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(54) Structural members for buildings and interconnection arrangements for such members

(57) A method of manufacturing a framed structure is described comprising at least a first and a second substantially parallel main elongate structural members with at least one secondary elongate structural member joined between the two main members in a load bearing manner, the main members being separated by a fixed distance and an opening being provided which extends part way along a side face of each main member; the method comprising:

inserting a first protrusion located on a first end of the secondary structural member in the opening of the first main member by moving the secondary structural member along a first direction parallel with the longitudinal axis of the secondary member,

inserting a second protrusion located on a second end of the secondary structural member in the opening of the second main member by moving the secondary member along a second direction which is the reverse direction of the first direction,

interconnecting the secondary member with the main members by a movement of said secondary member to bring the ends of the secondary member into a predetermined position on said main members, said openings and said first and

second protrusions co-operating to prevent disengagement of said secondary member from said predetermined position other than by reversal of said movement.

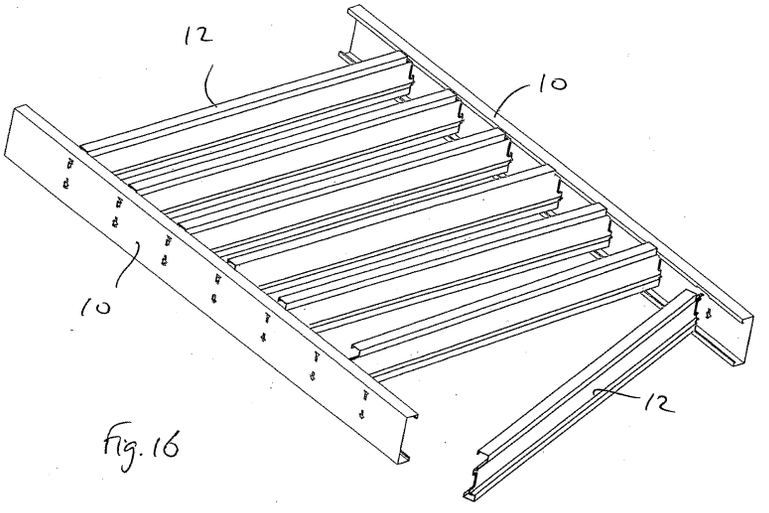


Fig. 16

EP 1 348 819 A1

Description

FIELD OF THE INVENTION

[0001] The present invention relates to structural members suitable for use in framework for buildings, especially for roofs or floors thereof as well as the frames made therefrom. The invention relates in particular to arrangements for interconnecting structural members such as bracing, sag rods, girts, purlins, joists and rafters and also to methods for production of such structural members and frames made from such members.

BACKGROUND TO THE INVENTION

[0002] Many buildings include framework such as flooring or roofing assembled from prefabricated sections, which may include frames, spaced apart by beams in the form of purlins running longitudinally along the building. The space between these purlins is often spanned by further structural members, known in the art as sag rods or braces. These sag rods join the purlins to each other and thereby increase rigidity of the roof structure. In addition to joining these other structural members together, the sag rods may also provide upper and or lower faces for use in supporting various roofing features, such as for example roofing sheets, insulation, ceiling sheets, fire sprinklers, lighting and maintenance hangers for workmen. In constructing roofing or flooring using many prior art arrangements, sag rods are often fixed to their purlins by fixing means such as bolts, clamps, by welding, rivetting or separate slot-in captive pieces. Similarly purlins are often fixed to frames or rafters by bolts, bolts, clamps, by welding, rivetting or separate slot-in captive pieces.

[0003] In US 4,201,021 for example, a building frame construction for a light metal building is proposed. The frame utilises a series of transverse sub-frame assemblies forming sidewall columns and main roof beams. Purlins are provided between the roof beams and are attached to the sub-frames to provide support for the side wall and roof panels. End wall columns and girts are provided to support the end wall covering. Each sub-frame comprises a plurality of modular truss units that are interconnected to form the unitary assembly of the sub-frame. Each truss unit comprises two main beams interconnected by struts and braces, the main beams each being formed from two angles aligned in a facing relation with a slot down the middle to permit attachment of purlins or girts along the beam. Joints are made using bolts.

[0004] US 6,276,094 proposes a lightweight prefabricated modular building system comprising nine prefabricated structural members and two prefabricated connectors which create the entire building main frame system. The connectors are right angle connectors, each employing a configuration of holes and slots for securing structural members to create a rigid attachment of rafters to columns. The same connectors can be employed to establish a shallow or steep pitch roof through selection of the holes and slot positions used to bolt the structural frame together. The connections here are again made using bolts.

[0005] In US 4,974,385 an interconnection system is disclosed incorporating a sliding locking member facilitating secured interengagement between a purlin and rafter. The sliding locking member is constructed for slip fit engagement within an extruded section of the purlin and for flanged interlocking with a rafter disposed at right angles to the purlin. The purlin further includes an overhanging lip for engaging a gutter of the rafter and preventing lateral movement in a first direction. The sliding member prevents movement between the purlin and rafter in second and third orthogonal directions. In this manner, a tri-axial securement system is proposed that is effected by a single sliding member that is moved or slid into position. The beams used as the purlin and the rafter are of complex cross-section and require tight tolerances to ensure a good sliding fit between the sliding member and its associated channel on both the purlin and the rafter. In addition to the cost of complexity, this arrangement does not lend itself easily to rafters or purlins made from many strong lightweight sections such as "I", "H", "C", "U", "Z" or "Σ", as they do not usually provide guttering for the lips or channels to receive the sliding member. Another disadvantage of the arrangement of US 4,974,385 is that fitting would require movement of a sliding member at each end and it could therefore prove difficult to fit it in one step and/or single-handed.

[0006] It is a disadvantage with many prior art arrangements, such as those just discussed, that extra parts are called for in joining purlins to the rafters. Such additional parts incur cost and complexity in the bill of materials for a construction job and/or in the manufacture of the structural members themselves, e.g. production of brackets, mounting faces and the machining of holes or slots to accommodate or clear such fixings. In addition to the effort expended in producing and managing the purlins, rafters and fixings, it is also often the case that the greatest expenditure in joining the purlins to the rafters is taken up in assembly labour. It may take several operatives at a time to fit each purlin, with any ones supporting the purlin being unproductive while the fixing means is applied. An alternative may be to weld the purlins in place, but this calls for skilled labour and increased health and safety considerations. Furthermore, on-site welding of prefabricated structural members does not lend itself to use of galvanisation or powder coating as a protective layer and this further reduces the attraction of this option.

[0007] WO 98/28504 describes a roof panel made of a rectangular frame with a plurality of ribs.

[0008] US 3,138,227 also describes a frame structure having first and second members joined at right angles to each other. Two slots, one vertical and one inclined

are provided in the web of a first of the members, the slots intersecting at an apex. Ends of two second members which are to be joined at the position of the web of the first member are prepared with protrusions and hooks. One end is located in the vertical slot and lowered so that its hook locates in a bottom portion of the slot. The protrusion on the end of another second member is inserted into the angled slot and then rotated into a position above the protrusion of the first second member. If the first members are fixed at a certain distance then it is difficult to assemble the second members.

[0009] US 3,283,467 describes a similar frame in which two angled slots are provided in a first member. Protrusions on a second member locate I the slots and can rotate into a final position.

[0010] The main disadvantages with these known systems are a) that they are difficult to install if the main members are fixed at a certain distance from each other, and b) having to rotate a member to locate it at both of its ends is difficult to do without two or more persons co-operating to attach the members to each other.

SUMMARY OF THE INVENTION

[0011] It is an object of the present invention to provide improved structural members, especially interlocking members, for buildings. It is a further object of this invention to provide improved arrangements for interconnecting such structural members and improved methods for their manufacture. It is a particular object of this invention to provide these improvements in such a manner that structural members according to the invention can be interconnected without using bolts, clamps or similar separate fixings or at least with only few of these. It is also a particular object of this invention to provide such interconnection in a manner that the connection is safe to load, that is that the interconnections between the members of a frame are not easily separated from each other. It is a further object of this invention to provide improved arrangements for interconnecting structural members so that they can be installed by a single operator.

[0012] Accordingly, the present invention provides a method of manufacturing a framed structure comprising at least a first and a second substantially parallel main elongate structural members with at least one secondary elongate structural member joined between the two main members in a load bearing manner, the main members being separated by a fixed distance and an opening being provided which extends part way along a side face of each main member; the method comprising:

inserting a first protrusion located on a first end of the secondary structural member in the opening of the first main member by moving the secondary structural member along a first direction parallel with the longitudinal axis of the secondary member, inserting a second protrusion located on a second end of the secondary structural member in the opening of the second main member by moving the secondary member along a second direction which is the reverse direction of the first direction,

interconnecting the secondary member with the main members by a movement of said secondary member to bring the ends of the secondary member into a predetermined position on said main members, said openings and said first and second protrusions co-operating to prevent disengagement of said secondary member from said predetermined position other than by reversal of said movement.

[0013] The openings may include a shape-defined blocking means adapted to prevent disengagement of said secondary member from said predetermined position other than by reversal of said movement. The locking movement may be a non-linear movement. The locking movement is preferably not a rotational movement of the secondary member about its longitudinal axis. The movement is preferably substantially transverse to the longitudinal axis of the main member. The interconnecting of the main to the secondary members is preferably bolt-, screw- and weld-free. The distance between neighbouring main members is preferably not changed during the interconnecting step. Support tabs may be formed by bending material from the main members at positions of the openings to support the ends of the secondary members. The first and second protrusions may each have a slot which locates around a portion of the main member adjacent to the openings during the interconnecting step. The slots may extend parallel to the longitudinal axis of the main member or transverse thereto when the secondary members are interconnected with the main members.

[0014] The present invention also provides an arrangement for interlocking structural members of a building, comprising:

a) a first longitudinally extending structural member defining through a substantially planar side face thereof at least one opening extending along a longitudinal axis of said side face;

b) a second longitudinally extending structural member having formed as part thereof, and extending longitudinally from at least one end thereof, at least one protrusion adapted for insertion into said opening in a first position and in a first direction substantially orthogonal to the plane of said side face, interlocking of said first and second members to restrain movement along said first direction but allowing movement along said opening into a second position.

The opening may have a shape-defined blocking profile formed integrally on a first extension portion of said opening and adapted to prevent movement of said protrusion away from said second position, at least in the

event of movement of said second member in a direction substantially orthogonal to the longitudinal axis of each of said first and second structural members. The connection also provides restraint against torsion.

[0015] The second member may comprise a first hook portion defined in said protrusion and adapted to hook said protrusion over a second extension portion of said opening and to keep an associated end of said second structural member substantially in abutment with said side face. The second member may further comprise a second hook portion extending from said end and spaced apart from said first hook portion, preferably substantially vertically when in use, and adapted to engage with a second said opening defined in said side face. The second member may further comprise a third hook portion extending from said end in a different plane from said first and second hook portions and adapted to engage with a said opening defined in said side face so as to provide three-position interconnection between said members. The blocking profile may be adapted to necessitate non-linear movement of said second member, such as a ratcheting action, in order to achieve interconnection with and/or disconnection from said first member. For example, the blocking profile may comprise various blocking elements which may be arranged in series, e.g. a series of serrations, such as teeth and/or at least one chicane means. The opening may be adapted to allow said first and/or second structural member to be fitted in only one orientation. The structural components may be joined to each other without using locally applied and separate fastening means such as bolts, clamps, welding, riveting or separate slot-in captive pieces or similar although the present invention does not exclude these as used in addition to the shape-defined blocking arrangement of the present invention.

[0016] The opening may be adapted to allow said first and/or second structural member to be fitted in a plurality of orientations. A further second member may be fitted to a said opening shared with the originally fitted second member. This further second member may extend from the first structural member in a direction remote from the first second member, e.g. so that the first and second second members are co-linear. A plurality of said first members may be provided in a substantially parallel array and one or more said second members are used to interconnect at least a pair of neighbouring said first members. The or each first member may comprise a rafter, a purlin or similar and the or each second member may comprise a purlin, a sag rod or similar, respectively, for example as used to form roofing or flooring for a building. A frame may be constructed using the main and secondary members. The frame can be made without disturbing the locations of the main members substantially.

[0017] The present invention may also provide a method of manufacturing a main elongate structural component, including:

a) defining in said main elongate structural component an opening extending part way along a side face of said main elongate structural component; and

b) forming as an integral part of said opening a fitting means adapted to interconnect a secondary elongate structural component with said main elongate structural component by non-linear movement of a protrusion of said secondary elongate structural component into a predetermined position, said fitting means including a shape defined blocking means adapted to prevent disengagement of said secondary elongate structural component from said predetermined position other than by reversal of said non-linear movement.

[0018] The present invention may also provide a main elongate structural component manufactured in this way. The method of manufacture may include forming on an end of said secondary elongate structural component a protrusion adapted to engage with a lip of said opening, said protrusion being adapted for fitting into engagement with a said main elongate structural component by non-linear movement of said secondary elongate structural component into a predetermined position along said opening. The present invention may also provide a secondary elongate structural component manufactured in this manner.

[0019] The present invention will now be described with respect to the following drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020]

Figure 1 is a section through a main elongate structural component along a longitudinal axis thereof and showing the substantially right-angled interconnection of a pair of secondary elongate structural components to said main elongate structural component from opposite sides thereof;

Figure 2a is an end view of a secondary elongate structural component of Figure 1;

Figure 2b is a plan view of the end of the secondary elongate structural component shown in Figure 2a;

Figure 2c is a plan view of a simplified version of the arrangement of figure 2b;

Figure 3 shows side, plane and end views of a further embodiment of a secondary structural component;

Figure 4a is a perspective view of the secondary elongate structural component of Figure 3 and Figure 4b shows a modification thereof;

Figure 5 is a side view of a face of the main elongate structural component of Figure 1, showing fitting slots defined therein for interconnection of one or more secondary elongate structural components in accordance with Figures 1 to 4; and

Figures 6 to 10 are variations of the arrangement of Figure 5.

Figures 11 to 13 show further modifications to secondary structural components.

Figures 14a, b show a further modification to a secondary component with the corresponding modification to a main structural component shown in Figure 14c.

Figure 15 shows a further modification to a main structural component.

Figure 16 shows a frame which can be constructed using elongate structural members according to embodiments of the present invention.

Figure 17 shows an end view of a prepared secondary member in accordance with a further embodiment of the present invention.

Figures 18a and b show a front view and an angled view of a main elongate member for use with the secondary member of figure 17.

Figure 19 shows the secondary member of figure 17 located into the main member of figure 18.

Figures 20a and b show side views of the joint shown in Fig. 19.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

[0021] The present invention will now be described with reference to certain embodiments and with reference to the above mentioned drawings. Such description is by way of example only and the invention is not limited thereto. In particular the present invention will mainly be described with reference to roofs but the present invention is not limited thereto.

[0022] The present invention provides structural building members and associated arrangements for interconnecting them, the connections being made without additional components beyond the structural members themselves and providing in use blocking against disconnection. In some embodiments the blocking will be demonstrated in relation to potential disconnection forces being applied substantially in opposition to gravity. The members used in the embodiments may be for example rafters and purlins, or purlins and sag rods and it will be appreciated that these may be used to construct roofing or floors in buildings.

