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

(11) **EP 4 390 003 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
26.06.2024 Bulletin 2024/26

(21) Application number: **22214684.7**

(22) Date of filing: **19.12.2022**

(51) International Patent Classification (IPC):
E04B 7/02 *(2006.01)* ***E04B 1/58*** *(2006.01)*
E04B 1/24 *(2006.01)* ***E04C 3/04*** *(2006.01)*

(52) Cooperative Patent Classification (CPC):
E04B 7/022; E04B 1/5806; E04B 7/024; E04C 3/07; E04B 2001/2469; E04B 2001/249; E04C 2003/0482

(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 ME MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA
Designated Validation States:
KH MA MD TN

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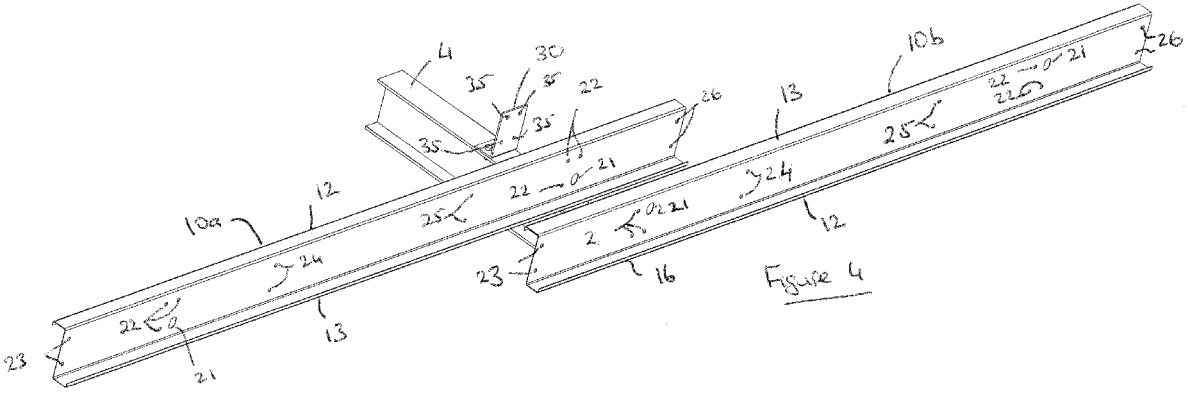
(54) **A PURLIN, A ROOFING STRUCTURE AND A METHOD OF FORMING A ROOFING STRUCTURE**

(57) A purlin comprising an elongate member which forms a profile having two opposing sides and an intermediate body portion. The intermediate body portion has formed therein a series of apertures for attaching the purlin to another purlin or to a cleat for securing the purlin to a roofing structure. The series of apertures formed therein include four apertures arranged in a rectangular pattern and with one of the apertures being in the form of a slot. Three apertures are dimensioned to be smaller than both the head of a bolt and the nut of a bolt, both of a given size, so that the purlin can be secured to another purlin or to a cleat by passing said bolt through a respective one of the apertures and securing said nut in place. The aperture in the form of a slot is dimensioned to be larger than both the head of said bolt and the nut of said bolt so that both the head and the nut of said bolt of a given size passes through the slot. A roofing structure comprising at least two such purlins is also disclosed. A method of forming a roofing structure comprises the steps of:
(a) providing a cleat;
(b) providing a first purlin of the invention;
(c) securing the first purlin to the cleat using a by a nut and bolt;
(d) providing a second purlin of the invention;
(e) overlapping the second purlin and the first purlin so that the nut and/or bolt passes through the aperture in the form of a slot defined in the second purlin.



EP 4 390 003 A1

Description

Field of the Invention

[0001] The present invention relates to a purlin, a roofing structure or roofing assembly and a method of forming or assembling a roofing structure or roofing assembly.

Background to the Invention

[0002] Often times a roofing structure is assembled on site. Typically these roofing structures are supported by uprights or walls. A truss and/or rafter may or may not be provided.

[0003] Purlins are often provided to support the roofing elements. The purlins typically run longitudinally along the roofing structure. Purlins can also run transversely across a roofing structure. Typically, the purlins provide sufficient support to allow roof covering elements to be applied and held in place. For example the roofing covering elements may be roofing panels.

[0004] An issue that arises is that depending on the location on the roofing structure, a different means of attachment, or a different orientation of a roofing element may be required. This may require different parts to be assembled together or indeed the same parts to be assembled differently.

[0005] For example with purlins, they are often overlapped to be assembled together, and they are often attached to a purlin securing bracket or cleat which fixes the purlin to an upright or roofing structural element such as a rafter. To allow for such different attachment points in the construction of a roof often times different purlins are provided to allow for different fixing in place.

[0006] Also sometimes a cleat has a central gusset (for reinforcement) and this can interfere with assembly.

[0007] It is desirable to simplify the process of assembling a roofing structure and the present invention which related to a purlin, a roofing structure and a method of forming a roofing structure.

Summary of the Invention

[0008] In one aspect the present invention provides a purlin comprising an elongate member which has a longitudinal axis and which forms a profile having two opposing sides (each opposing side may be in the form of a flange) on opposite sides of the longitudinal axis and an intermediate body portion (often called the web) running between the opposing sides,

the intermediate body portion having formed therein two apertures for attaching the purlin to another purlin, or for attaching the purlin to a cleat for securing the purlin to a roofing structure, wherein a first aperture is larger than the second aperture;
and the two apertures are positioned on opposite sides of, and substantially equidistant from, the longitudinal axis and the at least two apertures are both positioned on a first transverse axis which is perpendicular to the longitudinal axis.

[0009] Such purlin allows for ease of assembly. For example, the first larger hole may be utilised to prevent a fastening member for a first purlin interfering with mating with a second purlin.

[0010] Desirably the first larger aperture is dimensioned to be larger than: the head of a fastener; a securing nut for a fastener; or both. This means that if a fastener is in place the first larger hole in a second purlin can allow a possible interfering part of the fastener to pass through it. This allows for close mating fit of two purlins.

[0011] Desirably the second aperture is dimensioned to be smaller than: the head of a fastener; a securing nut for a fastener; or both. This means that when connecting purlins of the invention with a plurality of the same fastener the different apertures allow for securing of a first purlin by inserting the fastener into the second aperture and using the head and/or nut of the fastener to secure it in place. Additionally a second like purlin can be mated to the first purlin as the first larger aperture of the second purlin can allow the head and/or nut of the fastener to pass through thus allowing a close fitting.

[0012] Typically in such arrangements the purlins are close-fitting to each other.

[0013] The fastener may be a screw fastener with a screw head, for example a self-tapping screw; or a nut and bolt fastener with a bolt head and a nut.

[0014] Desirably the first larger aperture is in the form of a slot, for example in the form of an oblong circle.

[0015] Desirably the aperture pattern in the cleat matches the aperture pattern of the purlin. However it is desirable that none of the apertures in the cleat is dimensioned to be larger than: the head of a fastener; a securing nut for a fastener; or both.

[0016] For example the first and second apertures of the purlin may be positioned to align with respective apertures in a cleat.

[0017] Desirably the intermediate body portion has formed therein two further apertures for attaching the purlin to another purlin, or for attaching the purlin to a cleat for securing the purlin to a roofing structure, wherein said two further apertures are positioned on opposite sides of and substantially equidistant from the longitudinal axis and wherein the two further apertures are both positioned on a second transverse axis which is perpendicular to the longitudinal axis but the second transverse axis is spaced apart from the first transverse axis.

