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

(11) EP 2 546 428 A1

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
16.01.2013 Bulletin 2013/03

(51) Int Cl.:
E04B 5/12 *(2006.01)* ***E04B 7/22*** *(2006.01)*
E04C 3/292 *(2006.01)*

(21) Application number: **12187680.9**

(22) Date of filing: **01.06.2010**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO SE SI SK SM TR

(30) Priority: **01.06.2009 GB 0909349**
13.11.2009 GB 0919897

(62) Document number(s) of the earlier application(s) in accordance with Art. 76 EPC:
10164657.8 / 2 261 434

(71) Applicant: **MiTek Holdings, Inc.**
Wilmington, Delaware 19801 (US)

(72) Inventor: **Fillingham, Anthony J.**
Dudley, West Midlands DY2 0XW (GB)

(74) Representative: **Freeman, Jacqueline Carol**
WP Thompson
55 Drury Lane
London WC2B 5SQ (GB)

Remarks:
This application was filed on 08-10-2012 as a divisional application to the application mentioned under INID code 62.

(54) **Wall stud**

(57) A stud for use in timber frame walls comprising two parallel elongate timber posts joined together by at least a pair of struts, each strut having three conjoined sections comprising a first short section, a second longer section connected at an obtuse angle to the first section and a third short section connected to the second section at an obtuse angle and being generally parallel to the first section, with the first and third sections of each strut fixed to and parallel with the respective timber post so that the second sections form a bridge between the timber posts, and wherein the two struts are on opposing elongate faces of the timber posts.

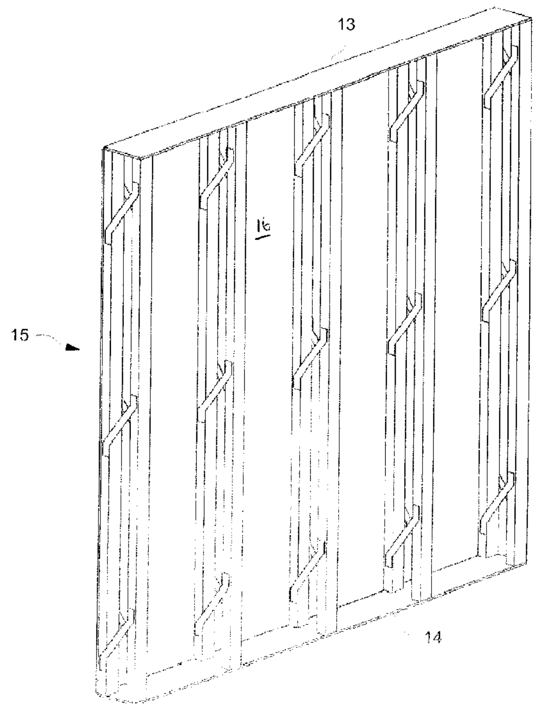

FIG.14.

EP 2 546 428 A1

Description

Introduction

[0001] The present invention relates to a wall stud and a wall using such a stud. Also described is a roof rafter and a roofing system using such a roof rafter.

Background

[0002] Traditionally roofs are made by positioning a series of roof rafters at spaced intervals across the roof line of a building, connecting them to a wallplate and tying the heads of the wallplate together with a ceiling joist which in turn supports the ceiling lining. An alternative and more popular approach is the use of trussed rafters which are prefabricated offsite and which sit on and are fixed to the wallplate and braced with diagonal and longitudinal braces to keep the trussed rafters vertical and to distribute the forces back to flanking walls. An outer pitched surface is then sometimes boarded and is covered with weatherproof roofing material such as roofing felt and tiles.

[0003] Traditional trussed rafters can be heavy and take up a large amount of space because the webs forming the trusses in the loft area render it unusable for living accommodation. Insulation is usually added piece by piece after the roof is constructed, preferably between the bases of the trusses and under the roofing material and this is time consuming on site.

[0004] There is an increasing need for lower cost housing in which a larger proportion of a building is useable as living space. There is also an increasing need for better insulated buildings and constructions in which a minimum of non-living space is heated, so as to make heating more economical and to reduce the carbon footprint of new buildings both from an ecological point of view and to meet modern legal standards.

[0005] There is also an increasing need for more insulation to be incorporated into walls to reduce CO_2 emissions and meet ever more stringent building regulations. Thicker insulation requires the walls to be deeper. However deeper walls of conventional construction require thicker stud timbers which increases the cost considerably. In addition thicker timbers are heavier and thus more difficult and expensive to transport and handle and walls made of thicker timbers require stronger support.

[0006] Braces are known in the building industry for strengthening timber frames and one example is given in US 3,591,997 in which a sheet metal channel member is arranged to form a diagonal brace connecting several upright members of a frame.

[0007] Metal web members for pre-manufactured wooden trusses are also known of V, U, W or S shapes. They are shown for example in US 5,996,303 and are used for horizontal roof trusses and floor joists.

Summary of the Invention

[0008] According to one aspect of the invention there is provided a stud for use in timber frame walls comprising two parallel elongate timber posts joined together by at least a pair of metal struts, each strut having three conjoined sections comprising a first short section, a second longer section connected at an obtuse angle to the first section and a third short section connected to the second section at an obtuse angle and being generally parallel to the first section, with the first and third sections of each strut fixed to and parallel with the respective timber post so that the second sections form a bridge between the timber posts, and wherein the two struts are on opposing elongate faces of the timber posts, and each one of the pair is arranged in opposite orientations, such that the second sections of each strut form a cross separated by the depth of the timber posts.

[0009] In a preferred embodiment each wall stud comprises a plurality of crossed struts at spaced intervals along its length.

[0010] A wall stud constructed in this manner can be used instead of a traditional timber wall stud or can be preassembled into a wall section or complete wall by joining together several such studs.

[0011] The struts may be formed with protrusions in a region of each of the first and third sections which can be pushed into a timber surface to positively engage and grip the side of the timber chords. Such protrusions preferably take the form of integral punched metal fasteners, i.e. nailbeds. Alternatively the struts could be provided with holes to accommodate nails, screws or rivets for fastening to the timber surfaces.

[0012] Preferably the struts are made of steel, and they may be stamped out of metal sheets. They may be formed by stamping V shaped forms and then breaking the V shape in half at the root of the V to make two symmetrical half struts. The steel plate used can be of relatively thin gauge because the arrangement of the crossed struts form very strong structures. The steel plate may be stamped to form struts of uniform width along their length and then peripheral portions along the edges of the second section may be folded over, e.g. at right angles to the plate, so as to add lateral strength to the strut.

[0013] Such struts make assembly of wall studs and roof rafters relatively easy and quick and provide increased strength to the studs and rafters. They are versatile since they can be made in a variety of sizes and shapes and can be manufactured to close tolerances. Thus any thickness of rafter and roof panel can be constructed to suit particular applications.

[0014] Wall studs constructed in this way have a cavity running along their length to accommodate insulation and building services such as electric wires or pipes without affecting the integrity of the structure.

[0015] The thicker the wall the more insulation can be installed, increasing the thermal resistance of the wall and decreasing the U value to meet modern building standards. Using the invention allows the wall thickness to be increased without using thicker timbers with consequent savings in cost and weight.

[0016] In addition a wall made in accordance with the invention has a cavity running along the whole height and length, rather than just between stud timbers and hence insulation is easier to install. Also building services such as wires and pipes are easier to fit.

[0017] If studs are required for eccentrically loaded locations it is relatively easy to increase the member size of one of the stud sections whilst maintaining the same strut size.

[0018] Use of such struts increases the bending stiffness in the plane of a stud or rafter without increasing the volume of the timber used. Economy of timber usage is a significant advantage of the invention.

[0019] Using struts on opposite sides of the rafter in a crossed arrangement increases the rigidity of the rafter since stiff points on the timber chords are provided at each position where a strut is fastened to the timber chords. It also gives equal bending resistance to both chords and reduces the risk of thermal bridging.

[0020] Also there is described a roof rafter comprising two parallel elongate timber chords joined together by two metal struts on opposite elongate faces of the timber chords so that the two struts form a cross separating the timber chords, wherein the struts each comprise a first short section, a second longer section connected at an obtuse angle to the first section and a third short section connected to the second section at an obtuse angle and being generally parallel to the first section, and wherein the first and the third section of each strut is fixed to and parallel with the respective timber chord so that the second section of each strut forms a bridge connecting the two timber chords.