[0023] The specific embodiments are also based around using metal members, e.g. rolled steel joists (RSJ's) to form the joists used as rafters or purlins and the particular profile given is referred to for convenience as a sigma profile ("Σ") due to its cross-section. Other profiles may be used, such as "I", "H", "C", "U" or "Z" section as required for cost, strength or convenience. Examples of other profiles are described in our co-pending application EP-1031669, the disclosure of which is incorporated herein by way of reference. Also the present invention may be used with box profiles as the main and or secondary structural members, in fact any profile is sufficient provided that the main structural member has a suitably flat side panel, and the secondary structural member has a flat section within its profile from at least one protrusion of from which two or more parallel or co-planar spaced apart protrusions can be formed.

[0024] The terms "horizontal" or "vertical" relate to a structure such as shown in Figure 16 when the frame is horizontal. However, it should be understood that these terms are for defining a co-ordinate system only and any of the members of the frame may be placed at a different angle.

[0025] Referring now to figures 1 to 16, a main structural component 10 comprises a suitable profile such as a metal sigma section ("Σ") such as a rolled steel joist in a form suitable for running along a roof or floor of a building substantially in parallel with similar such main elongate structural components 10 (only one illustrated). The profile may be such as "I", "H", "C", "U" or "Z", for example. To assist in torsional rigidity of a structure employing such parallel main elongate structural components, cross bracing is provided between them at suitable points along their length. This cross bracing is provided in the form of secondary elongate structural components 12a, 12b such as purlins or sag rods which also have a suitable form such as a metal sigma section ("Σ"), e.g. as a rolled steel joist or such as an "I", "H", "C", "U" or "Z" form. Once connected, the secondary elongate structural components 12a, 12b extend sideways substantially orthogonally between neighbouring main elongate structural components and interconnect them. They can then be formed into a frame, for instance, as shown in Fig. 16.

[0026] Referring for the moment in particular to Figures 2a, 2b, 3 and 4a, 4b one end of a secondary elongate structural component 12a,b is illustrated in detail. Each secondary elongate structural component 12a,b is preferably double ended and symmetrical, such that opposite ends are substantially identical and installation and manufacturing complexity is minimised. Each secondary elongate structural component 12a,b has a side face or web 16 that extends along its length and is substantially planar. It will be appreciated that, in a sigma profile "Σ", this face is divided into co-planar upper and lower strips 16a, 16c separated by a reinforcement in the form of a "U" or "V" shaped corrugation 16b. As an alternative the central web of such a profile may be used to form at least one of the protrusions.

[0027] At least one of the ends of each strip 16a, 16c extends beyond an end face of the secondary elongate structural component 12a, 12b and is formed into substantially vertically orientated planar hook portions 20. Each hook portion 20 defines a vertically orientated slot 22 between a claw 24 and the end face 18. Each claw 24 further comprises a steep sloping chamfer 26 outboard of the slot 22 and a shallow sloping chamfer 28 inboard of the slot 22. On each claw 24, there is an upper chamfer 30.

[0028] As can best be seen with particular reference to Figures 2a, 2b, 3 and 4a, 4b in a preferred embodiment each end 18 of each secondary elongate structural component 12a,b further comprises at least one substantially "L" shaped hook portion 32 formed by extending an upper (and/or lower) face 34 and its associated reinforcement 36 beyond the end face 18. As an alternative two such hooked portions may be formed, one from the top section and one from a bottom section of the profile as shown schematically in Figure 4b. In this case an appropriate opening must be formed in the side of the main structural member to receive the lower hook portion. The reinforcement 36 here comprises a substantially right-angled fold running along the upper surface 34 of the sigma profile, such that rigidity of the upper face 36 is increased in comparison with being left substantially planar. The purpose of the "L" shaped hook portion 32 is to provide a third attachment point between the secondary elongate structural component 12a,b and the main elongate structural component 10, such that they 10, 12a,b are interconnected in a triangulated array so as to provide greater torsional rigidity than might be possible using only two connection points 24. It will be appreciated that such a third attachment point 32 may not be found necessary in each installation and a simplified secondary elongate structural component 12c without this feature might surfice, such an embodiment being illustrated with reference to Figure 2c.

[0029] Referring now to the exemplary main elongate structural component 10, this comprises a sigma profile "Σ" having a wide and flat-bottomed central channel 38 formed therealong, the bottom of the channel 38 appearing as a central strip, as can be seen in the cross-sectional view in Figure 1. This central strip presents a substantially planar face 40 to opposing sides 40a, 40b of the main elongate structural component 10.

[0030] Wherever a secondary elongate structural component 12a,b is to be connected to the main elongate structural component 10, at least one and preferably a pair of fitting openings 42 are defined one above the other in the main elongate structural component face 40 and extend through it from one side 40a to the other 40b. The one or more fitting openings 42 will initially be described with particular reference to a basic embodiment illustrated by way of example in Figure 5 and may be formed by, for example, profile cutting or stamping or laser cutting.

[0031] Each opening 42 comprises a slot 44 which extends along the longitudinal axis of the face 40 and is high enough to allow insertion of the hook portion 24, 32 of a secondary elongate structural component 12a in substantially vertical orientation. To connect a secondary elongate structural component 12a,b to the main elongate structural component 10, the secondary elongate structural component 12a,b is initially inserted into the opening 42 with its hook claws 24 substantially vertically orientated and pointing downwards. The secondary elongate structural component 12a,b is pushed up against the side face 40, pushed downwards and backed out until the hook claws 24 locate themselves over lower lips 42a of their respective openings 42. The upper chamfer 30 assists in initially aligning and leading the hook portions 20 into the opening 42. The shallow chamfer 28 assists in leading the lower lips 42a to their respective hook slots 22. The steep chamfer 26 is useful for pulling two parallel main elongate structural components 10 towards each other when connecting them using a secondary elongate structural component 12a,b according to the present invention.

[0032] Generally, a secondary elongate structural component is placed between two main elongate structural components so as to join them together. This is preferably done by a single person located at the mid point of the secondary elongate structural component. To achieve this the secondary elongate structural component must be inserted far enough into a first main elongate structural component so that the other end of the secondary elongate structural component may be inserted into a similar opening in a parallel main elongate structural component without the need to disturb the main structural components. This is possible in accordance with the present invention because a portion of metal is provided between the hook slot 22 and the end of the secondary elongate structural component 18 to form a space so that the end 18 does not interfere with the face 40 of the main member. The one end of the secondary elongate structural component may be pushed too far into the opening in the main elongate structural component so that the other end of the secondary elongate structural component may be inserted in the other main elongate structural component and then the secondary elongate structural component can be centred between the two main elongate structural components before the final locking step described below.

[0033] Once a secondary elongate structural component 12a,b is engaged at each end with its associated parallel main elongate structural components 10, it is ready to be captured in position. To this end, in the region of a lower corner of the slot is an engagement passage 46 which slopes downwards and away from the insertion portion of the fitting opening 42, i.e. downwards and away from the slot 44. The engagement passage 46 is defined between a pair of serrated lips or extensions, top 46a and bottom 46b. The serrations on each lip 46a,b comprise a succession of teeth 48 spaced apart by a gap in such a manner that they form a channel or passage and a secondary elongate structural component 12a,b can only be moved down to the bottom of the engagement passage 46 by simultaneously providing a non-linear movement of the secondary elongate structural component 12a,b, such as for example a ratcheting-type or rocking action or similar in which a succession of back and forth and/or up and down movements are made while moving down the engagement passage 46. Around the last few movements the "L"

shaped hook, if present, will engage over the lower lip 42 towards the rear of the fitting opening 42 and a three-point connection will be made.

[0034] The shape defined blocking profile of passage 46 may be defined by at least two blocking elements defined by the shape of profile 46. Firstly, there is a first blocking element comprising the edge 47a which drops steeply from the bottom and beginning of the passage 46. This edge 47a co-operates with the first tooth 48a and a first recess 47c of the passage 46 to form a first chicane means. The protrusion of the secondary member has to follow a zigzag path to negotiate the first chicane means. A second chicane means can be provided by a step 47b at the end of the passage 46 which co-operates with a tooth 48b and a recess 47d immediately above it. Thirdly, additional chicane means may be provide by additional teeth/recesses in the passage 46.

[0035] Once the hook portions 20 have reached the bottom of the engagement passage 46, the secondary elongate structural component 12a,b can be stood upright such that at each end 18 the hook portions 20 abut against a stop lip 50 at the end of the engagement passage. At this position and stage, the secondary elongate structural component 12a,b is substantially upright and orthogonal to its flanking main elongate structural components 10 and is at the bottom of its engagement passage 46.

[0036] In the event of an upwardly directed force that might attempt to disengage the secondary elongate structural component 12a,b, a top edge 20a of each hook portion will come up against the top serrated edge 46a. The teeth 48 depending from the top edge 46a act as a blocking means adapted to prevent translation of the hook portions 20 along and up the engagement passage 46. Such disengagement may only take place if a reverse ratcheting action is performed.

[0037] A plurality of secondary elongate structural components 12a,b may be connected in line one each between a succession of substantially parallel main elongate structural components 10. Once one secondary elongate structural component 12a has been engaged in the engagement passage 46, a next secondary elongate structural component 12b can be connected to the same main elongate structural component 10 from the other side. The "L" shaped hooks 32 not only provide three point fixing but overlap an adjacent secondary elongate structural component 12a,b in such a manner as to prevent or reduce horizontal swinging of the secondary elongate structural component 12a,b. Their presence extending beyond their respective end faces 18 also ensures that, at least in relation to a fitting opening akin to that in Figure 5, great difficulty is experienced if an attempt is made to fit the secondary elongate structural component 12a,b upside-down. Furthermore, overlap of the "L" shaped hooks 32 locks adjacent secondary elongate structural components 12a,b together such that their end faces 18 cannot move further away from substantial abutment against their respective side faces 40a,b than is permitted by the tolerance of the width of the hook slot in item 32.

[0038] In Figures 6 to 10, variations to the shape of the engagement opening are considered. Turning first to Figures 6 to 8, it will be noted that an engagement passage 46 may be formed at each lower corner of one or more engagement slots 44. Such double ended engagement slots 44a enable secondary elongate structural components 12a,b on opposite sides of the main elongate structural component 10 to be aligned with each other either back-to-back using the same engagement passage 46 or back-to-front using opposing engagement passages 46a, 46b. In Figure 7, a basic version of such an arrangement is illustrated in which it is necessary on insertion of the secondary elongate structural component 12a,b for it 12a,b to be towards the end of the slot 44a at which is located the desired engagement passage 46a,b. Twisting of the secondary elongate structural component 12a,b may make achieving this difficult in all cases and a situation might arise in which opposite ends of the secondary elongate structural component 12a,b try to go down non-opposing engagement passages 46a,b on neighbouring main elongate structural components 10 with possible jamming or a false sense of engagement of the secondary elongate structural component 12a,b. In Figures 6 and 8, two possible versions of the double-ended engagement slot 44a are shown in which a lug 440 is provided to help reduce the chances of cross over between non-opposing engagement slots 44a. The length of the lug 440 can be varied to achieve different tolerances in initial alignment on entry to the slot 44.

[0039] Referring now for the moment to Figure 9, it can be seen that a version is possible with an engagement passage 46 in each corner of the slot 42, so as to create a quadruple slot 44b. In addition to the considerations relating to the double-ended slot 44a, the quadruple slot 44b enables the main elongate structural component to be fitted either way up in the vertical plane.

[0040] Referring now for the moment to Figure 10, it can be seen that a version is possible with engagement passages 46 converging on the middle of a fitting opening. The centrally converging version 44c enables the main elongate structural component 10 to be fitted either way around in the horizontal plane.

[0041] In the above embodiments the final position of the secondary elongate structural component is such that both the profiles of the secondary elongate structural component and main elongate structural component are vertical and both lie in the horizontal plane. However, the present invention is not limited thereto. For instance, the main elongate structural components could be rising at an angle as may occur in a roof. In this case the secondary elongate structural components may still have their profiles vertical so that the openings in the main elongate structural component must be formed at a suitable angle (rotated with respect to how they are described above). Also the main elongate

structural component could be rising vertically whereas the secondary elongate structural element runs horizontally, e.g. to make a frame for bookshelves or similar storage arrangements. The secondary member could lie flat to provide a load bearing surface as shown schematically in Figure 11. Further, the present invention has been described such that a secondary elongate structural component extends substantially orthogonally from a main elongate structural component when they are locked together. The present invention is however not limited to an orthogonal arrangement. By modifying the abutment piece 32 of the secondary elongate structural component other angles are possible.

[0042] The interengagement arrangement of the present invention enables secondary elongate structural components 12a,b to be assembled to main elongate structural components 10 without the necessary use of separate and locally applied mechanical fixings such as bolts, clamps, rivets or friction fixings like wedges, although the present invention does not prevent these also being used, e.g. for additional security. As no welding is necessary, the main elongate structural components 10 and secondary elongate structural components 12a, b of the present invention can be protected from corrosion by galvanising, powder coating or similar before assembly. Additional fixing using mechanical fixings or welding is not, however, excluded.

[0043] Using an interengagement arrangement according to the present invention, secondary elongate structural components 12a,b can be connected to their main elongate structural components 10 in such a manner that an assembly thereof 10, 12a,b can be effected in many circumstances single-handed. Sub-assemblies may be put together at one level, e.g. ground level, and subsequently lifted into place with, say, a forklift truck or a crane without significant danger of disassembly.

[0044] The hook portions 20 and the hook slot 22 may be formed with such dimensions and tolerances as found to be necessary for the particular gauges of material used. These may also take account of for example tolerances between main elongate structural components and load bearing requirements such as for roofing, insulation, lighting, flooring or maintenance access. The structural members of the present invention are considered particularly appropriate for structures where the span between main elongate structural components is above about 3m. The distance between secondary elongate structural components along the main elongate structural components may be up to 5m or more.

[0045] In particular the present invention includes variations to the designs of the various members. For example the hook 20 may be made double side as shown in Figure 12a. In this case two notches are provided 22a and 22b and each slots into the blocking profile of the main member. With reference to the secondary members the hook 20 of Fig. 3 may be facing upwards as shown schematically in Figures 12b and 13. This upper facing hook is also trapped by the blocking profile of the main member. To provide additional bearing surface the bottom of hook 20 may be formed by bending over a portion of the lower part of the hook 20 to form an "L" shaped member in cross-section. The dimensions of the blocking profile need to be amended to accommodate the additional width of the bottom portion of the "L" as shown in Figure 14c. As shown in Figures 14a, b schematically the bottom edge of hook 20 may be formed into a "Z" shape whereby a lower notch 22b is formed in the free standing lower edge of the "Z" and serves the same purpose notch 22 in Figure 3.

[0046] This additional bearing surface area may also be provided within the blocking profile on the main member as shown schematically in Figure 15. The additional width can be provided on both the main and secondary members to provide more load bearing capacity.

[0047] It will, of course, be appreciated that the main elongate structural components and/or secondary elongate structural components 12a,b are not limited to manufacture from a metal such as steel and other materials such as plastics may prove suitable in appropriate cases. Indeed, composite secondary elongate structural components are possible in which strong hook portions are integrated into plastic main beams by injection moulding.

