends of studs 7 with an upright flange 35 and otherwise forms a closure for the open cavities 38 between adjacent studs with a horizontal

flange 36. Horizontal flange 36 also forms a support ledge for a folded strip of metal mesh, forming an insect barrier 39 to the hollow cavities 38 within the wall panels but otherwise allowing for a current of air to flow through the barrier 39 into cavities 38. A skirting strip 40 is then secured to the inner wall

5 at the intersection between wall panel 6 and the upper surface of slab 30.

FIG. 8 shows the attachment of a wall panel to a floor panel supported by a conventional floor support structure.

The floor support structure 41 comprises spaced stumps or columns 42 secured in concrete foundations or the like (not shown). An angle bracket

10 43 secured to each stump or column 42 secures timber or RHS bearers 44 in spaced parallel rows.

A fixing beam 31 is secured via brackets 45 across the ends of each floor joist 4 and the floor joists 44 are in turn fixed to bearers 44 by mounting brackets 46. The floor panels are mounted on bearers 44 in edge to edge

15 abutting relationship to form a work platform from which further construction may be facilitated.

Wall panels 6 are then secured to fixing beams 31 and trimmed in the same manner as described with reference to FIG. 7.

FIGS. 9 and 10 respectively show the attachment of a roof structure

20 based on prefabricated roof trusses and a roof structure based upon prefabricated roof panels.

In FIG. 9, when the walls of the building structure are completed, a timber fixing beam 31 is secured across as least the opposed wall panels 6 supporting the roof structure 50. Prefabricated timber trusses 51 are

supported at 900 mm centres on the fixing beam 31 with the chord 52 resting in the top of fixing beam 31. Each alternate truss is secured via screws or bolts 53 to the upper protruding ends of alternate wall studs 7 and the trusses therebetween are secured to fixing beam 31 by mounting bracket 54
5 extending between the truss 51 and fixing beam 31. The roof structure may then be finished in a conventional manner by roof sheeting 55 supported on roofing battens 56 extending across the trusses 51. A fascia 57, gutter 58 and soffit 59 are all installed in a conventional manner. Similarly, a ceiling 60 of gypsum, MDF, particle board panels or the like then may be fixed to the
10 undersurface of ceiling battens 61 in a conventional manner and, if required, the junction between the ceiling 60 and the inner wall sheet 9 may be trimmed with a cornice or the like not shown.

FIG. 10 shows the attachment of an alternative roof structure in the form of prefabricated roof panels 70 comprising an outer skin 71 of weather
15 resistant ply or the like and an inner skin 72 of particle board or MDF separated by spaced rafter members 73 formed in a jig in a manner similar to the wall panels 6 as hereinbefore described and with parallel hollow cavities 7b between adjacent rafters.

The rafters 73 are spaced at 6500 mm centres such that when
20 supported on fixing beam 31 each rafter 73 may be secured to a respective protruding upper end of a wall stud 6 by screws or bolts 53. In addition, if required, rafters 73 may be secured to fixing beam 31 by mounting brackets 54 extending therebetween. The inner ends of rafters 73 are secured to respective inner ends of rafters of opposing roof panels in a gable roof

structure by brackets (not shown).

As illustrated, the eaves region of the roof panel 70 does not include an inner skin whereby access to the joint between the upper ends of studs 6 and rafters 73 is facilitated as in access to hollow cavities 74 between adjacent rafters for electrical wiring or the like.

A roofing material 75 such as contoured steel sheet, tiles, shingles or the like is secured directly to the outer roof panel skin 71 in an appropriate manner and otherwise the roof is finished in a conventional manner by attachment of a fascia 57 to the ends of rafters 73 and the attachment of a rain water gutter 58 to the fascia. A soffit panel 59 of fibre reinforced cement sheet, weather-proof ply or the like is secured in a conventional manner to the exposed rafters 73 in the region of the eaves.

FIG. 11 shows a part cross-sectional view of a building structure constructed in accordance with the invention.

As illustrated in the drawings, the wall panels 6 all comprise a plurality of hollow channels 38 between adjacent wall studs and these cavities are unimpeded by noggings, top or bottom wall plates thereby allowing easy access for the installation of services after the building has been constructed. These upright hollow cavities also provide a flow path for air to be drawn through the cavities from bottom to top by a convection current generated by solar radiation impinging on the outer wall surfaces. Cooler air from beneath or around the base of the building is drawn into the wall cavities via the insect screened openings as shown in detail in FIGS. 7 and 8 and progresses upwardly into the ceiling cavities 76 and thence into a space

between the opposed upper ends of roof panels supported by brackets 77.

