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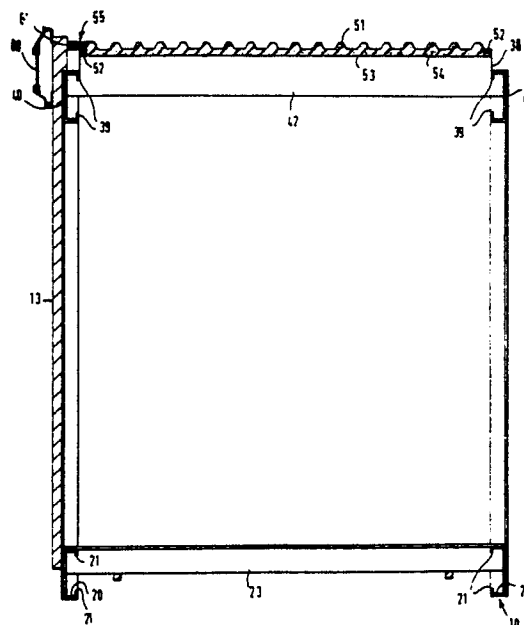
(71) Applicant: **PORTAKABIN LIMITED**
New Lane
Huntington York YO3 9PT(GB)

(72) Inventor: **Stericker, Stephen Wentworth**
21 Tadcaster Road
Copmanthorpe York YO2 3UN(GB)
 Inventor: **Goss, Martin**
2 Ox Close
Stamford Bridge York YO9 1JW(GB)
 Inventor: **Roberts, Peter Mansell**
The White House
Full Sutton York YO4 1HW(GB)
 Inventor: **Boddy, Glyn Thomas**
4 Holly Tree Cottage Main Street
Linton on Ouse York YO6 2AX(GB)

(74) Representative: **Leach, John Nigel et al**
FORRESTER & BOEHMERT
Widenmayerstrasse 4/I
D-8000 München 22(DE)

(54) **Roof structure.**

(57) A roof structure for a building unit of the kind which is factory assembled and self-contained, designed for delivery to a prepared site in an assembled condition complete with all floors (10), walls (12a,12b,13), and preferably, all windows, doors and internal fittings, comprising provision for coupling the units together to form a multi-unit building, the roof structure (11) comprising a pair of spaced parallel roof beams (40), interconnected by a plurality of transversely extending roof joists (41,42), at least one roof panel (50) supported on the roof joists (41,42) and the or each roof panel (10) comprising an external skin of metal (51), an internal skin (53) and an infilling therebetween (54).



"Roof Structure"

This invention relates to a roof structure for a portable building unit.

The portable building unit is factory assembled and self-contained, designed for delivery to a prepared site in an assembled condition complete with floors, walls, and, preferably, all windows, doors and internal fittings. Such units may be assembled together to form a multi-unit building, provision for coupling the units together in the desired arrangement being built into each unit before the unit leaves the factory, so that the only assembly work required on site is that of coupling units together where it is desired to form a multi-unit building.

In some cases the units will include end walls as well as side walls, but alternatively, one or more of such end or side walls may be omitted to permit full width linking of the units. Such a unit building will be described hereinafter as "of the kind specified".

An object of the invention is to provide a new and improved roof structure for a building unit of the kind specified.

According to one aspect of the invention, we provide a roof structure for a building unit of the kind specified comprising a pair of spaced parallel roof beams, interconnected by a plurality of transversely extending roof joists, at least one roof panel supported by the roof joists and the or each roof panel comprising an external skin of metal, an internal skin and an infilling therebetween.

The infilling may comprise thermally insulating material.

The external skin of metal may comprise plastics coated steel.

The internal skin may comprise metal foil and may comprise a paper/foil laminate.

The infilling may be bonded to the external skin.

The infilling may comprise a rigid foamed or expanded plastics material and preferably comprises foamed polyurethane.

The transversely extending roof joists may be disposed at a level so that the top surface thereof is substantially at or above the level of the top surface of the roof beams.

Preferably, the transversely extending roof joists are each disposed at a level which increases from one end of the roof beams towards the other so as to provide a sloping roof.

The roof beams may each have a flange at or adjacent their upper surface which extends inwardly towards the other roof beam and the transversely extending roof joists may be provided with a recess at opposite ends thereof to accommodate said inwardly directed flanges of the roof beams.

By providing the or each roof panel as an external skin of metal, with thermally insulating material sandwiched between the external skin and the internal skin, the roof structure may be regarded in practical terms as "permanent" in that the roof structure has a relatively high tolerance to damage, provides long term weather and pollution durability, resists solar gain and degradation and resists dynamic and static loads.

The external skin may extend as a one-piece skin over the full length of the roof structure from one end of a roof beam to the opposite end thereof.

The or each roof panel may be provided with a peripheral frame of material more rigid than the infilling for example softwood, and may be provided with intermediate spacers or studs of material more rigid than the infilling.

The roof structure may be provided with fascia around the whole of its periphery, the fascia having upper and lower edges at a constant horizontal level throughout the periphery.

The provision of such a fascia provides the roof structure with a visual appearance of the roof panel or panels being horizontal, even though the roof panels are sloping since the roof panels are hidden by the fascia which is level.

The fascia may conceal a rainwater gutter at the lower end of the roof structure.

A suspended ceiling may be suspended from the roof joists, the length of the suspension means varying along the length of the roof structure so as to provide a level ceiling despite the varying height of the roof joists.

According to another aspect of the invention, we provide a building unit of the kind specified provided with a roof structure according to the first aspect of the invention.