[0048] Referring now to figures 16 to 20, a further embodiment will be described with which it is possible to build a frame as shown in Fig. 16 comprising main structural components 10 and a secondary structural components 12 even when the main members 10 are at a fixed distance and have to be constructed by a single person. Component 10 comprises a suitable profile such as a metal "C" or sigma section ("Σ"), e.g. a rolled steel joist in a form suitable for running along a roof or floor of a building substantially in parallel with similar such main elongate structural components 10. The profile may be such as "I", "H", "C+", "C", "U" or "Z". To assist in torsional rigidity of a structure employing such parallel main elongate structural components as well as to provide a load bearing capability, e.g. for flooring, cross bracing is provided between them at suitable points along their length. This cross bracing is provided in the form of secondary elongate structural components 12 such as purlins or sag rods which also have a suitable form such as a metal "C" or sigma section ("Σ"), e.g. as a rolled steel joist, or other forms such as "I", "H", "C", "C+", "U" or "Z". Once connected, the secondary elongate structural components 12 extend sideways substantially orthogonally between neighbouring main elongate structural components 10 and interconnect them. They can then be formed into a frame as shown in Fig. 16. The connections between the main and secondary members 10, 12 need to be designed to be not only easy to assemble but also to transfer loads from the secondary members 12 to the main members 10, e.g. when a floor is loaded.

[0049] Referring Figure 17 one end of a secondary elongate structural component 12 is illustrated in detail.

This is only one example of an end section of secondary member 12 which is provided as an example only. Each secondary elongate structural component 12 is preferably double ended and, in one embodiment, symmetrical, such that opposite ends are substantially identical and installation and manufacturing complexity is minimised. Each secondary elongate structural component 12 has a side face or web 16 that extends along its length and has at least one section 16a, 16b, 16c that is substantially planar. It will be appreciated that, in a sigma profile "Σ", this face is divided into co-planar upper and lower strips 16a, 16c separated by a reinforcement in the form of a "U" or "V" shaped corrugation 16b. As an alternative the central web of such a profile may be used to form at least one of the protrusions.

[0050] At least part of one of the ends of each strip 16a, 16b, 16c extends beyond an end face of the secondary elongate structural component 12 and is formed into hook portions 20 that each comprise a vertically oriented planar portion 23 and a substantially horizontally orientated planar portion 25. Each hook portion 20 defines a horizontally orientated slot 22 in the planar portion 25 between a claw 24 and the end face 18 of the respective strips 16a, 16c. Optionally each hook portion 20 may also comprise a further horizontal portion 27 formed from part of the strip 16b which is formed on an opposite edge of the vertical planar portion 23 from the slot 22. This provides additional rigidity. Preferably, tow hook portions 20 are formed on each end of a secondary member 12 and a recess 19 is formed in the web 16b therebetween.

[0051] Referring now to the exemplary main elongate structural component 10, this comprises a suitable profile such as a "C" or "C+" profile as shown in Fig. 18a, b or a sigma profile "Σ" having a wide and flat-bottomed central channel 38 formed therealong, the flat bottom forming a planar face 40.

[0052] Wherever a secondary elongate structural component 12 is to be connected to the main elongate structural component 10, at least one and preferably a pair of fitting openings 42a, 42b are defined in the face 40 of channel 38 and extend through it. The openings 42 may be provided one above the other or may be offset both vertically and horizontally from each other. The relative position of opening 42a to opening 42b is determined by the profile of the secondary member and the relative position of the hooks 20 on the end of the secondary member. The one or more fitting openings 42a, b will initially be described with particular reference to a basic embodiment illustrated by way of example in Figure 19 and may be formed by, for example, profile cutting or stamping or laser cutting.

[0053] Each opening 42a comprises a slot 44a which extends transversely across the face 40 and is high enough to allow insertion of the hook portion 20 of a secondary elongate structural component 12 in substantially vertical orientation. At the end of the slot 44a is an opening 45a which is wider than slot 44a. Opening 45a is wide enough to receive the claw 24 of a secondary structural component 12 whereas the slot 44A is wide enough to receive the further horizontal portion 27 of the secondary elongate member 12 but not wide enough to receive the claw 24. At the lower end of slot 42a, a portion of the face 40 can be bent into towards the channel 38 to form a support tab 47a which strengthens the end of the slot 42a and provides a larger bearing surface area than the mere thickness of the metal of face 40.

[0054] Beneath each opening 42a there is a similar opening 42b being more or less a mirror image of opening 42a. Opening 42a comprises a slot 44b which extends transversely across the face 40 and is also high enough to allow insertion of the hook portion 20 of a secondary elongate structural component 12 in substantially vertical orientation. At the end of the slot 44b is an opening 45b which is wider than slot 44b and which narrows to a width smaller than slot 44b at the lowest position thereof. Opening 45b is also wide enough to receive the claw 24 of a secondary structural component 12 whereas the slot 44b is wide enough to receive the further horizontal portion 27 of the secondary elongate member 12 but not wide enough to receive the claw 24. The opening 45b narrows towards the bottom of opening 42b to such an extent that it is narrower than the claw 24. At the lower end of slot 42b, a portion of the face 40 can be bent into the channel 38 to form tab 47b which strengthens the end of the slot 42a and provides a larger bearing surface area than the mere thickness of the metal of face 40.

[0055] To connect a secondary elongate structural component 12 to the main elongate structural component 10 at one end, the secondary elongate structural component 12 is initially inserted into the opening 42 with its hook claws 24 substantially horizontally orientated and entering the openings 45a and 45b, respectively. The secondary elongate structural component 12 can be lowered so that the slots 22 of hook claws 24 locate themselves over a portion of the face 40 adjacent to the slot 44a and the opening 45b, respectively as shown best in Fig. 19. To prevent upward movement a plate may be fixed on to the top of the structure, e.g. floor boards or a floor plate. Such a floor plate is preferably connected to the main members 10 at a suitable number of places when the frame of Fig. 16 is to be used for flooring. To allow for flanges, e.g. on the extreme longitudinal edges of "C" or sigma profile main members, the sections 16a and/or 16b may be cut back as shown in Figs. 20a and 20b. Depending on the height of the secondary member 12, one section 16a, c or both sections 16a,c will need to be cut back.

[0056] Generally, a secondary elongate structural component 12 is placed between two main elongate structural components 10 so as to join them together as shown in Fig. 16. This is preferably done by a single person located at the mid-point of the secondary elongate structural component 12. To achieve this the secondary elongate structural component 12 must be inserted far

enough into a the openings 42a, b of a first main elongate structural component 10 so that the other end of the secondary elongate structural component 12 may be inserted into similar openings 42a, b in a parallel main elongate structural component 10 without the need to disturb the main structural components. This is possible in accordance with the present invention because a portion of metal section 25 is provided between the hook slot 22 and the end of the secondary elongate structural component 18 to form a space to prevent the end 18 from interfering with the face 40. The one end of the secondary elongate structural component 12 is so designed that it can be pushed too far into the opening 42 in the main elongate structural component 10 so that the other end of the secondary elongate structural component 12 is free to be inserted into the other main elongate structural component 10 and then the secondary elongate structural component 12 can be centred between the two main elongate structural components 10 before being lowered into a final locking position. To assist in this process the end of member 12 which is first inserted is preferably supported in the opening 42 of the one maim member 10. This support is provided by the horizontal portion 25 of the hook 20 of the secondary members 12 as it rests on the bottom of the opening 42. The secondary member 12 can then be slid back while at the same time entering with its other end into the openings 42 of the other remote main member 10. The overall length of the secondary member 12 and the space between the slot 22 and the end face 18 should be chosen so that the overall length is greater than the distance between two main members. In this case, once both ends of a secondary member are inserted, the secondary member 12 is prevented from falling. The operator can then adjust the position exactly so that the slots 22 slip down and locate around the relevant part of the face 40.

[0057] While the present invention has been particularly shown and described with respect to a preferred embodiment, it will be understood by those skilled in the art that changes in form and detail may be made without departing from the scope and spirit of the invention.

Claims

1. A method of manufacturing a framed structure comprising at least a first and a second substantially parallel main elongate structural members with at least one secondary elongate structural member joined between the two main members in a load bearing manner, the main members being separated by a fixed distance and an opening being provided which extends part way along a side face of each main member; the method comprising: inserting a first protrusion located on a first end of the secondary structural member in the opening of the first main member by moving the secondary structural member along a first direction parallel with the longitudinal axis of the secondary member,
inserting a second protrusion located on a second end of the secondary structural member in the opening of the second main member by moving the secondary member along a second direction which is the reverse direction of the first direction,
interconnecting the secondary member with the main members by a movement of said secondary member to bring the ends of the secondary member into a predetermined position on said main members, said openings and said first and second protrusions co-operating to prevent disengagement of said secondary member from said predetermined position other than by reversal of said movement.

2. A method according to claim 1, wherein the locking movement is a non-linear movement.

3. A method according to claim 2, wherein the locking movement is not a rotational movement of the secondary member about its longitudinal axis.

4. A method according to claim 1, wherein the movement is substantially transverse to the longitudinal axis of the main member.

5. A method according to any previous claim further comprising the step of forming the openings with a shape-defined blocking means adapted to prevent disengagement of said secondary member from said predetermined position other than by reversal of said movement.

6. A method according to any previous claim, wherein the interconnecting of the main to the secondary members is bolt-, screw- and weld-free.

7. A method according to any previous claim in which the distance between neighbouring main members is not changed during the interconnecting step.

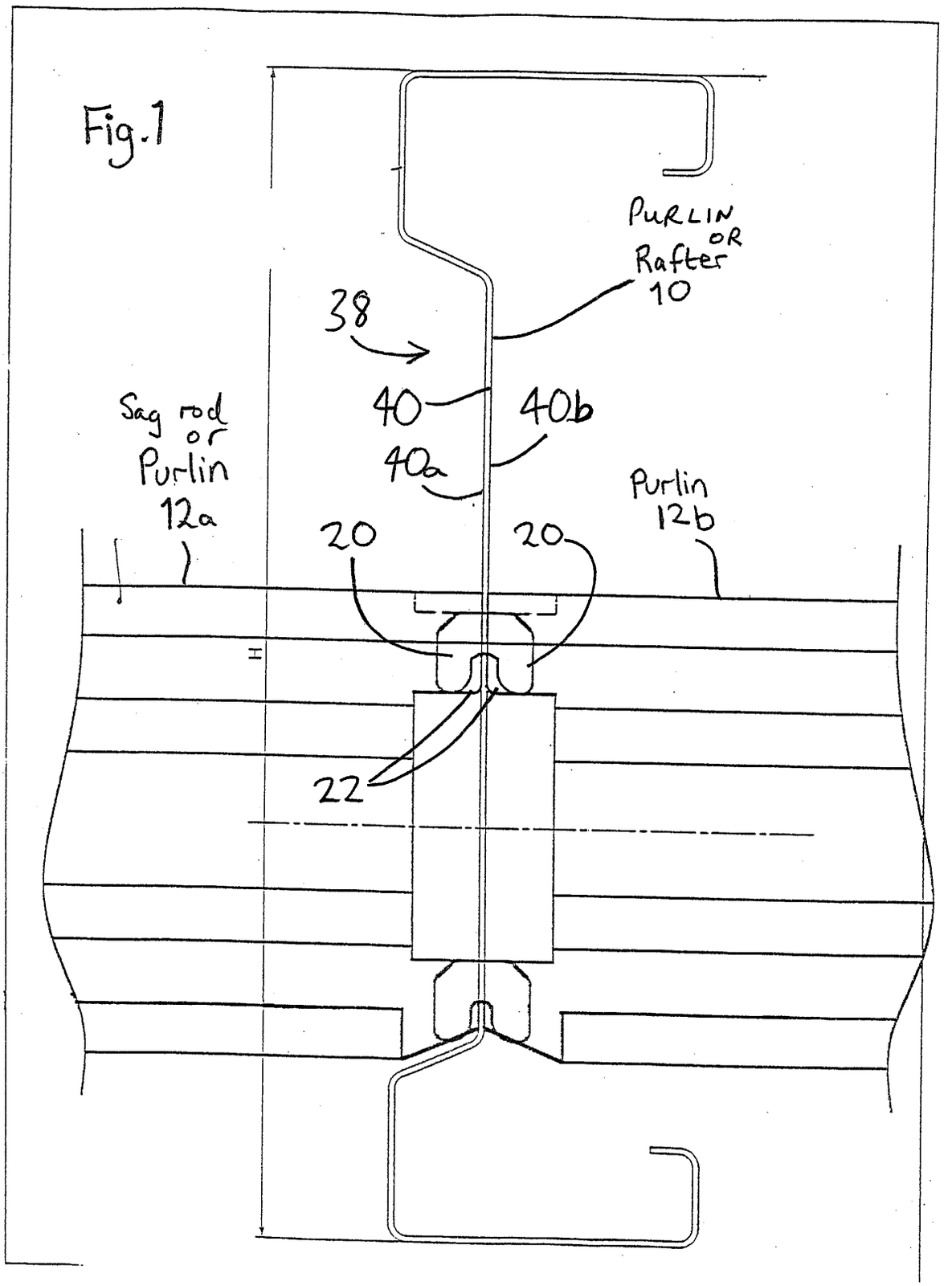
8. A method according to any previous claim, wherein support tabs are formed by bending at positions of the openings to support the ends of the secondary members.

9. A method according to any of the previous claims, wherein the first and second protrusions each have a slot which locates around a portion of the material of the main member adjacent to the openings during the interconnecting step.

10. A method according to claim 9, wherein the slots extend parallel to the longitudinal axis of the main member or transverse thereto when the secondary members are interconnected with the main members.

11. A frame structure constructed by the method of any of claims 1 to 10, wherein the frame structure comprises at least two main members and a plurality of secondary members.

