(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 799 941 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
08.10.1997 Bulletin 1997/41

(51) Int. Cl.[6]: **E04B 1/348**

(21) Application number: **97105306.1**

(22) Date of filing: **27.03.1997**

(84) Designated Contracting States:
BE DE FR GB NL

(30) Priority: **02.04.1996 GB 9606967**

(71) Applicant: **PORTAKABIN LIMITED**
Huntington York Y03 9PT (GB)

(72) Inventors:
- **Botham, Stephen Charles**
  Stockton on the Forrest, York YO3 9UT (GB)
- **Hoggarth, Christopher John**
  Huntington, York YO3 9RQ (GB)

(74) Representative: **Leach, John Nigel et al**
FORRESTER & BOEHMERT
Franz-Joseph-Strasse 38
80801 München (DE)

(54) Floor structure

(57) A floor structure (10) in or for a building unit, the floor structure comprising a floor frame comprising a pair of side beams (11,12) connected together by transversely extending joists (16-18), a floor panel (30) supported on the floor frame and an under-drawing (33) spaced from the floor panel (30) with the joists (16-18) disposed between the floor panel (30) and the under-drawing (33), characterised in that the under-drawing (33) provides a stress skin construction of the floor structure (10).

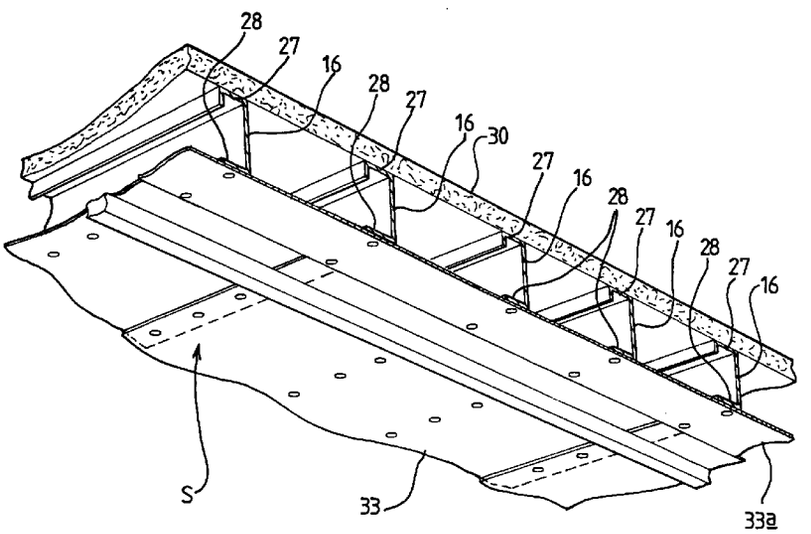


FIG 5

EP 0 799 941 A1

Description

Description of Invention

This invention relates to a floor structure in or for a building unit. The building is preferably a portable building unit which is factory assembled for delivery to a prepared site in assembled condition.

EP-B-0,058,354, EP-B-0,105,406 and GB-B-2,084,213 each disclose an example of such a portable building unit which may be intended, once delivered, to occupy a site, permanently or to occupy the site temporarily and then be transported to a further site.

EP-B-0,039,592 discloses an example of a building unit which is intended to be transported in a pack for erection when delivered to a suitable site.

GB-A-2,291,446 discloses a floor structure in which insulation material is disposed between a floor panel and an under-drawing and is bonded thereto in order to achieve a structure of desired strength. The floor structure is of reduced height between the floor panel and the under-drawing sheet in the region between the joists so as to minimise the thickness of insulation material required between the joists, thereby minimising the cost of the floor structure. However, the above-described system requires the presence of the bonded insulation material disposed between and bonded to the floor panel and the under-drawing and, hence, in certain applications the resultant cost of the floor structure is unacceptably high.

An object of the present invention is to provide a new and improved floor structure in or for a building unit in which the above-mentioned problem is overcome or is reduced.

According to one aspect of the present invention we provide a floor structure in or for a building unit, the floor structure comprising a floor frame comprising a pair of side beams interconnected together by transversely extending joists, a floor panel supported on the floor frame and an under-drawing spaced from the floor panel with the joists disposed between the floor panel and the under-drawing, characterised in that the under-drawing provides a stress skin construction of the floor structure.

The under-drawing may form a continuous tensile diaphragm which works in conjunction with the floor panel and the floor frame.

The under-drawing may comprise at least one sheet made of metal or of other suitable material depending on desired surface conditions, performance and ability to withstand tensile loads thereon imposed.

The under-drawing may be mechanically fixed to the underside of the joists.

The under-drawing may comprise a plurality of individual sheets at least one of which may be removed to allow access for mechanical and electrical services.

Where a plurality of lower sheets are provided adjacent edge portions of adjacent sheets may be disposed in overlapping relationship.

