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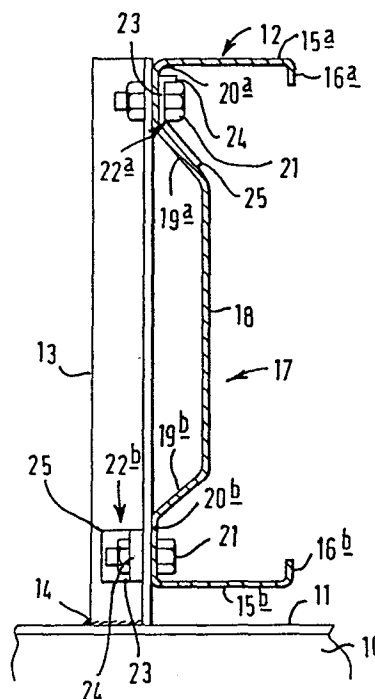
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Roof, wall or floor structure.

A structure comprising at least two structural members (10) and a purlin (12) supported by and extending between the structural members (10) and connected thereto by cleats (13), one fixed to each of said two structural members (10), wherein the purlin (12) comprises a cold rolled section having a pair of spaced side-by-side generally parallel opposed flanges (15a, 15b), each having an intumed lip (16a, 16b) at one edge and the flanges (15a, 15b) being interconnected by a web part (17) at their other edges, the web part (17) comprising a median portion (18) perpendicular to the flanges (15a, 15b) and connected by inclined portions (19a, 19b) to edge portions (20a, 20b) of the web (17) which are connected to the flanges (15a, 15b) to extend perpendicular thereto, and the purlin (12) is connected to the cleats (13) by fasteners (21) engaged with the edge web portions (20a, 20b) of the purlin (12).



Title: "Roof, wall or floor Structure"

This invention relates to a roof, wall or floor structure comprising at least two structural members and a purlin extending between the structural members and connected thereto by cleats, one fixed to each of said two structural members. The structural members comprise rafters, columns or beams, respectively, depending upon whether the structure is a roof, wall or floor structure. The purlins usually support an outer roof or wall cladding such as asbestos or metal sheets or flooring sheets of any conventional material.

The purlins used in such structures by virtue of their shape are subject to forces having a component which extends parallel to the structural members and which tends to cause the purlins to rotate about a longitudinally extending axis and consequently known purlins have to be designed to withstand such forces, and as a result the cost of a structure has been determined by the need to provide purlins of necessary dimensions and mass.

An object of the invention is to provide a structure which is economical to produce.

According to one aspect of the invention, we provide a structure comprising at least two structural members and a purlin supported by and extending between the structural members and connected thereto by cleats, one fixed to each of said two structural members, wherein the purlin comprises a cold rolled section having a pair of spaced side-by-side generally parallel opposed flanges, each having an intumed lip at one edge and the flanges being interconnected by a web part at their other edges, the web part comprising a median portion perpendicular to the flanges and connected by inclined portions to edge portions of the web which are connected to the flanges to extend perpendicular thereto, and the purlin is connected to the cleats by fasteners engaged with the edge web portions of the purlin.

The present invention achieves the above stated aim because the purlin and fastener configuration according to the invention permits of a purlin

comprising a cold rolled section incorporating less material than has been necessary hitherto to achieve the necessary strength.

Moreover, the purlin configuration is, itself, less susceptible to rotation than many known purlin configurations since the shear centre is within the
5 overall envelope of the purlin which is to be contrasted with the position of the shear centre in a conventional channel section purlin and the tendency of a Z-section purlin to rotate about its longitudinal axis.

The purlin may be disposed with the web part extending transversely away from the structural member and the web part may be perpendicular to
10 the adjacent surface of the structural member.

The inner flange of the purlin, i.e. that closest to the structural member may be spaced from the adjacent surface of the structural member to avoid premature failure by squashing of the purlin between the cleat and structural member.

15 The purlin may be provided with a stiffener comprising a member adapted to interfit with the inner edge web portion, flange and lip to reinforce the inner connection between the purlin and cleat.

The cleat may be of the same configuration as the purlin but without flange or may be the same as the purlin except for the median web portion
20 which may be wider or narrower than that of the purlin.

The cleat may be fixed to the structural member by welding.