The building unit may comprise a rigid frame carrying wall and floor panels, the frame comprising a rectangular floor sub-frame comprising a pair of spaced parallel floor beams connected together by transversely extending floor joists, a plurality of vertical columns extending upwardly from the floor sub-frame and carrying the roof structure.

At least one side or end of the frame may be provided with at least one panel to provide an end or side wall, the or each panel comprising a structural sandwich comprising an outer metal sheet and an inner sheet sandwiching therebetween an infilling.

The infilling of the or each end or side wall panel may be bonded to the outer sheet and may comprise thermally insulating material. The infilling may be a rigid foamed or expanded plastics material, and preferably comprises foamed polyurethane.

The or each wall panel may comprise an external skin of plastics coated steel and an internal skin of hardboard, plasterboard, or the like, for example 9mm thick plasterboard, on a wooden frame and infilled with rigid polyurethane foam.

The internal skin of the or each wall panel may be clad internally with plasterboard providing a fire resistance.

The roof structure may comprise a welded steel frame comprising channel roof beams and channel roof joists.

The floor sub-frame may comprise a welded steel frame comprising channel side beams, channel joists and may have two steel runners.

At least one floor panel may be supported on the floor sub-frame.

The columns may each comprise a steel angle member fastened to the floor sub-frame and to the roof structure.

According to a third aspect of the invention, we provide a building unit according to the second aspect of the invention stacked on top of another building unit of the kind specified.

The other unit may be similar to the building unit of the second aspect of the invention except for the absence of a roof panel or the presence of a roof panel of a different construction.

A fascia may be provided between the upper and lower units to protect the roof frame of the lower unit.

According to a fourth aspect of the invention, we provide two building units each according to the second aspect of the invention and connected together in side-by-side or end-to-end relationship.

If desired, the building units of the fourth aspect of the invention may each be stacked on top of one or two stacked other building units of the kind specified to form a two or three storey building respectively. Each of the other building units may be similar to the building units of the second aspect of the invention except for the absence of a roof panel or the presence of a roof panel of different construction.

The invention will now be described in more detail, by way of example, with reference to the accompanying drawings, wherein:-

FIGURE 1 is a side elevation of a portable building unit embodying the invention;

FIGURE 2 is an end elevation seen in the direction of the arrow A in Figure 1;

FIGURE 3 is an end elevation looking in the direction of the arrow B in Figure 1;

FIGURE 4 is a section on the line 4-4 of Figure 2;

FIGURE 5 is a section on the line 5-5 of Figure 4; and

FIGURES 6 and 7 are fragmentary cross-sectional views to an enlarged scale on the lines 6-6 and 7-7 respectively of Figure 2.

Referring to the drawings, there is illustrated a portable building unit intended to be linked to a similar building unit in side-by-side relationship. The building unit is of generally rectangular box-like configuration and comprises a floor structure 10, a roof structure 11, a pair of end walls 12a, 12b and a single side wall 13. No side wall is provided on the side of the unit which is to be linked to the similar unit.

If desired, a portable building unit embodying the present invention may comprise a single one of the building unit illustrated and in this case the building unit would be identical to the unit illustrated except that a second side wall, opposite to the side wall 13, would be provided.

It will also be appreciated that if desired, a building construction embodying the invention may comprise three or more building units, the building units may be linked together in side-by-side relationship or end-to-end relationship or any desired combination of such arrangements.

In each case, if desired, appropriate end or side walls is or are omitted from the linked-together units.

Alternatively, if desired, when two, or more than two, of the building units are linked together, each building unit may be provided with all its sides and end walls but with openings or doors provided in adjacent walls to permit intercommunication between the units. In certain circumstances it may be desired to provide a building construction comprising two or more units but with no communication between the units, although communication may be provided by way of a relatively small opening or merely by way of a window.

In all the above cases however, the building unit or units concerned are identical to the unit to be described hereinafter, except for the differences identified above, namely the presence or absence of the relevant side and/or end walls.

If desired, one or more building units embodying the invention may be stacked on a building unit or units which are similar, except for the absence of or a different construction of roof panel hereinafter to be described.

Each building unit comprises a rigid steel frame upon which floor, wall, roof and/or ceiling panels are mounted. The frame comprises a floor sub-frame 14 and a roof sub-frame 15 which comprises part of a roof structure. The sub-frames are interconnected by vertical columns 16. The floor

sub-frame 14 is a welded construction and comprises a pair of parallel side beams 20 of channel configuration having intumed lips 21 at the free ends of the limbs of the channel. The side beams 20 are connected together by channel configuration end joists 22 and intermediate joists 23. The end joists 22 have an intumed lip at the free ends of both the limbs of the channel, whilst the intermediate joists 23 have an intumed lip only at the free end of the upper limb of the channel. A portion (not shown) is cut out from the upper corner of each joist 23 to provide a recess to accommodate the top limb and downwardly turned lip 21 of the side beams 20. A pair of channel section runners 25 are welded to the underside of the joists 22, 23.

A floor deck comprising wood particle board in the form of panels 26 is fastened to the joists 22, 23 and side beams 20 with an underdrawing of bitumen-impregnated fibreboard, and mineral fibre insulation is laid between the joists on top of the underdrawing 27. If desired, the floor deck may be of other suitable construction, for example the panels 26 may comprise plywood.