[0018] This allows for a configuration where three apertures (other than the first larger aperture) can be utilised to fix a purlin to a cleat and/or another purlin. This can be done with a series of fasteners of the same dimensions.

[0019] Desirably the two further apertures are dimensioned to be smaller than: the head of a fastener; a securing nut for a fastener; or both.

[0020] Suitably the first larger aperture, the second aperture and the further two apertures are arranged in a trapezoidal pattern with the apertures positioned at the corners of a trapezoid shape. In this arrangement they are symmetrically positioned with respect to the longitudinal axis of symmetry.

[0021] The trapezoidal pattern is desirably a rectangular pattern. This is a simple arrangement for allowing purlins to be connected to each other.

[0022] For example the present invention may provide a purlin comprising an elongate member which forms a profile having two opposing sides (each opposing side may be in the form of a flange) and an intermediate body portion (often called the web),

> the intermediate body portion having formed therein a series of apertures for attaching the purlin to another purlin or to a cleat for securing the purlin to a roofing structure, wherein the series of apertures formed therein include four apertures arranged in a rectangular pattern and with one of the apertures being in the form of a slot, wherein
> three apertures are dimensioned to be smaller than the head of a fastener or a nut of a fastener or both, so that the purlin can be secured to another purlin or to a cleat by passing said fastener through a respective one of the apertures and securing it in place, and wherein, the aperture in the form of a slot is dimensioned to be larger than: the head of a fastener; a securing nut for a fastener; or both, so that the head of a fastener or a securing nut for a fastener passes through the slot.

[0023] In the present invention it is assumed that the fasteners are of a given size. A plurality of fasteners of the same dimensions are utilised.

[0024] In a purlin of the invention wherein the (series of) apertures defined in a first purlin of the invention, align with the (series of) apertures defined in a second purlin of the invention when one purlin is inverted relative to the other.

[0025] In this way even though the purlins are inverted relative to each other they come into register. A fastener can then be inserted through the apertures in register in the respective first and second purlin. And of course also with apertures in a cleat.

[0026] Such purlin allows for ease of assembly. For example, the first larger aperture such as a slot may be utilised to prevent a fastening member for a first purlin interfering with mating with a second purlin.

[0027] This also means that the first and second purlin can not only have the same profile but also the same pattern of apertures. This means that there is no requirement for providing a second purlin which is different to the first purlin. Two or more purlins can be connected together in sequence to form a single length. Furthermore the purlins of the invention are easily connected together in-situ, whether or not one purlin has already been connected to a cleat (purlin supporting bracket).

[0028] In particular within the present invention it is desirable that the series of apertures defined in a first purlin of the invention, align with the series of apertures defined in a second purlin of the invention (the two purlins are identical) when one purlin is inverted relative to the other.

[0029] The first larger aperture such as a slot can be of any desired shape including rectangular. The first larger aperture such as a slot may take the form of an oblong circle. This allows for some degree of adjustment and allows for a degree of tolerance. Desirably the first larger aperture such as a slot is elongate in the direction running transversely across the purlin between the two sides (which may be flanges).

[0030] Desirably two purlins of the invention (the two purlins are identical) are profiled to mate with each other, for example by sliding one into the other.

[0031] For example one of the two opposing sides may be smaller than the other. This means two purlins of the invention are profiled to mate with each other by nesting of the smaller side in the larger side. For example each of the opposing sides may take the form of a flange (optionally with one flange larger than the other).

[0032] Desirably the first larger aperture such as a slot is positioned closer to the larger side. This has the advantage that overlapping or nesting of two purlins of the invention may be achieved more easily. Alternatively it may be positioned closer to the smaller side.

[0033] A purlin of the invention may be a rolled form profile, for example a cold rolled or cold formed profile. This is a simple yet effective way of providing purlins of the invention.

[0034] The apertures defined in a purlin of the invention may be provided by punching and/or drilling. It will be appreciated that with a purlin of the invention only a single punch/drill pattern is required as all purlins desirably have exactly the same aperture pattern.

[0035] In the present invention the configuration/pattern of apertures (whether two or four or other amount of apertures) described above will be described as a "series" of aperture. In particular the series of apertures in question are those which are utilised to secure the purlin to a cleat.

[0036] Desirably a purlin of the invention has two of the series of apertures formed therein wherein each of the series of apertures include four apertures arranged in a rectangular pattern and with one of the apertures being in the form of a first larger aperture such as a slot. This allows for one joining with a further purlin on either or both ends as is desirable.

[0037] A purlin of the invention may have a Z ("Zed") profile.

[0038] The present invention also relates to a roofing structure comprising at least two (identical) purlins of the invention attached to each other. Optionally such a construction one purlin is inverted relative to the other. In this respect identical means having an identical cross-sectional profile and aperture pattern. It also desirably means

purlins having the same thickness though it will be appreciated that if the purlins have an identical cross-sectional profile and aperture pattern different thicknesses of purlin could be utilised.

[0039] A roofing structure of the invention comprises at least two purlins of the invention attached to each other, optionally wherein one purlin is inverted relative to the other. Such attachment can be achieved using fasteners.

[0040] For example at least two purlins of the invention may be attached to each other wherein a first purlin is secured to a cleat for securing the purlin to a roofing structure by a fastener and a head of the fastener or a nut of the fastener passes through the first larger aperture in the second purlin.

[0041] In a roofing structure of the invention the second purlin may be secured to the cleat by a fastener and a head of the fastener or a nut of the fastener passes through the first larger aperture in the first purlin.

[0042] For example the first and second purlins may each have formed therein two further apertures as set out above and the first and second purlins are attached to each other by fasteners through the two remaining apertures of each of the purlins.

[0043] The invention also relates to a method of forming a roofing structure of the invention comprising the steps of:

(i) providing a cleat;
(ii) providing a first purlin of the invention;
(iii) securing the first purlin to the cleat using a fastener;
(iv) providing a second purlin of the invention;
(v) overlapping the second purlin and the first purlin so that the head of the fastener or the nut of the fastener passes through the first larger aperture defined in the second purlin.

[0044] Thereafter the two overlapped purlins can be secured to each other and the cleat using fasteners and the remaining apertures. It will be appreciated that the head of the fastener or the nut of the fastener will pass through the slot in the first purlin and so that nut and bolt will secure the second purlin to the cleat. And it will be appreciated that as many purlins as desired may be secured together in a series of increasing length.

Brief Description of the Drawings

[0045] Embodiments of the invention will be described, by way of example only, with reference to the accompanying drawings in which:

Figure 1 is a perspective view of a building framework which includes a roofing structure of the invention formed by a method of the invention and utilising purlins of the invention within its roofing structure;
Figure 2 shows a view of a part of the roofing structure of **Figure** 1;
Figure 3 shows an enlarged (detail) view of the portion of the roofing structure that is circled in **Figure 2;**
Figure 4 shows a perspective view of two purlins of the invention being aligned with each other and for attachment to a cleat;
Figure 5 shows a side view of the arrangement of **Figure 4.**
Figure 6 shows a view similar to **Figure 4;**
Figure 7 shows an enlarged (detail) view of the portion of the roofing structure that is circled in **Figure 6;**
Figure 8 shows a side view of the arrangement in **Figure 6;**
Figure 9 shows an enlarged (detail) view of the portion of the roofing structure that is circled in **Figure 8;**
Figure 10 shows a view similar to **Figure 6;**
Figure 11 shows an enlarged (detail) view of the portion of the roofing structure that is circled in **Figure 10;**
Figure 12 shows a view similar to **Figure 10** but from the opposite side;
Figure 13 shows an enlarged (detail) view of the portion of the roofing structure that is circled in **Figure 12;**
Figure 14 shows a very similar arrangement to earlier figures save that there are now three identical purlins; and
Figure 15 shows an enlarged (detail) view of the portion of the roofing structure that is circled in **Figure 14.**

Detailed Description of the Drawings

[0046] It will be appreciated that the Figures are not all to the same scale to allow for ease of illustration.

