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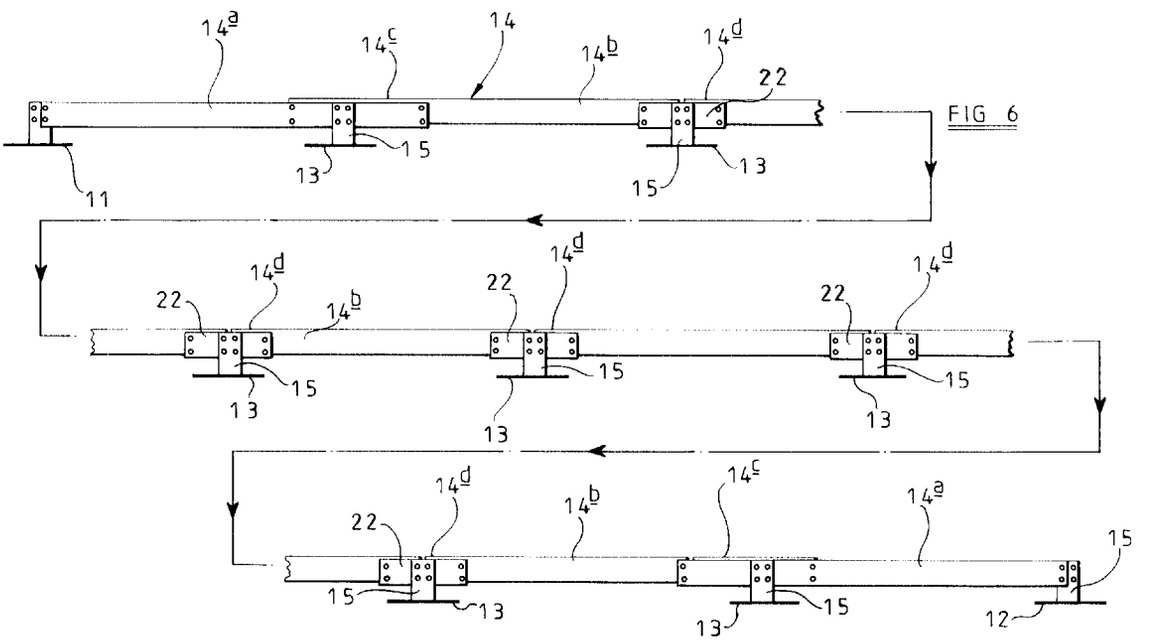
(71) Applicant: **METSEC PLC**
Oldbury, Warley B69 4HE (GB)

(72) Inventor: **Burns, Roy John**
Cannock Wood, Rugeley WS15 4RS (GB)

(74) Representative: **Carpenter, David et al**
MARKS & CLERK,
Alpha Tower,
Suffolk Street Queensway
Birmingham B1 1TT (GB)

(54) Constructional rafter and purlin system

(57) A building construction comprising a first rafter (13) substantially parallel with a gable end (11) and defining therewith an end bay, a second rafter (13) parallel to the first rafter and defining therewith an intermediate bay, a third rafter (13) parallel to the second rafter and defining therewith a further intermediate bay, and a purlin (14) spanning said bays and supported on the gable end and each of said rafters, said purlin (14) being formed from *n* cold rolled sections (14a, 14b) of predetermined length, and a first purlin section (14a) spanning said end bay and being joined to a second purlin section (14b) over said first rafter (13) by an overlapped joint (14c), the end of the second section remote from the first section being joined to a third pulin section (14b) above a respective rafter by a sleeved joint (14d), the *n* -2th section (14b) being connected to the *n* -1th section (14b) by a sleeved joint (14d) above a respective rafter, and the *n*th section (14a), being an end bay section at the end of the purlin remote from the first mentioned end bay section, being connected to the *n* -1th section (14b) by an overlapped joint (14c) above the rafter adjacent the second gable end, said first and *n*th sections (14a) of the purlin being formed from a material of heavier gauge than the material of at least some of the intermediate sections (14b).



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Description

This invention relates to building systems, and although the invention is particularly concerned with metal purlin assemblies in pitched roof constructions it may also find application in metal side-rail assemblies of wall constructions.