A thermal break and/or acoustic means to minimise sound arising from relative movement between the under-drawing and frame may be provided.

A tape such as foam tape, or other insulating material may be applied between the frame and the sheets, for example, to form the thermal break and/or acoustic means.

The floor frame may comprise a plurality of joists which span the width of the floor frame between the floor beams.

The joists may be welded or mechanically fixed to the floor beams.

Each joist may be generally channel shaped, comprising a web interconnecting two generally parallel opposed flanges.

At least one flange, preferably an upper flange, has at its outer end an inturned lip. The flanges may be generally perpendicular to the web and, when present, the or each lip may be generally perpendicular to the associated flange.

A joist may be engaged with an upwardly directed surface of the under-drawing.

A fastening may extend through a portion of the joist and of the or each sheet to secure said elements together.

The under-drawing sheets are preferably planar in all directions.

The under-drawing sheets may comprise at least one sheet of, for example, mild steel which may be galvanised.

The floor panel may be mechanically fixed to the upper face of the joists.

An insulation sheet or the like may be disposed over the joists to form two unventilated air spaces.

The insulation sheet may be a reflective sheet which may radiate heat back into the building through the floor panel and trap heated air in a cavity so that warmer air is adjacent to the floor panel.

Because the floor structure, including the under-drawing sheet, is made of gas impermeable, or at least substantially gas impermeable, material any air trapped within the floor structure thereby contributes to the thermal insulating properties of the floor structure as described hereinbefore.

The side beams and/or the joists may be made of metal. The metal may be steel which may be galvanised roll steel.

Since the lower part of the floor structure is subjected to tension forces in use, it is important that the under-drawing sheet can accommodate tension loads. This is achieved without bonding of the under-drawing sheets to the floor panel by a rigid foam expanded plastics material as is the case with GB-A-2291446.

An example of the invention will now be described with reference to the accompanying drawings wherein

FIGURE 1a) is a fragmentary plan view of a floor structure embodying the invention but with part of the floor panel and part of the under-drawing sheet

shown broken away,

FIGURE 1b) is a fragmentary underside plan view of the floor structure of Figure 1a),

FIGURE 2 is a section on the line 2-2 of Figure 1,

FIGURE 3 is a section on the line 3-3 of Figure 1,

FIGURE 4 is a fragmentary underneath perspective view showing part of the floor structure of Figure 1 inwardly of the ends thereof, and

FIGURE 5 is a fragmentary underneath perspective view showing another part of the floor structure of Figure 1 inwardly of the ends thereof.

Referring to the drawings, a floor structure for use in a building unit of, for example, the kind described in any one of EP-B-0,058,354; EP-B-0,105,406; GB-B-2,084,213 and EP-B-0,039,592, or in any other suitable portable or permanent building unit, is shown at 10 and comprises two parallel longitudinally extending floor side beams 11, 12 disposed to extend along the longitudinal sides of the floor structure. The floor side beams 11, 12 are identical and are made as rolled sections in steel, preferably cold rolled and are preferably galvanised mild steel but may be made of any other suitable material and/or be corrosion protected in any other suitable manner.. Floor side beams 11, 12, as best shown in Figures 3 and 4 are of essentially channel configuration having a web 13, and top and bottom limbs 14, 15 which extend perpendicular to the web part 13. The limbs 14, 15 have perpendicular inturned lips 14a, 15a respectively. Fastened by welding to the side beams 11, 12 and spaced inwardly from their ends are a plurality of intermediate cross beams or joists 16 which extend transversely of the floor structure and which are located at spaced positions longitudinally of the side beams 11, 12 at positions intermediate their opposite ends 19, 20. In addition, end cross beams or joists 17, 18 are provided to extend adjacent opposite said ends 19, 20 respectively of the side beams 11, 12.

The ends 19, 20 of the side beams 11, 12 have upright columns 21 disposed adjacent thereto to which the ends 19, 20 of the side beams are connected by four bolts 22 extending through the columns 21 and one limb 23 of an angle member, the other limb 24 of which is fastened to the web 13 by means of welding. The upper bolts 22 are accessible through a cut-out 23 in the end joist 18 whilst the lower bolts 22 are accessible beneath the end joist 18. A bracket 25 is provided between the web 13 and the upturned lip 15a and is held in position by welding. The bracket is provided for lashing the floor to a lorry for transportation in this example, but may be omitted if desired.

If desired, the opposite ends of the joists 16-18 may be fastened to the associated side beam 11-12 by means other than welding, for example by means of fasteners. In the present example the joists 16-18 are spaced at 400mm centres and thus are considerably more closely spaced than are the joists of GB-A-2,291,446.

Each joist 16-18 comprises a web 26 having at opposite ends and perpendicular thereto spaced parallel upper and lower flanges 27,28. Each upper flange 27 has a downwardly extending perpendicular lip 27a. The lower flange 28 of the intermediate joists 16 is unprovided with an upturned lip whilst the lower flanges 28 of the end joists 17, 18 are provided with an upturned lip 28a.