Fig.1


PURLIN OR Rafter 10
38
40
40b
40a
Sag rod or Purlin 12a
Purlin 12b
20
20
22

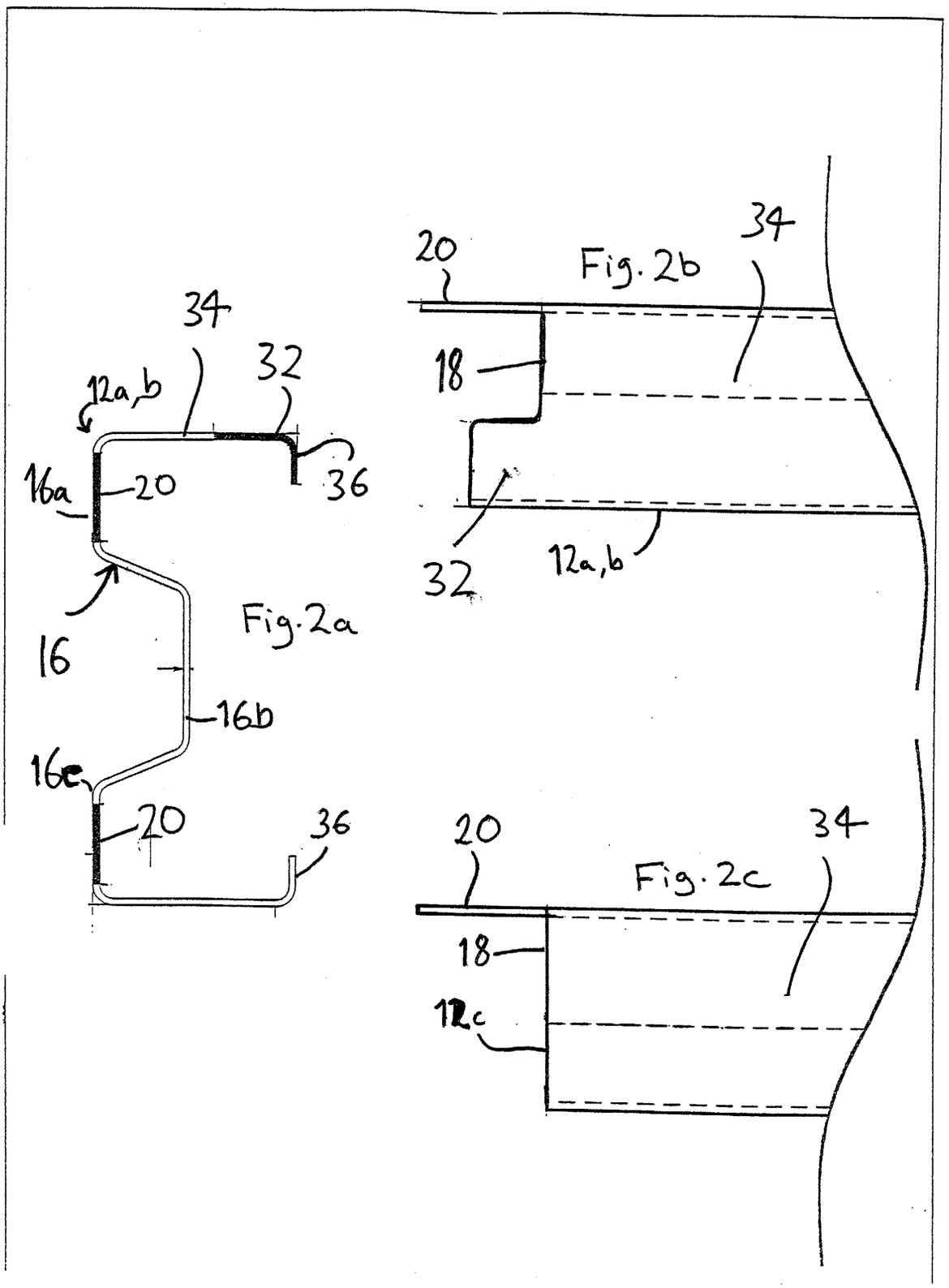


Fig. 2a

Fig. 2b

Fig. 2c

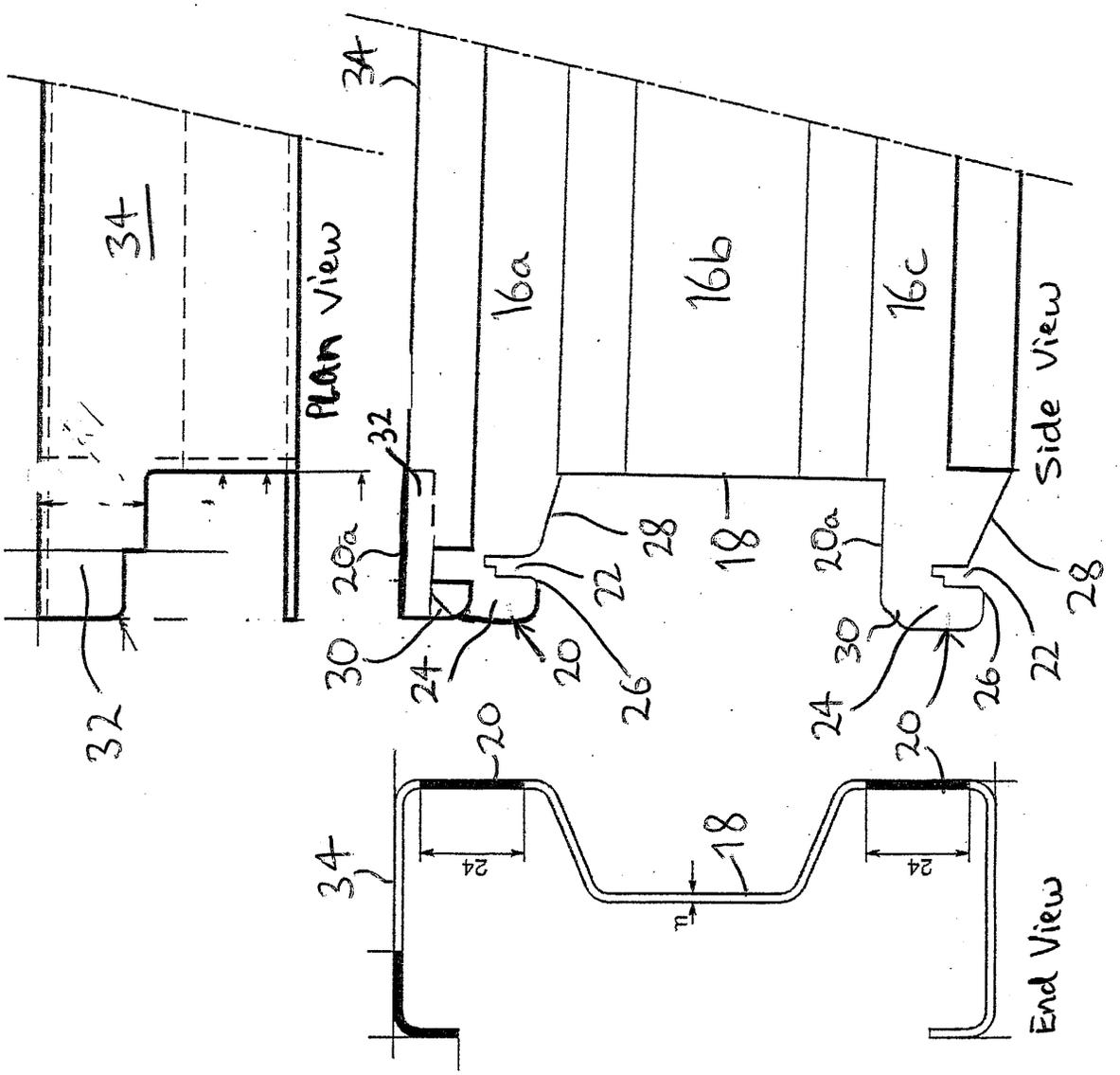

34
Plan View
32
16a
16b
16c
Side View
20a
28
18
22
30
24
20
26
End View

Fig. 3

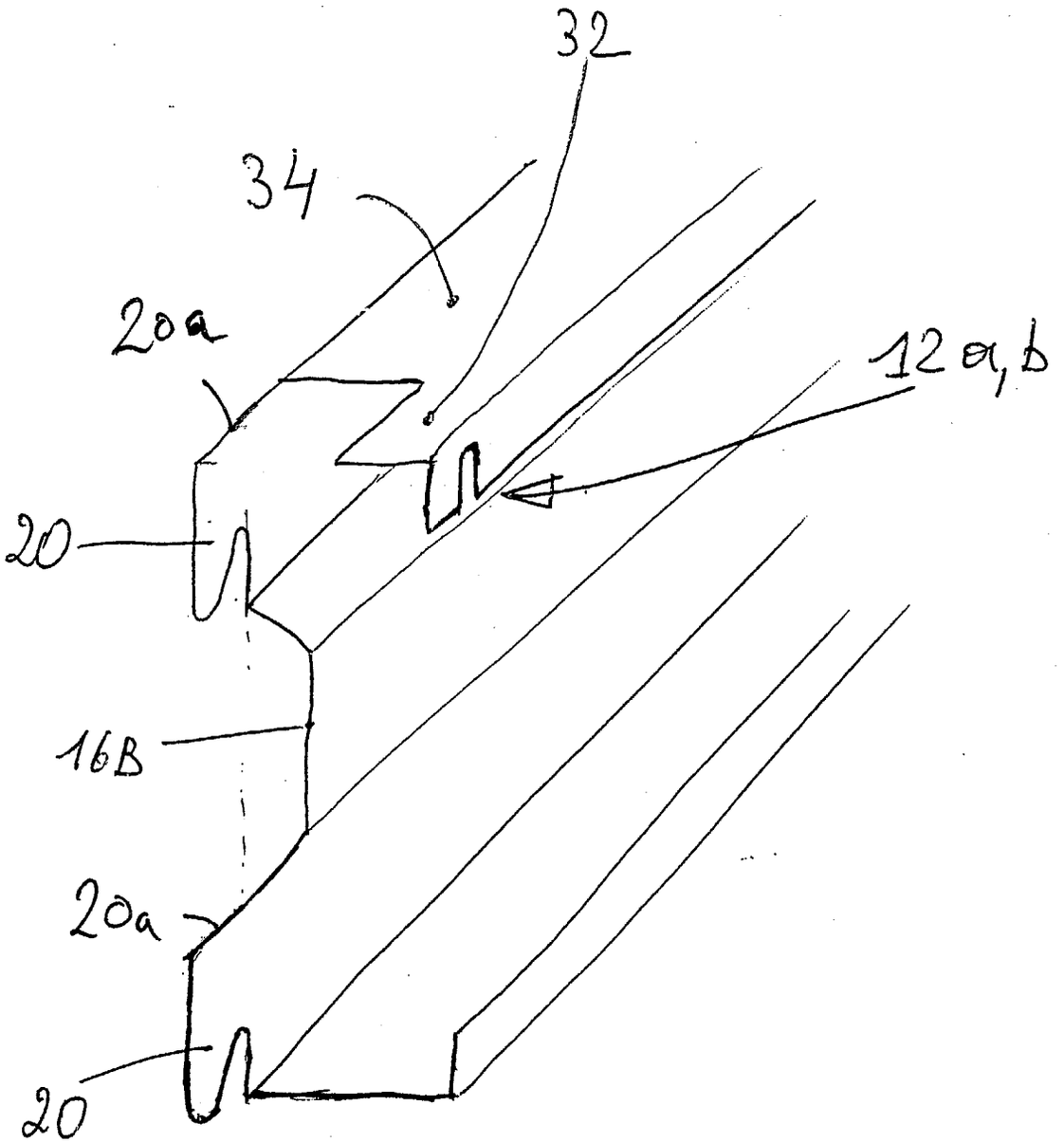


FIG. 4a

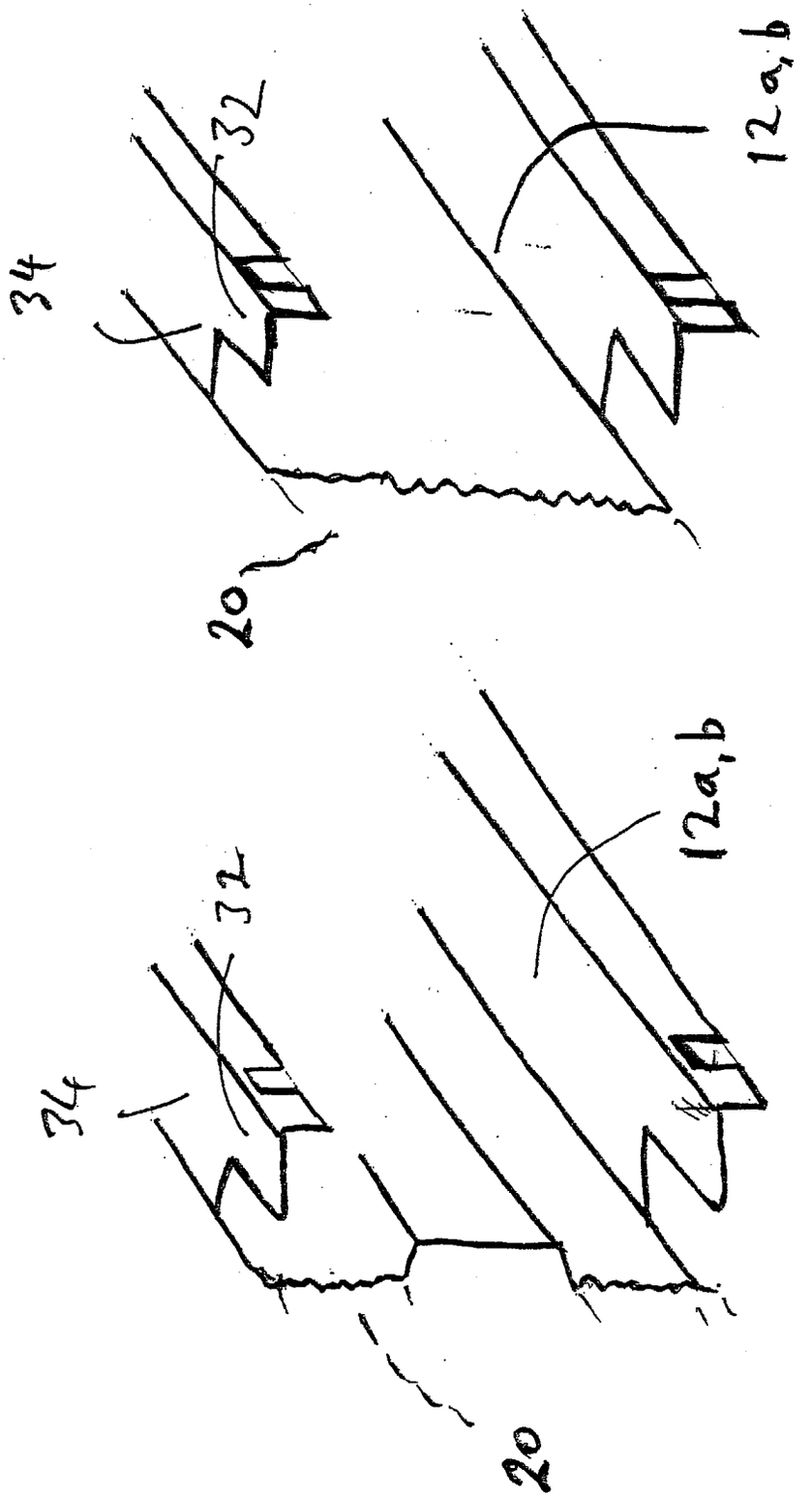
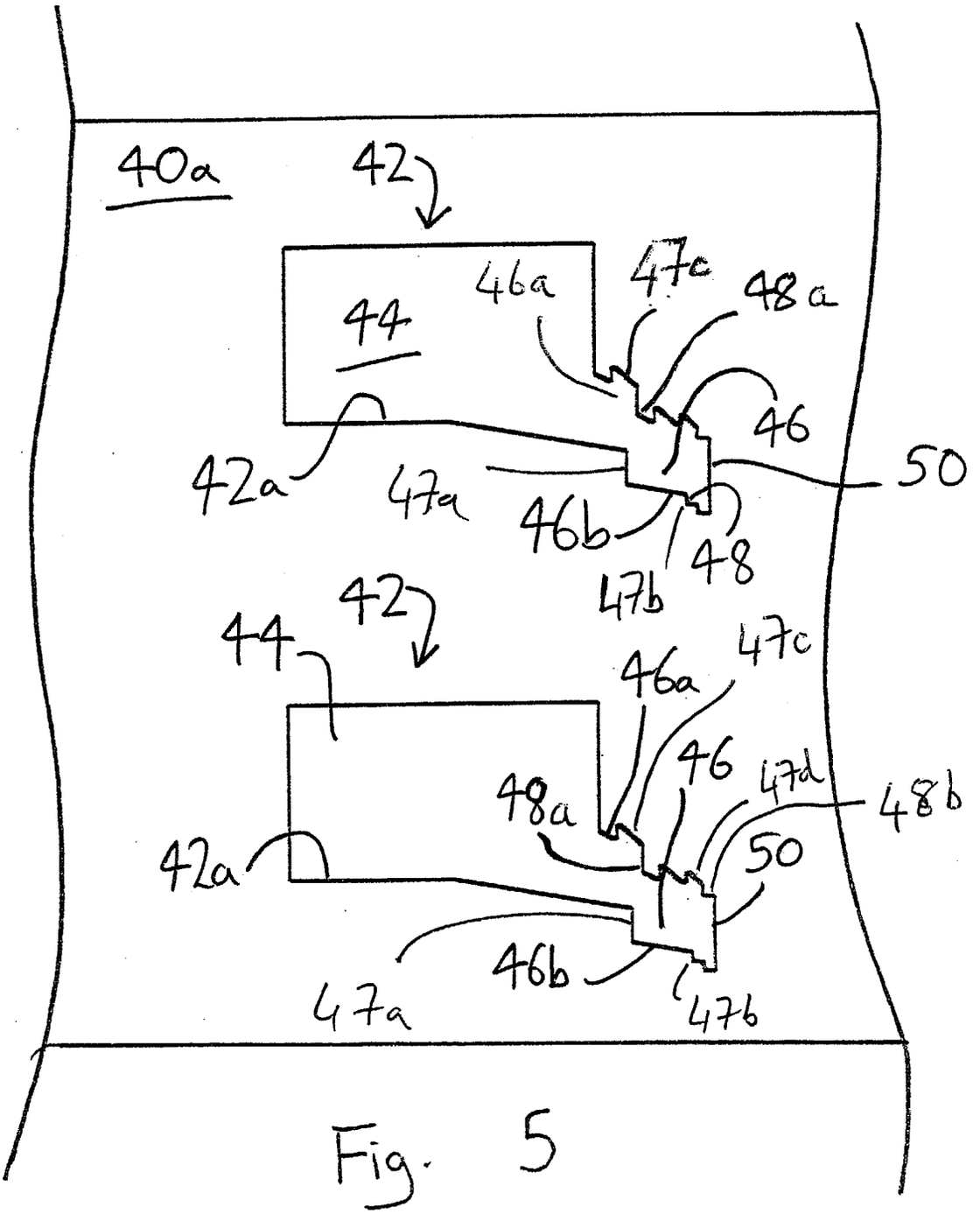