The invention will be described herein using the terminology of pitched roof construction where the main load supports of the roof construction, which extend from the ridge of the roof to the walls of the building, are normally referred to as rafters, and the structural members which extend at right angles to the rafters, spanning the bays defined between the rafters, are normally referred to as purlins. It should be noted however that in a wall construction it would be more normal to refer to the vertical main load supports as columns, and to refer to the horizontal structural members spanning the bays defined between the columns as side-rails.

Metal purlins are constructed from predetermined lengths of cold rolled section secured together to produce an elongate purlin of appropriate length. The purlin, which spans the bays defined between the rafters is secured to the rafters by appropriate cleats, each cleat being secured both to a rafter, and to the purl in. There are three recognised ways of securing together the lengths of cold rolled section to form the purlin. The lengths can simply be butted end-to-end, the two adjacent ends of the section being bolted to the respective cleat. Such butt joints are generally not preferred, and in practice are only used in short or uneven spans, in small buildings where the loading conditions are very light.

In general the choice for joining the cold rolled sections to form the purlin is between a sleeved joint and an overlapped joint. In the sleeved joint the two lengths of section are butted end-to-end, and a predetermined length of an additional section is bolted to the butted sections across the butt. The two sections and the sleeve section are then bolted to the rafter cleat. In an overlapped joint the two lengths of section overlap with one another, with the overlapping region disposed over a rafter. The overlapping regions are then bolted together, and are bolted to the rafter cleat. In terms of strength the overlapped joint is the strongest since there are two continuous lengths of section passing over the underlying rafter. The butt joint is weakest of the three, and the sleeved joint is of a strength intermediate that of the butt joint and the overlapped joint.

It is known to produce a roof construction in which all of the purlin sections are interconnected by butt jointing to define the purlins, and similarly it is known to produce a roof construction wherein all of the purlin sections are joined by sleeve joints to produce the purlins. In the same way a roof construction where all purlin sections are joined by overlapped joints is known. It is also generally recognised that in all usual roof constructions the region of the purlins spanning the end bays, that is to say the bays defined between the two gable ends of the roof and the next adjacent rafters, needs to have the greatest load bearing capacity and thus often roofs are constructed with purlins which are, throughout their length, engineered to meet the worst-case situation occurring at the end bays. Clearly this constructional technique is convenient since it does not distinguish between regions of the purlins, but is wasteful in that the purlin regions overlying the intermediate bays are over specified.

An attempt has previously been made to minimise such material wastage by using heavier gauge, and therefore stronger, purlin sections for those parts of the purl in which span the end bays. In this way the gauge of the material of the purlin spanning all intermediate bays can be reduced towards the theoretical strength requirement in relation to the intermediate bays. This system has become known as the "Metsec Heavy End Bay System". Although there have been roof constructions where the purlins have sleeved joints at the first rafter inward from the gable end, and alternating sleeved and butt joints throughout the remainder of the purlin, such constructions are unusual and are wasteful in material. It has generally been considered that optimum material utilisation is achieved with a heavy end bay system wherein each purlin has sleeved connections throughout its length.

An object of the present invention is to provide a building system wherein efficiency of material utilisation is further improved by providing a purlin system capable of meeting particular span/strength characteristics using the minimum gauge of metal in the purlin sections.

In accordance with the present invention there is provided a building construction comprising opposite gable ends or like end supports, a plurality of spaced rafters generally parallel to said gable ends, the first and last of said rafters defining with said gable ends respective end bays and the rafters defining between them respective intermediate bays, and, a purlin spanning said bays and supported on the gable ends and said rafters, said purlin being formed from a plurality of cold rolled sections including a first, end bay, section spanning said end bay and being joined above said first rafter by an overlapped joint to a second, intermediate, section, the end of the second section remote from the first section being joined above a respective rafter by a sleeved joint to a third, intermediate, section, the n-2th, intermediate, section being joined above a respective rafter by a sleeved joint to the n-1th, intermediate, section, and the nth section, being an end bay section at the end of the purlin remote from the first mentioned end bay section, being connected to the n-1th, intermediate, section by an overlapped joint above said last rafter, said first and nth sections of the purlin being formed from a material of heavier gauge than the material of at least some of the intermediate sections.