Supported on the upper flanges 27 of the joists 16-18 and the upper flange 14 of the side beams 11, 12 is a floor deck made, in the present example, of three floor panels 30 made of, in the present example, 18mm thick structural board floor deck which is moisture resistant and air impermeable, although if desired, may be made of other material such as plywood. In either case, vinyl or other floor covering may also be fitted.

The nature of the floor panels provides a floor structure with a solid feel which may be aided by the floor covering of vinyl.

The floor deck panels 30 are fastened to the upper flanges 27 of the joists 16-18 and to the flanges 14 of the side beams 11, 12 by self-tapping fasteners 32 at 320mm centres as best shown in Figures 1 and 3.

In the region where the floor panels 30 abut, a pair of fasteners 32 are provided in the uppermost flange 27.

The floor structure is provided with an under-drawing which, in the present example, comprises a plurality of under-drawing sheets 33. In the present example the joists 16-18 are spaced at 400mm centres and the lower sheets 33 have an overall dimension in the direction of the length of the floor unit of 1235mm. Hence, each lower sheet effectively spans the lower flange 28 of four adjacent joists with adjacent panels overlapping each other in the region below each fourth joist as best shown at S in Figure 5. The lowermost flange 28 is 50mm wide in the longitudinal direction and the sheets overlap by about 35mm in the present example, but may overlap by less or more up to, for example 50mm so long as the fasteners pass properly through both sheets to achieve the hereinbefore described stress skin.

The under-drawing sheets 33 in the present example are made of galvanised mild steel sheets of, for example, Aluzink but, if desired, may be made of any other suitable material and/or corrosion protected in any other suitable manner.

The under-drawing sheets 33 are generally rectangular and are fastened to the lowermost flanges 28 by self-tapping fasteners 34, the fasteners being disposed at no greater than 350mm centres. There is no fixing between the under-drawing and beam. To obtain a reasonable seal between the sheet and beam a foam tape, which is also used as a thermal break is wrapped around the edge of the side under-drawing sheets and are interposed where the sheets abut the beams (as shown at Figures 3 and 4).

The sheets 33 have a dimension of 2500mm in a direction transverse to the direction of the length of the floor unit and so are spaced apart from the side beams. These two gaps are closed by sheets 33a which are 235mm wide and comprise a plurality of sheets which

are cut from the sheet stock material and hence have a dimension of 2500mm long to span between seven joists whilst remaining sheets are provided as appropriate for access to various components and in the present example comprise two end sheets each forming 450mm long to span a single pair of joists and a single sheet 1650mm long to span five joists. Of course, the precise dimension may be provided as desired but with a view to economic use of material.

The sheets 33a may be added after the sheets 33 have been added so as to facilitate the introduction of the services into the panel or connection of components.

By virtue of the lap jointing and mechanical fixing of the lowermost sheets 33 to the lowermost flange 28 of the joists 16-18, the sheets effectively form a continuous tensile diaphragm which works in conjunction with the structural board deck and the steel floor frame assembly to reduce deflections and improve the overall "feel" of the floor assembly. Thus, the construction is a composite unit, where shear stresses in the joists (from imposed loading) are transferred into the structural board as compression stresses and into the under-drawing as tension. The minimum tensile strength of the under-drawing sheets in the present example is about 10 N/mm^2.

Although it is preferred that the sheets 33, 33a are planar in all directions, if desired the sheets may be contoured in one or more directions consistent with their ability to accommodate tensile stresses and thus provide a stress skin. More particularly, the sheets may be contoured to a minimum extent, for example to provide a pattern of any desired configuration but of course, if appropriate, the sheets could be contoured as desired by making them of appropriate strength to accommodate the herein before mentioned tensile stress.

The fasteners may be positioned at centres no greater than 300mm apart. Preferably, a screw with a larger diameter flanged head is used. The large flange acts to prevent pivoting of the screw under load and hence reduces deflection. It also provides an increased clamping or bearing area.

The position of the extra mass, such as is provided by the under-drawing, beneath the joists, may act as a counterbalance and dampen vibration induced by walking, hence improving the floor feel.

The individual sheets 33, 33a may be removed, as necessary, to allow access for mechanical and electrical services if required.

A foam tape 35 is applied between the flanges 28 and the under-drawing sheets 33 to form a thermal break and eliminate floor "squeaks" and like noise. If desired other forms of thermal break and acoustic minimisers may also be provided.

A reflective insulation sheet 40 is draped over the joists 16-18 beneath the floor panel 30.