[0021] Preferably a bearing is provided on one chord for supporting the weight of the rafter. The bearing may be provided by a timber member plated onto one of the chords. A second bearing may be provided by a timber cross piece joining the two chords of the rafter.

[0022] One of the chords is preferably longer than the other so as to provide an overhang to a roof constructed with a rafter according to the invention.

[0023] A roof panel may be formed as a rafter cassette by joining together a plurality of the inventive roof rafters. This makes on-site construction of a roof quicker. The rafters may be boarded on the underside with any suitable material such as OSB (Oriented Strand Board). Insulation is preferably fitted between the rafters and between chords and flanges.

[0024] Roofs constructed with such rafters have a cavity running along their length which can accommodate insulation and could also accommodate building services such as electric wires or pipes without the need to drill through trusses or braces which could affect the integrity of the finished roof structure.

[0025] The deeper the rafter the more insulation can be installed in a roof, increasing the thermal resistance of the roof panel and decreasing the U value to meet modern building standards. The roof panel depths can be increased without using thicker timbers, with consequent savings in cost and weight.

Specific embodiments

[0026] For a better understanding of the present invention and to show how the same may be carried into effect, reference will now be made, by way of example, to the accompanying drawings, in which:

Figure 1 is a perspective view of a rafter according to one aspect of the present invention;

Figure 2 is a side view of part of the rafter of Figure 1 showing more detail;

Figure 3 is a schematic view of a strut used in the construction of the rafter of Figures 1 and 2;

Figure 4 is a schematic view of an alternative embodiment of the strut of Figure 3;

Figures 5 to 13 illustrate construction of a roof using rafters according to the first aspect of the invention;

Figure 14 is a perspective view of a wall section constructed of studs according to the second aspect of the invention.

Detailed description of drawings

[0027] Figures 1 and 2 illustrate a roof rafter 41 according to one aspect of the invention. Figure 1 shows a perspective view of the whole length of the rafter 41 and Figure 2 shows an enlarged schematic view of part of the rafter 41. The rafter 41 comprises two spaced apart parallel timber chords 9 and 10 connected by metal struts 1a and 1b on opposite sides of the chords 9 and 10.

[0028] Towards the upper end of the rafter 41a bearing member 45 is plated onto the lower chord 10 (which is on the left hand side as shown in Figure 1) by a series of punched metal plate fasteners. A second bearing is provided at the lower end of the rafter by a timber cross piece 47 joining the two chords 9 and 10. An overhang 49 is provided by making the upper chord 9 longer than the lower chord 10.

[0029] Figure 2 is a side view of part of the rafter showing more detail of the crossed pairs of struts 1a and 1b connecting the chords 9 and 10. In each pair, one strut 1a is on the near sides of the chords 9 and 10 and one strut 1b is on the far sides of the chords 9 and 10, as viewed in the figure. It can be seen that each pair of struts forms a cross shape, with the diagonals of the crosses keeping the two chords 9 and 10 apart. The crossed pairs of struts 1a and 1b may be fastened to the chords 9 and 10 at any position but, in one example, they are spaced a distance of about 0.6 metres and each extends a total of 0.3 metres along the length of the rafter.

[0030] The design of the struts 1a and 1b is shown in Figures 3 and 4. Each strut has three sections 2, 3 and 4. End sections 2 and 4 are parallel to each other and make an obtuse angle with the middle section 3. In Figure 3 on each of the end sections there is a nail plate or a set of protrusions 5, 6 standing out from the surface of the strut 101 for engagement with the timber chord. Preferably the protrusions are each tapered to a relatively sharp point to make it easier to insert them into undrilled timber, for example by means of pressing the end sections against the timber. Such pressing will be done using an industrial press to apply an appropriate pressure to fully embed the protrusions in the timber. The struts 1a, 1b are preferably formed of metal which may be pressed or cast, and are advantageously formed of steel. They may be pressed out of a metal blank as a V shape and then split or cut at the base of the V to form two separate struts. The struts may be pressed with uniform width along their length and then the edges folded over along peripheral parts of the sides of the middle section to increase the lateral strength and rigidity of the strut.

[0031] Figure 4 shows an alternative embodiment of a strut 1a, 1b in which the end sections 2 and 4 are provided with holes 7 and 8 by which the strut may be fixed to the timber chords 9 and 10 using nails, screws or rivets.

[0032] Figures 5 to 13 illustrate steps in the construction of a roof using rafters according to the invention.

[0033] Figure 5 illustrates the top floor 21 of a building onto which a roof is to be added. This top floor 21 may be formed using prefabricated floor cassettes constructed of double timber floor joists connected by a frame and boarded over. A hole 19 is provided for a staircase (not shown). This top floor 21 is constructed to be level and square so as to provide a good base to work from for construction of the roof. Floor cassettes make it easier to achieve this since they can be constructed to high tolerances in the factory and can be laser levelled on site. However cassettes are not essential and any traditional top floor surface can be used.

[0034] Two lower flat-top spandrels 23 and 24 are then erected on opposite long sides of the laser levelled top floor 21 as shown in Figure 6. Each of these spandrels 23 and 24 are approximately trapezoidal in shape with a frame comprising an upper horizontal chord 61 generally parallel to a lower horizontal chord 62 and joined by two sloping chords 71 and 72 and two vertical stub chords 70. A plurality of internal vertical webs 63 are located in the frame to increase strength and rigidity, but no horizontal chords are used since these are more difficult to press. The chords and webs are all joined together with punched metal plate fasteners.

[0035] Subsequently one or more ceiling cassette frames 29 are craned into position as shown in Figure 7, which illustrates two such ceiling cassette frames 29. These rest on the top chords 61 of the lower spandrels 23 and 24 and are located by means of a locator channel 65 in the top surface of one or each upper chord 61. This channel is formed by a three ply construction of the top chord 61, for example using 97mm inner and outer chords and a 72mm internal chord.

[0036] These ceiling cassettes 29 are then insulated and decked as shown in Figure 8, so that the roof space above is a cold roof space to avoid unnecessary heating of the loft space in the finished building. The ceiling cassettes may be pre-insulated and decked in the factory before being installed on site.

[0037] As shown in the figures the ceiling 29 has upstanding edge beams 46a, 46b to support the roof rafters as explained later. The edge beams 46a and 46b are fitted with ceiling noggins 58 (see Figure 8) which are angle cut so as to meet the roof rafters at an appropriate angle.

[0038] Two relatively low timber frame walls 22 are then built on the other two opposite short sides of the floor 21 as shown in Figure 9 so as to abut the spandrels 23, 24 at the stub beams 70.

[0039] Triangular shaped upper, apex, spandrels 30 are then lifted into position on top of the ceiling cassette 29 and aligned with the lower spandrels 23, 24 as shown in Figure 10. These apex spandrels 30 may also incorporate a locator groove in the underside surface of their horizontal beam to make fitting on site easier and more accurate.

[0040] As shown in Figure 11 an elongate rafter cassette 40 is positioned to bridge the gap between the low wall 22 and the edge beam 46b on the ceiling cassette 29. In this example the rafter cassette 40 comprises three of the double chorded rafters 41 of Figure 1, but it may comprise more rafters as required. These are joined together at the upper end by a timber connecting piece 42 and boarded on the underside for example with OSB 43.

[0041] The bearing members 45, which are plated onto the lower timber chords 10, rest on the top of the edge beam 46b of the ceiling cassette 29. The rafter cassette 40 is also supported at its lower end by the bearing surface 47 resting on the low wall 22. The rafter cassette 40 overhangs the low wall 22 as shown at 49 because of the extended upper chord 9, and abuts the side of the sloping beam 71 of the spandrel 23. The rafter cassette 40 may be pre-insulated between the rafters and insulation may also be pressed between the timber chords during manufacture. The cassette 40 may also be felted and counter-battened during manufacture in the factory to make roof construction faster on site. Alternatively the roof may be insulated and subsequently felted and counterbattened on site.

[0042] In Figure 12 a second rafter cassette 50 is positioned adjacent the cassette 40. Each rafter cassette 40, 50 comprises three rafters 41 but cassettes of any suitable number of rafters 41 may be produced. Cassette 50 is constructed with an opening 51 for a dormer window.

[0043] In Figures 11 and 12 the apex spandrels 30 are omitted so as to show more detail of the other features.

[0044] After all of the rafter cassettes 40, 50 have been positioned on one side of the roof to fill the gap between the spandrels 23 and 24 then rafter cassettes are assembled on the other side of the roof from gable to gable as shown in Figure 13.