Preferably all intermediate sections are interconnected by sleeved joints.

Desirably all intermediate sections are of a length such that the joint between two adjacent sections occurs over respective rafters.

Alternatively at least one intermediate section is of a double-span length so that it can bridge an intermediate rafter.

Preferably the cross sectional shape of the purlin sections is such that the sections can nest with one another when overlapped.

Desirably the cross-sectional shape of the purlin sections is that of a "Z" comprising a web with oppositely directed flanges at its opposite longitudinal edges, the flanges and the web of each section contacting the flanges and the web of an adjacent section when the two are nested in overlapped relationship.

Preferably where the purlin sections are of Z section then the sleeve member of a sleeved joint is a short length of material of the same cross-section nested with the two end-to-end sections so as to overlap both sections.

The invention further resides in a purl in for such a building construction.

The invention still further resides in a method of building including the assembly of such purlins and to a method of constructing a purl in.

In the accompanying drawings:-

Figure 1 is a diagrammatic representation of a conventional heavy end bay roof construction,

Figure 2 is a diagrammatic perspective view of part of a roof construction illustrating overlapped joints between purl in sections,

Figure 3 is an enlargement of part of Figure 2,

Figure 4 is a view similar to Figure 2 but illustrating sleeved connections,

Figure 5 is an enlargement of part of Figure 4,

Figure 6 is a diagrammatic representation of a purl in assembly of a building system in accordance with one example of the present invention,

Figure 7 is a cross-sectional view of an overlapped joint between purl in sections in Figure 6, and

Figure 8 is a diagrammatic representation of a number of alternative purlin cross-sections.

As mentioned previously the invention will be described with reference to roof constructions using the terms gable end, rafter, and purlin. It must be understood however that the invention can be applied to wall constructions where vertical supports are more often referred to as columns, and the horizontal structural members are referred to as side-rails.

In Figure 1 one face of a pitched roof is illustrated, and it can be seen that there are gable end supports 11, 12 which, in a steeled frame building would be steel gables, but which could be brick structures in a building with brick gable ends. The nature of the gable ends is not particularly relevant, and it can be considered, for the purposes of understanding the invention, that the gable ends are simply supporting members parallel to, and serving the same function, as intermediate rafters. Thus between the gable end members 11, 12 are a plurality of equi-distantly spaced parallel rafters 13 extending between the ridge of the roof and the upper edge of the side wall. Conventionally the regions defined between the rafters are known as bays, and thus the regions between the gable end members and the next adjacent rafters are known as end bays. The purlins 14 extend parallel to the ridge of the roof and span all of the bays parallel to one another and usually equally spaced between the ridge and the wall. Where a purl in passes over a rafter it is normally secured to the rafter by a cleat in the form of an L-shaped bracket having one limb welded or bolted to the rafter and an upstanding limb bolted to the purlin. Such a cleat can be seen at 15 in Figure 5.

The invention is principally, but not exclusively, concerned with purlins of Z-shaped cross-section (see Figure 7). Such purlins are formed from a number of interconnected lengths of cold rolled section and have a web 16, upper and lower integral, oppositely extending flanges 17, 18 projecting outwardly from the longitudinal marginal edges of the web 16, and each flange 17, 18 having at its free end an upturned lip 19, 21 extending parallel to the web 16. It can be seen in Figure 7 that the flange 18 of each length of section is wider than the flange 17 thereof.

Figures 2 to 5 illustrate two different ways of interconnecting such Z-sections to form a continuous purlin. In Figures 2 and 3 it can be seen that two adjacent lengths of purl in section are overlapped above a rafter 13 and are bolted together using six bolts in three spaced pairs along the length of the overlap. In order to overlap two identical lengths of the Z-shaped section one of them must be inverted relative to the other so that the flange 17 of the one section fits within the flange 18 of the other section and vice versa. This interrelationship is known as "nesting" and it will be recognised that when two sections are overlapped in this manner and are bolted together with their webs 16 in facial contact, then in the overlapped region each flange 17 supports, and is supported by the flange 18 of the other section. Desirably the centre pair of bolts secures the purlin to the underlying rafter by passing through the upstanding limb of a cleat appropriately secured to the rafter.