The reflective insulation sheet 14 may conveniently be provided by a thin air impervious member of, for example, thin reinforced aluminium foil and is arranged to form two unventilated air spaces or cavities 41, 42. Because the steel 14 is reflective, it radiates heat back into the building through the floor panels 30 and so traps heated air in a cavity 42 so that warmer air is adjacent to the floor panels 40. If desired other insulation means such as a glass fibre insulation may be provided.

A floor runner 44 is disposed beneath the intermediate joists 16 adjacent to, but spaced inwardly of the side beams 11, 12 as best shown in Figures 1, 2 and 5. The runners 44 terminate at positions aligned with the floor panels 30 and thus adjacent runners 44 are connected together in abutting relationship by self-tapping fasteners 45, as best illustrated in Figure 2.

Claims

1. A floor structure in or for a building unit, the floor structure comprising a floor frame comprising a pair of side beams connected together by transversely extending joists, a floor panel supported on the floor frame and an under-drawing spaced from the floor panel with the joists disposed between the floor panel and the under-drawing, characterised in that the under-drawing provides a stress skin construction of the floor structure.

2. A floor structure according to claim 1 wherein the under-drawing forms a continuous tensile diaphragm which works in conjunction with the floor panel and the floor frame.

3. A floor structure according to claim 1 or claim 2 wherein the under-drawing comprises at least one sheet made of metal.

4. A floor structure according to any one of the preceding claims wherein the under-drawing comprises a plurality of individual sheets.

5. A floor structure according to claim 5 or 6 wherein adjacent edge portions of adjacent sheets are disposed in overlapping relationship.

6. A floor structure according to any one of the preceding claims wherein a thermal break and/or acoustic means to minimise sound arising from relative movement between the under-drawing and frame is provided.

7. A floor structure according to any one of the preceding claims wherein each joist is generally channel shaped, comprising a web interconnecting two generally parallel opposed flanges.

8. A floor structure according to any one of the preceding claims wherein a fastening extends through a portion of a joist and the under-drawing to secure said elements together.

9. A floor structure according to any one of the preceding claims wherein the under-drawing is planar.

10. A floor structure according to any one of the preceding claims wherein an insulation sheet is disposed over the joists to form two unventilated air spaces.

11. A floor structure according to claim 10 wherein the insulation sheet is a reflective sheet adapted to radiate heat back into the building through the floor panel and trap heated air in a cavity so that warmer air is adjacent to the floor panel.

12. A floor structure according to any one of the preceding claims wherein the floor structure, including the under-drawing is made of gas impermeable, or at least substantially gas impermeable, material.

13. A floor structure according to any one of the preceding claims where the side beams and/or the joists are made of metal.

14. A floor structure according to any one of the preceding claims wherein the under-drawing is made of steel and/or the side beams and/or joists are made of steel.