A ridge capping 78 having an enlarged central cavity enables heated air to be exhausted to atmosphere from opposed ends of the capping. As shown, a combination trim/ventilation member 78 is secured over the space
5 between the inner roof panel sheets and allows air to be exhausted from within the building structure. If required, additional interior vents 80 may be provided at the junction between the interior wall and ceiling panel joints to exhaust air from within the structure by a venturi effect due to the air flow within the wall and ceiling cavities.

10 Depending upon the orientation of the structure, the season and the time of day, the convection cooling effect may be enhanced by solar radiation impinging on both an outer wall and at least one side of the roof.

Although the prefabricated modular nature of structures according to the invention lend themselves well to low cost housing for disadvantaged
15 persons, relocatable housing for remote mining camps or the like, the flexibility in design and quality of finishings allows an almost unlimited range of choice in single storey dwelling designs to accommodate a wide range of budgets from standard designs to minimally adapted designs to unique architecturally designed structures.

20 The prefabricated modular nature of the structures coupled with the fact that structural kits or packages are designed to fit neatly into a shipping container offer substantial savings in materials costs, transportation and building construction with unskilled or semi-skilled labour.

It readily will be apparent to a person skilled in the art that many

modifications and variations may be made to the various aspects of the invention without departing from the spirit and scope thereof.

CLAIMS:

1. A prefabricated modular building construction system for a building structure, a system comprising:

5 a plurality of wall panels adapted for interlocking edge to edge abutment, the wall panels each comprising a plurality of spaced parallel stud members secured between opposing facing sheets to define a plurality of parallel hollow chambers, opened at opposing ends thereof;

10 wall panels characterised in that at least some of the stud members protrude beyond upper and lower edges of the wall panel to permit, in use, direct load bearing connection between the wall panel adjacent lower and upper edges thereof to a base structure and a roof structure respectively.

2. The prefabricated modular building construction system of claim 1 wherein each wall panel has an outer facing sheet applied after erection of the wall panel.

15 3. The prefabricated modular building construction system of claim 1 wherein the base structure comprises:

20 a precast concrete slab with fixing beams secured about a perimeter thereof, the fixing beams, in use, forming an anchor structure for fasteners extending through protruding lower ends of stud members of the wall panels.

4. The prefabricated modular building construction system of claim 1 wherein the base structure comprises a plurality of floor panels supported on spaced bearer members, the floor panels each comprising an inner facing sheet with a plurality of spaced parallel joist members secured thereto, the

base structure including fixing beams extending about a perimeter thereof, the fixing beams, in use, forming an anchor structure for fasteners extending through protruding lower ends of stud members of the wall panel.

5. The prefabricated modular building construction system of claim 1
5 wherein the said roof structure comprises a plurality of spaced trusts members extending between said walls of said building structure, said trusts members, in use, being secured directly to respective protruding upper ends of said stud members of said wall panels by fasteners extending there between.

10 6. The prefabricated modular building construction system of claim 1 wherein the roof structure comprises a plurality of edge to edge abutting panels, said roof panels each comprising a plurality of spaced parallel rafter members secured between opposing facing sheets to define a plurality of parallel hollow chambers, opened at the opposing ends thereof, an inner
15 side of an eaves region of each said roof panel being exposed to permit, in use, direct connection between rafter members and prospective protruding upper ends of said stud members of said wall panels by fasteners extending there between.