Figure 4 and Figure 5 illustrated a sleeved connection. In order to produce a sleeved connection a sleeve member is cut from a length of the same section as that from which the purlin sections are produced and is inverted, and nested with the two sections to the be joined,

which have previously been positioned in end-to-end butting relationship. Two pairs of bolts are then introduced through each of the purlin sections and the sleeve member to bolt the sleeve member to both purlin sections as illustrated in Figure 4. It should be noted that in Figure 5 the sleeve member 22 is shown, for convenience, held in place by fewer bolts than are depicted in Figure 4.

The roof construction illustrated in Figure 1 can utilise section of the same gauge throughout the whole length of each purl in, but as mentioned previously it is usual for the optimum material utilisation in a sleeved system to be achieved in such a building system by using a heavier gauge material for the purlin sections which span the end bays.

The heavy end bay system has been thought, for a number of years, to be the optimum in material utilisation in a roof construction using sleeved joints, but now, surprisingly, it has been established by the present inventor that a more efficient utilisation of material, to produce a building system of the same strength, can be achieved if the purlin arrangement illustrated in Figure 6 is utilised.

In Figure 6 the rafters are again illustrated at 13, with end bay support members illustrated at 11 and 12, and cleats indicated by the reference numeral 15. The purlin 14 is again constructed from a plurality of predetermined lengths of Z-section material, and the opposite end sections 14a, spanning the end bays, are of heavier gauge than the remaining intermediate purlin sections 14b. Each end bay section 14a of the purlin is inverted with respect to the remaining intermediate sections, and is connected to the next adjacent intermediate section 14b by means of an overlapped joint 14c. All intermediate purlin sections 14b are connected to adjacent intermediate purlin sections 14b by a sleeved joint 14d. The overlapped joints and the sleeved joints each utilize eight bolts rather than six as used in the previous proposals.

It will be noted that in the two overlapped joints 14c there is a greater length of overlap at the intermediate section side of the supporting rafter 13 than at the end bay side of the rafter. This is a deliberately introduced feature, and provides a "tuning" of the strength and rigidity characteristics of the purlin in the region of the end bay, and the adjacent intermediate bay. The exact relationship between the overlap and the length of the span will be determined by the characteristics of the purlin material, the gauge of the material, and the length of the span, and will vary with the differences between the gauge of the material of the end bay span and the gauge of the material of the intermediate spans. Furthermore, any difference between the length of the end bay span and the adjacent intermediate span will be of relevance.

Variations can be made in the above purlin construction without departing significantly from the optimum. Thus there will be situations in which certain intermediate section joints need not be sleeved joints, and could be overlapped joints. However, in all arrangements each end bay section will be connected to its next intermediate section by an overlapped joint, and that intermediate section will be connected to its next intermediate section by a sleeved joint. Moreover, certain intermediate sections of the purlin could be double span sections in that they are of sufficient length to span an intermediate rafter 13 without there being a joint above that rafter. In such circumstances it is usual to secure the purlin to the spanned rafter by a cleat 15 notwithstanding the fact that there is no joint at that point. In addition, there may be situations in which it is advantageous to use the heavier, end span gauge of material for an intermediate double span purlin section.

It will be recalled that the end span sections 14a are inverted with respect to the intermediate sections 14b of the purlin. For optimum structural strength, with minimum material utilisation, the end span sections 14a will be positioned with their narrow flange 17 uppermost and therefore all intermediate sections will have their wider flange 18 uppermost. Naturally, where side rails in a wall construction are being considered then the end span sections will have their narrow flanges outermost such that all intermediate sections have their wider flanges outermost.