Alternatively, the cleat may be generally L-shaped, one limb being connected to the structural member by fasteners and the other limb being connected to the purlin.

25 Longitudinally adjacent purlins may be connected together by a connecting member of a configuration to conform to at least the web part of the purlins and fastened to the web parts so as to span between the adjacent purlins.

The connecting member may be fastened to the edge web parts of the
30 purlins.

The connecting member may have a flange to conform to and engage below the inner flanges of the purlins.

The fasteners may be bolts, both for the cleat to purlin connection and for the cleat to structural member connection.

35 The purlin may have dimensions in accordance with the following range:
Where F equals the width of each flange:

	Lip height	0.15 to 0.5 x F
	Edge web portion width	0.28 to 1.0 x F
	Inclined portion width	0.25 to 1.0 x F
	Inclined portion inclined at to the web portions	65° to 25°
5	Median web portion width	0.15 to 4.5 x F

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

FIGURE 1 is a cross-sectional view through part of a roof structure embodying the invention illustrating a purlin to rafter connection;

10 FIGURE 2 is an exploded fragmentary perspective view of the part of the roof structure shown in Figure 1;

FIGURE 3 is an exploded fragmentary perspective view showing part of another roof structure embodying the invention and showing a sleeved connection between two purlins;

15 FIGURE 4 is a diagrammatic illustration showing the cross-sections of a purlin, cleat and sleeves used in the roof structure shown in the preceding Figures; and

20 FIGURES 5 and 6 are diagrammatic representations of the strength of a purlin to rafter connection embodying the invention, compared with previously known purlin to rafter connections.

Referring now to Figures 1 and 2, a roof structure embodying the invention comprises a plurality of spaced parallel structural members comprising rafters 10 supported, in conventional manner, on uprights (not shown). The rafters 10 may be of any desired appropriate section, but in the example illustrated are of I-section and support above their upper surface 11 a plurality of spaced parallel purlins which extend at right angles to the rafters 10. One such purlin is illustrated at 12 in Figures 1 and 2.

Each purlin 12 is connected to its associated rafter 10 by a cleat 13 which, in the example illustrated, is welded, as indicated at 14 to the upper surface 11 of the rafter 10.

The purlins 12 support an outer roof cladding (not shown) of conventional form, for example, asbestos or metal cladding sheets.

35 The purlin 12 is made of cold rolled steel and comprises a pair of spaced side-by-side parallel opposed flanges 15a, 15b each having an intumed lip 16a, 16b at one edge which extend perpendicular to their associated flange, and the flanges being interconnected at their other edges by a web part 17 which

comprises a median portion 18 perpendicular to the flanges and connected by inclined portions 19_a, 19_b to edge portions 20_a, 20_b of the web part which are connected to the flanges to extend perpendicular thereto.

5 The dimensions of the purlin shown in Figures 1 and 2 are set out in the column headed J in the table below with the metal thickness being 2.7mm.

	<u>A</u>	<u>B</u>	<u>C</u>	<u>D</u>	<u>E</u>	<u>F</u>	<u>G</u>	<u>H</u>	<u>J</u>	<u>K</u>
Flange Width mm	56	56	70	56	70	56	70	70	70	100
Lip Height mm	14	14	14	14	14	14	14	14	14	20
Overall Height mm	120	140	140	170	170	200	200	230	260	300
Median Web Portion Width mm	10	30	30	60	60	90	90	120	150	190
Inclined Web Portion Width mm	30	30	30	30	30	30	30	30	30	30
Edge Web Portion Width mm	34	34	34	34	34	34	34	34	34	34
Angle of Inclination	40°	40°	40°	40°	40°	40°	40°	40°	40°	40°
Inner Bend Radii mm	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
Metal Thickness mm	1.5	1.5	1.55	1.55	1.55	1.55	1.6	1.8	2.05	2.5
	1.65	1.65	1.65	1.65	1.65	1.65	1.8	2.05	2.4	3.0
	1.85	1.85	1.85	1.85	1.85	1.85	2.05	2.5	2.7	3.5
		2.05	2.05	2.05	2.05	2.05	2.05	3.0	3.2	

If desired, the purlin may have other dimensions such as those set out in Columns A-J in the above table and it will be seen that each of the purlins of Columns A to J may be made in material of any one of a number of specific thicknesses as may be the purlin illustrated.