[0047] **Figure 1** is a perspective view of a building framework 1 which includes a roofing structure 2 of the invention formed by a method of the invention and utilising purlins 10 of the invention within its roofing structure 2.

[0048] In particular the building framework 1 comprises a series of uprights or columns 3. The uprights 3 provide the framework for the walls of the building. Bridging the uprights 3 and forming a truss type support are a series of rafters 4. Opposing rafters 4 meet defining an apex or ridge 5 for the roof. 6. A series of tie rods or tie lines 6 provide further rigidity to the structure. These can be considered anti-sag ties. Diagonal tie wires 7 also provide rigidity to the structure.

[0049] The construction of roofing structure 2 shown is that of a steel framework. Indeed the entire building framework 1 is formed of steel.

[0050] In the roofing structure of **Figure 1** the purlins 10 are attached to the rafters 4 using cleats and fasteners in the form of nut 8 and bolt 9 fasteners, and this arrangement is best seen from later figures.

[0051] **Figure 2** shows a view of a part of the roofing structure 2 of **Figure 1** and **Figure 3** shows an enlarged (detail) view of the portion of the roofing structure 2 that is circled in **Figure 2.** The roofing structure 2 includes a

full purlin of the invention 10, but shows only a part of a rafter 4. The purlin 10 is being aligned for attachment to the rafter 4 by a purlin securing bracket or cleat 30. The rafter 4 is in the form of an H-profile steel beam.

[0052] The purlin 10 comprises an elongate member 11. The elongate member 11 forms a profile (generally considered to be a "Z" or "Zed" profile). The elongate member 11 has two opposing sides, with a top side 12, a bottom side 13 and an intermediate body portion or web 14. The elongate member 11 has a longitudinal axis L. It will be appreciated that, as is desirable for all embodiments the aperture pattern (as will be described below) is symmetrical about the longitudinal axis L.

[0053] The top side 12 has a flat end 15 which extends perpendicularly from the intermediate body portion 14 and has and a turned-in end 16 which extends perpendicularly downwards from the flat side 15. The turned-in end 16 is generally parallel to the intermediate body portion 14.

[0054] The bottom side 13 has a flat end 17 which extends perpendicularly from the intermediate body portion 14 and has a turned-in end 18 which extends perpendicularly upwards from the flat side 17. The turned-in end 18 is generally parallel to the intermediate body portion 14.

[0055] It is to be noted that for the purlin 10 shown in these figures of the two opposing sides, one is smaller than the other and in particular the top side 12 is smaller than the bottom side 13. The opposing sides 12, 13 can be considered flanges. In particular the top side 12 can be inserted into the bottom side 13 so as to nest therein. This allows for mating of two adjacent purlins 10. So two purlins are profiled to mate with each other by nesting of the smaller side in the larger side. The adjacent purlins can be mated together by sliding one into the other.

[0056] The intermediate body portion 14 has formed therein a series of apertures for attaching the purlin 10 to another purlin 10 and/or to the purlin securing bracket 30 for securing the purlin 10 to the roofing structure 2.

[0057] The series of apertures formed therein include four apertures 20 arranged in a rectangular pattern. One of the apertures, is a larger first aperture in the form of a slot 21. In general the larger first apertures/slots in the purlins of the invention described herein are in the form of an oblong circle. As mentioned above they can be of any desired shape including rectangular.

[0058] As is desirable for all embodiments the aperture in the form of a slot is positioned closer to the larger side of the purlin.

[0059] The larger first aperture in the form of the slot 21 is dimensioned to be larger than the head of a fastener or a securing nut for a fastener and in this case is dimensioned to be larger than both. In the embodiments the fasteners are nut and bolt fasteners. In the embodiments the slot 21 is dimensioned to be larger than both the head of said bolt and the nut of said bolt so that both the head and the nut of said bolt passes through the slot.

[0060] The three other apertures 22 are dimensioned to be smaller than both the head of the bolt 9 and the nut 8. When comparing the apertures 22 to the slot 21 it is clear that the comparison is being done using the same fastener/nut and bolt (i.e. a given size is used for both) size. One of the apertures 22 is positioned on the opposite side of the longitudinal axis L and this aperture and the larger aperture 21 are both positioned on a first transverse axis which is perpendicular to the longitudinal axis L.

[0061] These two apertures are substantially equidistant from the longitudinal axis L. In this respect this equidistance means, and as will be described below, when a first purlin is mated to a second inverted purlin the larger aperture or slot 21 of the first purlin will come into register with the aperture 22 (positioned on the opposite side of the longitudinal axis L) of the second purlin.

[0062] Indeed as is desirable for all embodiments, the purlin 10 has two series of apertures formed therein, each of which include four apertures 20 arranged in a rectangular pattern.

[0063] Each set of four apertures 20 are adapted to be attached to a respective cleat 30.

[0064] The two series of apertures (each of which include four apertures 20 arranged in a rectangular pattern) may be (centred) equidistant from each other and equidistant from the opposing ends of the purlin 10. In general it is to be noted that the aperture pattern is desirably centred and equidistant from each other. However for purlins which are mated by inversion it is desired that all the apertures line up. This includes having the/each slot arranged so that it/they too line up with an aperture in the purlin to which it is mating.

[0065] While a rectangular pattern is preferred it is to be noted that as the intermediate body portion has formed therein two further apertures 22 for attaching the purlin to another purlin the main requirement is that the apertures align/come into register when two purlins, one inverted with respect to the other are mated. The two further apertures 22 are both positioned on a second transverse axis which is perpendicular to the longitudinal axis but the second transverse axis is spaced apart from the first transverse axis.

[0066] This means that a trapezoidal arrangement of apertures is possible where for example two apertures are closer to each other (perpendicularly) across the longitudinal axis L than the other two apertures.

[0067] So an assembly of the invention that comprises at least two purlins and a cleat (or purlin securing bracket) is that the apertures in a first purlin are in register with those of a second purlin and those apertures are also in register with the apertures in the cleat. This means all three parts (the two purlins and the cleat) can be secured together.

[0068] It is to be noted that even though the two series of apertures (each of which include four apertures 20 arranged in a rectangular pattern) are on opposing sides of a transverse plane bisecting the purlin 10 they are not mirror images of each other. In particular, as is desirable

for all embodiments where the two series of apertures (each of which include four apertures 20 arranged in a rectangular pattern) are present, it is desirable that the slot 21 is in the same position within the two series of apertures.

[0069] Four additional pairs of holes respectively labelled 23, 24, 25 and 26 are formed in the intermediate body portion 14 and these may be utilised to secure a first purlin to a second purlin as will be described in more detail below.

[0070] A purlin of the invention may be a rolled form profile, for example a cold rolled or cold formed profile.

[0071] As is desirable for all embodiments of the invention the cleat 30 is generally L-shaped. It has a base plate 31 and an upstanding plate 32. The base plate is for securing to a roof. The upstanding plate is for securing to a purlin. It has a pair of apertures 33 in the base plate 31. These are used so secure the cleat 30 to the rafter 4 using bolts 34.

