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54	TITLE OF INVENTION

ROOF STRUCTURE

57	ABSTRACT (NOT MORE THAN 150 WORDS)

NUMBER OF SHEETS 17

The sheet(s) containing the abstract is/are attached.

If no classification is furnished, Form P.9 should accompany this form.
The figure of the drawing to which the abstract refers is attached.

ABSTRACT

This invention relates to a roof structure. The roof structure includes at least one roof panel which includes a planar rectangular frame. The frame includes a first pair of opposite, parallel side members and at least one I-configuration composite beam, perpendicular to the side members. One end of the beam is connected to one of the side members at a position intermediate the length of the side member and an opposite end of the beam is connected to the other side member at a position intermediate the length of the side member. The beam is comprised of two cold formed channel sections secured together back to back and disposed with the webs of the channel sections perpendicular to the plane of the frame.

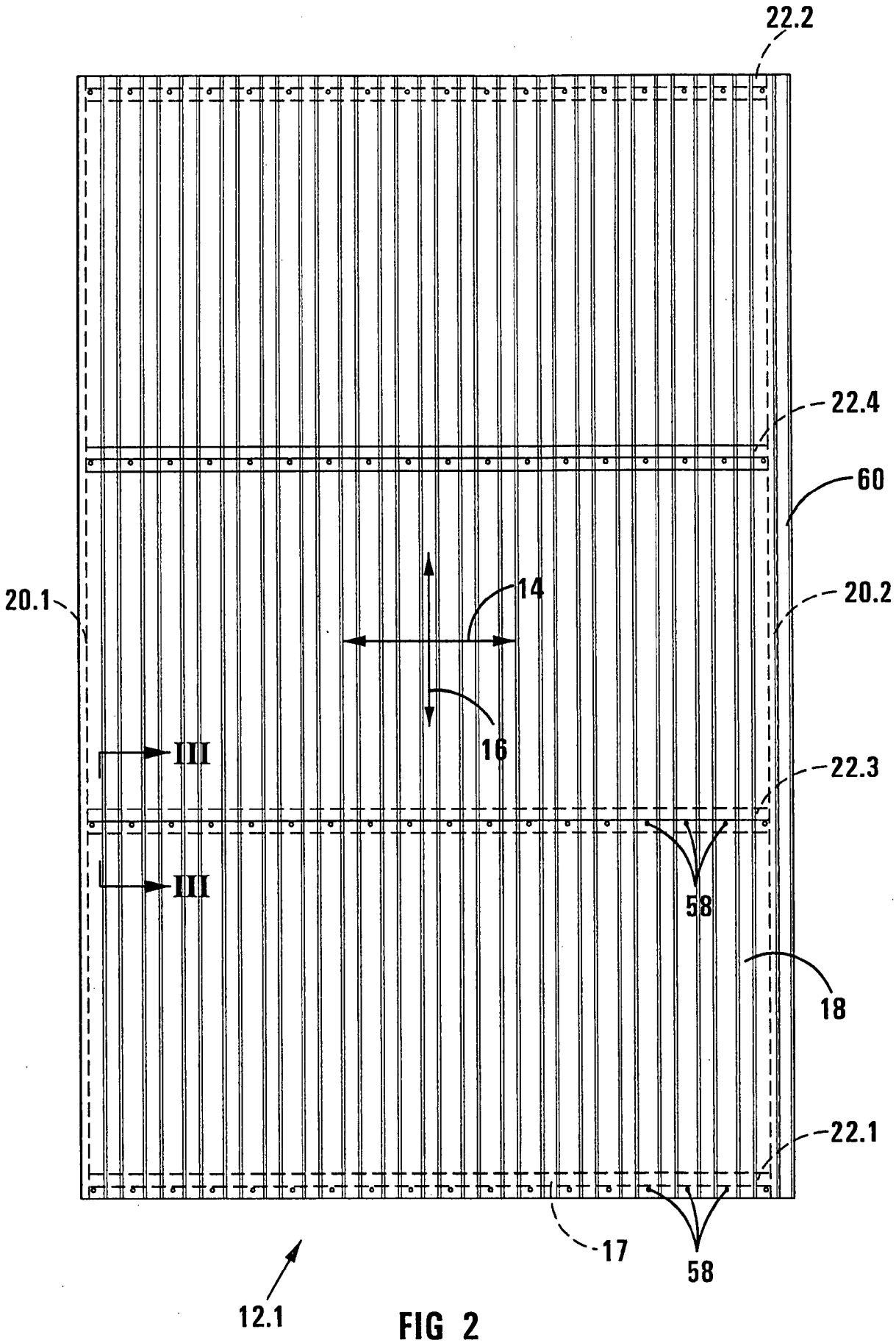

FIG 2

THIS INVENTION relates to a roof structure. It relates, more particularly, to a roof panel and to a roof structure including such a panel.

For the purpose of this specification, the definition of a rectangle is sufficiently broad to include a square.

According to a first aspect of the invention there is provided a roof panel which includes a planar frame including a first pair of opposite, parallel side members and at least one I-configuration composite beam, perpendicular to the side members, in which:

one end of the beam is connected to one of the side members at a position intermediate the length of the side member;

an opposite end of the beam is connected to the other side member at a position intermediate the length of the side member; and

the beam is comprised of two cold formed channel sections secured together back to back and disposed with the webs of the channel sections perpendicular to the plane of the frame.

In a typical operative configuration of the roof panel, the panel spans in a direction perpendicular to the first pair of opposite, parallel side members. In this configuration, a resulting bending moment is resisted by the or each I-configuration composite beam, as the case may be. The Applicant believes that the use of a composite beam comprising two suitably selected cold formed channel sections provides for making the

roof panel lighter than what would have been achievable using commercially available hot formed beams, or cold formed channel sections used spaced apart from each other. This implies a cost saving.