[0045] Dormer windows are then installed in the relevant openings such as 51 and the whole roof is then completed with felting and weatherproof roofing material such as tiles.

[0046] Figure 14 illustrates a skeleton wall structure 15 comprising five wall studs 12 each comprising two generally parallel posts 9 and 10, fastened together with three pairs of struts 1a and 1b. Three of the struts 1a are on the near sides of the posts 9 and 10 and three of the struts 1b are on the far sides of the posts 9 and 10 as viewed in the figure. Each pair of struts forms a cross shape, with the diagonals of the crosses are separated by the depth of the posts. Such a wall stud 12 may be constructed to be any size but typically would be around 2.35 metres long with a depth of 0.200 metres. The crossed pairs of struts 1a and 1b may be fastened to the posts at any position but in one example they are separated by a distance of about 0.6 metres and each extend a total of 0.3 metres in the direction of the stud.

[0047] The studs 12 are attached together at their ends with planks 13 and 14 to form the skeleton wall structure 15, which is boarded on one side as shown as 16.

[0048] The following clauses comprise the original subject matter of the claims of the parent application EP 10164657.8 published as EP 2 261 434 and are included for a complete disclosure of the subject matter relevant to the invention.

1. A roof rafter (41) comprising two parallel elongate timber chords (9, 10) joined together by two metal struts (1a, 1b) on opposite elongate faces of the timber chords so that the two struts (1a, 1b) form a cross separating the timber chords (9, 10), wherein the struts (1a, 1b) each comprise a first short section (2), a second longer section (3) connected at an obtuse angle to the first section (2) and a third short section (4) connected to the second section (3) at an obtuse angle and being generally parallel to the first section (2), and wherein the first (2) and the third section (4) of each strut (1a, 1b) is fixed to and parallel with the respective timber chord (9, 10) so that the second section (3) of each strut (1a, 1b) forms a bridge connecting the two timber chords (9, 10).

2. A roof rafter (41) according to clause 1 wherein a first bearing is provided on one chord for supporting the weight of the rafter (41).

3. A roof rafter (41) according clause 2 wherein the first bearing is provided by a timber member plated onto one chord (10).

4. A roof rafter (41) according to clauses 2 or 3 comprising a second bearing provided on the one chord (10) for supporting the weight of the rafter (40).

5. A roof rafter (41) according to clause 4 wherein the second bearing is provided by a timber cross piece joining the two chords (9, 10) of the rafter (41).

6. A roof rafter (41) according to any one of the preceding clauses wherein one of the chords (9) is longer than the other chord (10) so as to provide an overhang (49) for a roof constructed with the rafter (41).

7. A roof panel (40) comprising a plurality of roof rafters (41) according to any one of the preceding clauses.

8. A roof panel (40) according to clause 7 comprising boarding on one side.

9. A roof panel (40) according to clause 7 or 8 comprising insulation fitted between the rafters (41) and between the chords (9, 10).

10. A method of constructing a roof on top of a building comprising: fixing two lower spandrels, one on each of two opposite sides of the top of a building, the lower spandrels each having two parallel sides and two sloping sides; fixing at least one panel to the upper of the parallel sides of the spandrels to form a platform; fitting upper spandrels above the respective lower spandrels on the platform; and fitting roof rafters according to any one of clauses 1 to 6, or roof panels according to clauses 7 to 9, between the sloping sides of the spandrels to bridge the gap between the top floor of the building and the platform to form a roof.

Claims

1. A stud for use in timber frame walls comprising two parallel elongate timber posts joined together by at least a pair of metal struts, each strut having three conjoined sections comprising a first short section, a second longer section connected at an obtuse angle to the first section and a third short section connected to the second section at an obtuse angle and being generally parallel to the first section, with the first and third sections of each strut fixed to and parallel with the respective timber post so that the second sections form a bridge between the timber posts, and wherein the two struts are on opposing elongate faces of the timber posts, and each one of the pair is arranged in opposite orientations, such that the second sections of each strut form a cross separated by the depth of the timber posts, comprising a plurality of crossed struts (1a, 1b) at spaced intervals along its length.

2. A stud according to claim 1, wherein the struts (1a, 1b) are formed with protrusions in the form of integral punched metal fasteners in a region of each of the first and third sections which protrusions are adapted to be pushed into a timber surface to positively engage and grip the timber.

3. A stud according to claim 1, wherein the struts (1a, 1b) are provided with holes to accommodate nails or screws or rivets for fastening to the timber surfaces.

4. A stud according to claim 1, wherein the struts are formed by stamping V shaped forms from steel sheets and then breaking the V shape in half at the root of the V to make two symmetrical half struts.

5. A stud according to claim 1, wherein the struts are formed by stamping to form struts of uniform width along their length and then peripheral portions along the edges of the second section are folded over, generally at right angles to the plate.

6. A wall section formed by joining together a plurality of studs according to claim 1.

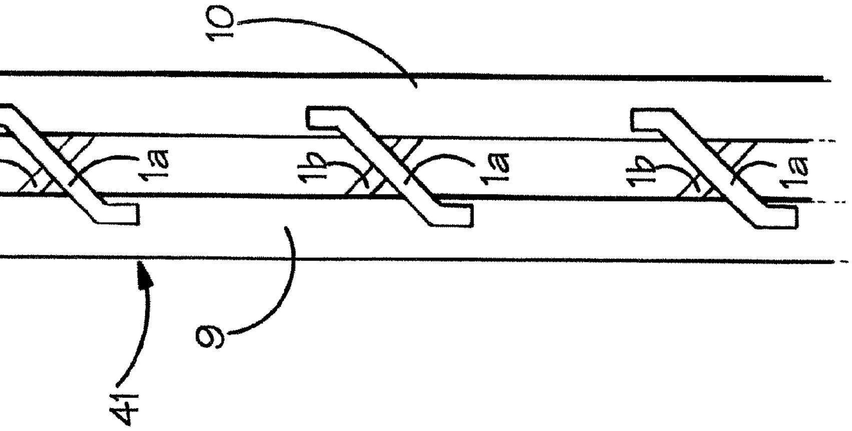

FIG.2.