[0072] As is desirable for all embodiments the cleat 30 has formed therein, and in particular formed in its upstanding plate 32, a series of apertures formed therein which matches the pattern of the four apertures in the purlin 10. In particular four apertures 35 are defined in its upstanding plate 32 are arranged in a rectangular pattern which matches the pattern of the four apertures in the purlin 10. However none of the apertures 35 are in the form of a slot. All of the apertures 35 are dimensioned to be smaller than both the head of the bolt 9 and the nut 8. This means a nut and bolt 8, 9 can be used to secure a purlin 10 to the cleat 30 using any of the three holes 35 which each align with apertures 22 in the purlin 10.

[0073] **Figure 4** shows a perspective view of two purlins of the invention being aligned with each other and for attachment to a cleat 30. **Figure 5** shows a side view of the view of **Figure 4.**

[0074] The two purlins have been labelled 10a and 10b to allow independent reference. The two purlins 10a and 10b are identical to each other. This is an important aspect of the invention as there is no requirement to provide different purlins. In particular the position of, and the pattern of, four apertures 20 arranged in a rectangular pattern and the position of slot 21 within the pattern of the four apertures is the same. More particularly the pattern of all apertures (other than the slot 21) matches even when on purlin is inverted relative to each other.

[0075] It is important to note however that the purlins 10a and 10b have been arranged to mate with each other. In particular it is to be noted that while purlin 10a is in the same orientation as shown in earlier figures, purlin 10b has been inverted with respect to that orientation. So purlin 10b can be considered inverted relative to purlin 10a. This relative inverted orientation is achieved by rotating the purlin 10b by 180 degrees about its longitudinal axis L.

[0076] It will be appreciated that the pattern of four apertures 20 arranged in a rectangular pattern defined in the first purlin 10a, align with the pattern of four apertures 20 arranged in a rectangular pattern defined in the second purlin 10b. It will be noted however that as the rectangular pattern in the purlin 10b is inverted with respect to the rectangular pattern in the purlin 10a the respective slots 21 are not aligned. This is an advantage associated with the present invention which will be described in more detail below.

[0077] Reference is now made to **Figures 6** to **9** where there is shown a method of forming a roofing structure 2 using purlins 10 of the invention.

[0078] **Figure 6** shows a view which is entirely the same as **Figure 4** (and **Figure 7** shows an enlarged (detail) view of the portion of the roofing structure 2 that is circled in **Figure 6)** save that the purlin 10a has been placed against and secured to the cleat 30 using a nut and bolt 40 which has been inserted through the top right aperture 35 in the bracket 30 and the top right aperture 22 in the purlin 10a and secured in place. Thereafter the second purlin 10b (in its inverted orientation) is (almost completely) mated with the purlin 10a. It is to be noted that the nut and bolt 40 does not interfere with the mating of the two parts as the slot 21 is dimensioned to be larger than both the head of said bolt and the nut of said bolt so that both the head and the nut of said bolt passes through the slot 21.

[0079] So this means that the purlin 10a can be secured to the cleat 30 without interfering with the mating of purling 10a to purlin 10b.

[0080] And of course the two purlins 10a, 10b can be secured to each other, and to the cleat 30 by using further nut and bolt fasteners fastened within the remaining three apertures 21.

[0081] This means that the top side 12 of purlin 10a can be inserted into the bottom side 13 of purlin 10b so as to nest therein. And the top side 12 of purlin 10b can be inserted into the bottom side 13 of purlin 10a so as to nest therein. This allows for mating of the two adjacent purlins 10a and 10b.

[0082] **Figure 8** shows a side view of the arrangement in **Figure 6** (and **Figure 9** shows an enlarged (detail) view of the portion of the roofing structure 2 that is circled in **Figure 8).** It can be seen that the nut and bolt 40 which is fastening the purlin 10a to the cleat 30 can pass through the slot 21 in the purlin 10b and thus allow close mating of the purlins 10a and 10b. It will be appreciated that in these figures purlin 10b has not yet been fully mated to purlin 10a and is instead disposed at an angle thereto.

[0083] **Figure 10** shows a view similar to **Figure 6** (and **Figure 11** shows an enlarged (detail) view of the portion of the roofing structure 2 that is circled in **Figure 10). Figure 12** shows a view similar to **Figure 10** from the opposite side (and **Figure 13** shows an enlarged (detail) view of the portion of the roofing structure 2 that is circled in **Figure 12).** These figures show an arrangement which is entirely the same as **Figures 6** and following except that the purlins 10a and 10b are fully mated and that additional nut and bolt fasteners are utilised as discussed below.

[0084] Additional nut and bolt fasteners 41 are aligned for fastening through apertures 22 in purlin 10b. These nut and bolt fasteners 41 will also pass through respective apertures 22 in purlin 10a and one will pass through the slot 21 in purlin 10a. All nut and bolt fasteners 41, (and as mentioned above nut and bolt fastener 40) will pass through apertures 35 in the cleat 30.

[0085] So now the two purlins 10a and 10b are fastened to each other and to the cleat 30. In this way fixation to the roofing structure 2 is achieved.

[0086] Further securing of the purlins 10a and 10b to each other is also achieved. Nut and bolt fasteners 42 are aligned for fastening through apertures 23 in purlin 10b and apertures 25 in purlin 10a. Nut and bolt fasteners 43 are aligned for fastening through apertures 24 in purlin 10b and apertures 26 in purlin 10a.

[0087] This securing arrangement is clearly seen from both sides as **Figures 10** and **11** show the arrangement from one side and **Figure 12** and **13** show the arrangement from the other side.

[0088] **Figure 14** shows a very similar arrangement to earlier figures save that there are now three identical purlins 10a, 10b, and 10c. **Figure 15** shows an enlarged (detail) view of the portion of the roofing structure 2 that is circled in **Figure 14.**

[0089] Purlins 10a and 10b are the same as in earlier figures. Purlin 10c is added and it has the same (inverted) orientation as purlin 10b as it too mates with purlin 10a albeit on the opposite side of purlin 10a to purlin 10b. It will be appreciated that purlin 10a and 10C can be secured together and to a cleat 30 in an exactly analogous manner.

[0090] And of course there is no limit to how many purlins can be joined together in this manner. For example purlins in the same orientation as purlin 10a could be added to either side of the arrangement in **Figure 14** or **15.**

[0091] The words "comprises/comprising" and the words "having/including" when used herein with reference to the present invention are used to specify the presence of stated features, integers, steps or components but do not preclude the presence or addition of one or more other features, integers, steps, components or groups thereof.

[0092] It is appreciated that certain features of the invention, which are, for clarity, described in the context of separate embodiments, may also be provided in combination in a single embodiment. Conversely, various features of the invention which are, for brevity, described in the context of a single embodiment, may also be provided separately or in any suitable sub-combination.

Claims

1. A purlin comprising an elongate member which has a longitudinal axis and which forms a profile having two opposing sides on opposite sides of the longitudinal axis and an intermediate body portion running between the opposing sides,

   the intermediate body portion having formed therein two apertures for attaching the purlin to another purlin, or for attaching the purlin to a cleat for securing the purlin to a roofing structure, wherein a first aperture is larger than the second aperture;
   and the two apertures are positioned on opposite sides of and substantially equidistant from the longitudinal axis and the at least two apertures are both positioned on a first transverse axis which is perpendicular to the longitudinal axis.

2. A purlin according to Claim 1 wherein the first larger aperture is dimensioned to be larger than: the head of a fastener; a securing nut for a fastener; or both.

3. A purlin according to any preceding claim wherein the second aperture is dimensioned to be smaller than: the head of a fastener; a securing nut for a fastener; or both.

4. A purlin according to Claim 2 or Claim 3 wherein the fastener is a screw fastener with a screw head, for example a self-tapping screw; or a nut and bolt fastener with a bolt head and a nut.