10 It will also be seen that the dimensions of the inclined web portions, edge web portions and the angle of inclination of the inclined web portions to the remainder of the web portions is identical for all of the range of sections. Furthermore, there are five sections with a flange width of 70mm, four sections with a flange width of 56mm and all these have a lip height of
15 14mm. There is also a section with a flange width of 100mm and lip height of 20mm.

All the sections with the same flange and lip dimensions can be made using the same rolls merely by inserting appropriate roll spacers to produce a median web portion of the desired width, thereby contributing to the economy of production of the purlin and hence the resultant roof structure.

5 In general terms, the section may have any desired dimensions lying within the following range of dimensions:

Where F is equal to the flange width:

Lip height	0.15 to $0.5 \times F$
Edge web portion width	0.28 to $1.0 \times F$
10 Inclined portion width	0.25 to $1.0 \times F$
Inclined portion inclined at to the web portions	65° to 25°
Median web portion width	0.15 to $4.5 \times F$

The cleat 13, in the example illustrated, is made of material having the same configuration as that set out in Column J of the above table but without
15 the flanges and, of course, inturned lips. Thus the cleat may be made using the same rolling equipment as is used to make the purlins.

As mentioned above, the cleat 13 is welded to the rafter 10 and the purlin is secured to the cleat by four bolts 21 of 12mm diameter which pass through apertures 26 in the edge web portions 20a, 20b of the purlin and
20 apertures 27 in the corresponding purlins of the cleat. In order to facilitate assembly of the roof structure, a bolt check washer is provided as indicated at 22a, 22b. The check washer may be fitted under either the head of the bolt, as indicated at 22a, or under the nut as indicated at 22b. In both cases the check washers are of identical configuration having a main part 23
25 through which the shank of the bolt extends and a lip 24 extending perpendicular to the main part 23 to engage a flat on the head or the nut, and an inclined part 25 to engage an inclined portion 19a, 19b of the purlin, or a corresponding inclined portion of the cleat, depending upon whether the check washer is engaged under the head or the nut of the bolt.

30 If desired, any other suitable fastener may be used instead of bolts 21.

As will be seen from Figure 1, the inner flange 15b of the purlin is spaced from the rafter 10 by about 10mm in the example illustrated, so that in the event of any distortion of the cleat the purlin is not squashed between the cleat and rafter.

35 Tests have been performed on the example illustrated in Figures 1 and 2 compared with other fastening configurations and other purlin shapes and the

results of these tests are indicated in diagrammatic form in Figures 5 and 6 where Test 1 is a test of a purlin to rafter connection, as illustrated in Figures 1 and 2, and the remaining tests are of connections having the configurations illustrated in Figures 5 and 6. It will be seen that the results
5 obtained in Test 1 compared with the other tests is surprisingly good.

Referring now to Figure 3, where it is desired to join two purlins 12 together of the configuration described above, a connecting member having the same configuration as the purlins, but without flanges, is provided, as illustrated at 30 in Figure 3. It will be seen that the connecting member 30 is
10 provided with eight apertures for bolted connections, four of the apertures, indicated at 31, being used to accommodate bolts corresponding to the bolts 21 illustrated in Figures 1 and 2, and the apertures 32 being provided to accommodate further bolts (not shown) passing through apertures 33 in the edge web portions 20a, 20b of the purlin.

Figure 4 is a diagrammatic illustration at (a) and (b) respectively of the cross-sections of the purlin 12 and cleat 13 in Figures 1 to 3 and at (c) the connecting member 30 in Figure 3, as well as at (c) a stiffener 34 which is dimensioned to nest and interengage with the lower edge web portion, flange and upturned lip and through which the inner bolts 21 extend.
15

The provision of such a stiffener increases the strength of the connection still further compared with the data given in Test 1.
20

An alternative form of connecting member 30a, shown at (d), has a flange 35 which extends under the inner flange 15b of the purlin 12 to increase stiffness. The stiffener 34 may also be used with the connecting member 30a.
25

Normal methods of predicting purlin system load carrying capacity can be expressed in the form:

Where

$$Z = \frac{WL}{K}$$

30

Z = section modulus in cm³

W = load carried in kN

L = span in cm

K = constant

The higher the value of K then the lower the section modulus required to carry a given load.