Fig. 4b


40a
42
44
46a
47c
48a
46
42a
47a
46b
48
50
47b
42
44
47c
46a
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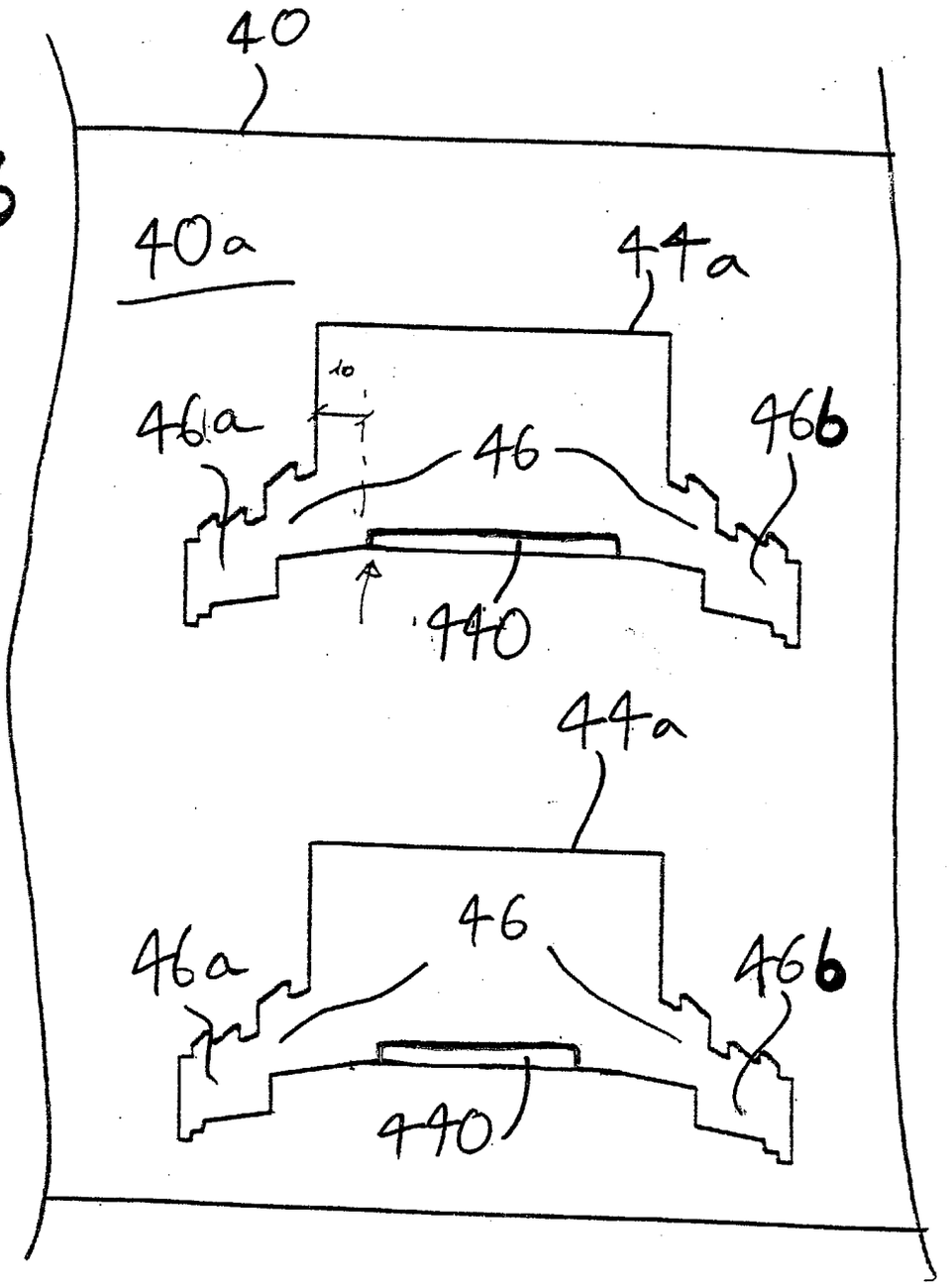
48a
47d
48b
42a
50
46b
47a
47b