5. A purlin according to any preceding claim wherein the first larger aperture is in the form of a slot, for example in the form of an oblong circle.

6. A purlin according to any preceding claim wherein the first and second apertures of the purlin are positioned to align with respective apertures in a cleat.

7. A purlin according to any preceding claim wherein the intermediate body portion has formed therein two further apertures for attaching the purlin to another purlin, or for attaching the purlin to a cleat for securing the purlin to a roofing structure, wherein said two further apertures are positioned on opposite sides of and substantially equidistant from the longitudinal axis and wherein the two further apertures are both positioned on a second transverse axis which is perpendicular to the longitudinal axis but the second transverse axis is spaced apart from the first transverse axis.

8. A purlin according to Claim 7 wherein the two further apertures are dimensioned to be smaller than: the head of a fastener; a securing nut for a fastener; or both.

9. A purlin according to any of Claims 7 or 8 wherein the first aperture, the second aperture and the further

two apertures are arranged in a trapezoidal pattern with the apertures positioned at the corners of a trapezoid shape; optionally wherein the trapezoidal pattern is a rectangular pattern.

10. A purlin according to any of Claims 7 to 9 wherein the first aperture, the second aperture and the further two apertures are positioned to align with respective apertures in a single cleat.

11. A purlin according to any preceding claim which is profiled to mate with itself, for example by sliding a first purlin of any preceding claim into a second purlin of any preceding claim.

12. A purlin according to any preceding claim wherein one of the two opposing sides is smaller than the other and wherein two purlins are profiled to mate with each other by nesting of the smaller side in the larger side; optionally wherein the first larger aperture is positioned closer to the larger side.

13. A purlin according to any preceding claim wherein the purlin is a rolled form profile, for example a cold formed profile for example a cold rolled profile.

14. A purlin according to any preceding claim wherein the purlin has a Z ("Zed") profile, and/or wherein the apertures have been formed by punching.

15. A roofing structure comprising at least two purlins according to any preceding claim attached to each other, optionally wherein one purlin is inverted relative to the other.

16. A roofing structure comprising at least two purlins according to any of Claims 1 to 14 attached to each other wherein a first purlin is secured to a cleat for securing the purlin to a roofing structure by a fastener and a head of the fastener or a nut of the fastener passes through the first larger aperture in the second purlin, optionally wherein the second purlin is secured to the cleat by a fastener and a head of the fastener or a nut of the fastener passes through the first larger aperture in the first purlin.

17. A roofing structure according to Claim 15 or Claim 16 further wherein each purlin has formed therein two further apertures as set out in Claim 7 and the first and second purlins are attached to each other by fasteners through the two remaining apertures of each of the purlins.

18. A method of forming a roofing structure according to any of Claims 15 to 17 comprising the steps of:

(a) providing a cleat;
(b) providing a first purlin according to any of Claims 1 to 14;
(c) securing the first purlin to the cleat using a fastener;
(d) providing a second purlin according to any of Claims 1 to 14;
(e) overlapping the second purlin and the first purlin so that the head of the fastener or the nut of the fastener passes through the first larger aperture defined in the second purlin.