35 Calculations based on classical elastic bending theory give a value K of 182, for the material quality used in the example illustrated. Tests of roof structures embodying the invention show that a K value of 240 is to be

expected. Furthermore, with regard to cleat strength, it can be estimated that a conventional laminar cleat bent only in a direction parallel to the purlin span will need to be 10mm thick in order to restrict its deflection to acceptable limits and to provide sufficient stiffness to prevent premature failure being induced by crushing against the rafter or rolling of the purlin.

The cleat of Applicant's invention in the example illustrated is of equivalent strength to a 12mm thick plate and has deflection characteristics of an 18mm thick plate and so ensures overall stability of the roofing structure without the addition of external restraints and with considerable economy in material.

Although the invention has been described above as embodied in a roof structure, the invention may be embodied in a wall or floor structure. In the case of a wall structure, components corresponding to the rafters are disposed to provide columns whilst the purlins act as rails and components corresponding to the roofing sheets provide wall cladding which is typically vertical, whilst in the case of a floor structure components corresponding to the rafters are disposed to provide floor beams and whilst the purlins act as cross beams, components corresponding to the roofing sheets provide floor sheets.

For convenience of description, the term "structural member" is used herein to refer generically to a rafter, a column, or a floor beam and the term "purlin" is used herein to refer generically to a purlin proper, a wall rail or a floor cross beam.

The features disclosed in the foregoing description, in the following claims and/or in the accompanying drawings may, both separately and in any combination thereof, be material for realising the invention in diverse forms thereof.

CLAIMS:

1. A structure comprising at least two structural members (10) and a purlin (12) supported by and extending between the structural members (10) and connected thereto by cleats (13), one fixed to each of said two structural members (10), wherein the purlin (12) comprises a cold rolled section having a pair of spaced side-by-side generally parallel opposed flanges (15_a,15_b), each having an inturned lip (16_a,16_b) at one edge and the flanges (15_a,15_b) being interconnected by a web part (17) at their other edges, the web part (17) comprising a median portion (18) perpendicular to the flanges (15_a,15_b) and connected by inclined portions (19_a,19_b) to edge portions (20_a,20_b) of the web (17) which are connected to the flanges (15_a,15_b) to extend perpendicular thereto, and the purlin (12) is connected to the cleats (13) by fasteners (21) engaged with the edge web portions (20_a,20_b) of the purlin (12).

5

10
2. A structure according to Claim 1 wherein the web part (17) is perpendicular to the adjacent surface of the structural member (10).
3. A structure according to Claim 1 or Claim 2 wherein the inner flange (15_b) of the purlin (12) is spaced from the adjacent surface of the structural member (10).

15
4. A structure according to any one of Claims 1 to 3 wherein the purlin (12) is provided with a stiffener (34) comprising a member adapted to interfit with the inner edge web portion (20_b), flange (15_b) and lip (16_b) to reinforce the inner connection between the purlin (12) and cleat (13).

20
5. A structure according to any one of the preceding claims wherein the cleat (13) is of the same configuration as the purlin (12) but without a flange.
6. A structure according to any one of the preceding claims wherein the cleat (13) is of the same configuration as the purlin (12) except for the median web portion (18) which is wider or narrower than that of the purlin.

25
7. A structure according to any one of the preceding claims wherein the cleat (13) is fixed to the structural member (10) by welding.

8. A structure according to any one of Claims 1 to 6 wherein the cleat (13) is generally L-shaped, one limb being connected to the structural member (10) by fasteners and the other limb being connected to the purlin (12).
- 5 9. A structure according to any one of the preceding claims wherein longitudinally adjacent purlins (12) are connected together by a connecting member (30) of a configuration to conform to at least the web part (17) of the purlins (12) and fastened to the web parts (17) so as to span between the adjacent purlins (12).
- 10 10. A structure according to Claim 9 wherein the connecting member (30) is fastened to the edge web portions of the purlins (12).
11. A structure according to Claim 10 wherein the connecting member (30) has a flange (35) to conform to and engage below the inner flanges (15b) of the purlins (12).
- 15 12. A structure according to any one of the preceding claims wherein the fasteners are bolts (21).
13. A structure according to any one of the preceding claims wherein the purlin has dimensions in accordance with the following range:
- Where F equals the width of each flange (15a,15b):
- | | |
|---|-----------------|
| 20 Lip (16a,16b) height | 0.15 to 0.5 x F |
| Edge web portion (20a,20b) width | 0.28 to 1.0 x F |
| Inclined portion (19a,19b) width | 0.25 to 1.0 x F |
| Inclined portion (19a,19b) inclined to the edge web portions (20a,20b) at | 65° to 25° |
| Median web portion (18) width | 0.15 to 4.5 x F |