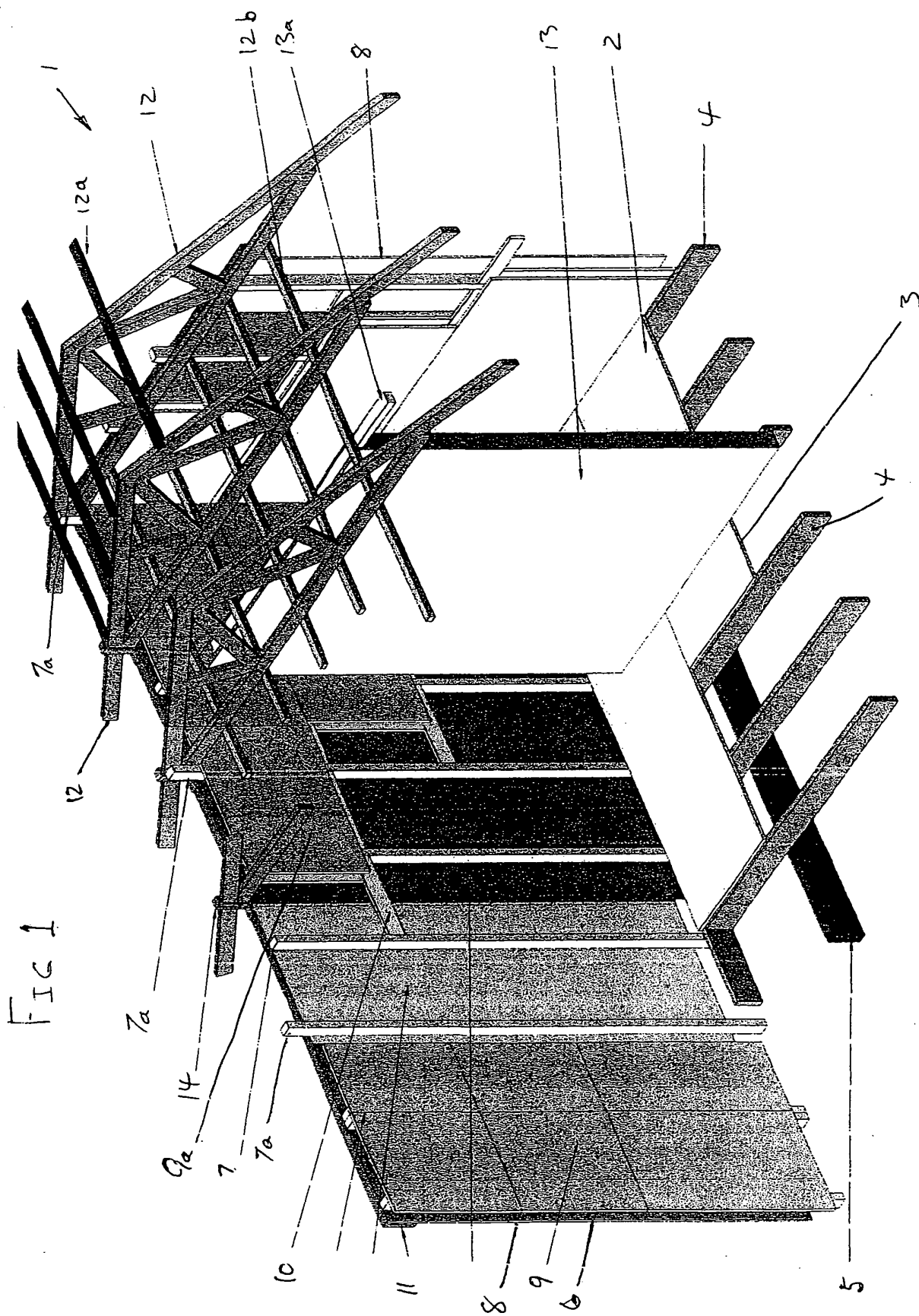
7. The prefabricated modular building construction system of claim 1
20 wherein the roof structure is supported on fixing beams extending adjacent an outer upper edge of opposed walls of said building structure.

8. The prefabricated modular building construction system of claim 1 wherein the parallel hollow chambers of said wall panels communicate with a ceiling cavity of said roof structure whereby, in use, a wall of said building

structure facing solar radiation is cooled by a convection current generated by heating of air within said parallel hollow chambers.

9. The prefabricated modular building construction system of claim 8 wherein heated air accumulating in said ceiling cavity is exhausted by opposite ends of a ridge cap extending along the ridge of a gabled roof structure.

10. The prefabricated modular building construction system of claim 1 wherein components for assembly are dimensioned to fit into a shipping container.