Figures 8a, 8b, 8c, 8d, and 8e show alternative cross-sectional shapes which can be cold rolled and lengths of which can be interconnected to form purlins in a building construction as described above. In each case the sections will in practice have one of the flanges wider than the other so that two lengths can be nested by inverting one relative to the other. Thus sleeved and overlapped joints can be made as described above. However, the sections illustrated in Figures 8f to 8i are variants of C-sections and sleeve connections must be provided by rolling a sleeve member of the same shape, but slightly larger dimensions so that the ends of the purlin sections can fit within the sleeve member. Where overlapped joints are to be produced then two purlin sections would need to be positioned back to back so that their webs are in facial contact, it being appreciated that there is no nesting interrelationship and thus flanges do not support one another in an overlapped joint using such sections.

It is believed that all of the sections illustrated in Figure 8 could, with advantage, be utilised in a purl in assembly of the kind illustrated in Figure 6.

Claims

1. A building construction comprising opposite gable ends (11, 12) or like end supports, a plurality of spaced rafters (13) generally parallel to said gable ends, the first and last of said rafters defining with said gable ends respective end bays and the rafters defining between them respective intermediate bays, and, a purlin (14) spanning said bays and supported on the gable ends and said rafters, said pur-

lin being formed from n cold rolled sections (14a, 14b), and the construction being characterised by a first, end bay, purlin section (14a) spanning said end bay and being joined above said first rafter by an overlapped joint (14c) to a second, intermediate, purlin section (14b), the end of the second section remote from the first section being joined above a respective rafter by a sleeved joint (14d) to a third, intermediate, purlin section (14b), the n-2th, intermediate, purlin section (14b) being joined above a respective rafter by a sleeved joint (14d) to the n-1th, intermediate, purlin section (14b), and the nth purlin section, being an end bay section (14a) at the end of the purlin remote from the first mentioned end bay section, being connected to the n-1th, intermediate, purlin section (14b) by an overlapped joint (14c) above said last rafter, said first and nth sections (14a) of the purlin being formed from a material of heavier gauge than the material of at least some of the intermediate sections.

2. A construction as claimed in claim 1 characterised in that all intermediate sections (14b) are interconnected by sleeved joints (14d).

3. A construction as claimed in claim 1 or claim 2 characterised in that all intermediate sections (14b) are of a length such that the joint between two adjacent sections (14b) occurs over respective rafters (13).

4. A construction as claimed in claim 1 or claim 2 characterised in that at least one intermediate purlin section (14b) is of a double-span length so that it can bridge an intermediate rafter (13).

5. A construction as claimed in any one of the preceding claims characterised in that the cross sectional shape of the purlin sections is such that the sections can nest with one another when overlapped.

6. A construction as claimed in any one of the preceding claims characterised in that the cross-sectional shape of the purlin sections is that of a "Z" comprising a web (16) with oppositely directed flanges (17, 18) at its opposite longitudinal edges, the flanges and the web of each section contacting the flanges and the web of an adjacent section when the two are nested in overlapped relationship.

7. A construction as claimed in claim 6 characterised in that the sleeve member (22) of a sleeved joint is a short length of material of the same cross-section as the purlin sections (14b), nested with the two end-to-end sections (14b) so as to overlap both sections.

8. A purlin for building construction, characterised by being formed from n of cold rolled sections of predetermined lengths, including a first, end bay, section (14a) joined to a second section (14b) by an overlapped joint (14c), the end of the second section (14b) remote from the first section (14a) being joined to a third section (14b) by a sleeved joint (14d), a *n* -2th section (14b) being connected to a n -1th section (14b) by a sleeved joint (14d), and a *n*th section (14a), being an end bay section at the end of the purlin remote from the first mentioned end bay section, being connected to the *n* -1th section (14b) by an overlapped joint (14c), said first and *n*th sections (14a) of the purlin being formed from a material of heavier gauge than the material of at least some of the intermediate sections (14b).