The connection between the side beams 20 and end joists 22 comprises an angle section member to the lower end of which is welded a gusset plate which overlies, and is welded to, the upwardly facing surface of the lower limb of the beam 20 within the upturned lip 21. The upper and lower limbs of the end joists 22 are cut away to accommodate the end of the beam 20 and the web part of the end joist is welded to one of the gusset plate, whilst the other limb is welded to the web of the beam 20.

The intermediate joists 23 are welded directly to the side beams 20, 20a and again have a portion cut out from the upper corner to accommodate the top limb and downwardly turned lip 21a of the side beams.

The roof structure comprises spaced parallel side beams 40 of channel configuration having intumed lips 39 at the free ends of the limbs of the channel. The roof side beams 40 are connected together by channel end joists 41 having intumed lips at the free ends of the limbs of the channel, and intermediate joists 42 which are welded to the side beams 40 in a similar manner that the joists 22, 23 are welded to the side beams of the floor frame. Again, appropriate cut-outs 38 provide recesses at the upper corners of the joists, and the connection between the roof beams 40 and the end joists 41 uses an angle member and gusset plate as described in connection with the floor sub-frame.

The roof structure differs from the floor sub-frame in that the joists 41 and 42 are arranged at a different level along the length of the roof beams 40, as best shown in Figure 4. More particularly, at

the left hand end of Figure 4, hereinafter referred to as the low end L, the end roof joist 41 has the upper surface of its upper limb 41a slightly below the upper surface of the top limb of the roof beam 40, whilst at the opposite end of the roof structure, hereinafter referred to as the high end H, the end roof joist 41 projects above the top of the roof beams 41 by approximately half of its height, whilst the intermediate roof joists 42 are disposed at intermediate heights to provide a rectilinear gradient between the end roof joists.

In addition, the spacing of the joists is different in that the distance between two joists in the roof structure is occupied by three joists in the floor frame.

If required, the roof beams 40 may be bowed before being internally and externally clad, as hereinafter described, so that when they are subjected to the static load imposed by the cladding, they straighten out.

Plasterboard ceiling panels (not shown) may be suspended by clips comprising a one-piece cold rolled section clipped to the lower limb of the associated roof joist, the length of the clips varying from roof joist to roof joist to accommodate the different level of roof joists whilst providing a horizontal ceiling. If desired, other material may be used for the ceiling panels such as mineral fibre board. If desired, such suspended ceilings may be installed on site.

A roof deck 50 is provided and supported on the roof joists 41, 42. The roof deck comprises a single panel which extends over the whole length of the roof structure from the high end to the low end and over the whole width of the roof structure. The roof panel comprises a one-piece polyurethane foamed filled sandwich panel comprising external skin of plastic coated galvanised mild steel sheet 51 of desired profile. Bonded by suitable adhesive to the internal surface of the steel skin 51 is a softwood perimeter frame 52 and intermediate studs of high density profiled foam/ply composite (not shown). The panel has an internal skin 53 of foil faced building paper and injected therebetween is rigid polyurethane foam 54 which is bonded to the internal surface of the steel skin 51 and to the internal surface of the foil faced building paper 53. The plastic coated steel sheet may extend as a single sheet over the whole width of the panel or comprise a plurality, for example three, sheets, each of which extend over the full length of the roof structure from the high end to the low end but which are disposed in side-by-side relationship with edge corrugations which overlap and are sealed together by an interposed bead of elastomeric material.

The roof panel is fastened to the joists 41, 42 by wood screws driven upwardly through apertures in the joists and into the intermediate studs of the roof panel.

If desired, the roof panels may be made of different material, for example the infilling may be made of any suitable thermal insulating material and the peripheral frame may be made of any other suitable material than softwood. The internal skin may be made of a steel lining instead of the foil faced building paper and the external surface may be made of other metal such as aluminium.

As best shown in Figure 5, an infill 60, comprising a plywood panel having laminated thereto foamed insulation material, is spaced above the one roof beam 40 provided with the side wall 13 and hence there is a gap between the infill and the beam, which varies along the length of the beam. A suitable weatherproofing membrane material, such as Hypalon, is provided to cover the infill 60 and the top of the panel which provides the side wall 13 to form a seal with the roof panels and completes the insulation, to prevent cold bridging and possible condensation problems. At each side of the roof panel a steel flashing, not shown, is provided over the top of the side walls and the end corrugation of the roof panel. Where the unit is disposed side-by-side with an identical unit, a suitable flashing is provided to extend over the adjacent end corrugations of the end panels of the units.

The roof structure and floor sub-frame described hereinbefore are interconnected in spaced parallel relation by columns 16 which are bolted to the side beams 20 and 40 of the floor sub-frame and roof structure. The columns at the high and low end of the building unit are of the same height, the slope of the roof being provided by the different level of the roof joists 41, 42. In the present example, the slope of the roof is approximately 1° to ensure positive water shedding and avoiding the risk of water pooling on the roof. If desired, other slopes may be used but it is preferred that the slopes exceed one in sixty.

Each end wall 12 a, 12b, and the side wall 13 is provided by a single structural panel comprising an outer plastics coated galvanised mild steel sheet 70 bonded to a softwood frame 71 with hardboard or 9mm thick plasterboard internal panelling 72 nailed to the frame 71 with a rigid polyurethane foam infilling 73 therebetween. An internal lining of 12.5mm thick fibre reinforced plasterboard may be bonded to the 9mm thick plasterboard and also nailed to the frame.