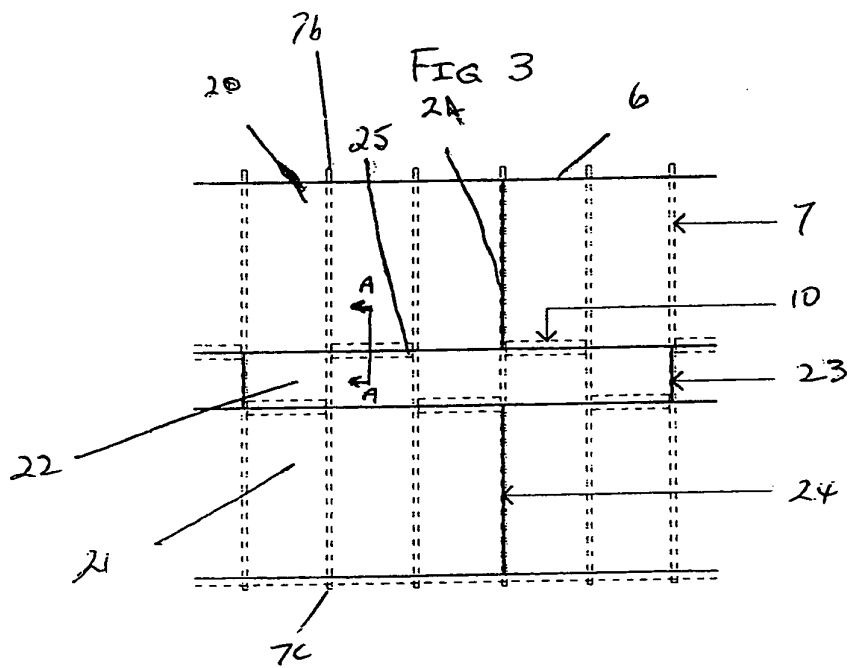
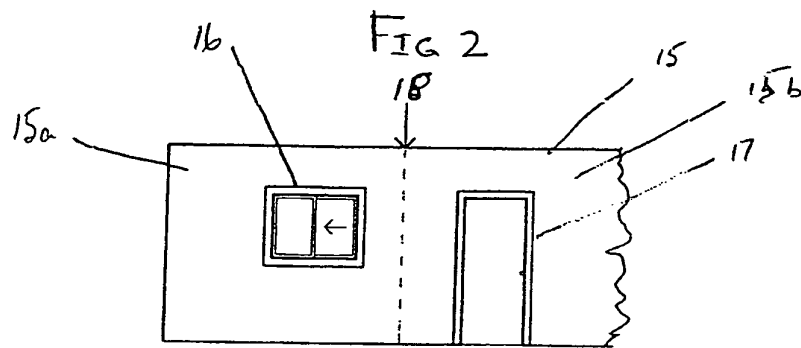