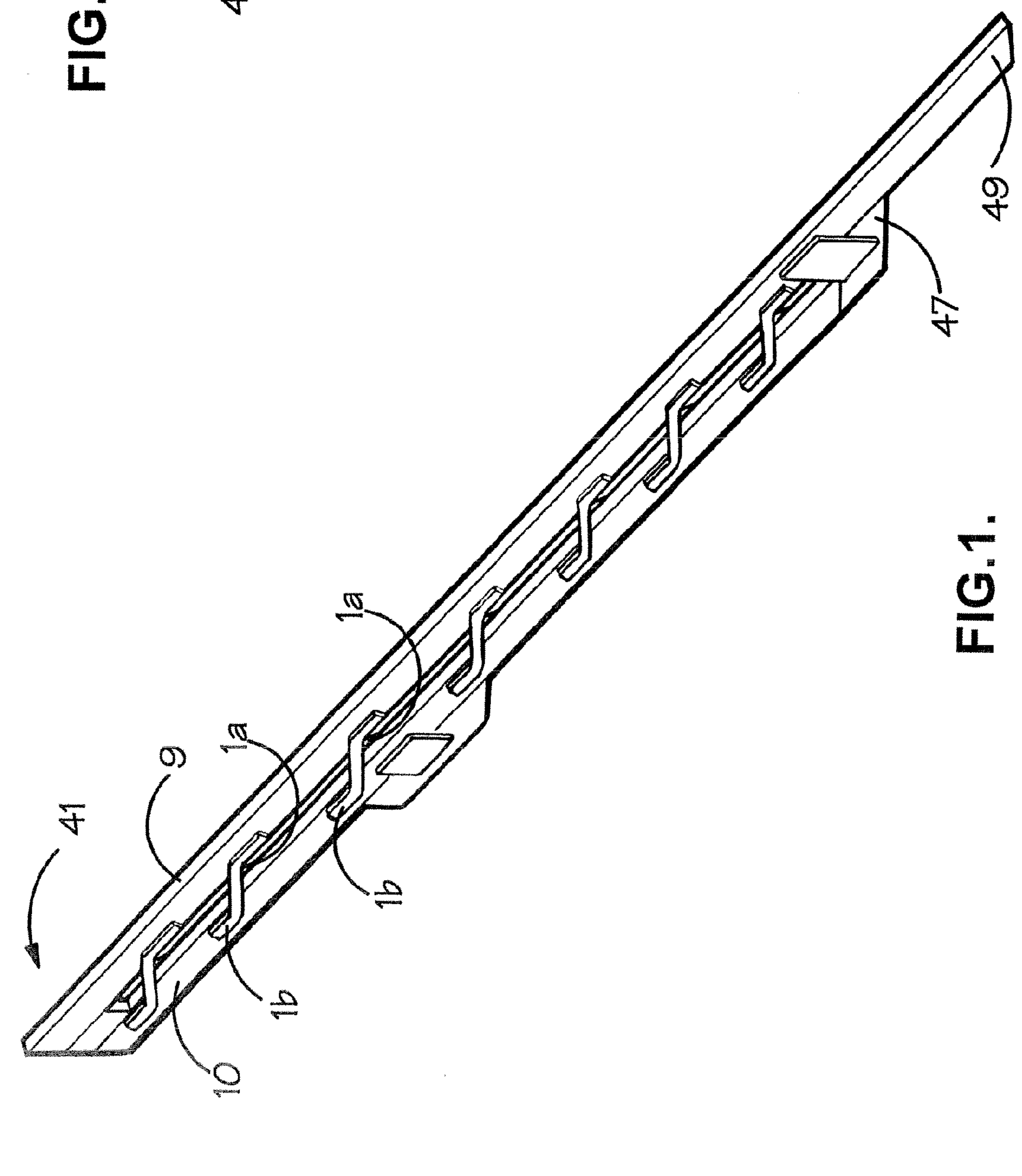

FIG.1.

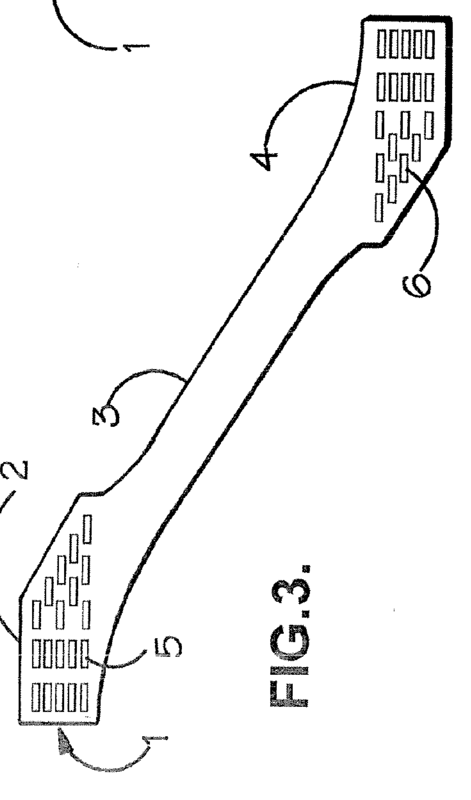

FIG.3.

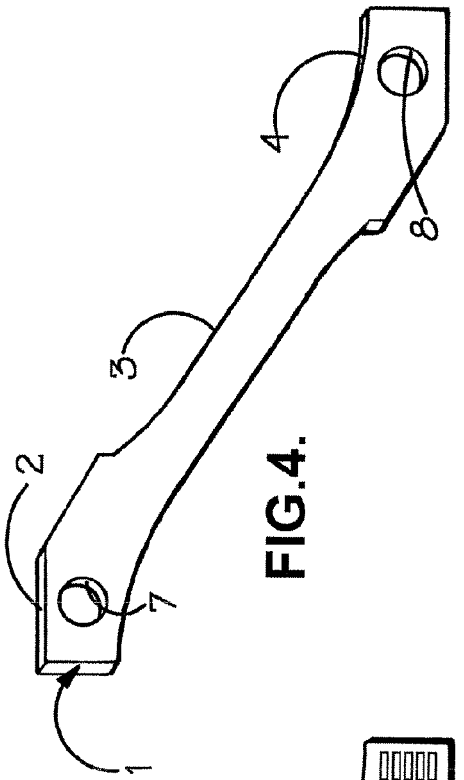

FIG.4.

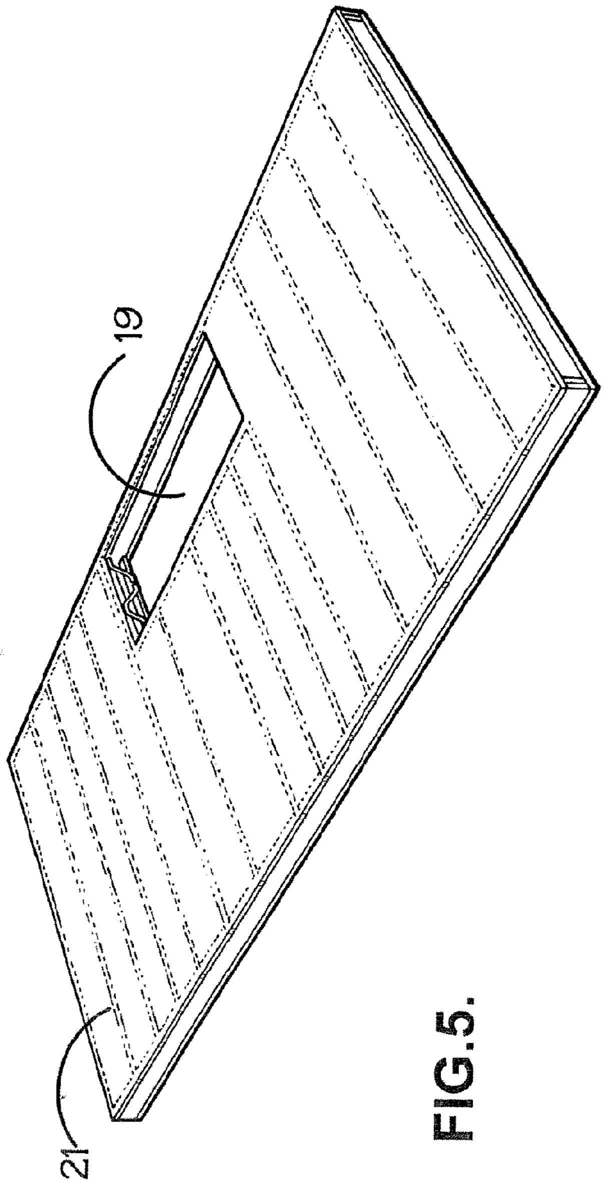

FIG.5.