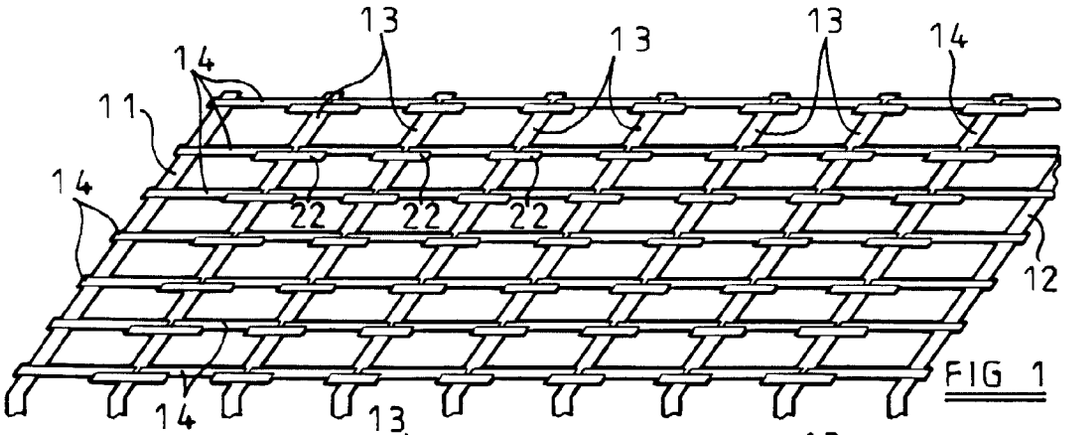


FIG 1

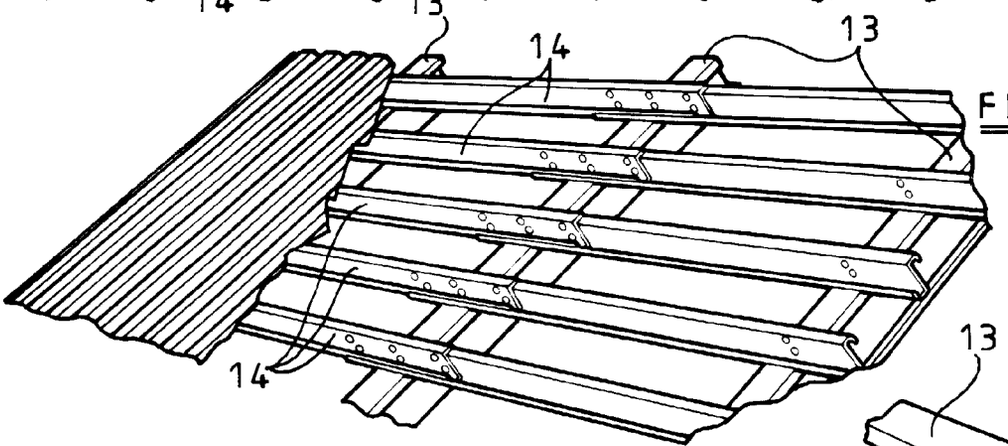


FIG 2