FIG 4

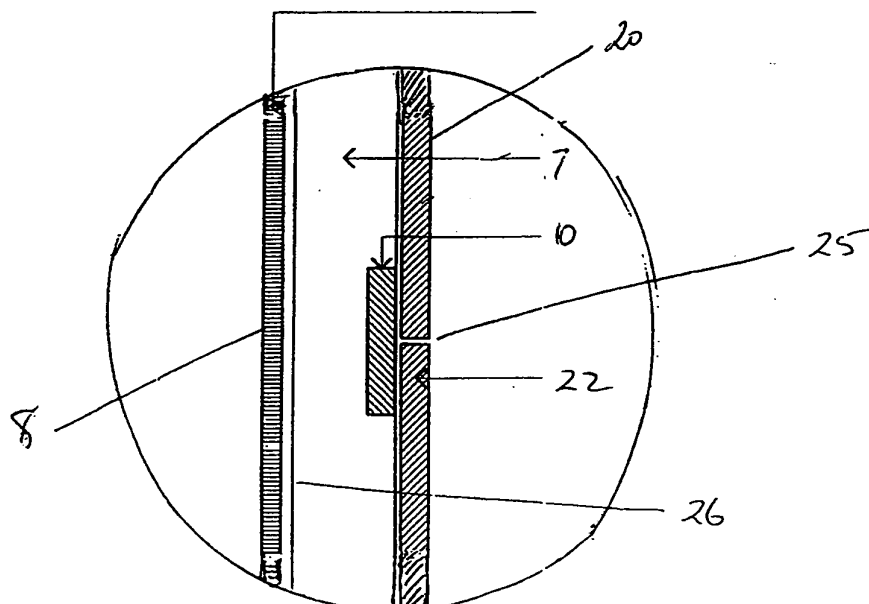


FIG 5

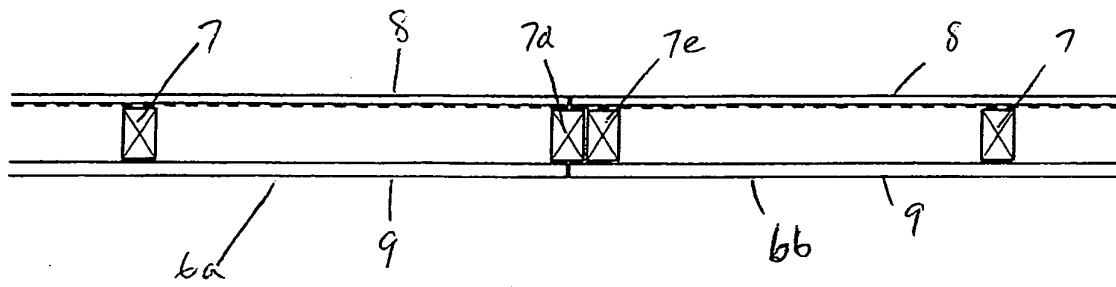


FIG 6