The webs of the respective channel sections of the I-configuration composite beam may be secured to each other. More particularly, the webs may be secured to each other via a plurality of fasteners, e.g. screws or rivets.

The channel sections may be secured to each other via a series of spaced apart welds in between their respective operative top flanges and another such series in between their respective operative bottom flanges, along the length of the channel sections.

The at least one I-configuration composite beam may include two such beams that are spaced apart.

The frame may be rectangular. In this case, the roof panel may include a second pair of opposite, parallel side members, perpendicular to and joined end to end with the first pair. In this case, the second pair of opposite, parallel side members may include at least one I-configuration composite beam, the composite beam being comprised of at least two cold formed channel sections secured together back to back and being disposed with the webs of the channel sections perpendicular to the plane of the frame.

The roof panel may include sheet material cladding secured to the frame to be operatively supported on the frame. The sheet material cladding may comprise profiled sheeting, e.g. IBR or Perspex sheeting, spanning in a direction parallel to the first pair of opposite, parallel side members. The cladding typically will be secured to the frame of the panel via suitable fasteners, e.g. rivets, screws, and the like.

According to a second aspect of the invention there is provided a roof structure including at least two roof panels, in accordance with the first aspect of the invention, that are joined together in a side by side coplanar configuration in which the first pairs of

opposite side members of the panels are disposed in the same direction and in which the panels define a monolithic roof structure.

In a particular embodiment of the roof structure, a side member of a first pair of opposite, parallel side members of a roof panel is joined to a side member of a first pair of opposite, parallel side members of another roof panel by a joint configured for operatively resisting a positive bending moment about an axis extending between the side members along their length. In this embodiment, the side members that are joined together may be two cold formed channel sections, disposed with their webs adjacent to each other. In this case, the joint joining the two channel sections together may include a third cold formed channel section with the outside of its web disposed against and along the operative bottom flanges of the first-mentioned two channel sections, each of these flanges being secured to the web. In this case, each flange may be secured to the web via one of welding and a series of spaced apart fasteners, e.g. screws or rivets, along the length of the channel sections.