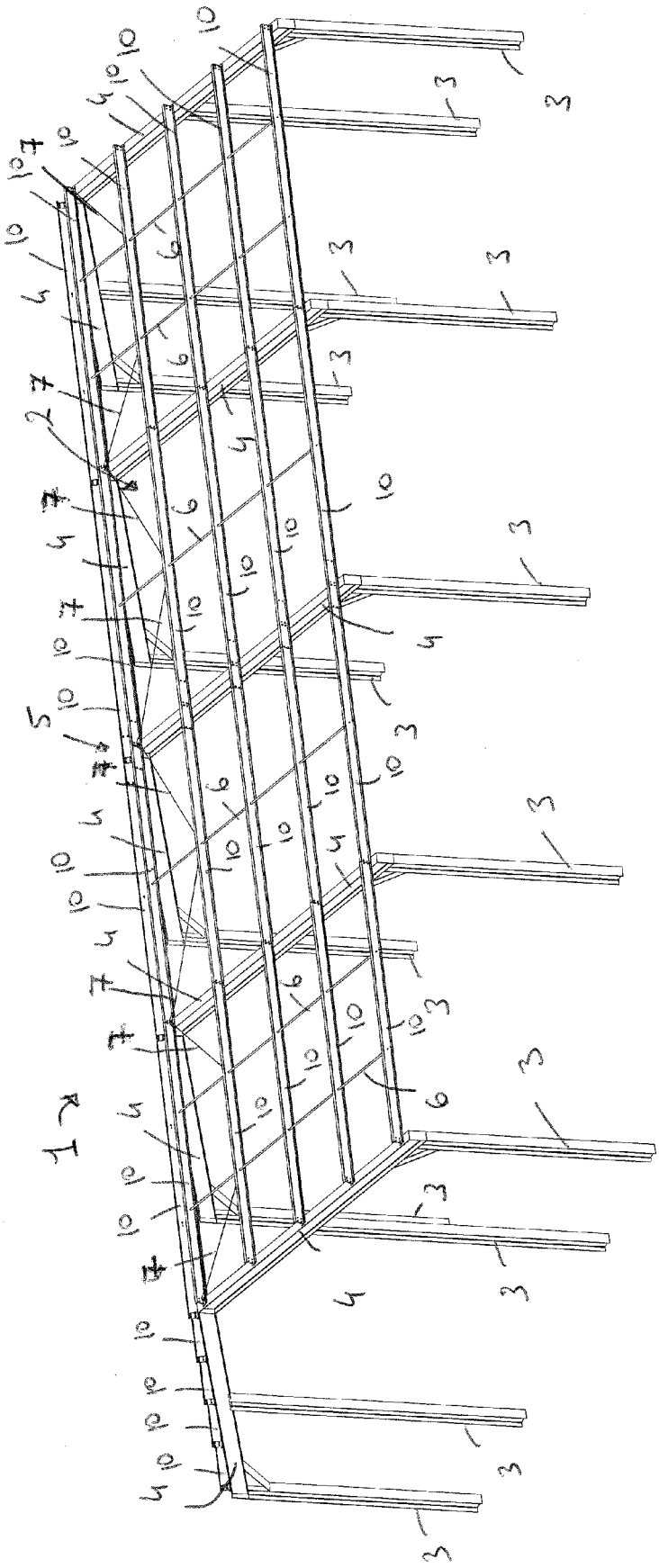


Figure 1

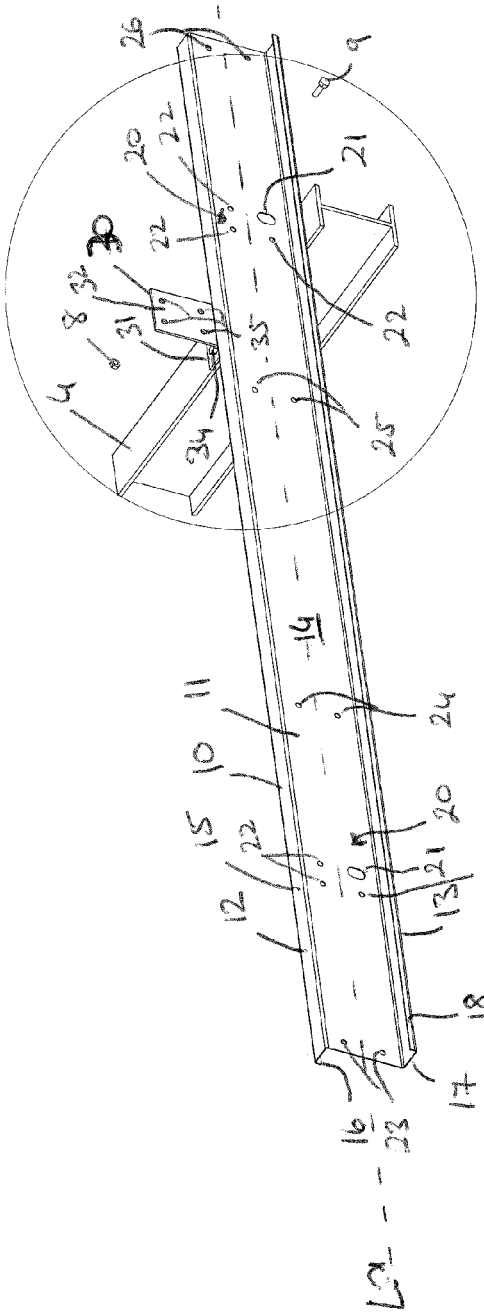
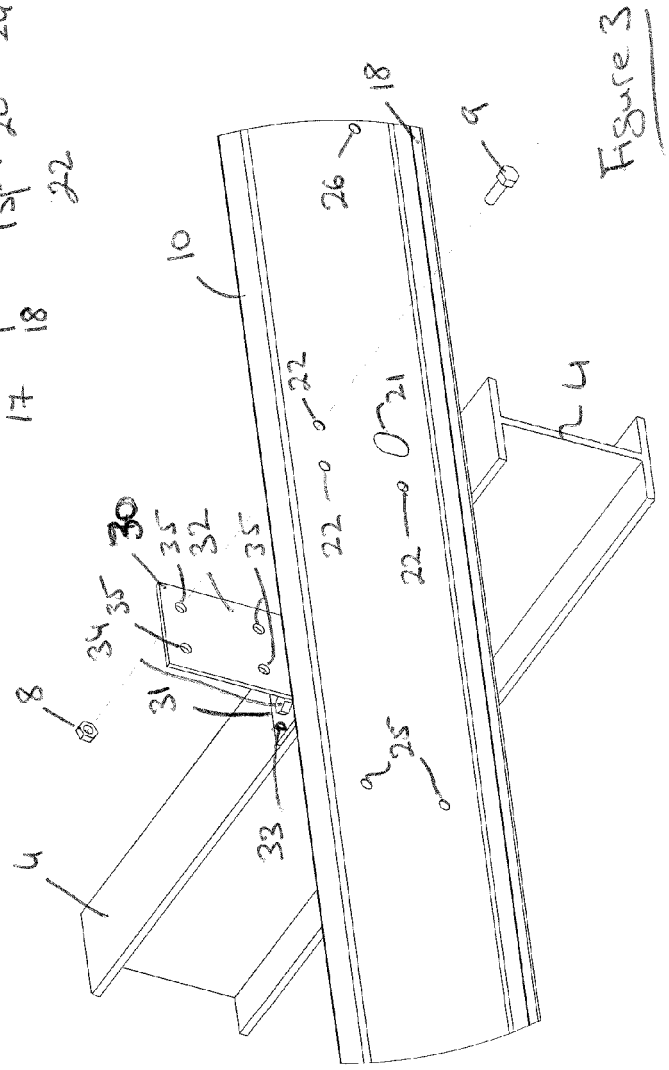


Figure 2



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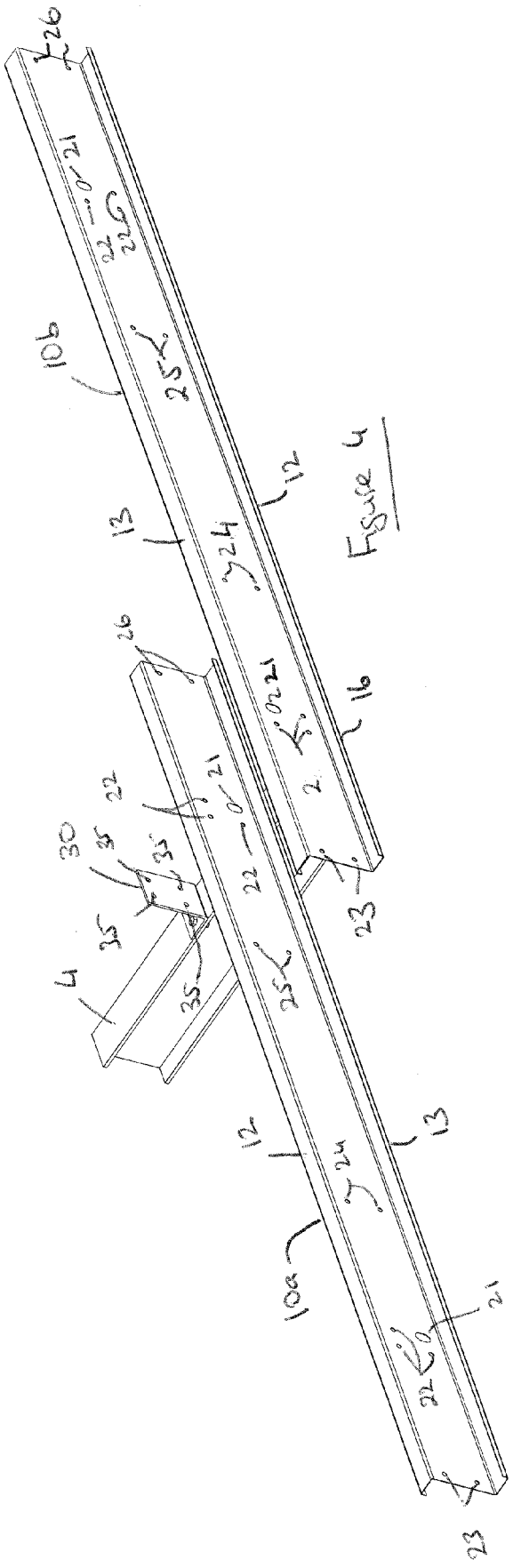

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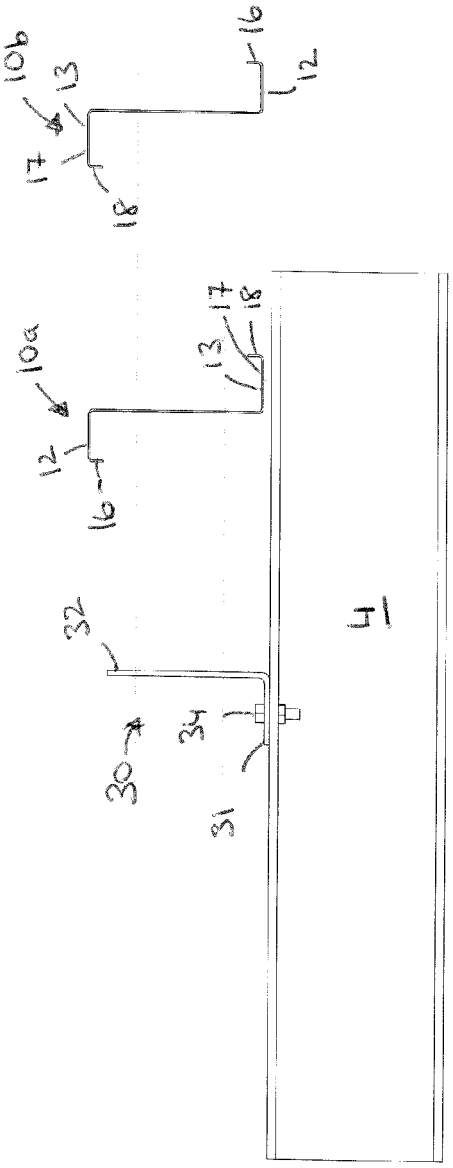