The frame for each side and end wall panel comprises top and bottom rails interconnected by vertical end rails with intermediate vertical rails therebetween. The spacing between the rails is such that every rail is located at the junction be-

tween adjacent sheets of the plastics coated steel panel. The steel sheets are connected together by interlocking double folded seams as described in our previous Patent Specification No. 1,520,272.

The vertical end frame members are secured to the vertical columns 16 by screws driven from the interior of the unit and the top and bottom rails are nailed to the associated side beams 20, 40 of the floor sub-frame and roof structure or end joist members thereof.

A facia arrangement 80 is shown at the high end of the unit and comprises a facia panel 81 and a lipped channel configuration facia mounting element 82, screwed to a wall panel 83, screwed to an associated roof joist 41. The facia panel 81 is maintained in the element 82 by its own weight and an adhesive sealing strip which locates it against the back faces of the lipped channels. At the low end, the unit is provided with a facia arrangement 84 comprising a facia panel 85 identical with the panel 81 and a facia mounting element 86 of such configuration as to accommodate a concealed gutter 87, and which is fixed to the peripheral frame of the roof panels so that the upper edge of the facia panel 85 is in the same horizontal plane as the upper edge of the facia panel 81. In addition, a facia panel 88 of the same configuration as the panels 81 extends along the side wall 13 provided with the wall panel and thus masks the fall in height of the roof. This longitudinally extending facia panel 88 is mounted on the unit by facia mounting elements, identical to the elements 82, which are fixed to the ply/foam infill 60.

Where the building unit is provided with a wall panel on both long sides, then of course a further facia panel assembly, identical to the panel assembly 88, 89, is provided on both sides of the building unit.

Where the building units are connected together in end-to-end relationship, then an appropriate facia element is omitted and suitable ridge or valley gutter components provided.

Other details of the building unit and its connection or stacking to similar units are described in our published specification No. 2,084,213B except that instead of the HYPALON (Registered Trade Mark) sheeting being folded around the ends of the peripheral frames and associated beams 40, there are provided metal trims and flashings.

Where the building unit above described is to be stacked on one similar unit, or two, stacked similar units, to provide a top storey of a two or three storey building, respectively, the or each similar building unit does not have a roof panel as described above but is preferably provided with a temporary weatherproof roof comprising a panel with a weatherproof membrane which affords protection in storage and during transport until a unit

with a roof panel as described above is stacked thereon. The panel comprises a particle board decking fastened to cold formed second members with a membrane to prevent ingress of moisture.

The features disclosed in the foregoing description, or the accompanying drawings, expressed in their specific forms or in terms of a means for performing the disclosed function, or a method or process for attaining the disclosed result, or a class or group of substances or compositions, as appropriate, may, separately or in any combination of such features, be utilised for realising the invention in diverse forms thereof.

Claims

1. A roof structure for a building unit comprising a pair of spaced parallel roof beams, interconnected by a plurality of transversely extending roof joists, at least one roof panel supported by the roof joists and the or each roof panel comprising an external skin of metal, an internal skin and an infilling therebetween.

2. A structure according to Claim 1 wherein the external skin comprises plastic coated steel.

3. A structure according to claim 1 or claim 2 wherein the internal skin comprises metal foil.

4. A structure according to any one of the preceding claims wherein the transversely extending roof joists are disposed at a level so that the top surfaces thereof are substantially at or above the level of the top surfaces of the roof beams.

5. A structure according to any one of the preceding claims wherein the transversely extending roof joists are each disposed at a level which increases from one end of the roof beams towards the other so as to provide a sloping roof.

6. A structure according to any one of the preceding claims wherein the roof beams each have a flange at or adjacent their upper surface which extends inwardly towards the other roof beam, and the transversely extending roof joists are provided with a recess at opposite ends thereof to accommodate said inwardly directed flanges of the roof beams.

7. A structure according to any one of the preceding claims wherein the external skin extends as a one piece skin over the full length of the roof structure from one end of the roof beams to the opposite end thereof.

8. A structure according to any one of the preceding claims wherein the or each roof panel is provided with a peripheral frame of material more rigid than the infilling.

9. A structure according to any one of the preceding claims wherein the roof structure is provided with a fascia around the whole of its periphery, the fascia having upper and lower edges at a constant horizontal level throughout the periphery.

10. A structure according to Claim 5 or any one of Claims 8 to 7 when appendant to Claim 5 wherein a suspended ceiling is suspended from the roof joists by suspension means, the length of the suspension means varying along the length of the roof structure so as to provide a level ceiling despite the varying height of the roof joists.