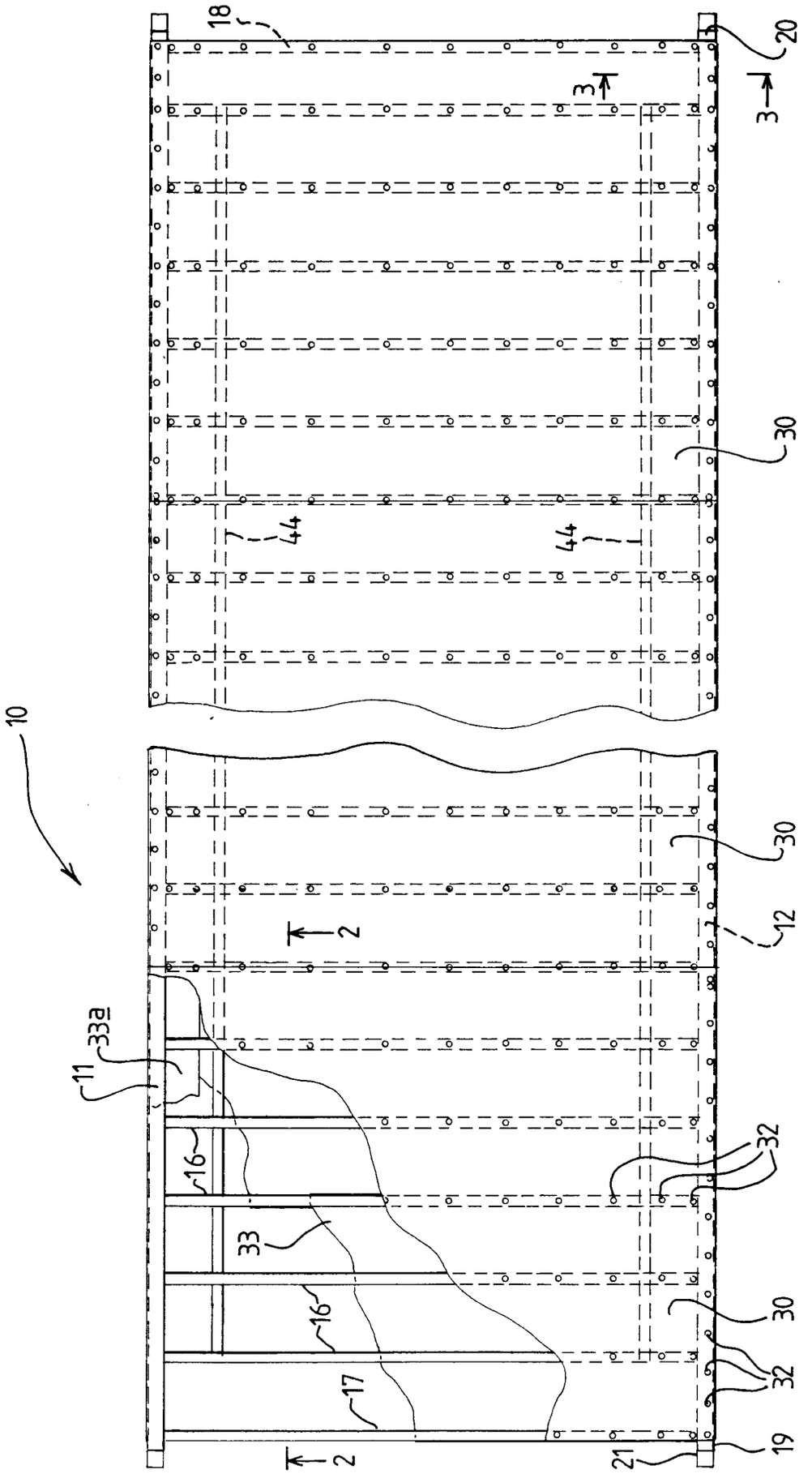


FIG 1a

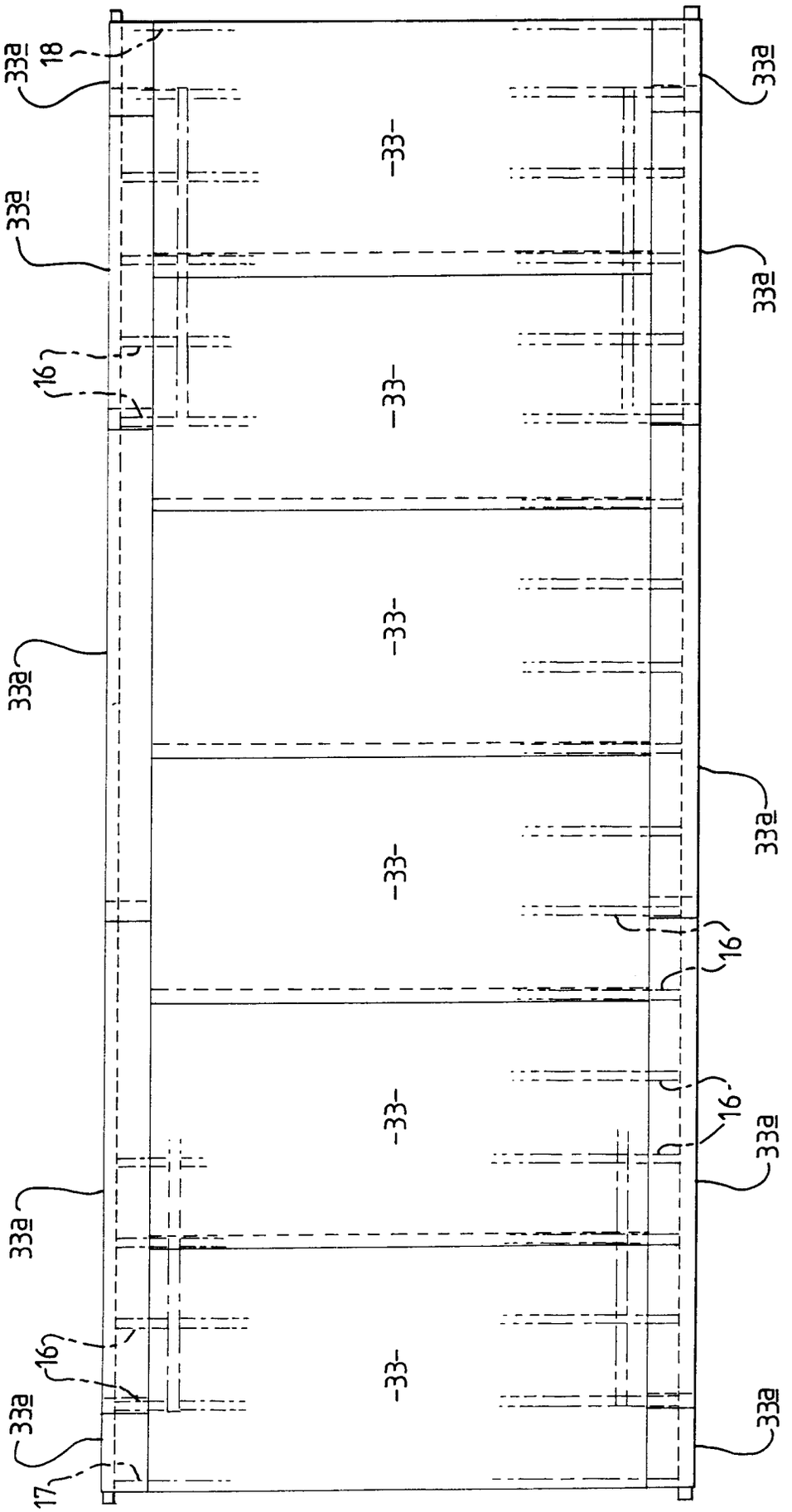