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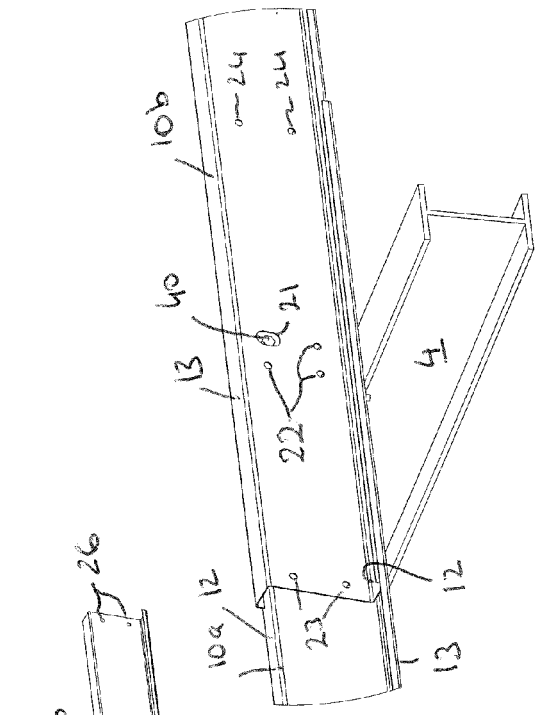

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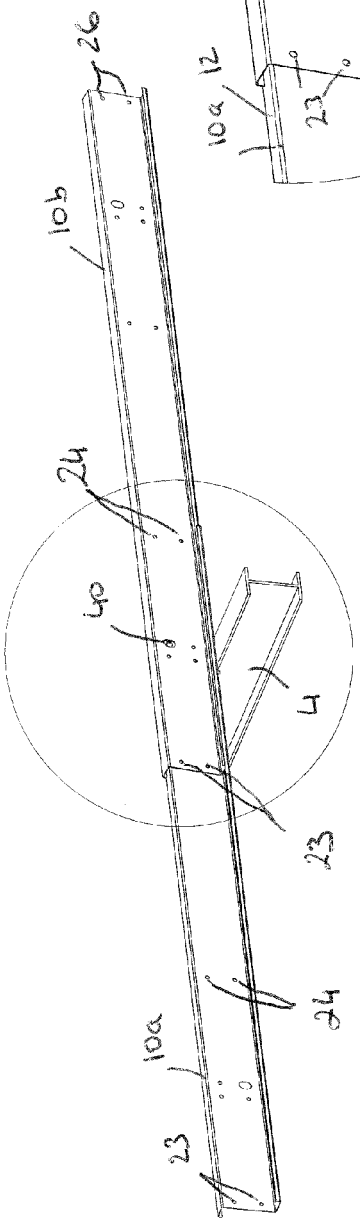

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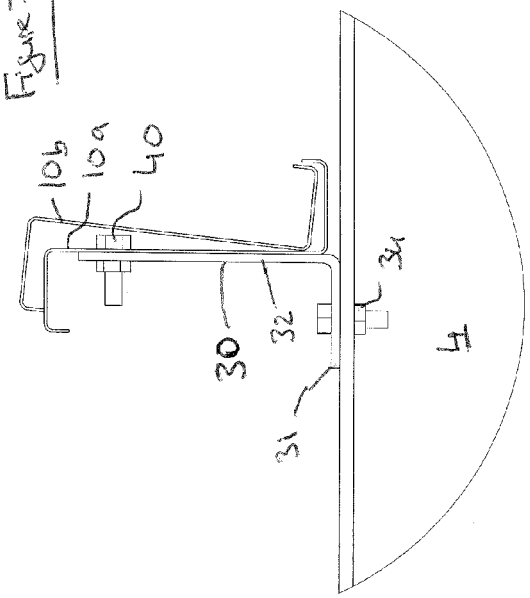
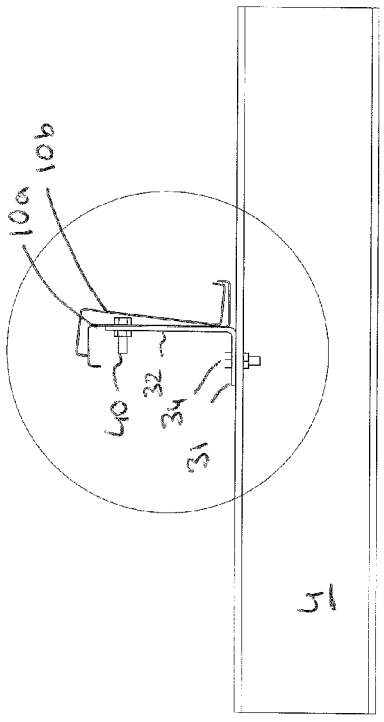


Figure 9



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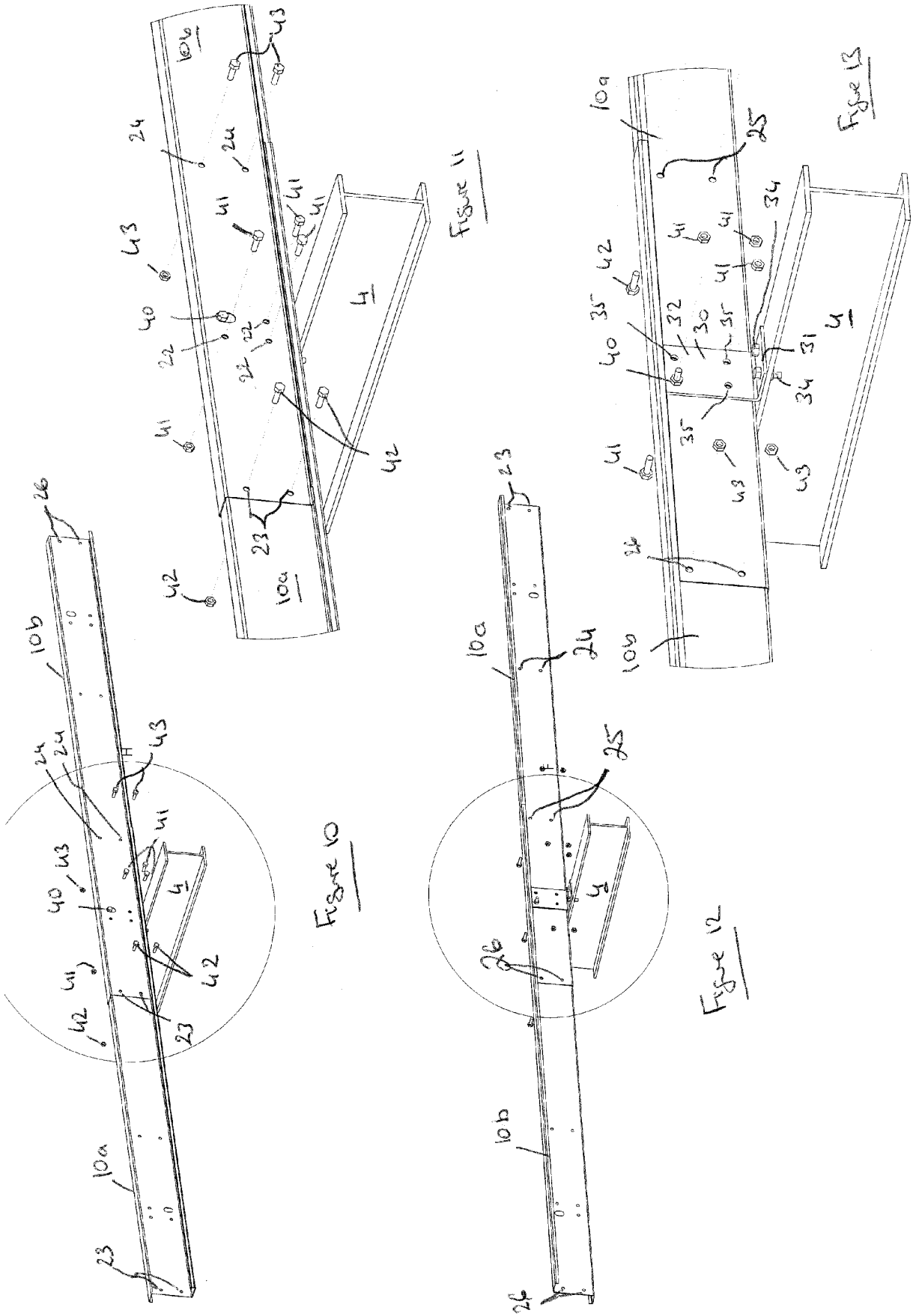
10b
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Figure 11
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Figure 10
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Figure 12
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Figure 13