11. A building unit having a roof structure according to any one of claims 1 to 18.

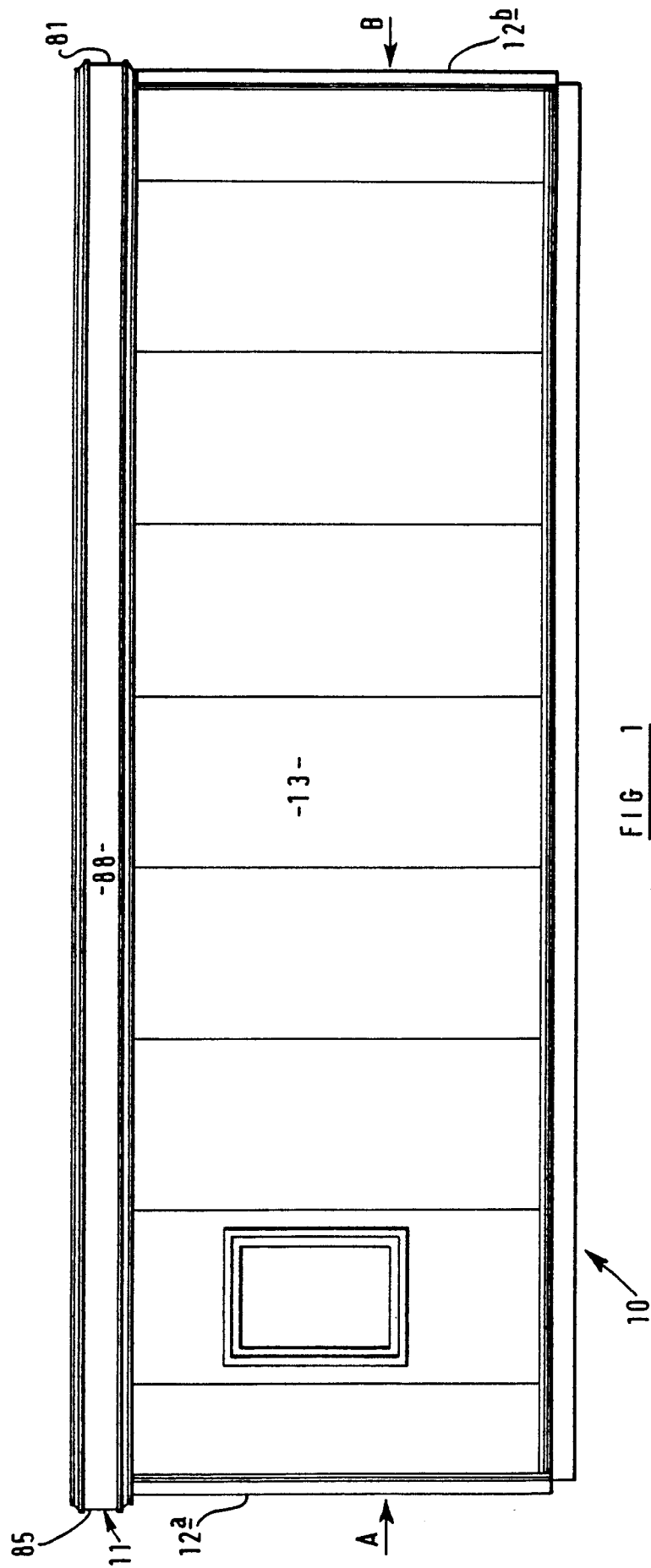
12. A unit according to claim 11 wherein the building unit comprises a rigid frame carrying wall and floor panels, the frame comprising a rectangular floor sub-frame comprising a pair of spaced parallel floor beams connected together by transversely extending floor joists, a plurality of vertical columns extending upwardly from the floor sub-frame and carrying the roof structure.

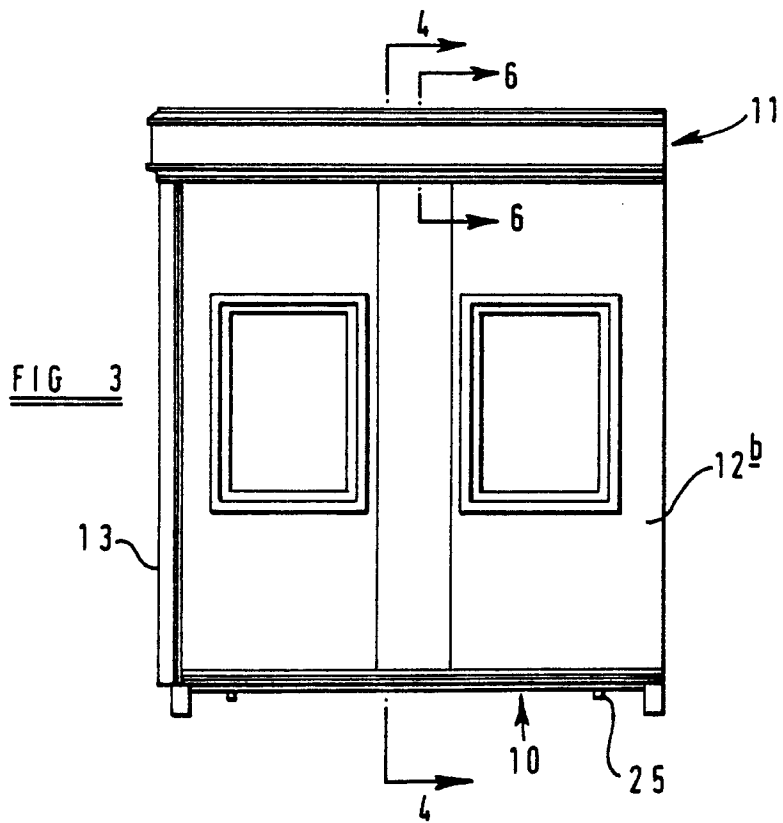
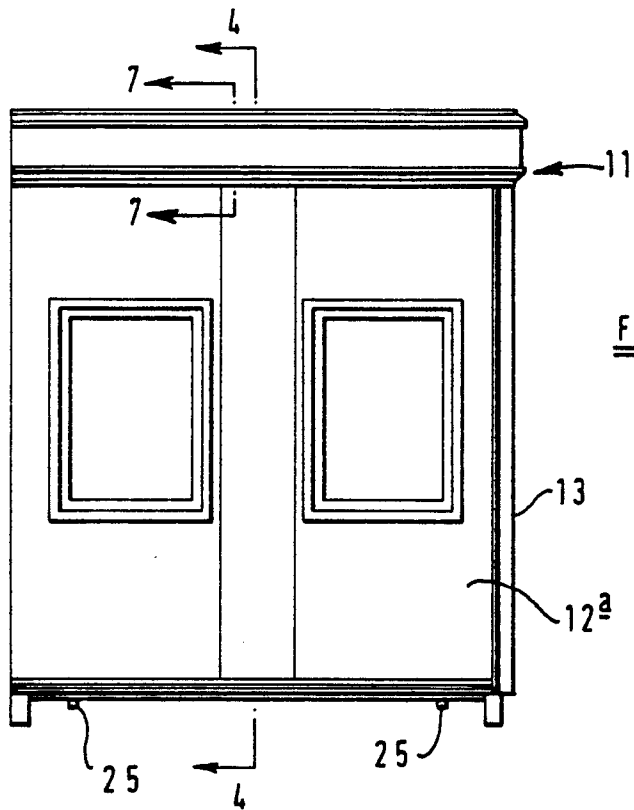
13. A unit according to claim 12 wherein at least one side or end of the frame is provided with at least one panel to provide an end or side wall, the or each panel comprising a structural sandwich comprising an outer metal sheet and an inner sheet sandwiching therebetween an infilling.