33a
18
33a
33a
33a
16
33a
33
33
33
33
33
33
33a
33a
33a
33a
33a
16
16
16
33a
33a
33a
17

FIG 1b

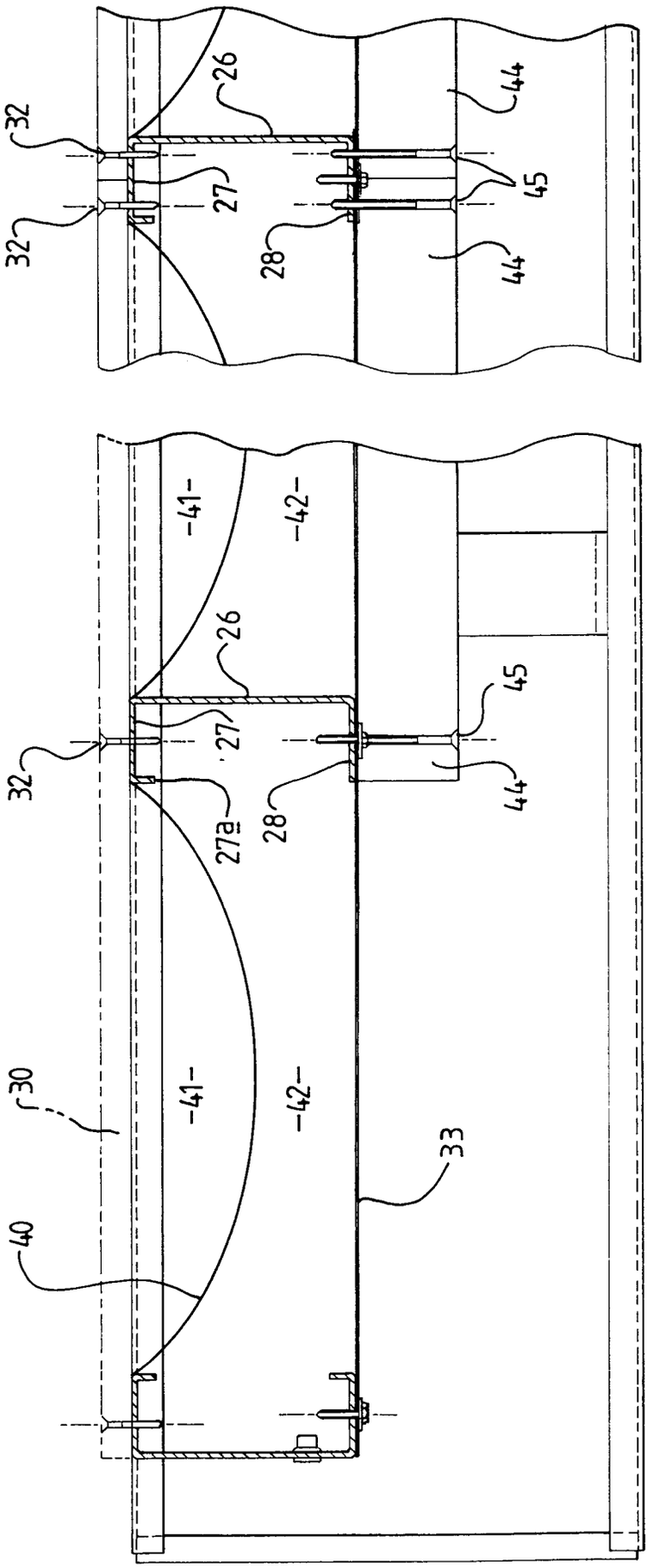
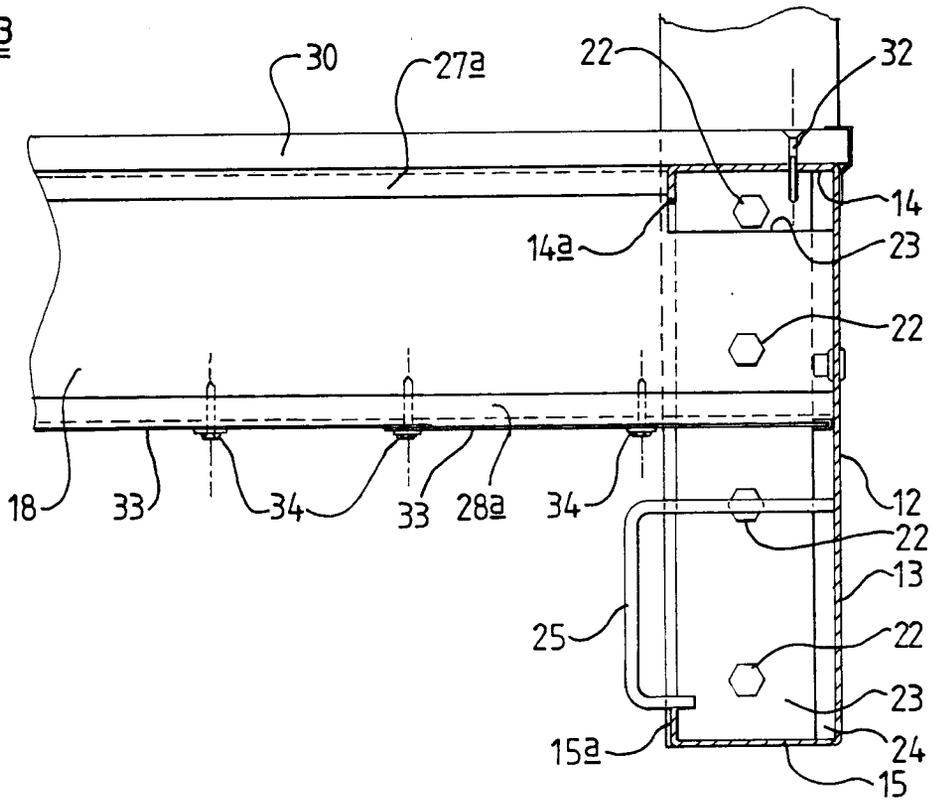