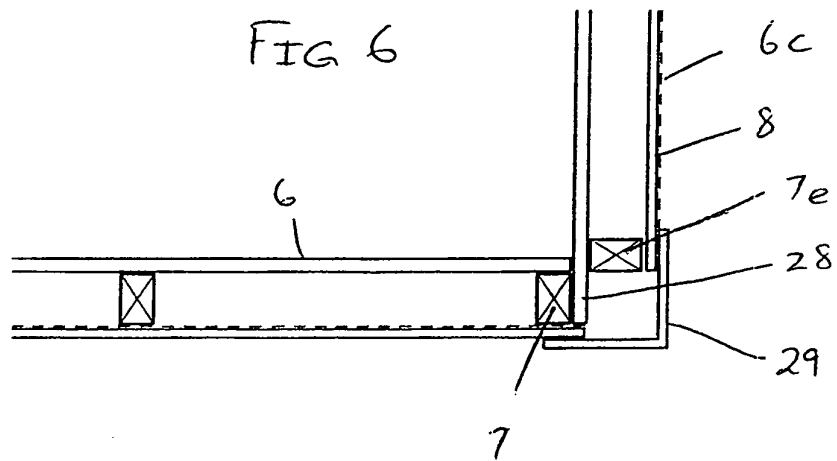


FIG 7

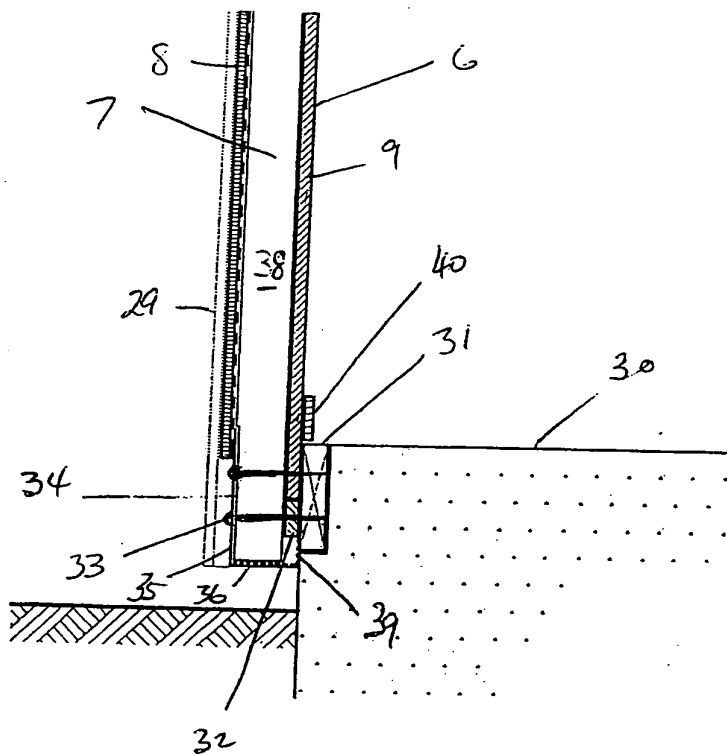


FIG 8

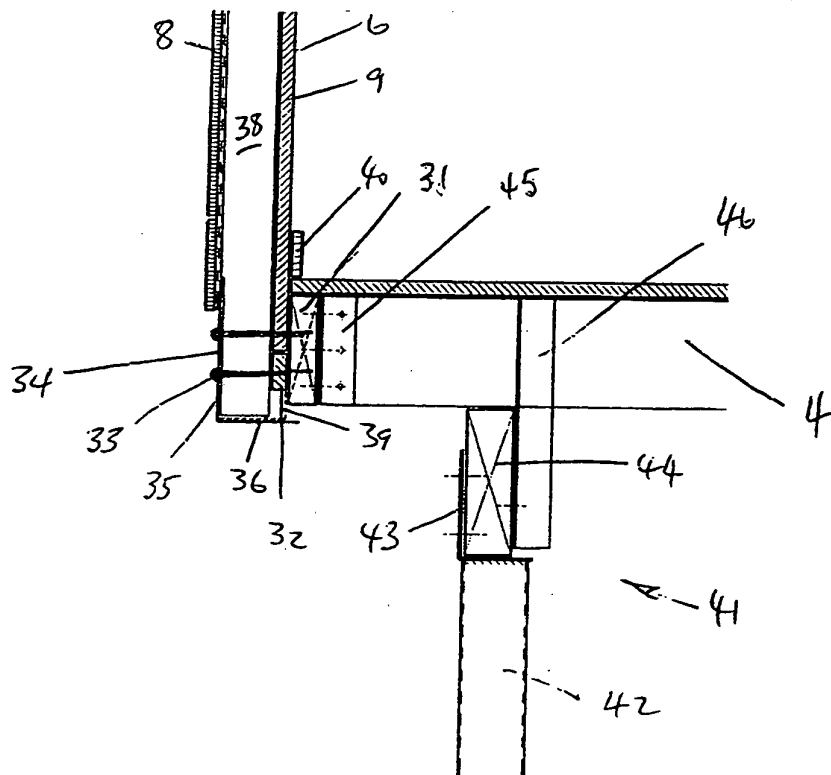