The roof structure may be configured to have sufficient bending capacity to, in use, span freely between supports at opposite ends of the structure in the direction perpendicular to the first pairs of opposite, parallel side members. As such, in a typical application of the roof structure, there is no requirement for supporting elements such as purlins, rafters, and roof trusses.

The Applicant submits that the roof panel of the first aspect of the invention is well suited to at least partial manufacture in a factory. Particularly, such a roof panel may be at least substantially completely manufactured in a factory and then transported to an installation site. The use of cold formed channel sections results in a lightweight panel, facilitating transportation. Where more than one roof panel is required for forming a roof structure, such panels may be joined together on site, either before or during installation of the roof structure. Some advantages which may result from factory manufacture as opposed to on site manufacture include lower cost of manufacture, better quality control, minimized on site construction time and labour requirements, etc.

The invention is described below by way of an example of an embodiment of a roof structure, in accordance with the second aspect of the invention, comprising two roof panels, in accordance with the first aspect of the invention, with reference to and as illustrated in the accompanying diagrammatic drawings. In the drawings:

Figure 1 shows a diagrammatic general view of an embodiment of a roof structure, in accordance with the second aspect of the invention, comprising two roof panels, in accordance with the first aspect of the invention;

Figure 2 shows a diagrammatic enlarged general view of one of the roof panels of Figure 1;

Figure 3 shows a diagrammatic section through a composite beam of the roof panel of Figure 2, along the line III-III of Figure 2; and

Figure 4 shows a diagrammatic section through the roof structure of Figure 1, along the line IV-IV of Figure 1.

In Figure 1, an embodiment of a roof structure, in accordance with the second aspect of the invention, is designated generally by the reference numeral 10. The roof structure 10 comprises a first roof panel 12.1 and a second roof panel 12.2, each panel being a roof panel, in accordance with the first aspect of the invention. The roof panels 12.1 and 12.2 are identical and, as such, only the roof panel 12.1 will be described in detail below.

The roof structure 10 is rectangular and defines a first direction 14 and a second direction 16, perpendicular to the first direction. The overall dimensions of the roof structure 10 of this example in the directions 14 and 16 are approximately 4.2 and 3.4m, respectively, but these dimensions clearly are highly variable. The roof structure 10, in use, is typically installed sloping in its second direction 16.

With reference particularly to Figure 2, the roof panel 12.1 is rectangular and comprises a frame 17 and sheeting material cladding, particularly IBR roof sheeting 18, and a

number of fasteners, which will be described below. Another type of cladding, e.g. corrugated Perspex plates, may alternatively be used.

The frame 17 of the panel 12.1 includes:

a first pair of opposite side members in the form of cold formed channel sections 20.1 and 20.2, disposed in the second direction 16;

a second pair of opposite side members in the form of I-configuration composite beams 22.1 and 22.2, disposed in the first direction 14; and

two intermediate I-configuration composite beams 22.3 and 22.4 extending between the channel sections 20.1 and 20.2.

In this example, the entire frame 17 is made of galvanized cold formed steel channel sections. The frame 17 may be conveniently manufactured in a factory.

The beams 22.1 and 22.2 and the channel sections 20.1 and 20.2 are joined together end to end and each end of each of the beams 22.3 and 22.4 is joined to the proximate one of the channel sections 20.1 and 20.2 at a position intermediate the ends of the channel section. Such joining may be done via any suitable securing means, e.g. at least one of welding and fasteners such as screws and rivets. Insofar as such securing may be conventional, it will not be elaborated on herein.

The composite beams 22 are all identical and only one of them will thus now be described, with reference to Figure 3.

With reference to Figure 3, the composite beam 22.3 is formed of two cold formed steel channel sections 26.1 and 26.2, each including a web 28, an operative top flange 30, an operative bottom flange 32, and two lips 34 as shown. The depth of each channel section 26.1 and 26.2, in the view shown, is approximately 70mm and its width approximately 35mm. It is made of steel plate with a thickness of between approximately 0.5 and 0.8mm.