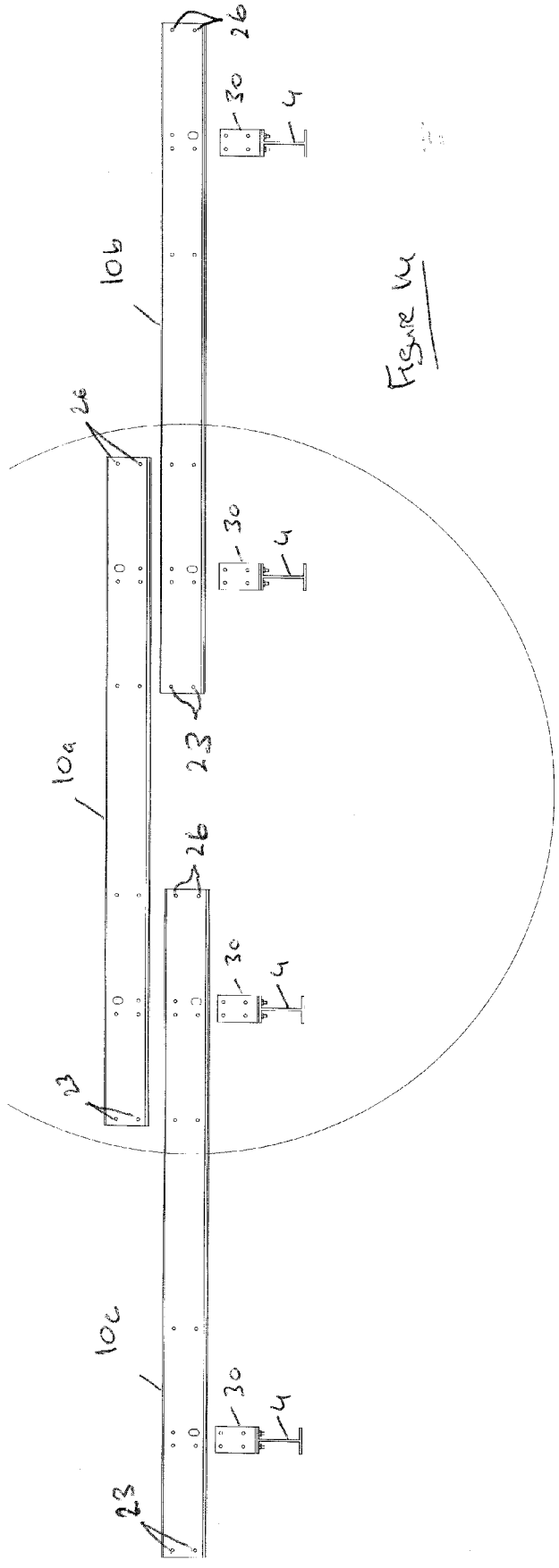

Figure 14

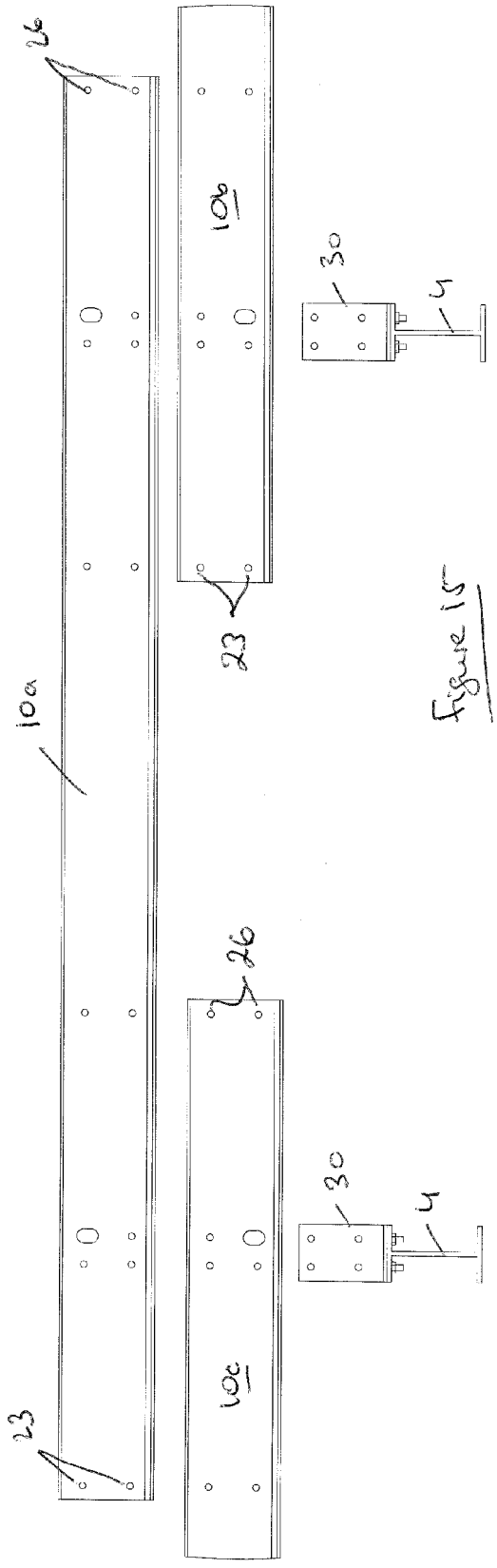

Figure 15

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EUROPEAN SEARCH REPORT

Application Number
EP 22 21 4684

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	EP 0 132 894 A1 (REGOUT NV THOMAS [NL]) 13 February 1985 (1985-02-13)	1-15,17	INV. E04B7/02
A	* figures 1,2,6c-d * * first paragraph; page 6 *	16,18	E04B1/58 E04B1/24 E04C3/04
A	EP 1 327 728 B1 (PROFIL DU FUTUR SA [FR]) 17 May 2006 (2006-05-17) * paragraphs [0021], [0027]; figure 6 *	1-18	
A	US 2021/388598 A1 (GOSLING GEOFF WILLIAM [CA]) 16 December 2021 (2021-12-16) * figure 3A *	1-18	

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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	17 May 2023	Tran, Kim Lien

CATEGORY OF CITED DOCUMENTS

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