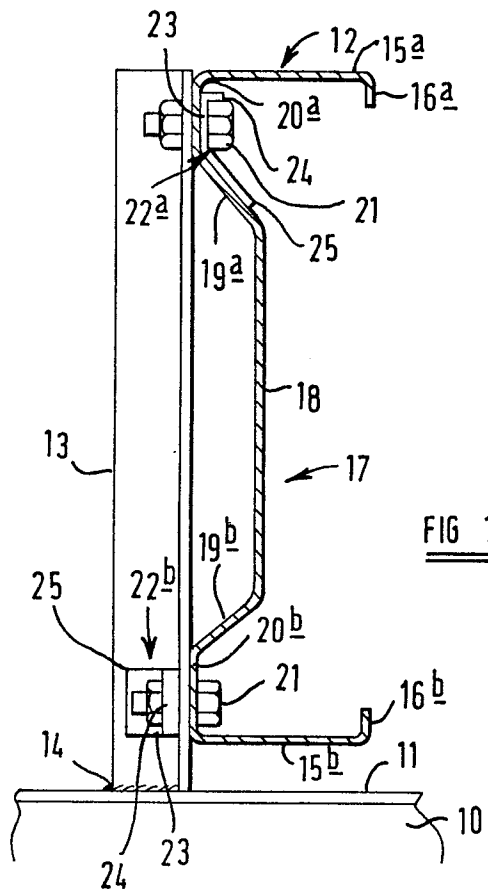


FIG 1