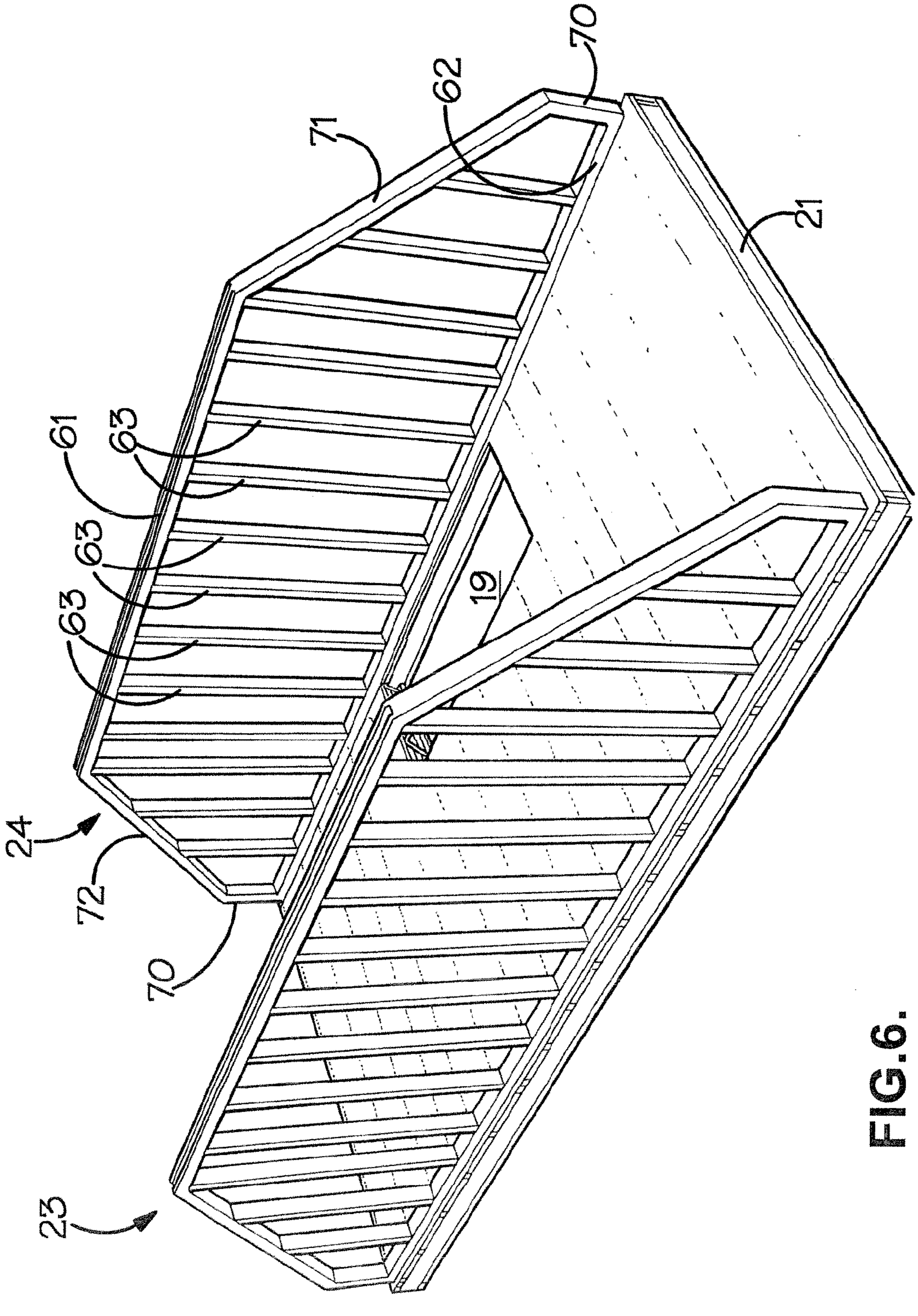

FIG.6.

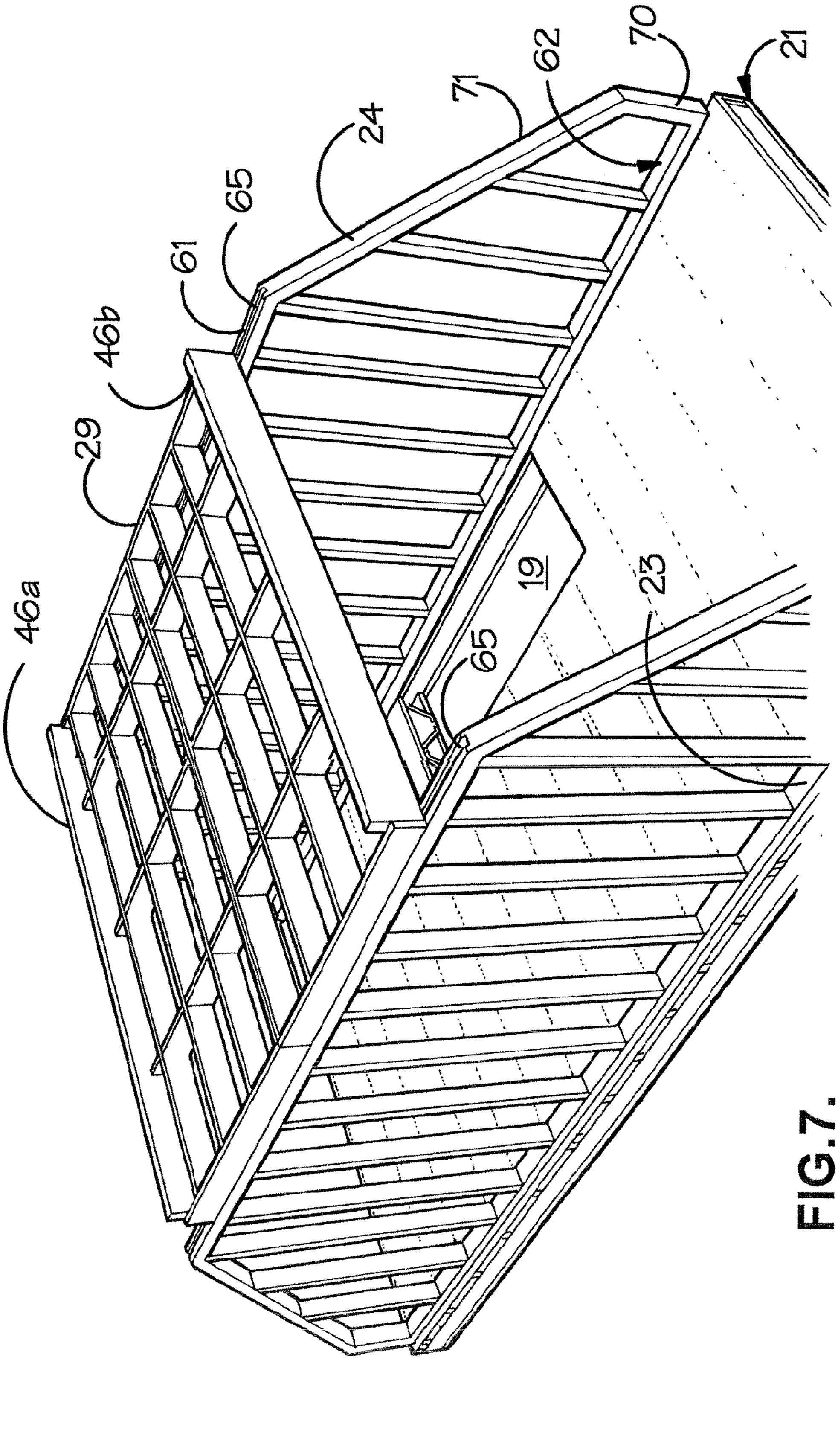

FIG.7.

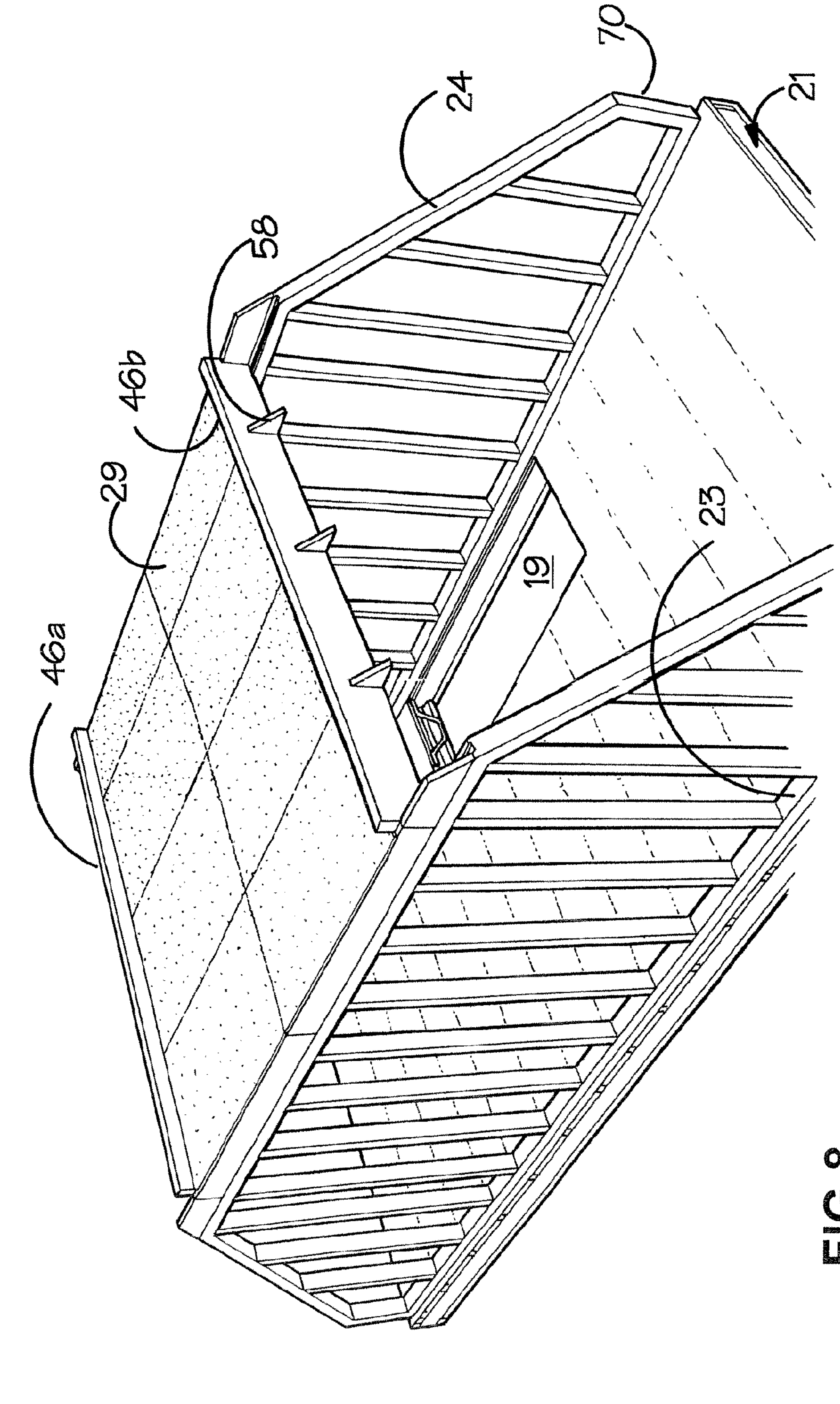

FIG.8.