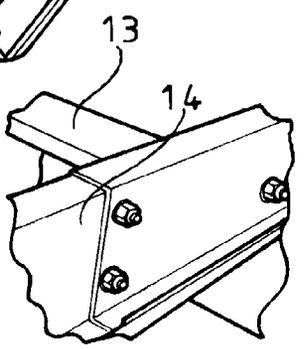


FIG 3

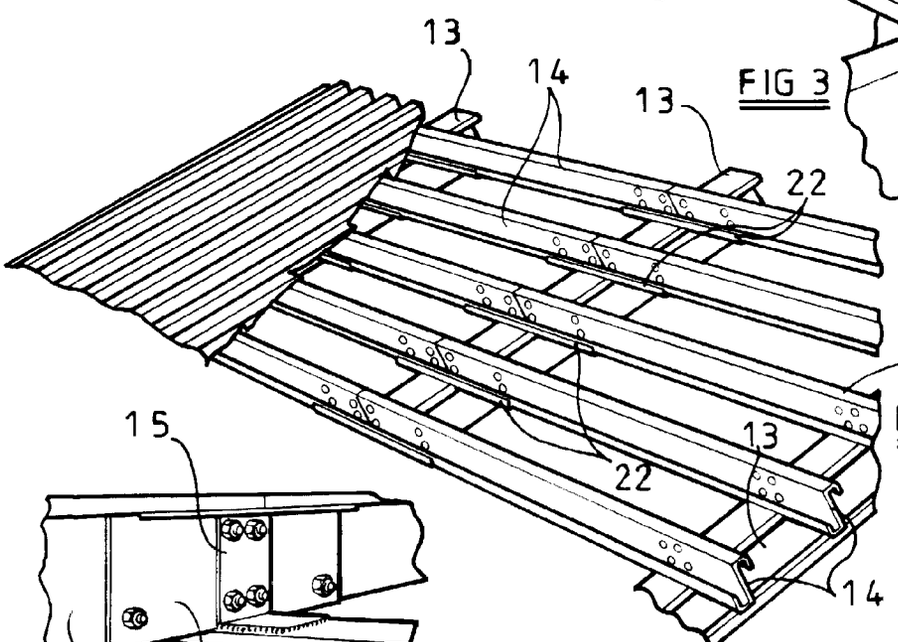
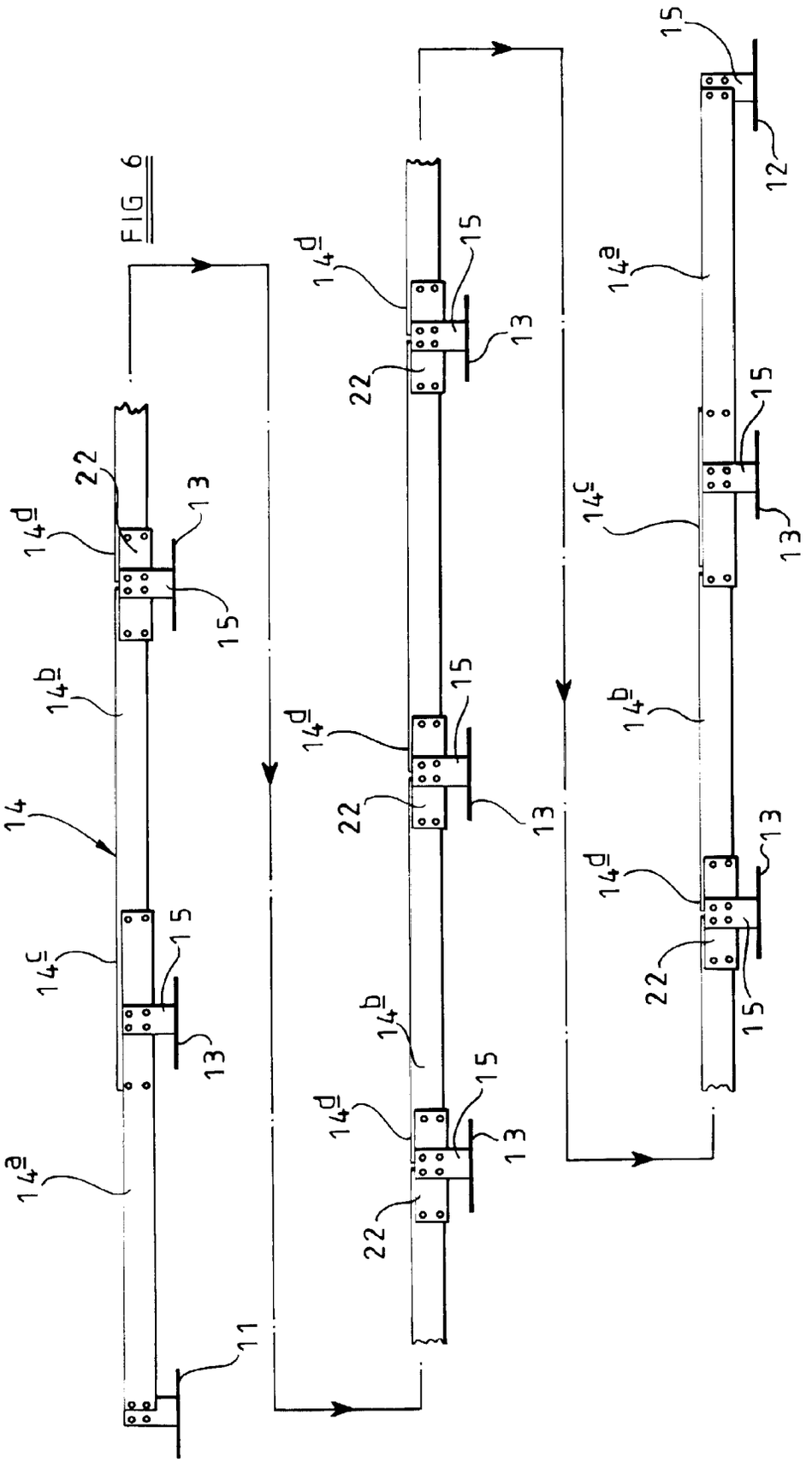