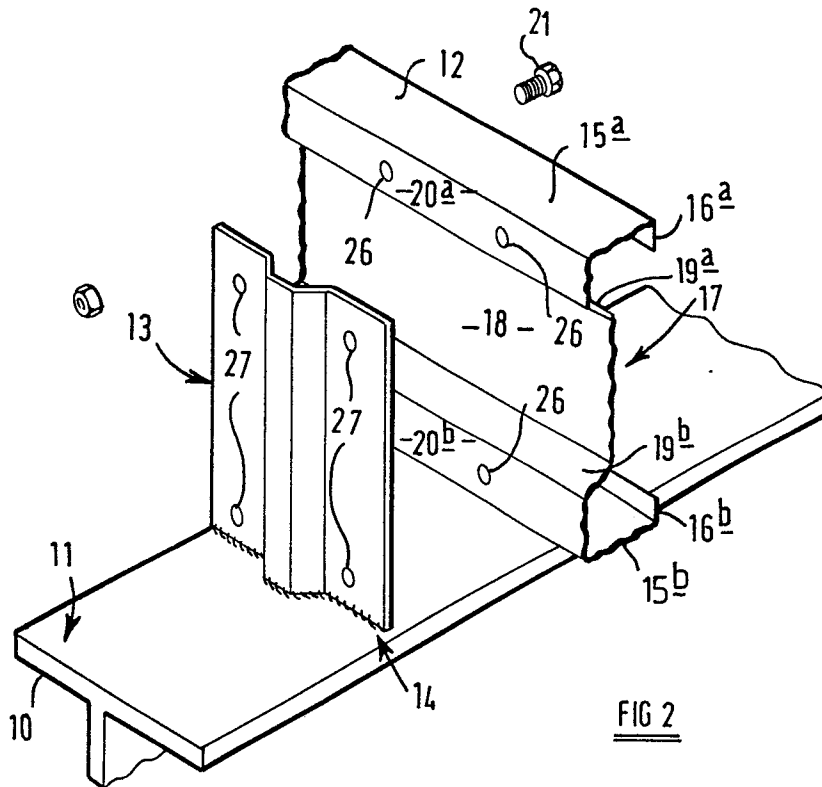
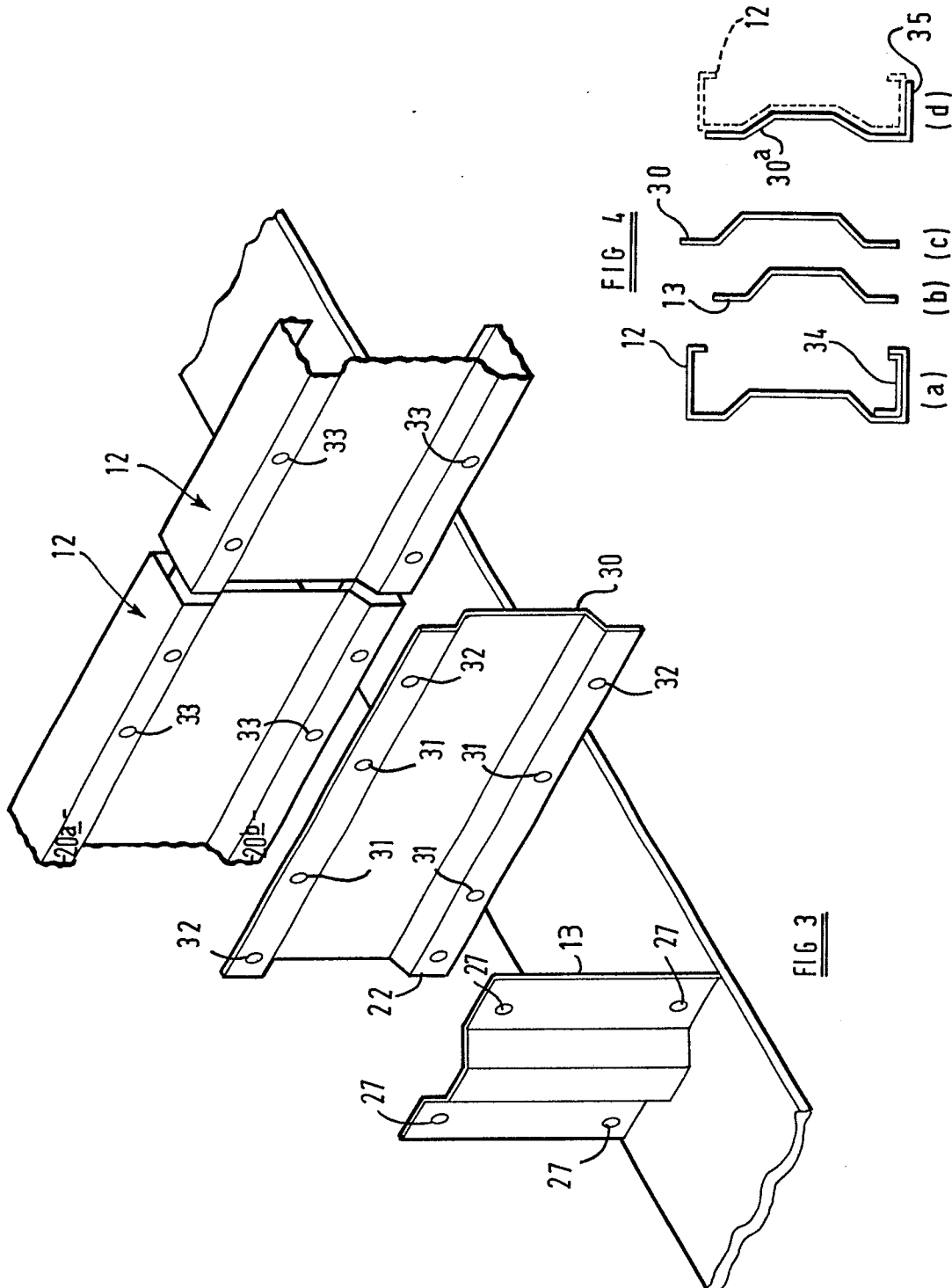