Fig. 5

Fig.6



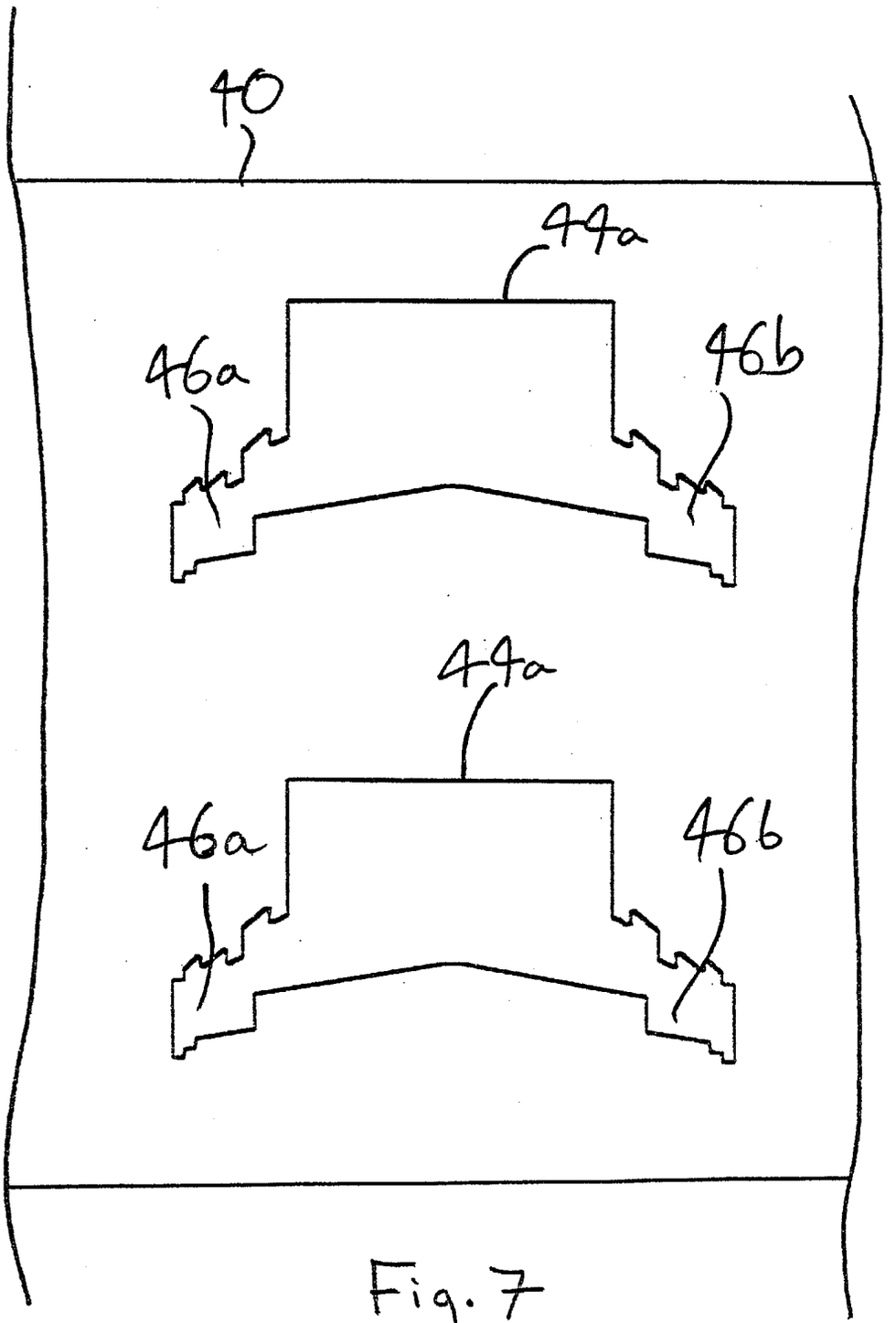


Fig. 7

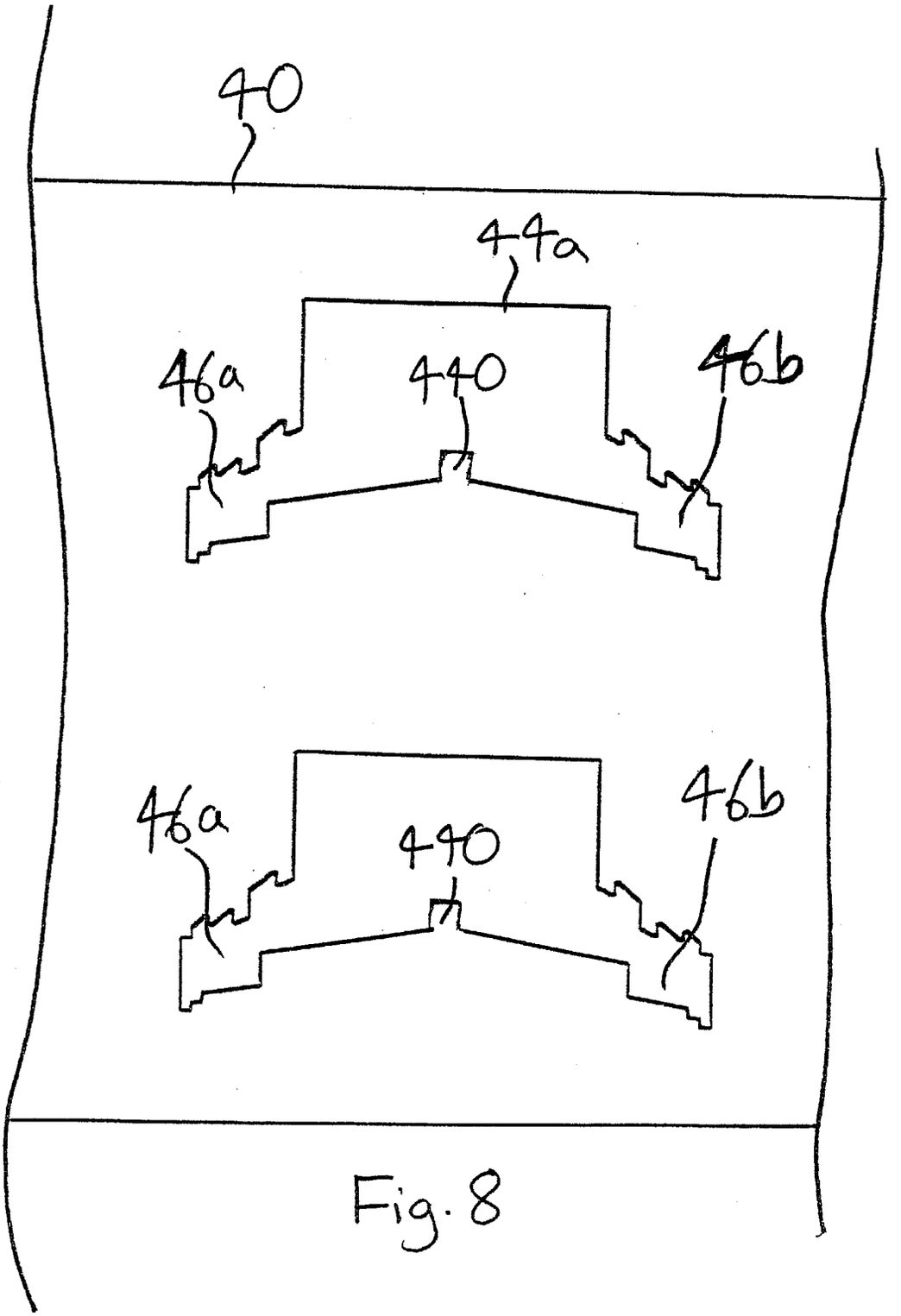


Fig. 8

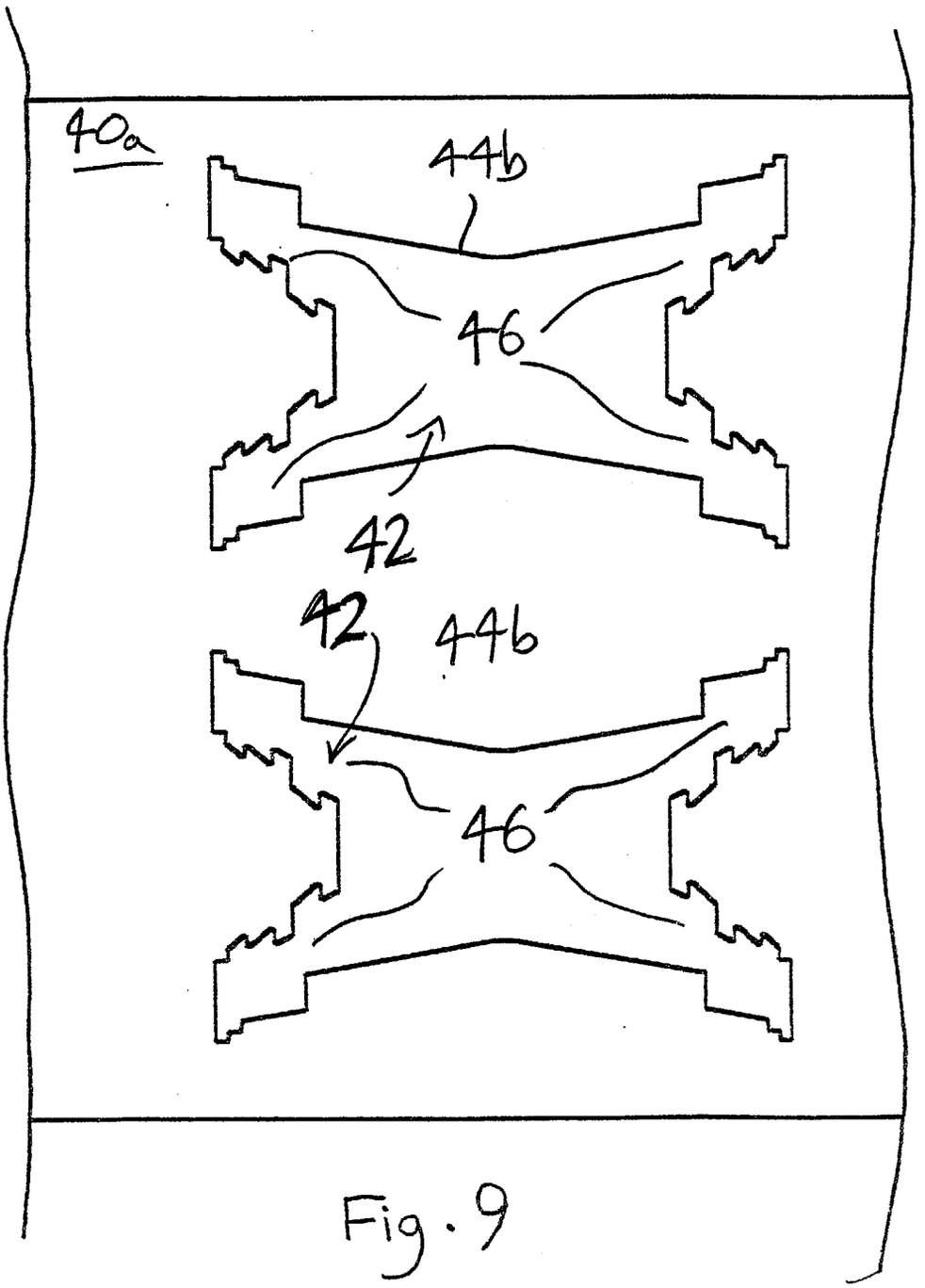


Fig. 9

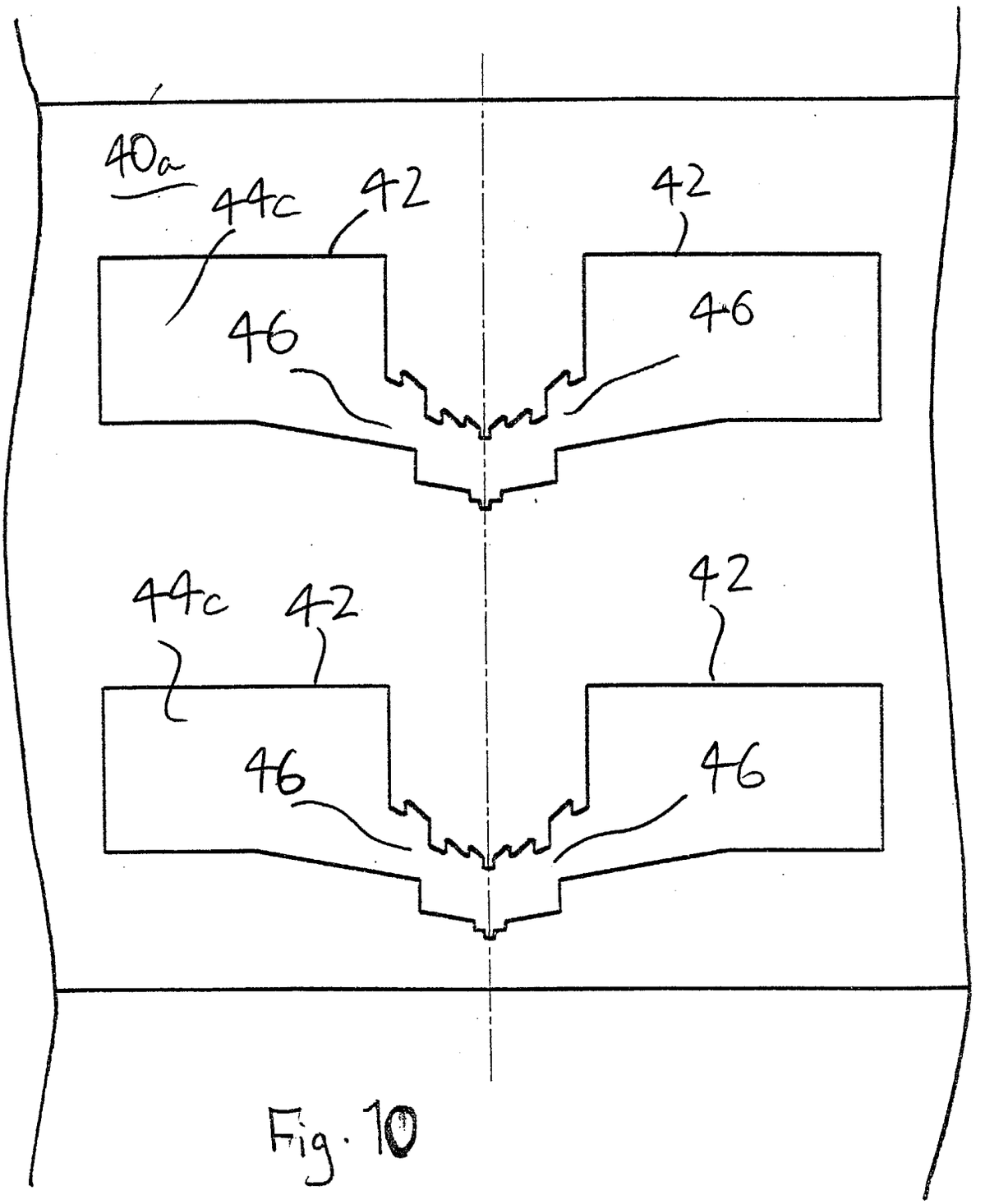
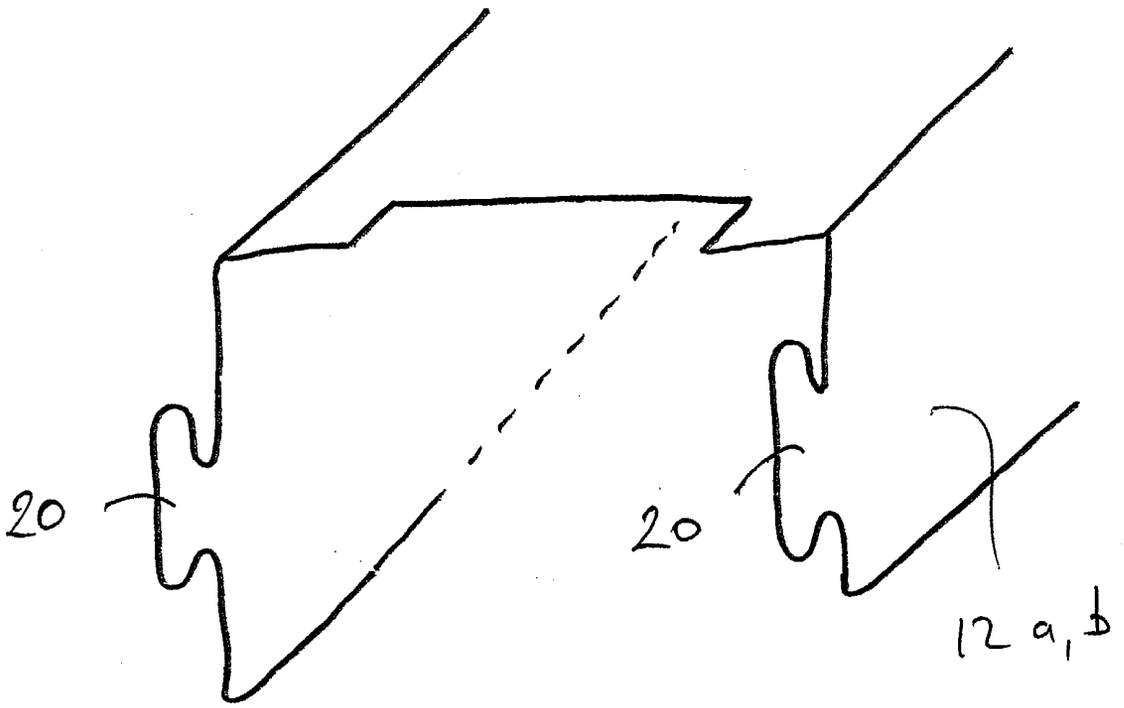


Fig. 10



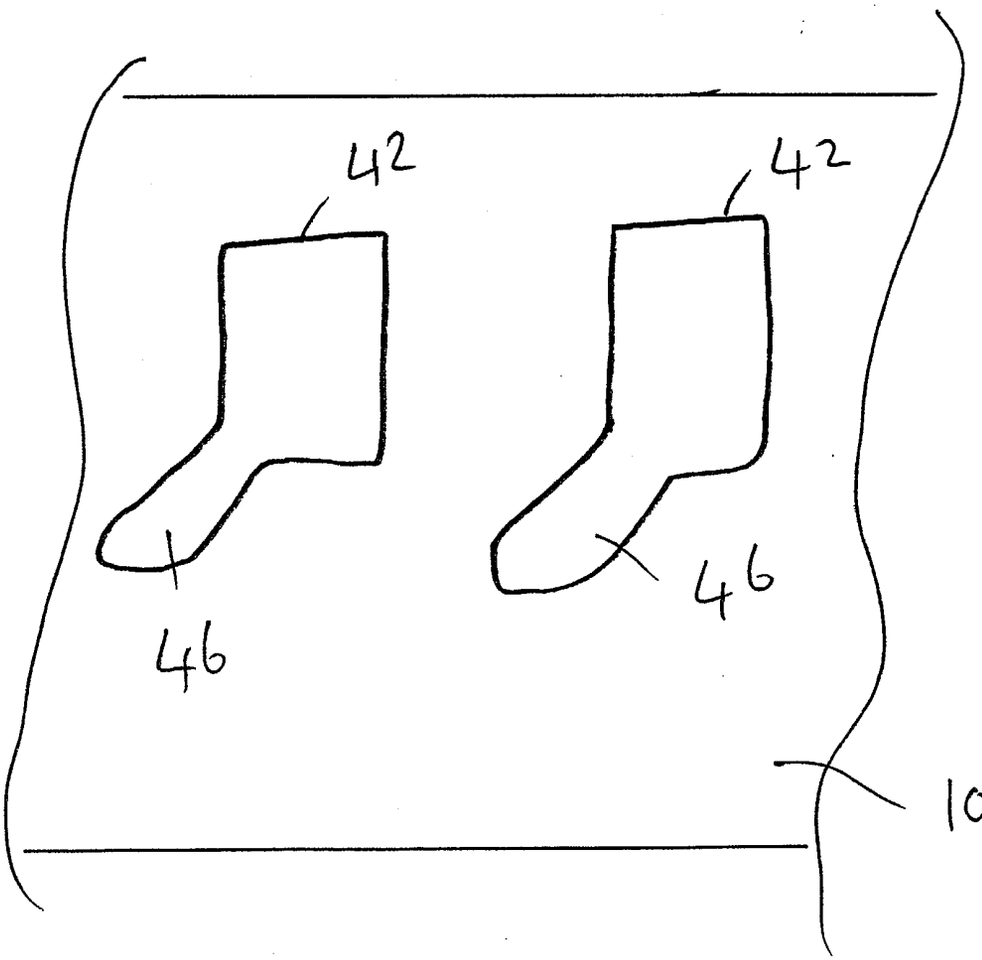


Fig. 11

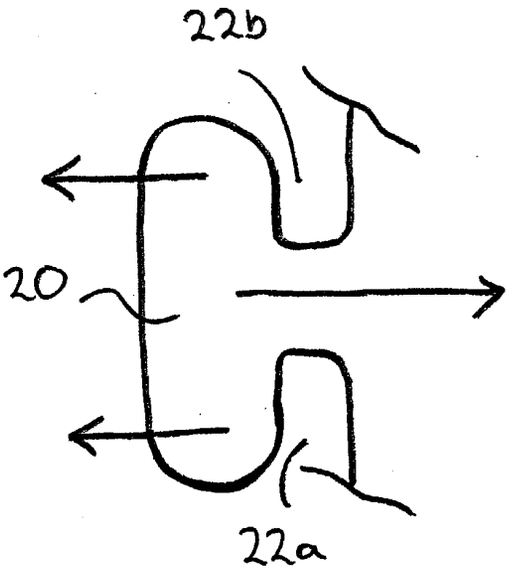
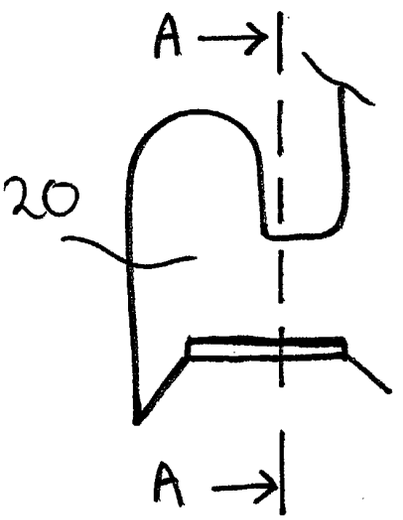