The channel sections 26.1 and 26.2 have been secured back to back with the webs 28 adjacent to each other. Due to the configuration of the webs 28, a gap 36 of approximately 4mm is defined between the webs 28 along the major, particularly a central, portion of their heights. A 4mm spacer 37, e.g. one made of a material known as NUTEC, has been sandwiched between the webs 28, it having been placed against one of the webs 28 before placing the channel sections 26.1 and 26.2 back to back. The spacer 37 extends along the entire length of the beam 22.3. The webs 28 have been secured to each other via a series of pairs of screws 38 at a spacing of, say, 150mm along the entire length of the beam 22.3, each screw extending through the webs 28 and the spacer 37. As such, the beam 22.3 is composite and has a bending capacity about a central horizontal axis of the beam, in the section shown, significantly exceeding the sum of the bending capacities of the channel sections 26.1 and 26.2 about corresponding axes prior to joining them.

As an alternative to the screws 38, suitable rivets (not shown) may be used.

As an alternative to or in addition to securing the channel sections 26.1 and 26.2 to each other via the screws 38 or rivets, they may be secured to each other via a series of spaced apart welds 39.1 (shown in broken line) in between the operative top flanges of the respective channel sections and another such series 39.2 in between their operative bottom flanges, along the length of the channel sections.

In Figure 4, certain components of the roof panels 12.1 and 12.2 of Figure 1 are shown. As these roof panels are identical, certain features of the panel 12.2 are designated here by the same reference numerals as the corresponding features of the panel 12.1, as shown in Figure 2 and described above.

Each of the cold formed channel sections 20.1 and 20.2 includes a web 40, an operative top flange 42, and an operative bottom flange 44. The webs 40 are secured to each other via a series of pairs of screws 46 at, say, 150mm spacing along the entire length of the channel sections 20.1 and 20.2.

In order to permit the roof structure of Figure 1 to span freely between supports at its opposite ends in the direction 14, it is clearly required that the connection or joint defined between the panels 12.1 and 12.2 is capable of withstanding a significant positive bending moment about an axis coinciding in this drawing with the line of the arrow showing the direction 16. Primarily for this reason, a cold formed channel section 48, identical to the channel sections 26.1 and 26.2 of Figure 3, has been secured to the channel sections 20.1 and 20.2. The channel section 48 includes a web 50 and two opposite flanges 52. The outside of the web 50 has been placed against the operative bottoms of the flanges 44 of the channel sections 20.1 and 20.2 and the flanges have been secured to the web via a series of screws 54 at, say, 150mm spacing along the entire length of the channel sections 20.1, 20.2, and 48. These channel sections thus are joined together to define a composite beam 56 (see Figure 1 also). The composite beam 56 will have significant bending capacity about a central horizontal axis of the beam, in the section shown, permitting it to span freely between supports at its ends in applications where required.

Figure 4 also shows how the IBR roof sheeting 18 is secured to the beams 22.3 via screws 58 (see Figure 2 also). The arrangement of these screws 58 is clear from Figure 2. The IBR sheeting 18 of each of the panels 12.1 and 12.2 has, for the sake of this example, been secured to the frame 17 of the panel in the factory in which the frame had been made. The IBR sheeting 18 of the panel 12.1 defines an overhang 60 (see Figure 2 also) which has been secured to the IBR sheeting 18 of the panel 12.2 via a series of screws 62 (see Figure 1 also) at, say, 300mm spacing along the length of the beam 56. Such securing enhances the strength of the joint defined between the panels 12.1 and 12.2.

As an alternative to the IBR roof sheeting 18, another form of sheet material cladding suitable for roofing applications may be used. Another type of fastener, e.g. rivets, may be used as an alternative to the screws 58 or 62 or both.