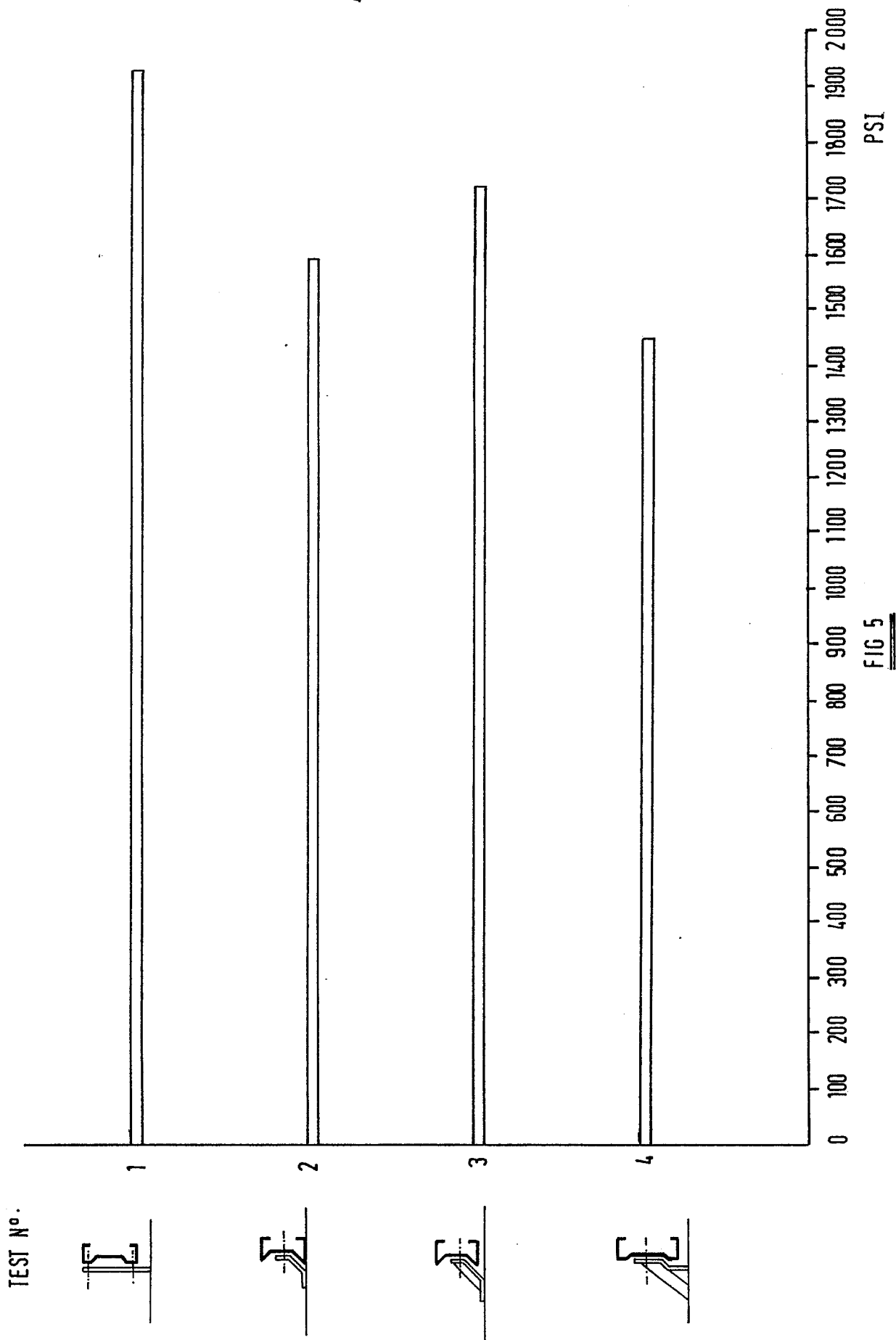