Fig. 12a



View on A-A

Fig. 12b

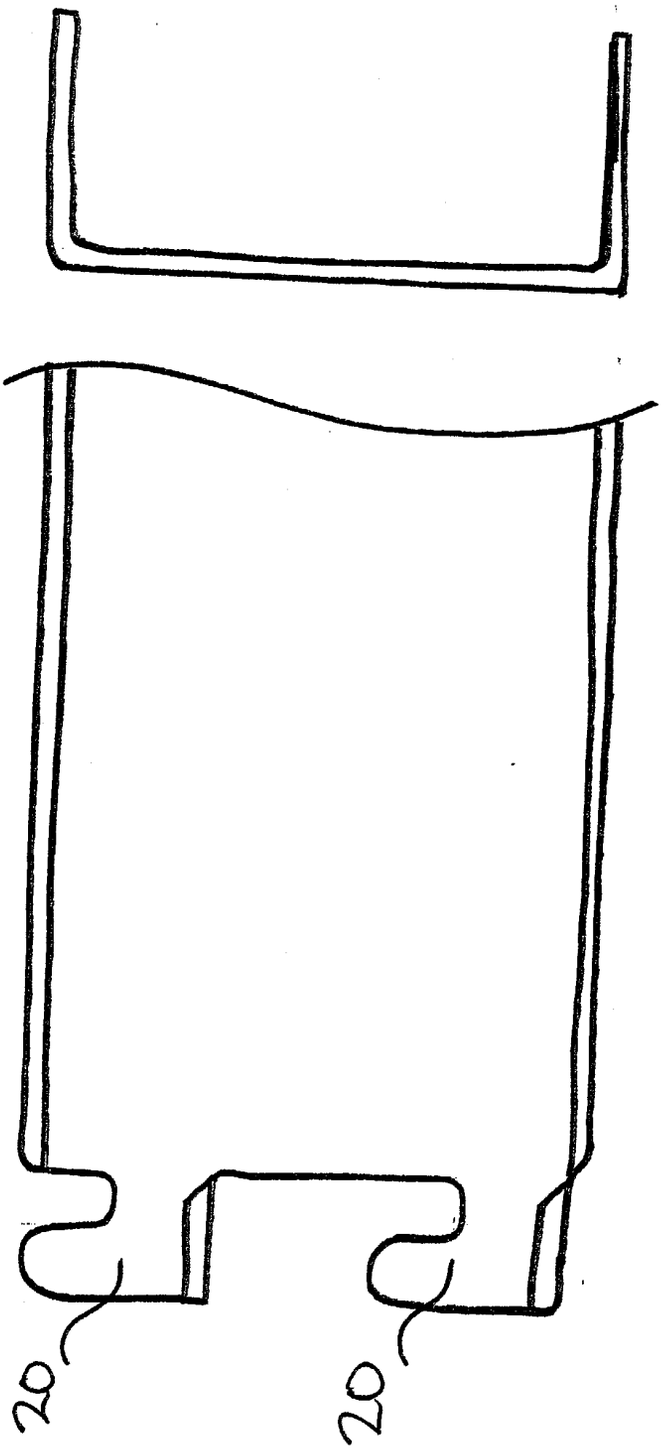


fig. 13

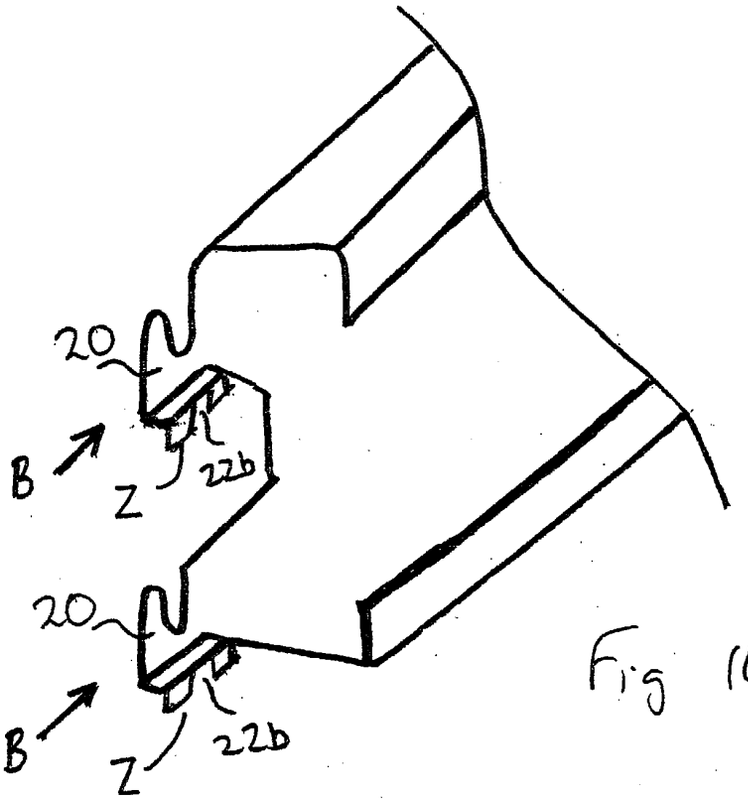
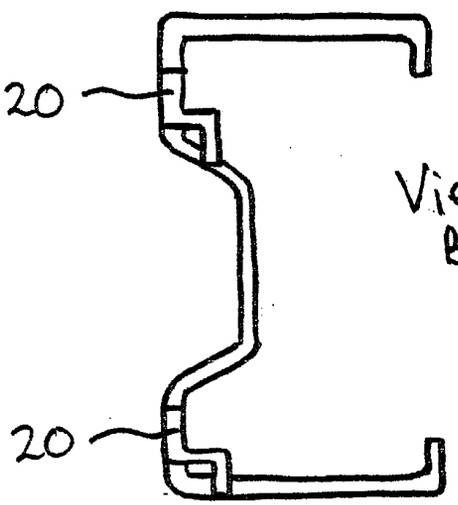


Fig 14a



View on
B-B

Fig. 14b

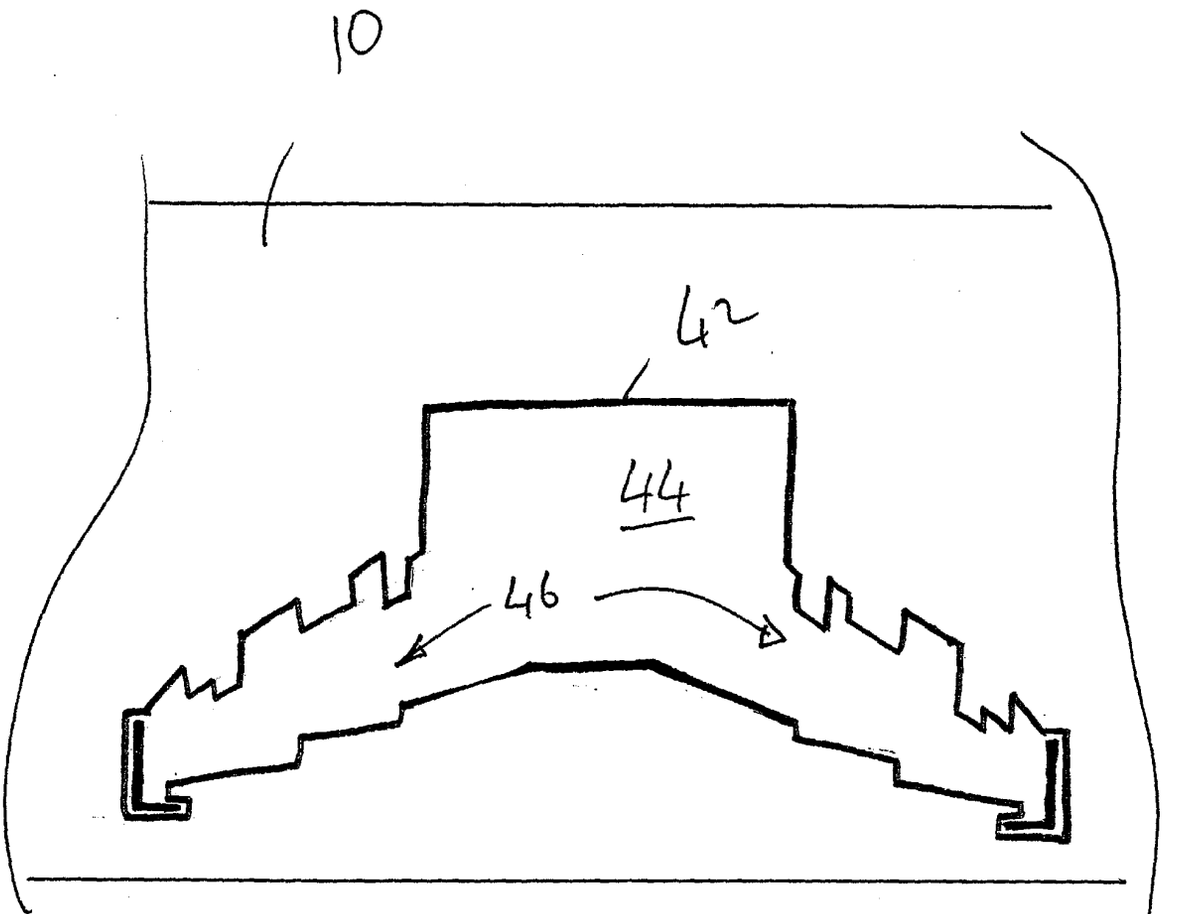
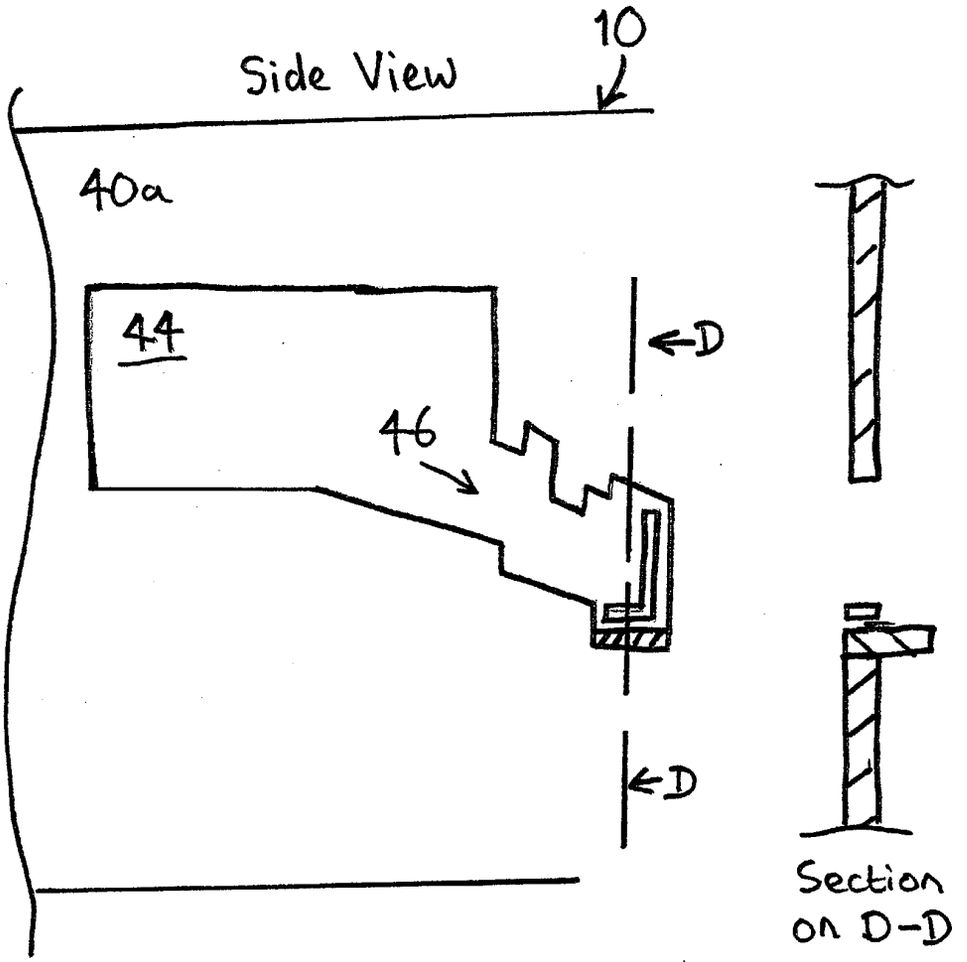


Fig. 14c



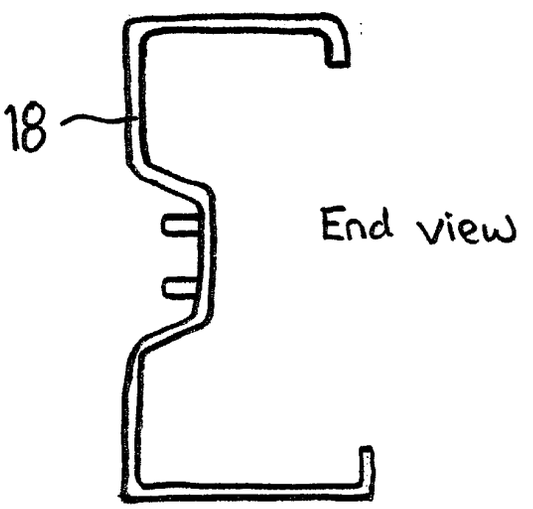


Fig. 15

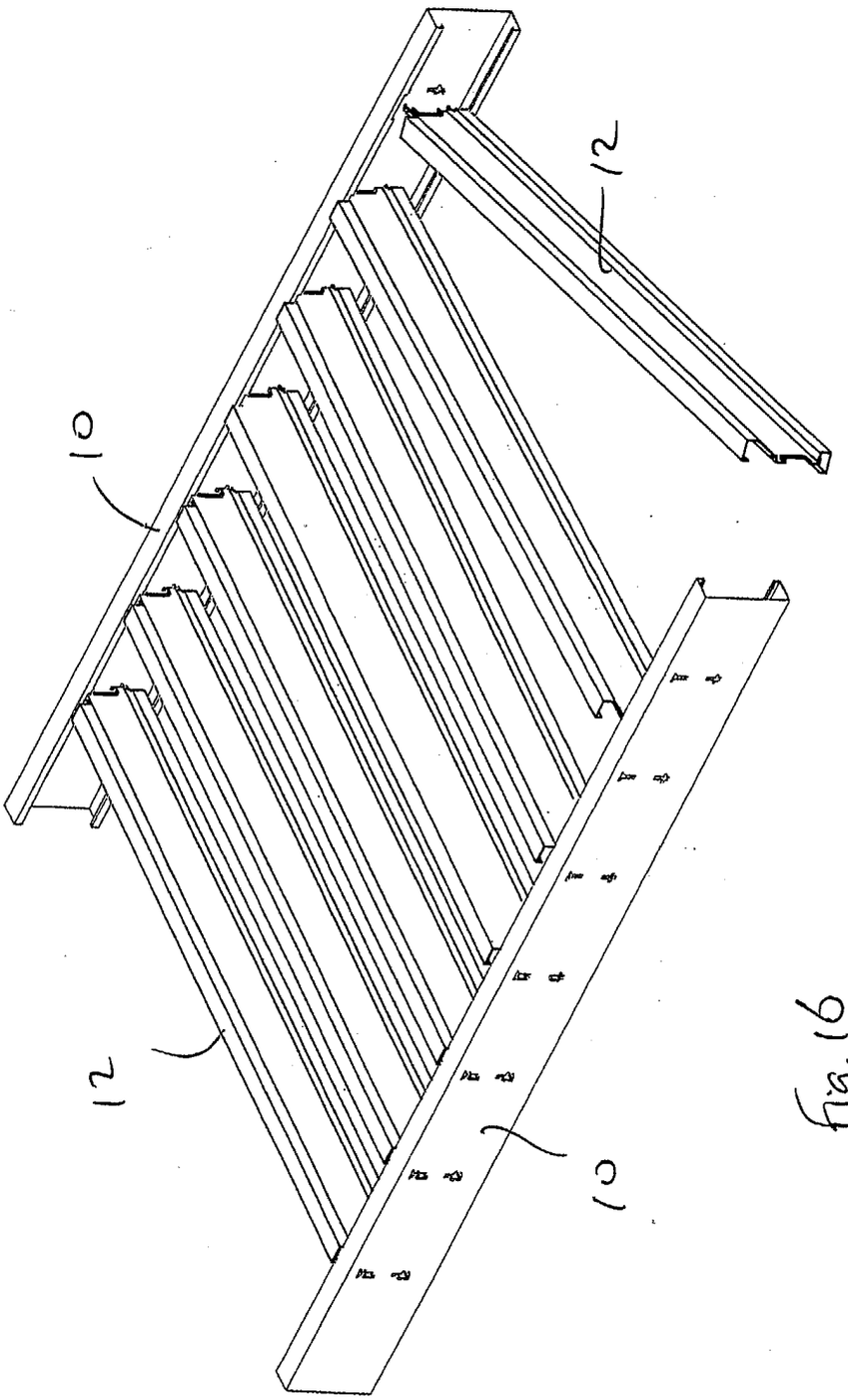
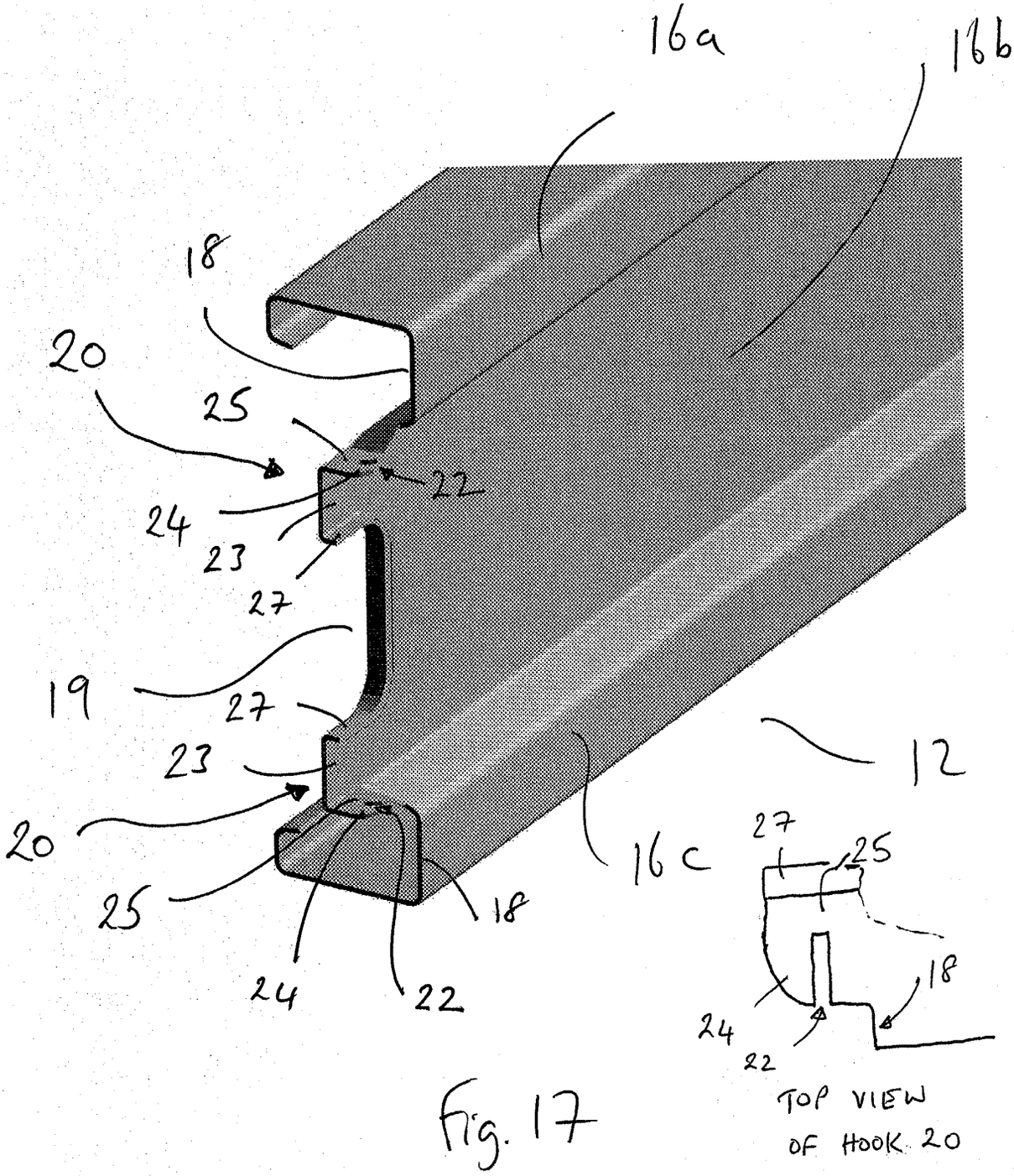