As was alluded to above, the Applicant envisages that the roof structure 10 of the example, dimensioned as described above, will be capable of spanning freely between supports at its opposite ends in the first direction 14. Each beam 22 will effectively support itself and a band of the IBR cladding 18 by resisting a bending moment induced in the beam and must also have capacity to resist the effect of an additional prescribed design load on the roof, e.g. at least one of a live load and a snow load. As such, in a typical application of the roof structure 10, there is no requirement for supporting elements such as purlins, rafters, and roof trusses.

As was also alluded to above, each roof panel 12.1 and 12.2 may be completely manufactured in a factory and then transported to an installation site. The Applicant envisages that, due to the use of cold formed channel sections to form the frames of the roof panels, the roof panels, suitably sized, may be sufficiently light to be safely loaded, offloaded, and carried by workmen.

The panel 12.1 may serve as a roof structure by itself. Alternatively, panels such as the panel 12.1 may be used to build a roof structure of almost unlimited size, provided it is suitably supported. In this case, on site construction time and labour requirements may be minimized by making the roof panels in a factory.

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CLAIMS

1. A roof panel which includes a planar frame including a first pair of opposite, parallel side members and at least one I-configuration composite beam, perpendicular to the side members, in which:

one end of the beam is connected to one of the side members at a position intermediate the length of the side member;

an opposite end of the beam is connected to the other side member at a position intermediate the length of the side member; and

the beam is comprised of two cold formed channel sections secured together back to back and disposed with the webs of the channel sections perpendicular to the plane of the frame.

2. A roof panel as claimed in claim 1, in which the webs of the respective channel sections are secured to each other.

3. A roof panel as claimed in claim 2, in which the webs are secured to each other via a plurality of fasteners, e.g. screws or rivets.

4. A roof panel as claimed in any preceding claim, in which the channel sections are secured to each other via a series of spaced apart welds in between their respective operative top flanges and another such series in between their respective operative bottom flanges, along the length of the channel sections.

5. A roof panel as claimed in any preceding claim, in which the at least one I-configuration composite beam includes two such beams that are spaced apart.

6. A roof panel as claimed in any preceding claim, in which the frame is rectangular.

7. A roof panel as claimed in claim 6, which includes a second pair of opposite, parallel side members, perpendicular to and joined end to end with the first pair.

8. A roof panel as claimed in claim 7, in which the second pair of opposite, parallel side members includes at least one I-configuration composite beam, the composite beam being comprised of at least two cold formed channel sections secured together back to back and being disposed with the webs of the channel sections perpendicular to the plane of the frame.

9. A roof panel as claimed in any preceding claim, which includes sheet material cladding secured to the frame to be operatively supported on the frame.

10. A roof panel as claimed in claim 9, in which the sheet material cladding comprises profiled sheeting spanning in a direction parallel to the first pair of opposite, parallel side members.

11. A roof structure including at least two roof panels, as claimed in any preceding claim, that are joined together in a side by side coplanar configuration in which the first pairs of opposite side members of the panels are disposed in the same direction and in which the panels define a monolithic roof structure.

12. A roof structure as claimed in claim 11, in which a side member of a first pair of opposite, parallel side members of a roof panel is joined to a side member of a first pair of opposite, parallel side members of another roof panel by a joint configured for operatively resisting a positive bending moment about an axis extending between the side members along their length.

13. A roof structure as claimed in claim 12, in which the side members that are joined together are two cold formed channel sections, disposed with their webs adjacent to each other.

14. A roof structure as claimed in claim 13, in which the joint joining the two channel sections together includes a third cold formed channel section with the outside of its web disposed against and along the operative bottom flanges of the first-mentioned two channel sections, each of these flanges being secured to the web.

15. A roof structure as claimed in claim 14, in which each flange is secured to the web via one of welding and a series of spaced apart fasteners, e.g. screws or rivets, along the length of the channel sections.

16. A roof structure as claimed in any one of claims 11 to 15, which is configured to have sufficient bending capacity to, in use, span freely between supports at opposite ends of the structure in the direction perpendicular to the first pairs of opposite, parallel side members.