FIG 2

FIG 3


30
27a
22
32
14
14a
23
22
18
33
34
33
28a
34
12
22
13
25
22
23
15a
24
15

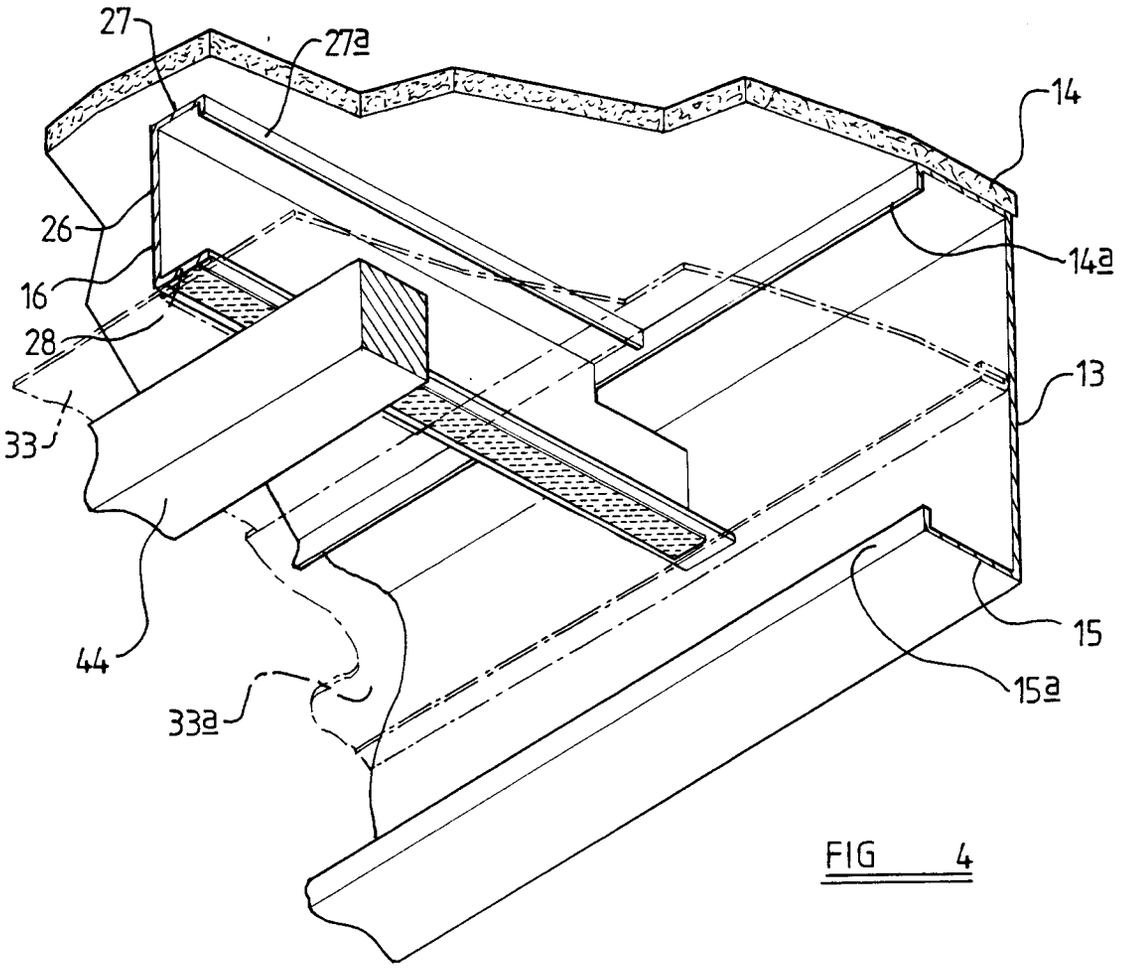

27
27a
14
26
14a
16
28
13
33
44
33a
15
15a

FIG 4

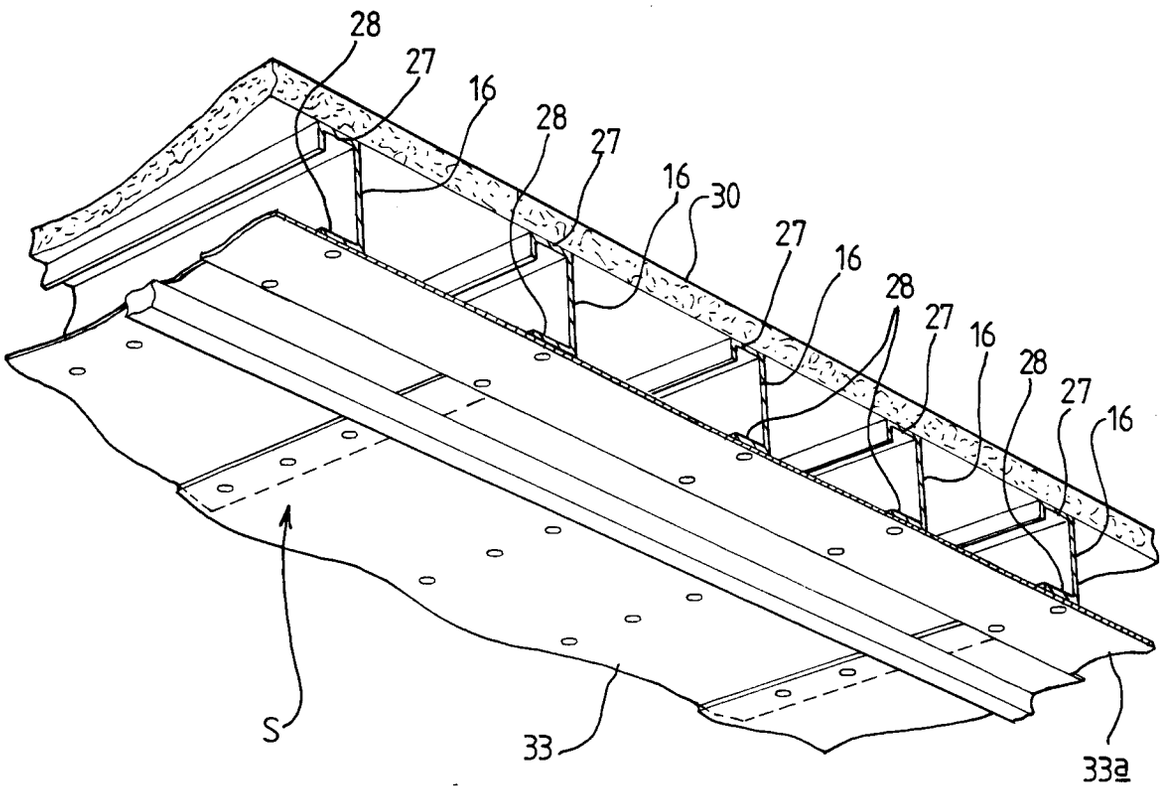


FIG 5

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 97 10 5306

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.6)
D,X	GB 2 291 446 A (PORTAKABIN LIMITED) * the whole document *	1-9, 12-14	E04B1/348
Y		10,11	
Y	EP 0 693 601 A (PORTAKABIN LIMITED) * figures 1,2,16 *	10,11	
A	WO 93 06316 A (EMBLIN ET AL.) * page 2, line 16 - line 21 * * page 5, line 20 - page 6, line 24; claim 4; figures *	1	

TECHNICAL FIELDS SEARCHED (Int.Cl.6)

E04B
E04C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	15 July 1997	De Coene, P

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

EPO FORM 1503 03.82 (P04C01)