FIG 9

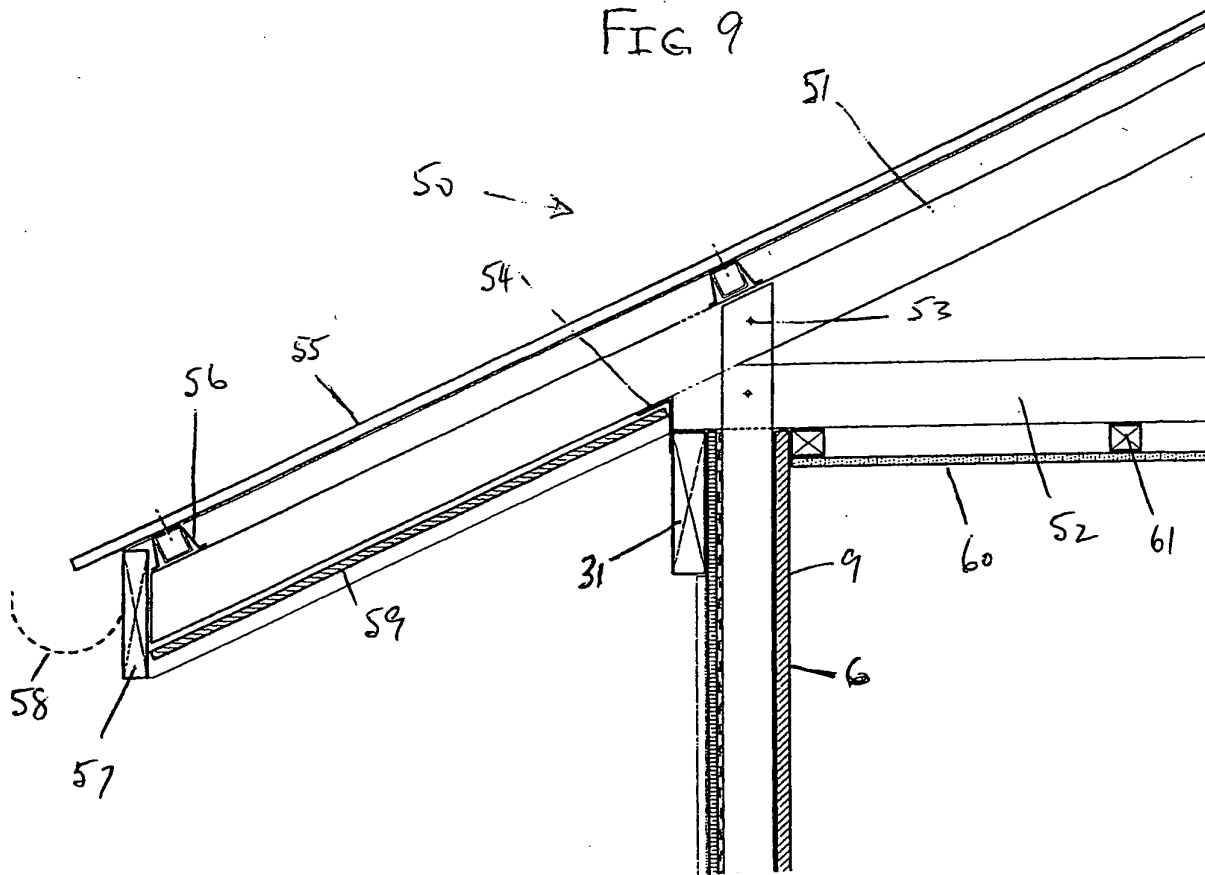


FIG 10

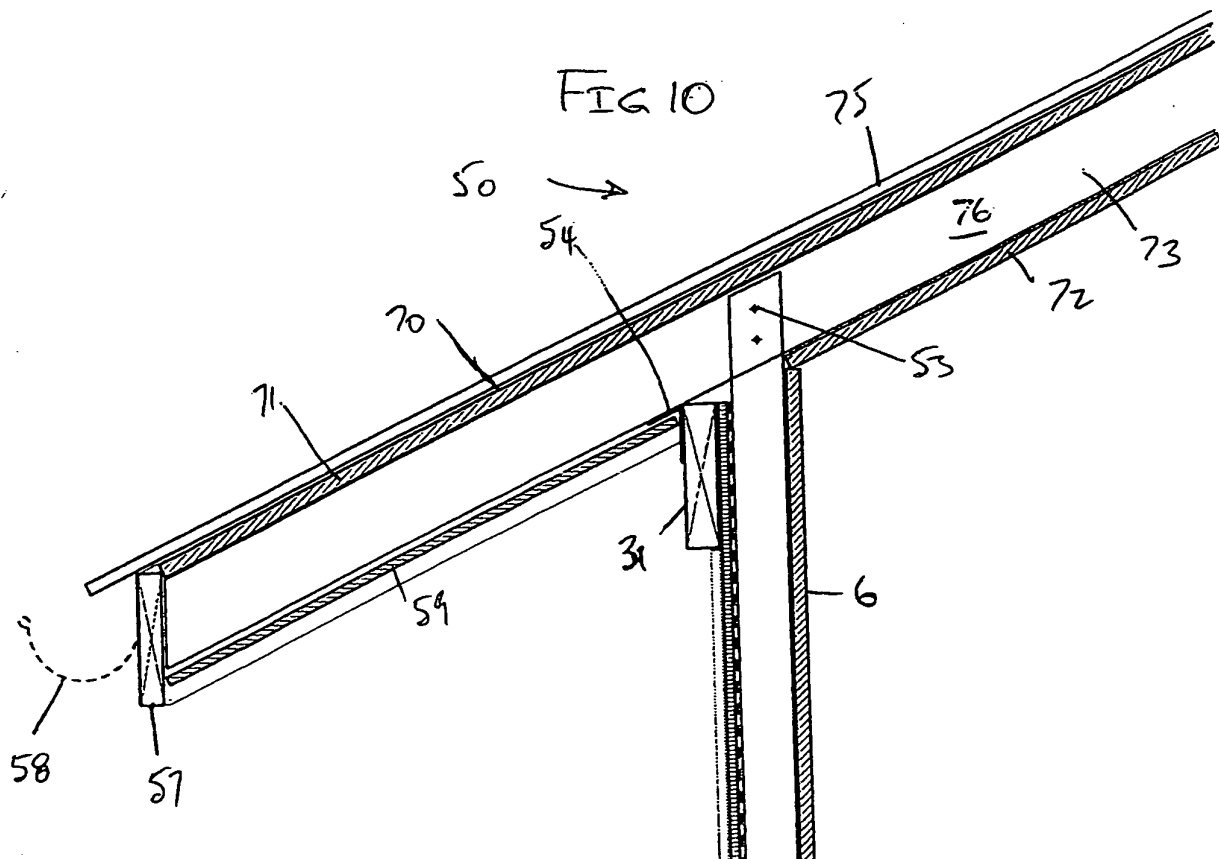


FIG 11