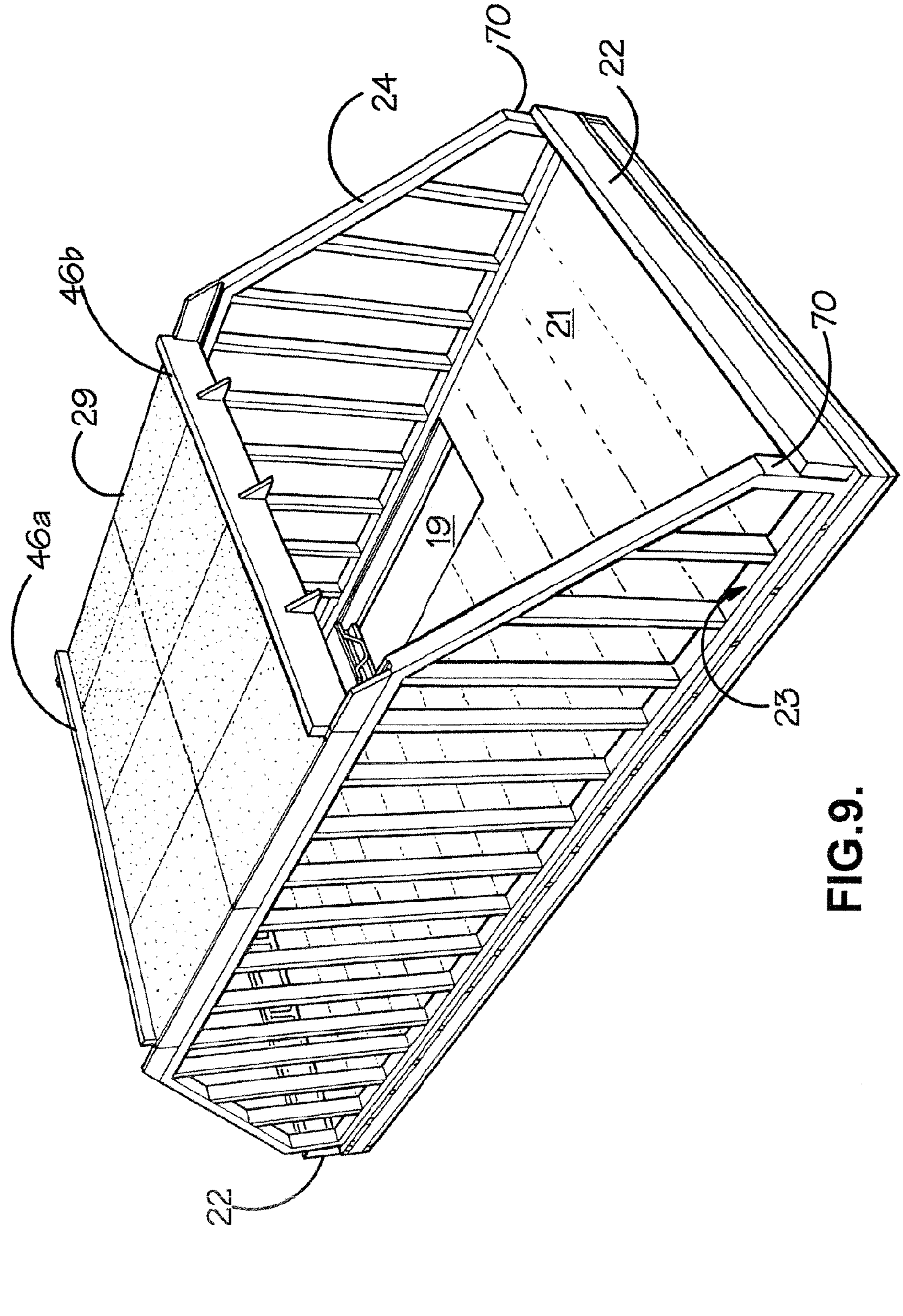

FIG.9.

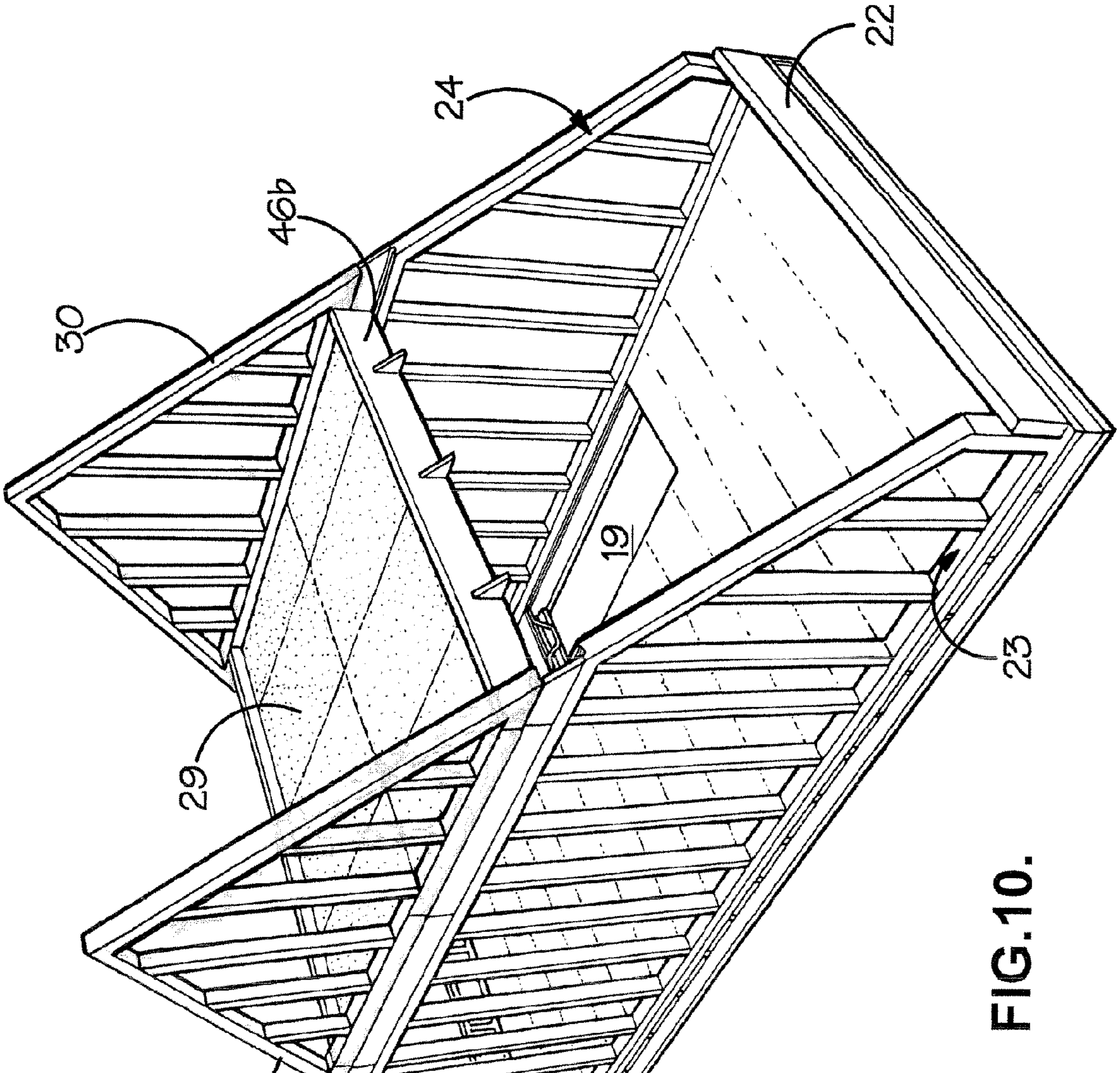

FIG.10.