FIG 2

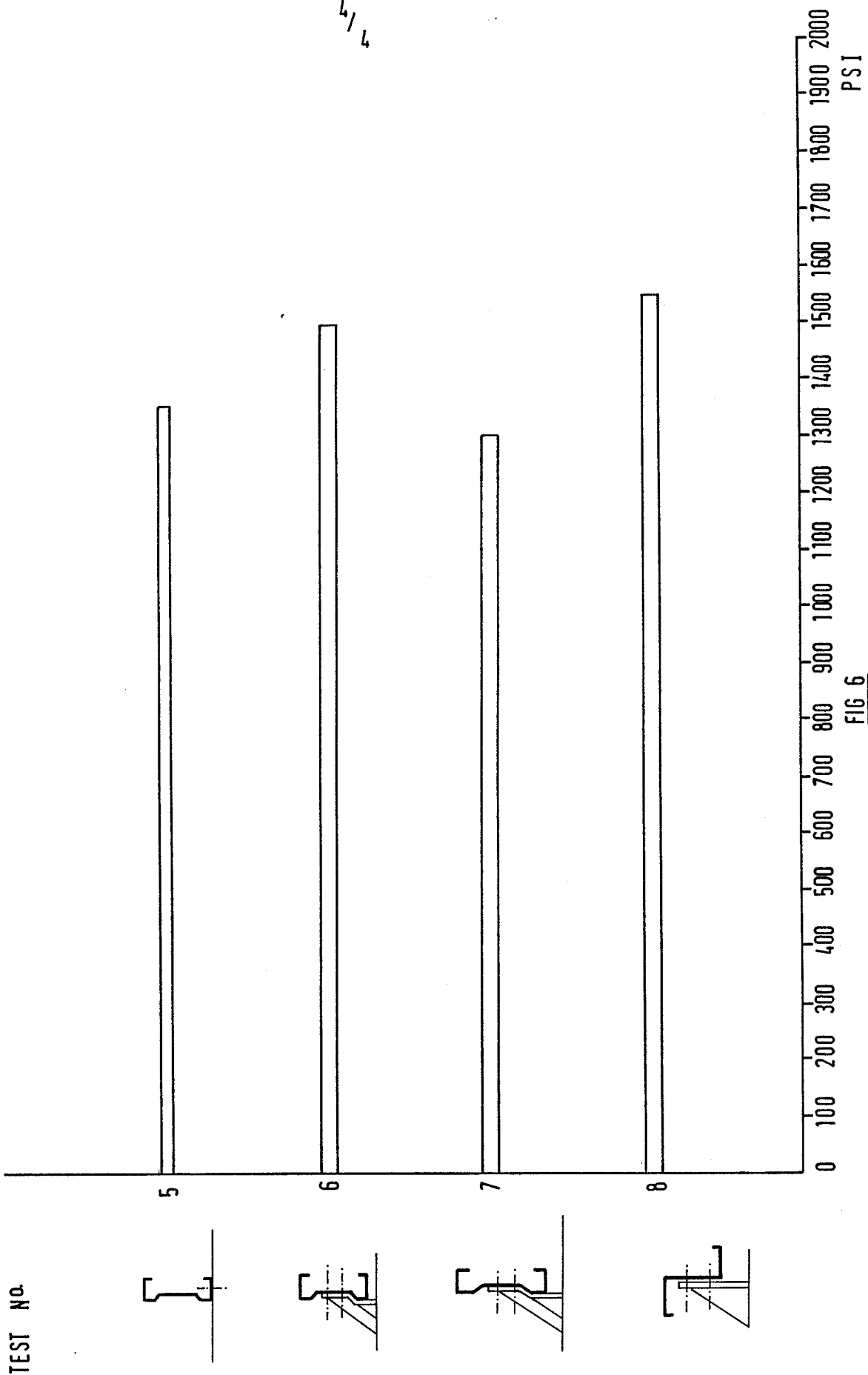


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European Patent
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EUROPEAN SEARCH REPORT

0110373
Application number

EP 83 11 1944

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. ³)
A	FR-A-2 107 974 (USS ENGINEERS AND CONSULTANTS, INC.) * Figures 1-7; whole document *	1,2,4	E 04 C 3/07 E 04 B 1/24 E 04 B 7/02
A	GB-A-1 487 244 (VALLOUREC) * Figures 1-3; page 2, lines 34-46, 98-103 *	1,2,7	
A	GB-A-1 562 688 (WARD BROTHERS LTD.) * Whole document *	1,2,5	
A	AU-B- 484 884 (G. HOLLINGS PTY. LTD.) * Figures 1,2 *	1,2,7	
			TECHNICAL FIELDS SEARCHED (Int. Cl. ³)
			E 04 B 1/00 E 04 B 7/00 E 04 C 3/00 E 04 D 12/00
The present search report has been drawn up for all claims			
Place of search BERLIN		Date of completion of the search 23-02-1984	Examiner VON WITTKEN-JUNGNIK
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			