17. A roof panel as claimed in any one of claims 1 to 10, substantially as herein described with reference to and as illustrated in the drawings.

18. A roof structure as claimed in any one of claims 11 to 16, substantially as herein described with reference to and as illustrated in the drawings.

DATED THIS 15th DAY OF FEBRUARY 2008

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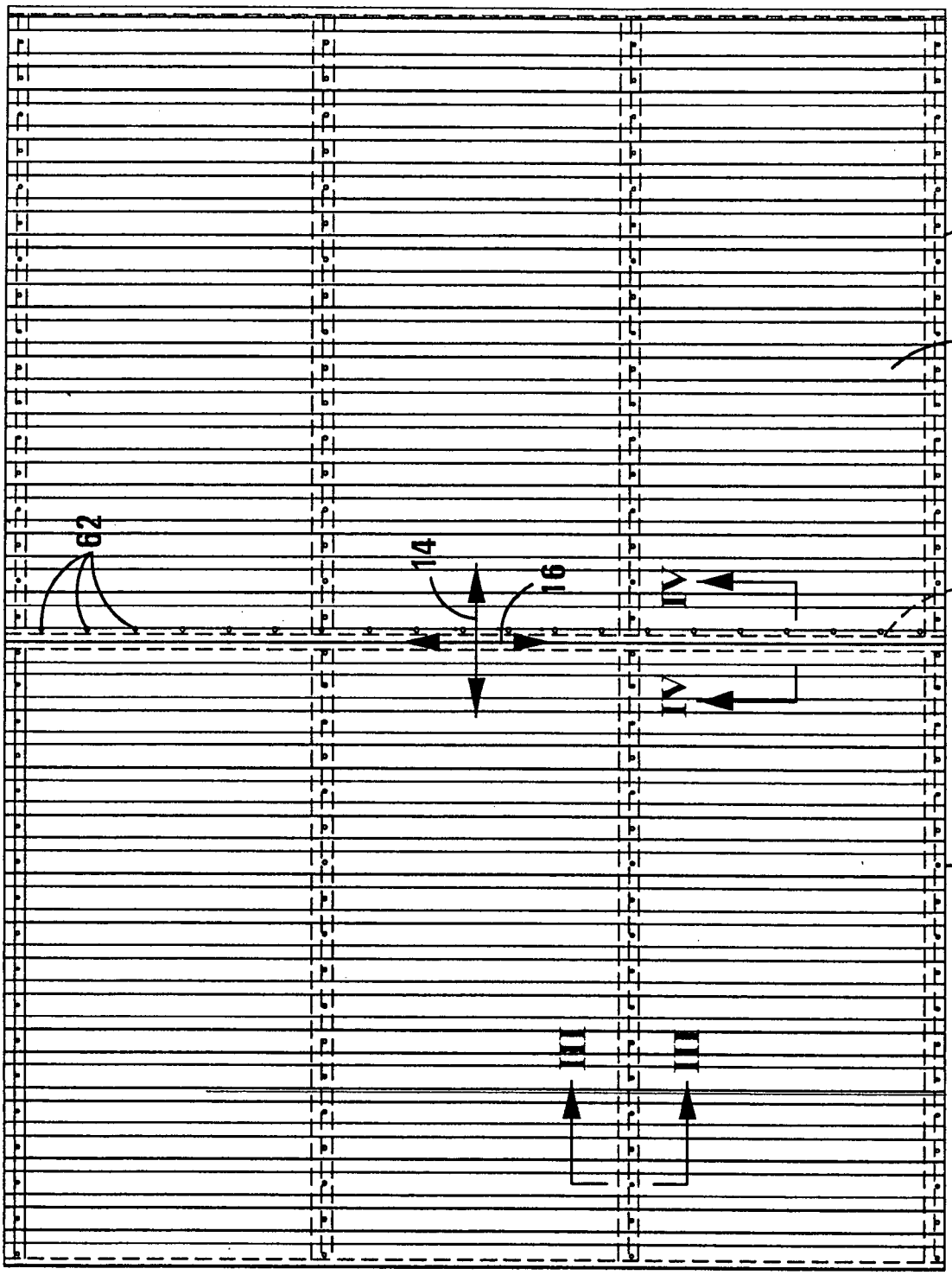