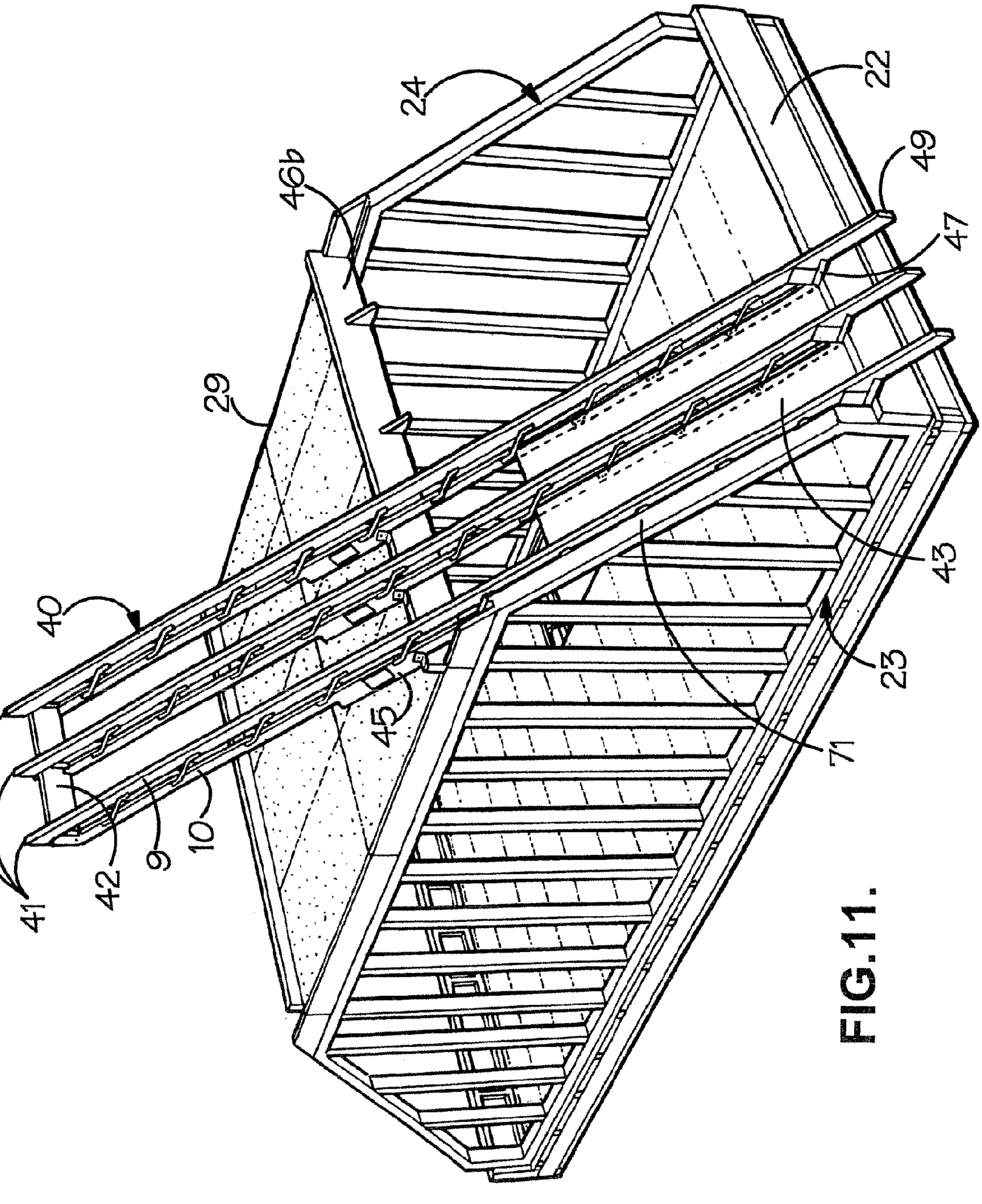

FIG.11.

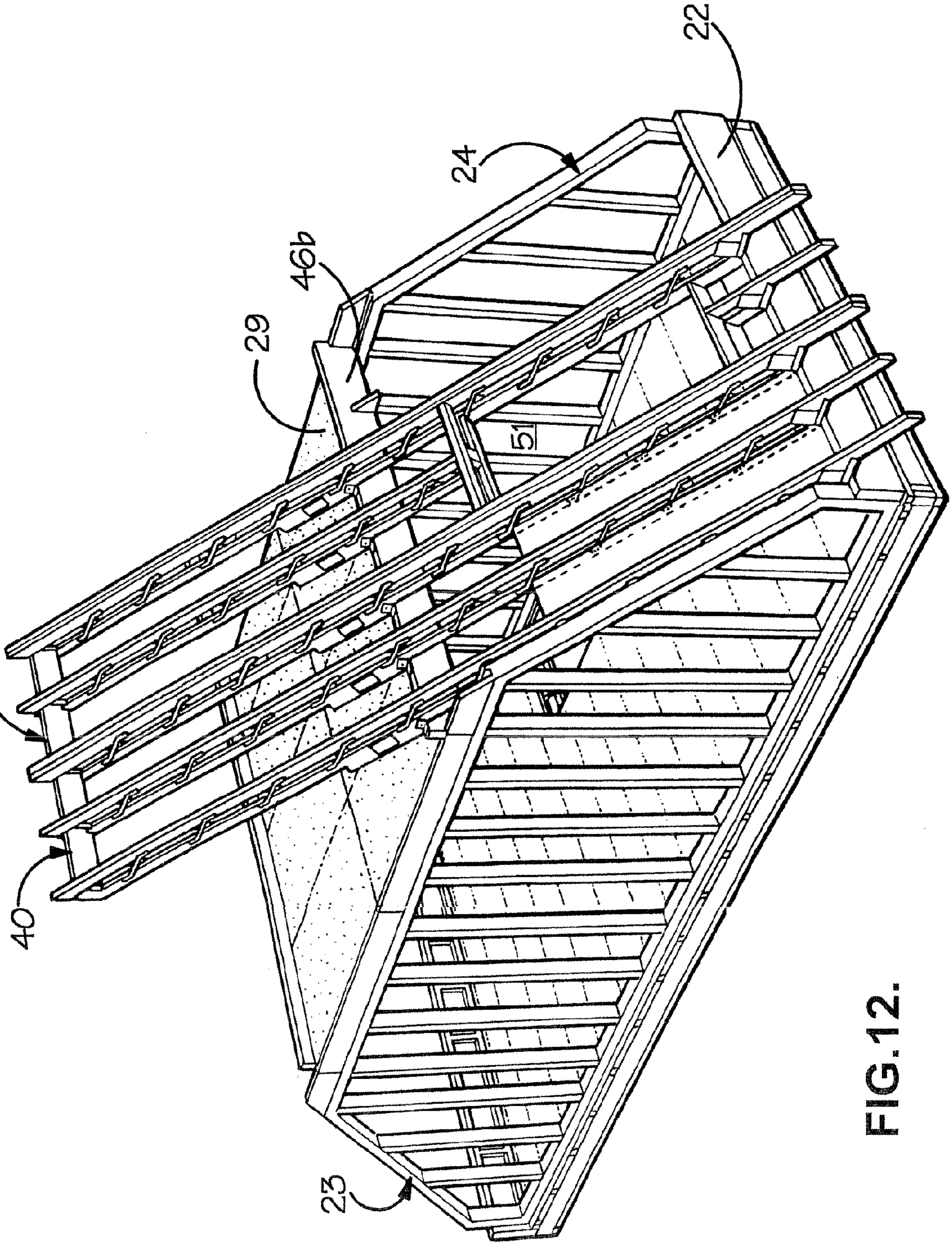

FIG.12.