14. A unit according to Claim 13 wherein the or each wall panel comprises an external skin of plastics coated steel and an internal skin of hardboard or plasterboard on a wooden frame and infilled with rigid polyurethane foam.

15. A unit according to any one of Claims 11 to 14 wherein the roof structure comprises a welded steel frame comprising channel roof beams and channel roof joists.

16. A unit according to Claim 12 or any one of Claims 13 to 15 where appendant to Claim 12 wherein the floor sub-frame comprises a welded steel frame comprising channel side beams and channel floor joists.





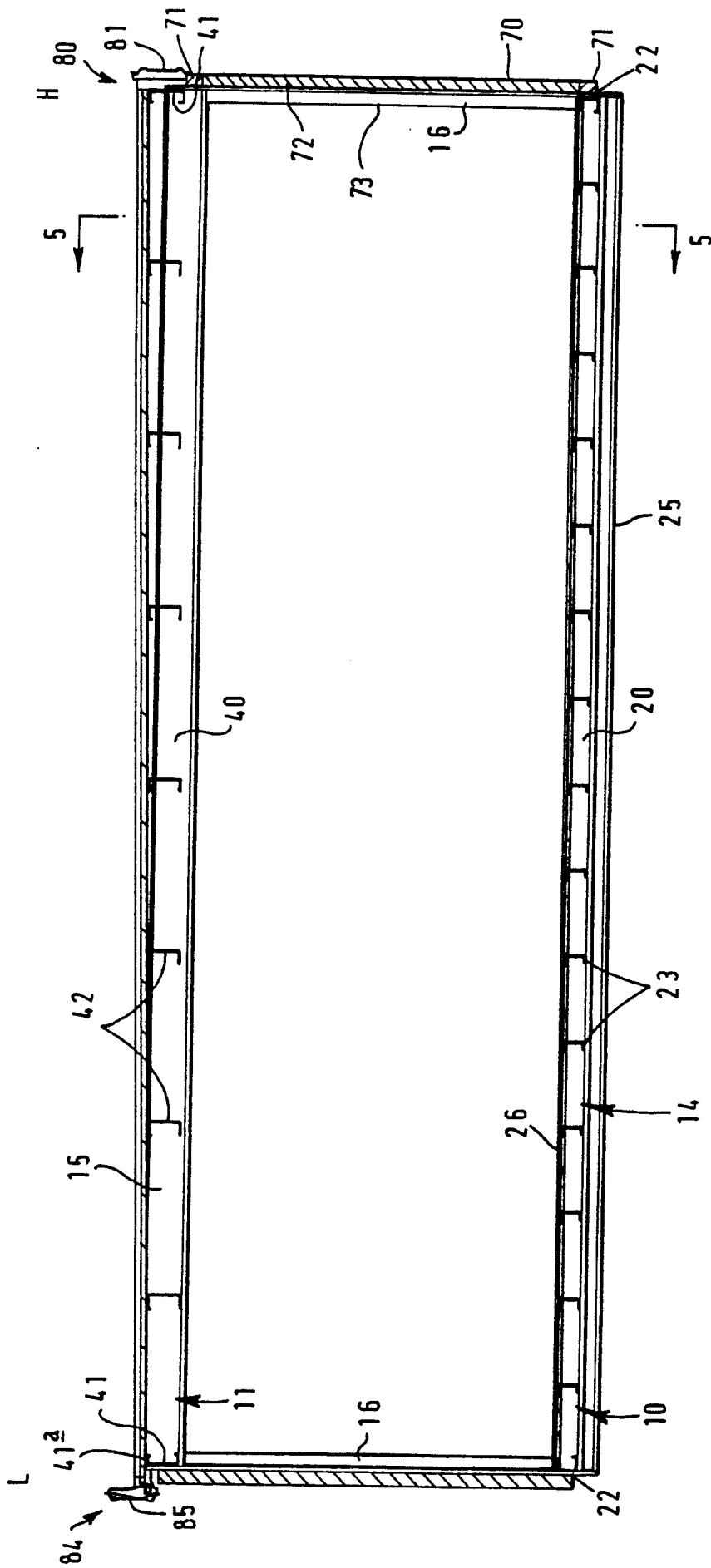
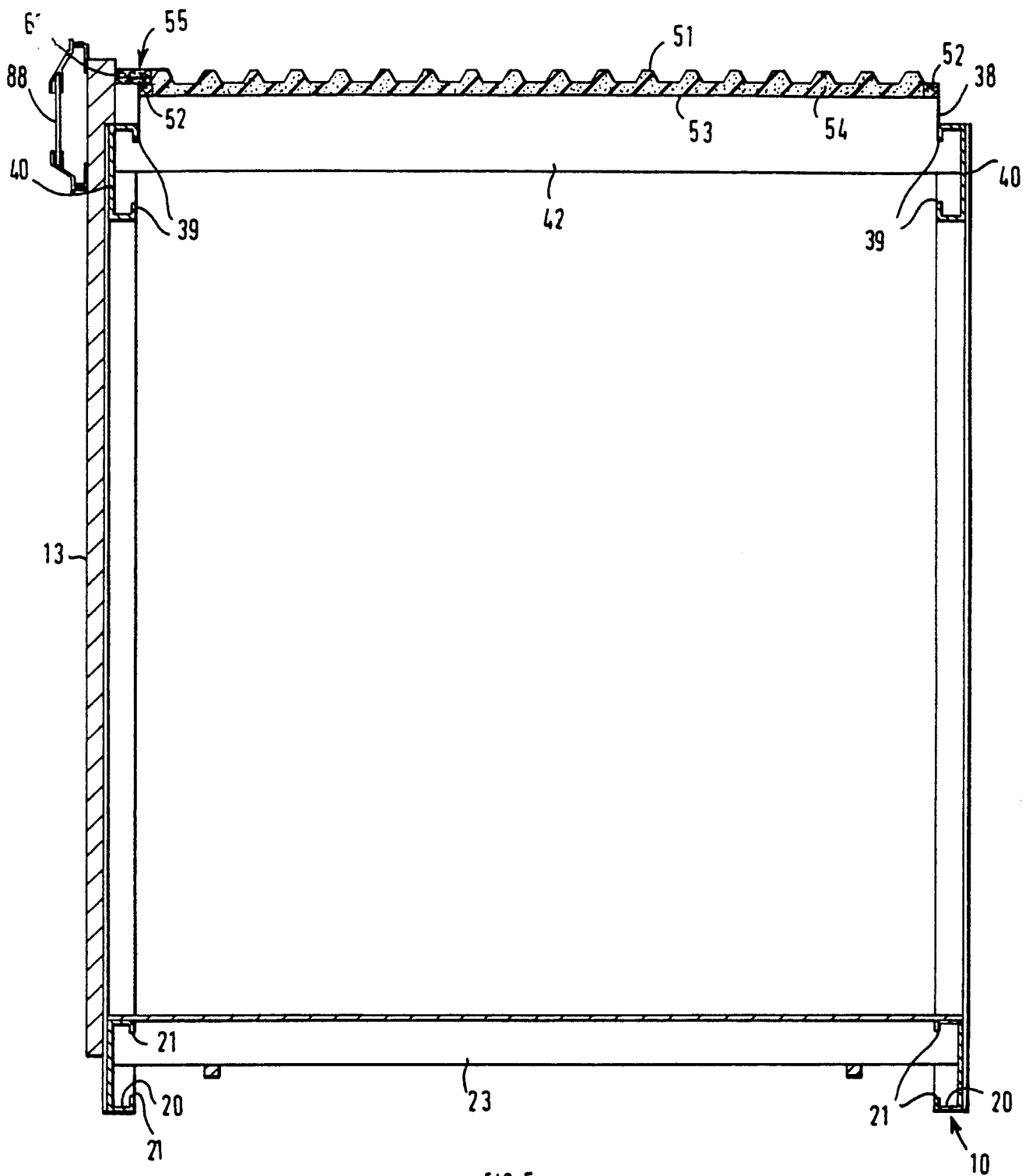