FIG 1

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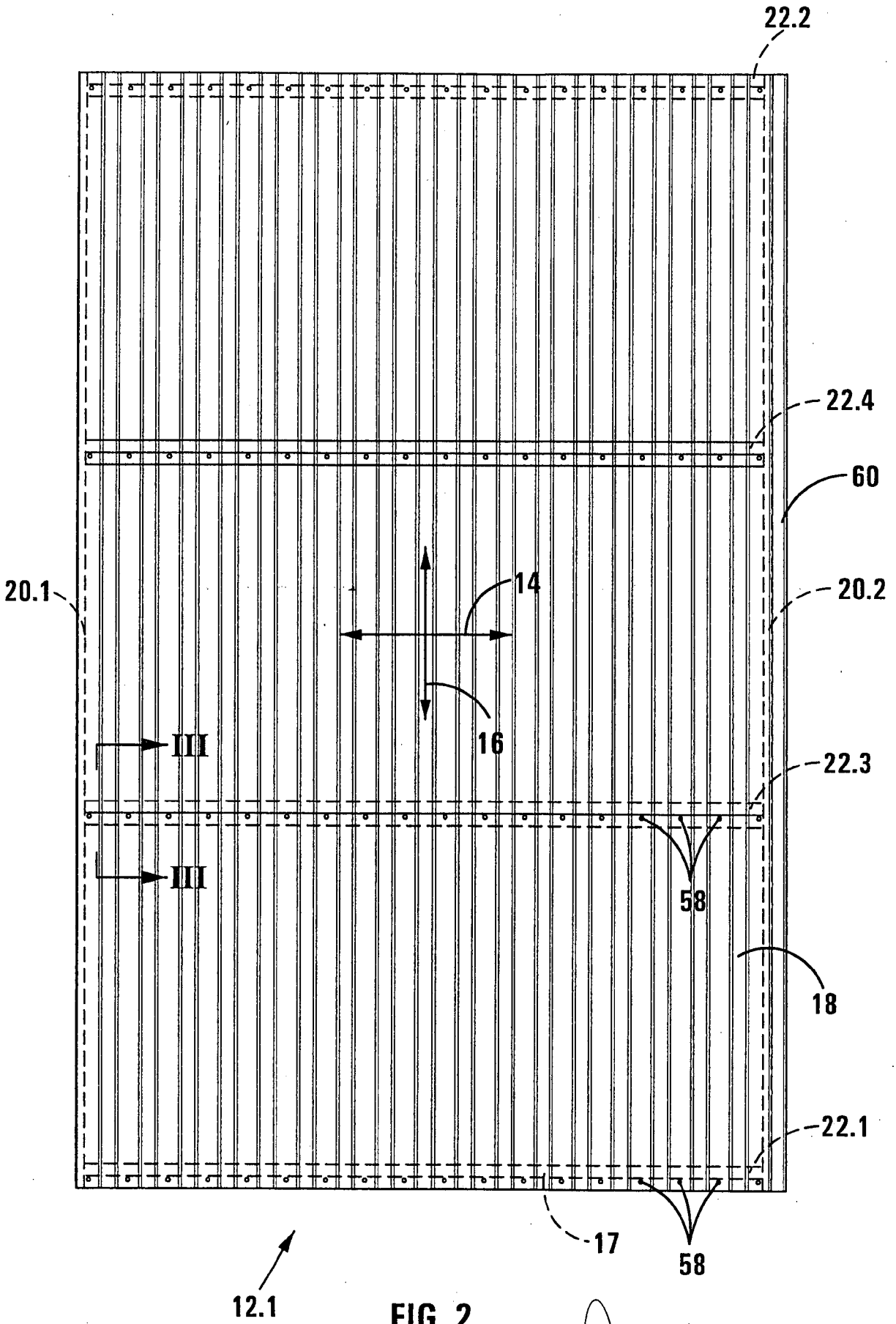