FIG 4

FIG 5

FIG 6



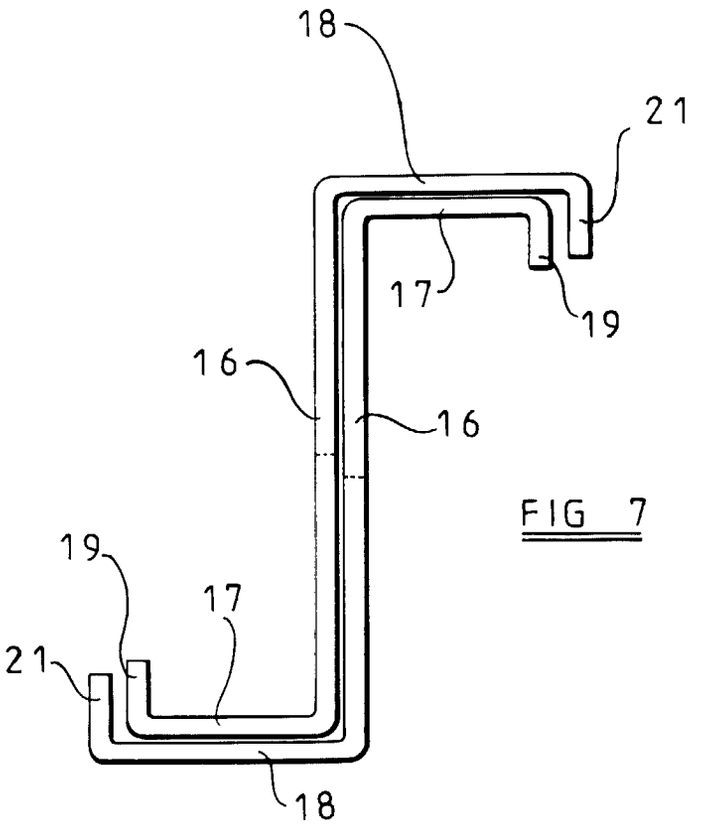


FIG 7

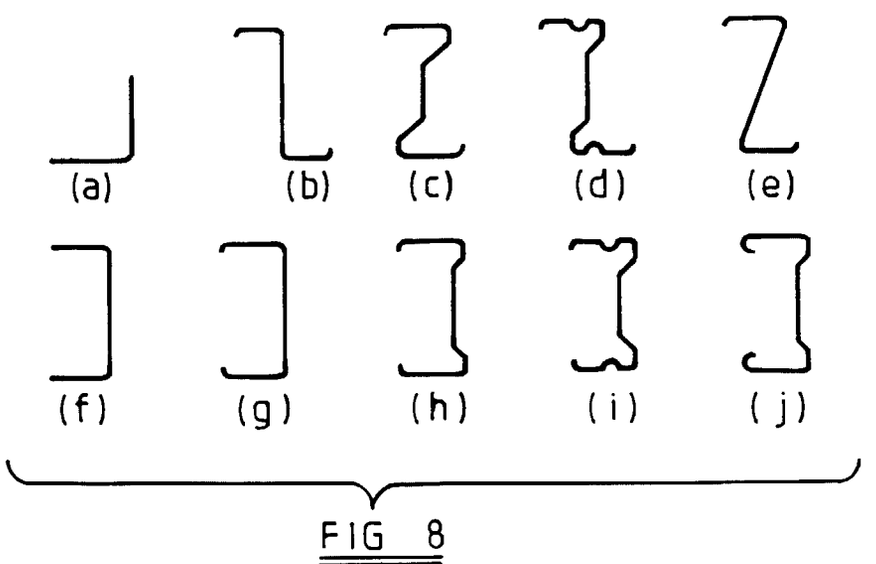


FIG 8