FIG 4



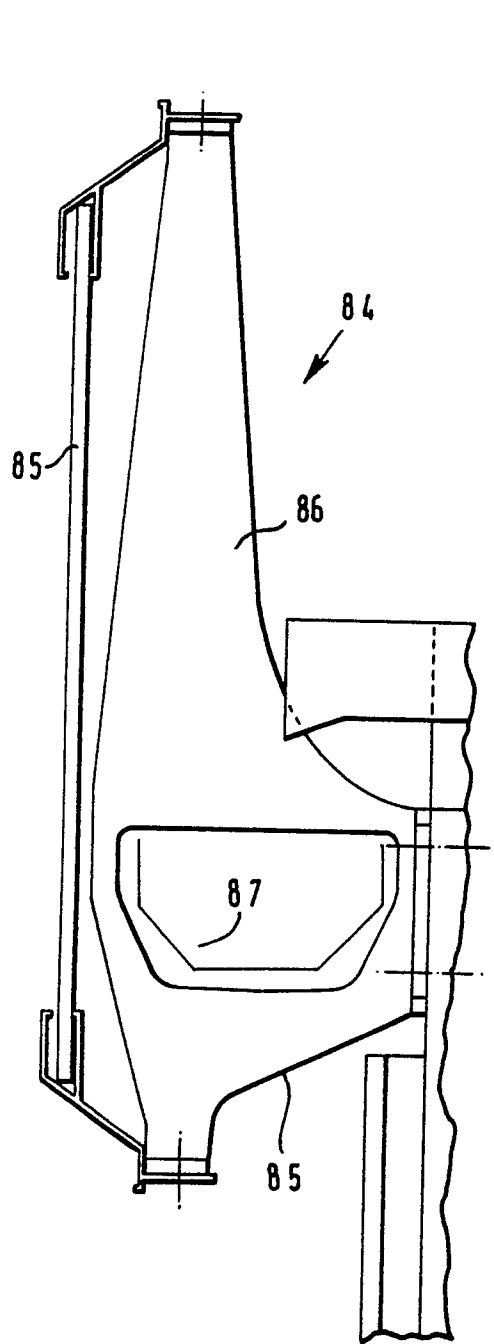


FIG 7

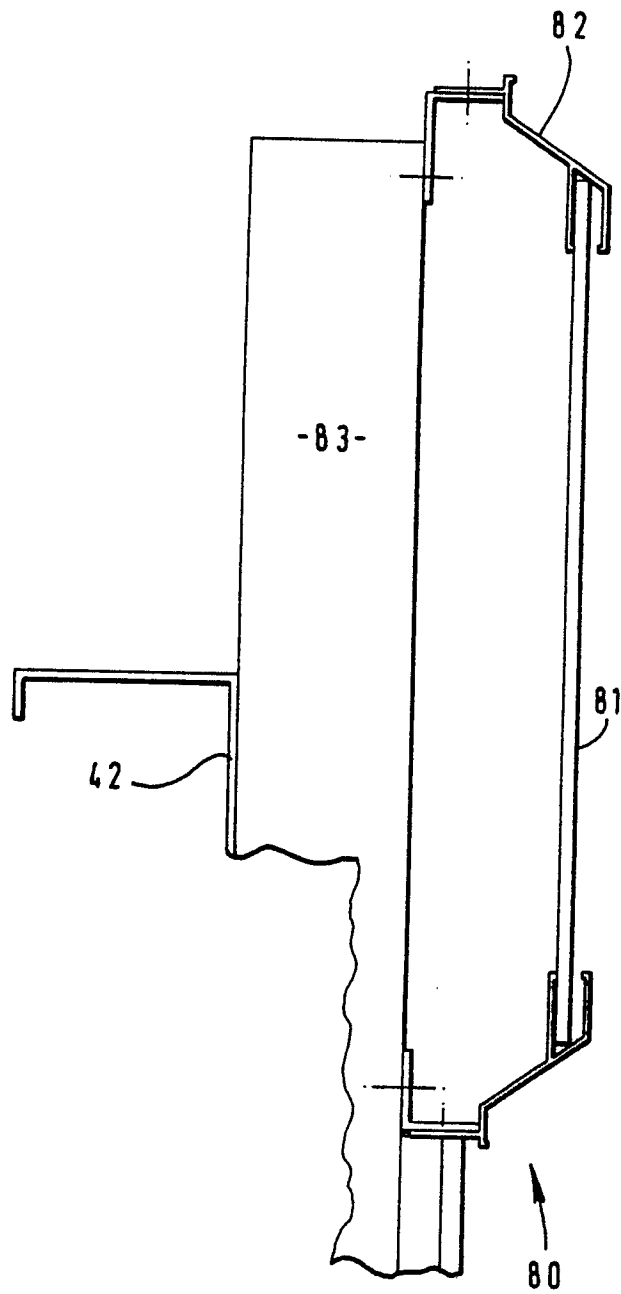


FIG 6



EP 86 11 3857

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. 4)
X,D	GB-A-2 084 213 (PORTAKABIN) * Page 1; page 2, lines 1-34, 105-130; page 3, lines 1-22, 50-81, 112-130; page 4, lines 1-15; claims; figures *	1, 2, 6, 8, 9, 11-16	E 04 B 7/00 E 04 D 3/35 E 04 B 1/348
Y	---	3, 4, 5, 7, 10	
Y	EP-A-0 058 354 (PORTAKABIN) * Claim 6; figures *	3	
Y	---	3	
Y	US-A-3 307 306 (OLIVER) * Page 2, column 2, lines 33-45; figure 1 *		TECHNICAL FIELDS SEARCHED (Int. Cl. 4)
Y	---	4, 5, 10	E 04 B E 04 D
A	---	4, 5	
A	US-A-3 869 836 (ALLEN) * Column 3, lines 28-50; figures 1, 3 *		
	---	5	
	US-A-4 106 243 (HORN) * Column 3, lines 13-68; column 4; column 5, lines 1, 2; figures 2, 3, 5 *		

The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 15-05-1987	Examiner CHESNEAUX J.C.
CATEGORY OF CITED DOCUMENTS			
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	



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DOCUMENTS CONSIDERED TO BE RELEVANT			Page 2
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. 4)
A	GB-A-2 049 015 (C.C.G.) * Page 1, lines 51-60; figures *	1	
Y	--- EP-A-0 105 406 (PORTAKABIN) * Page 7, lines 34-36; page 8, lines 1-8; figures 4,5 *	7	
A	--- FR-A-2 270 398 (SOMI) * Figures 1,2 *	7	
E	--- GB-A-2 173 229 (PORTAKABIN) * The whole document *	1-16	
			TECHNICAL FIELDS SEARCHED (Int. Cl. 4)
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 15-05-1987	Examiner CHESNEAUX J.C.
CATEGORY OF CITED DOCUMENTS			
X : particularly relevant if taken alone		T : theory or principle underlying the invention	
Y : particularly relevant if combined with another document of the same category		E : earlier patent document, but published on, or after the filing date	
A : technological background		D : document cited in the application	
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P : intermediate document		& : member of the same patent family, corresponding document	