fig. 16


16a
16b
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18
16c
12
27
25
18
24
22
TOP VIEW
OF HOOK 20

Fig. 17

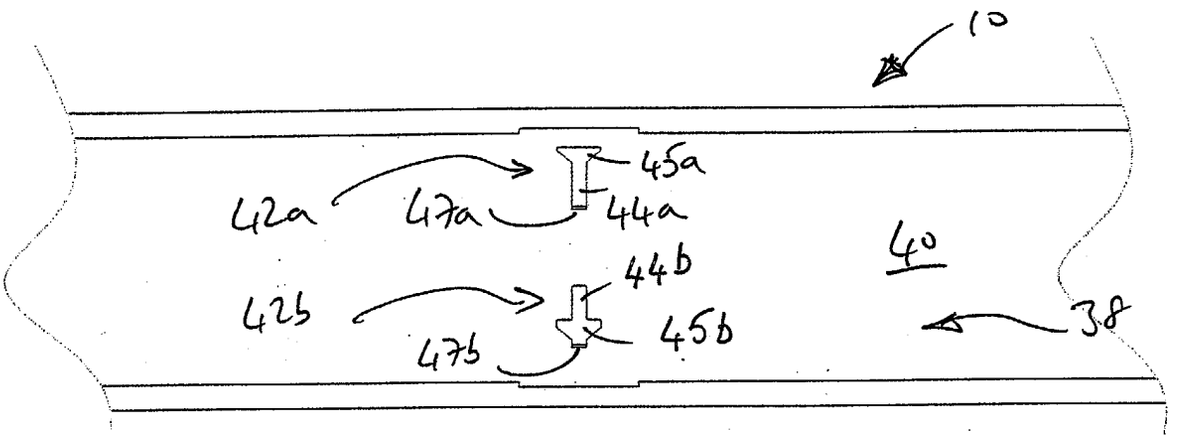

Fig. 18a

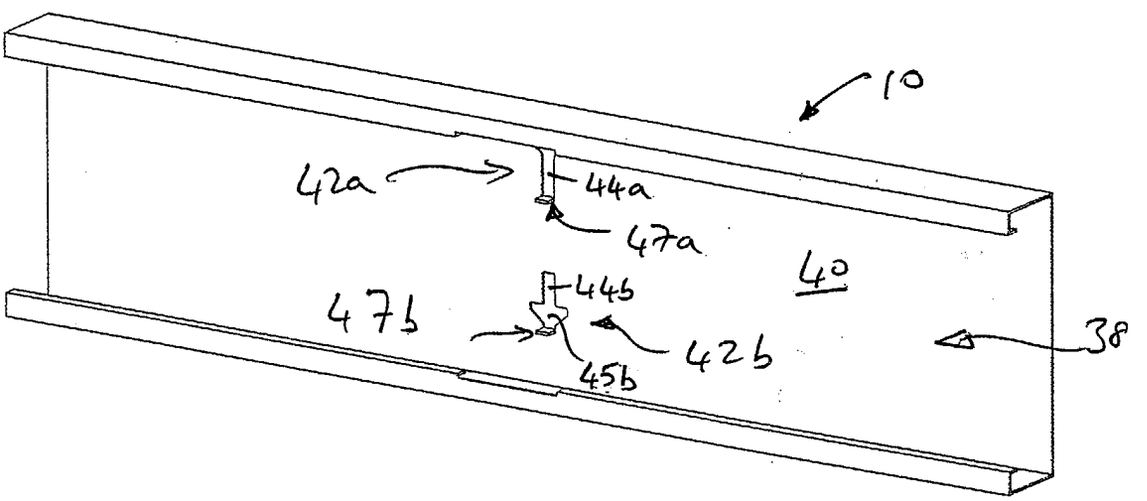

Fig. 18b

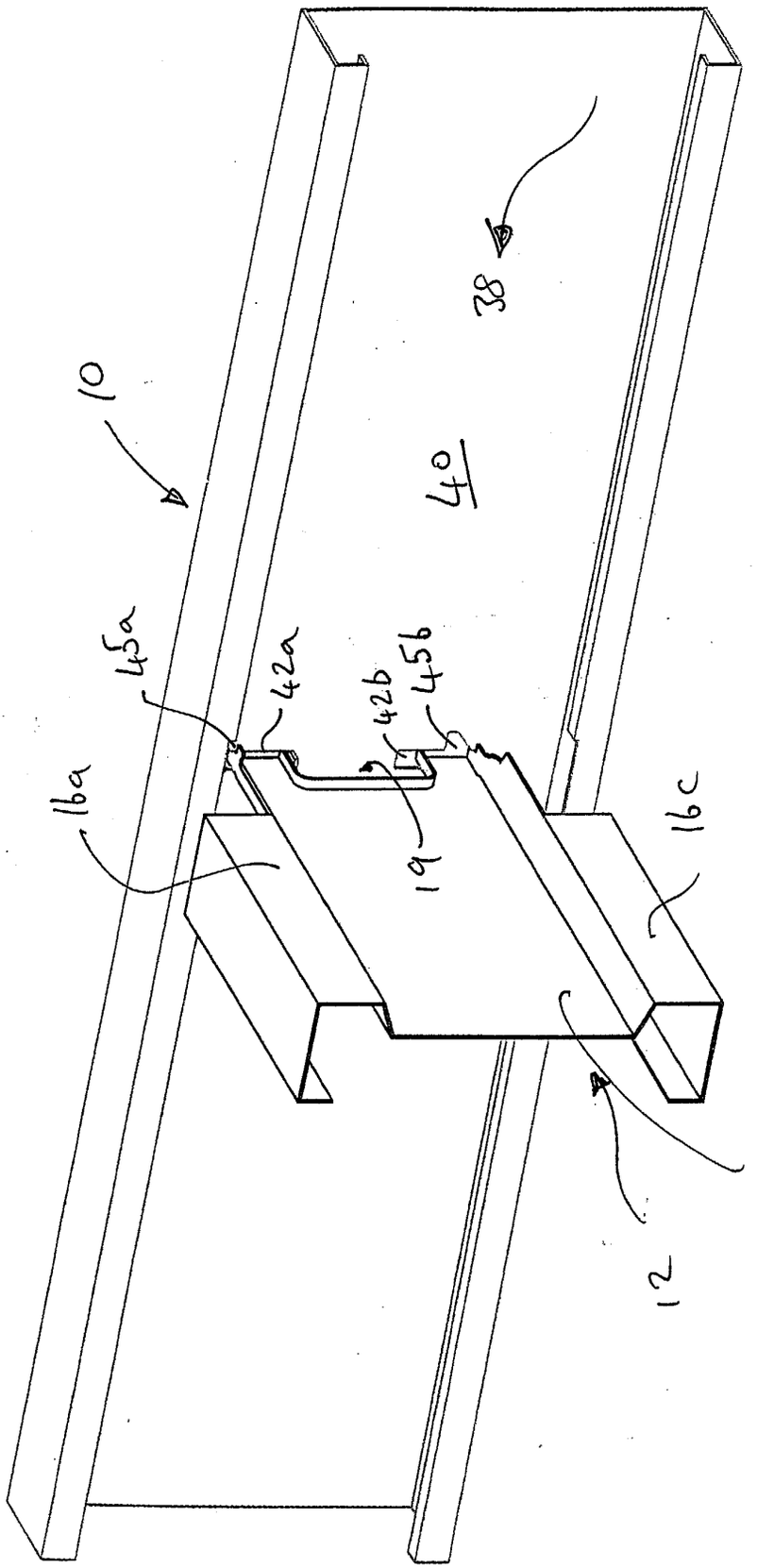

Fig 19.

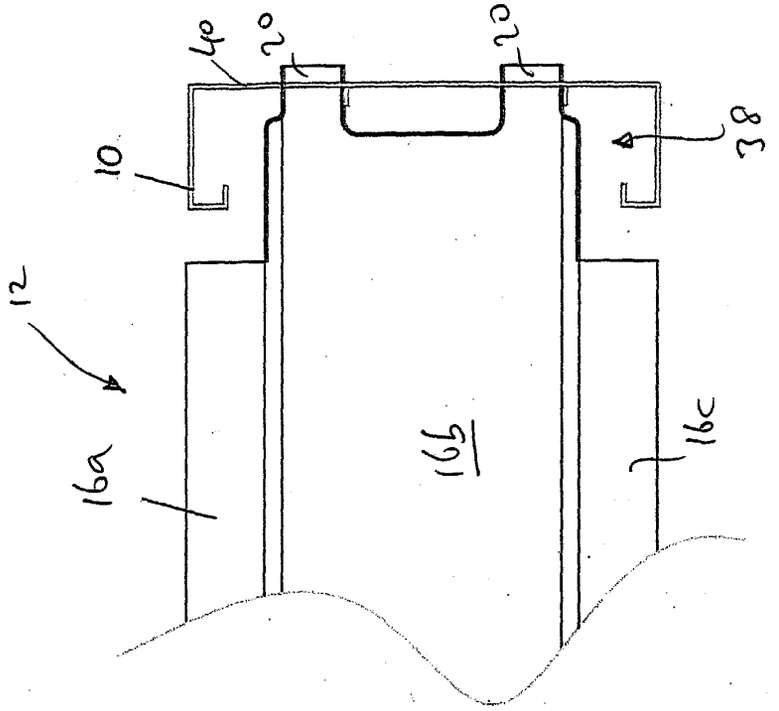

Fig. 20b

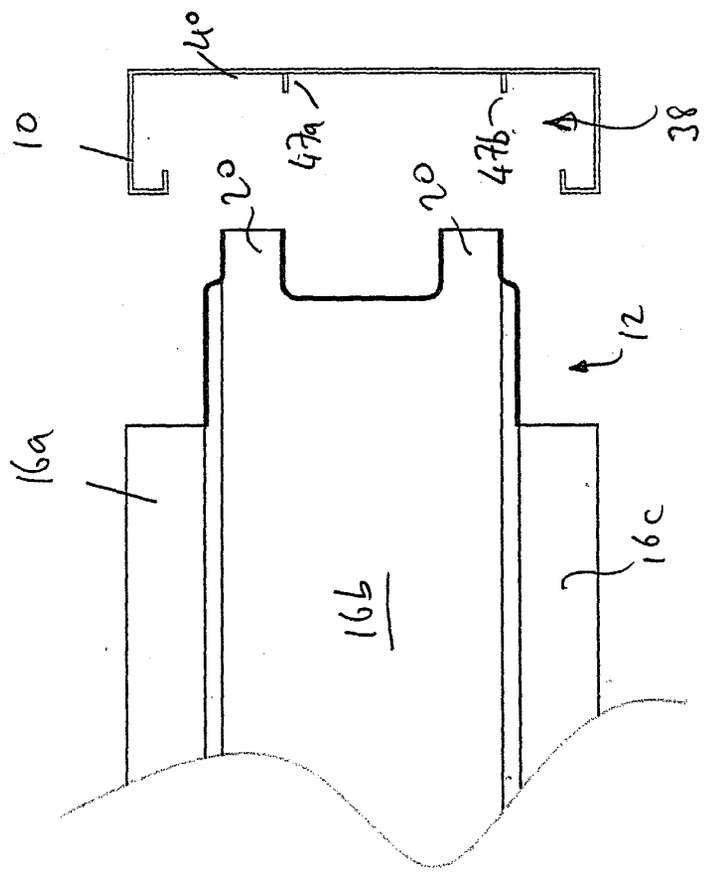

fig. 20a

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 03 44 7029

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.7)
X A	GB 1 431 312 A (ELWELL SECTIONS) 7 April 1976 (1976-04-07) * page 1, line 58 - page 2, line 120; figures *	1,2,4-6, 9-11 3,7,8	E04B9/12 E04B5/14 E04B7/02
X A	GB 1 279 863 A (WARD BROTHERS) 28 June 1972 (1972-06-28) * page 1, line 45 - page 2, line 110; figures *	1-7,9,11 8,10	
A	GB 2 097 038 A (WARD BROTHERS) 27 October 1982 (1982-10-27) * abstract; figures *	1,2,5-7, 9-11	
A,D	US 3 138 227 A (GORDON) 23 June 1964 (1964-06-23) * the whole document *	1-6	
A,D	US 3 283 467 A (ZNAMIROWSKI) 8 November 1966 (1966-11-08) * column 2, line 5 - column 5, line 20; figures *	1-6	
A	US 5 829 908 A (SLOWBE) 3 November 1998 (1998-11-03) * abstract; figures *	1,8	

TECHNICAL FIELDS SEARCHED (Int.Cl.7)
E04B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	17 April 2003	Righetti, R

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
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P : intermediate document

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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 03 44 7029

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
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17-04-2003

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