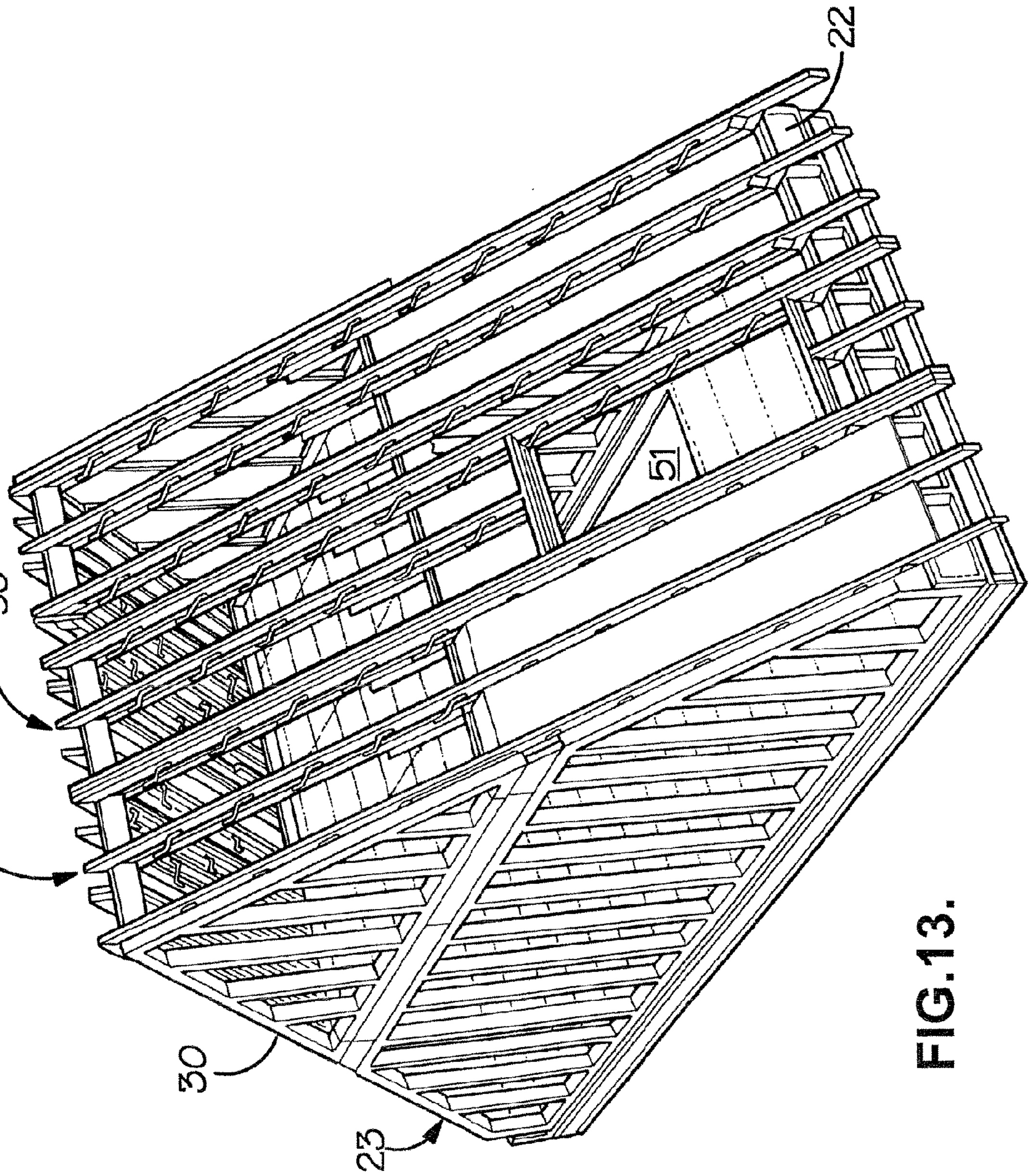

FIG.13.

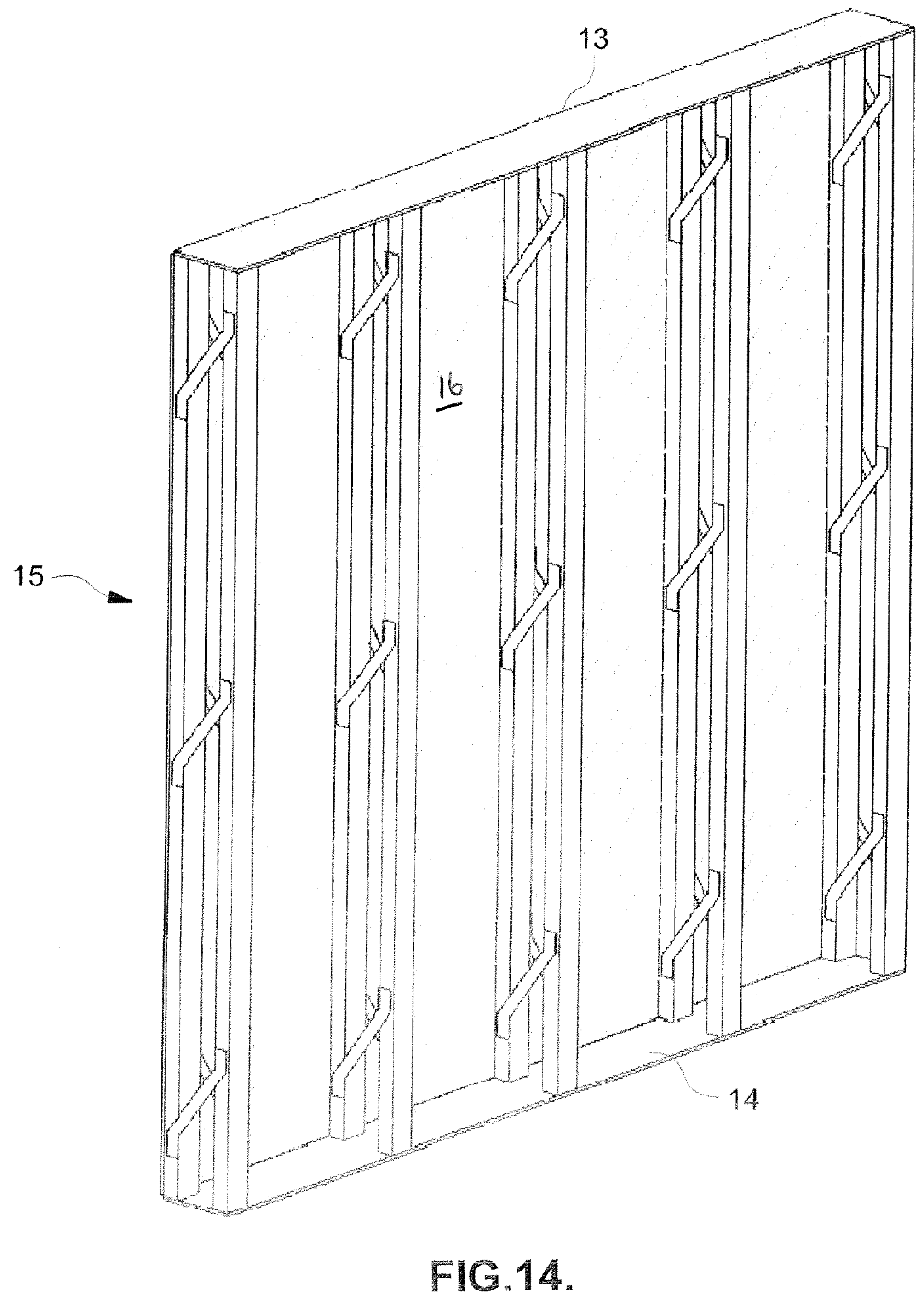

FIG.14.

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 12 18 7680

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	US 4 435 929 A (BUSSELL HUGH M [US]) 13 March 1984 (1984-03-13) * figure 1 * -----	1-6	INV. E04B5/12 E04B7/22 E04C3/292
A	EP 1 609 920 A1 (MITEK HOLDINGS INC [US]) 28 December 2005 (2005-12-28) * figure 3 * -----	1,4	
A	US 1 405 889 A (HENRY BARLING WALTER) 7 February 1922 (1922-02-07) * figure 6 * -----	1	

TECHNICAL FIELDS SEARCHED (IPC)
E04B
E04C

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
The Hague	13 November 2012	Bauer, Josef

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)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 12 18 7680

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

13-11-2012

Patent document cited in search report		Publication date	Patent family member(s)		Publication date
US 4435929	A	13-03-1984	NONE		
EP 1609920	A1	28-12-2005	CA 2510216	A1	21-12-2005
			EP 1609920	A1	28-12-2005
			NZ 540883	A	29-09-2006
			US 2005279051	A1	22-12-2005
			ZA 200505004	A	26-04-2006
US 1405889	A	07-02-1922	NONE		

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- US 3591997 A **[0006]**
- US 5996303 A **[0007]**
- EP 10164657 A **[0048]**
- EP 2261434 A **[0048]**