FIG 2

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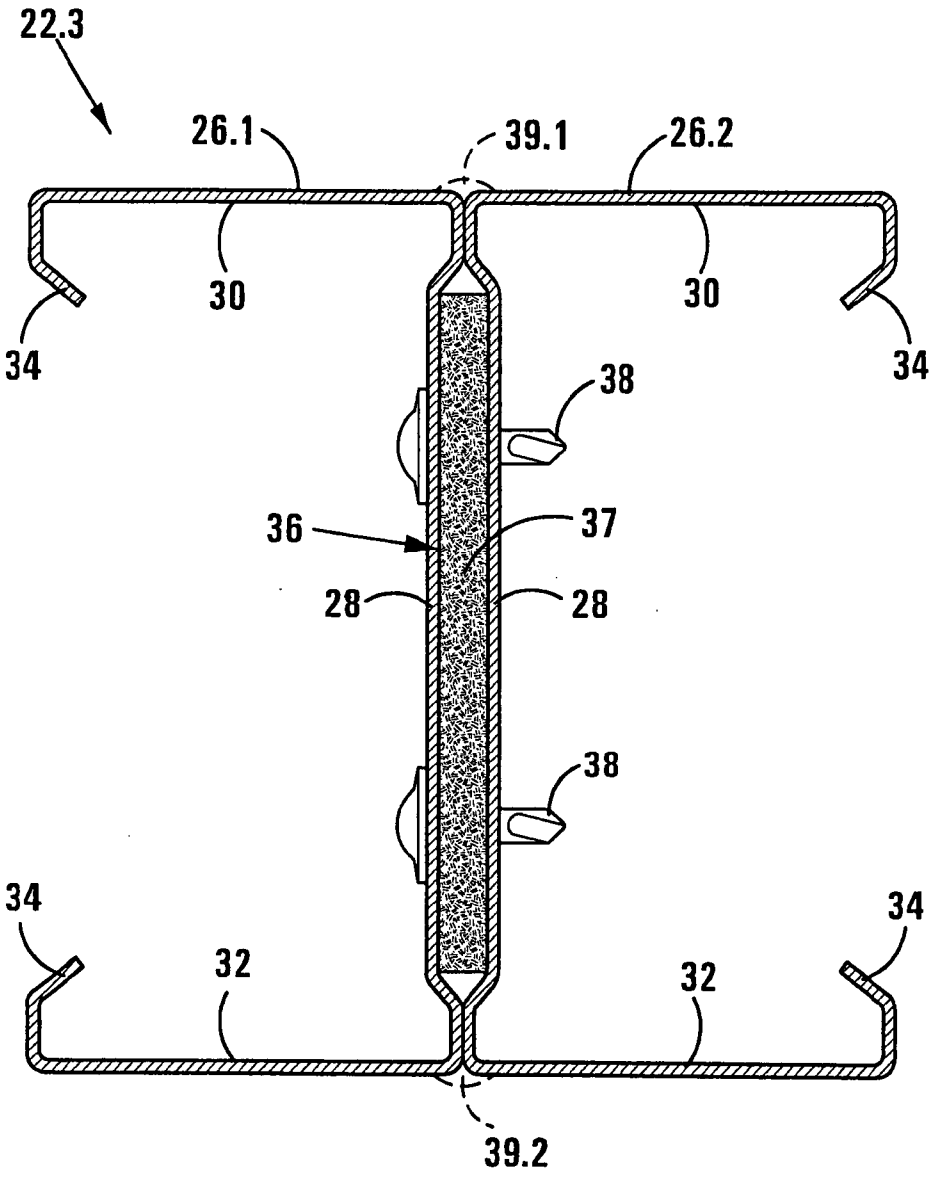

FIG. 3

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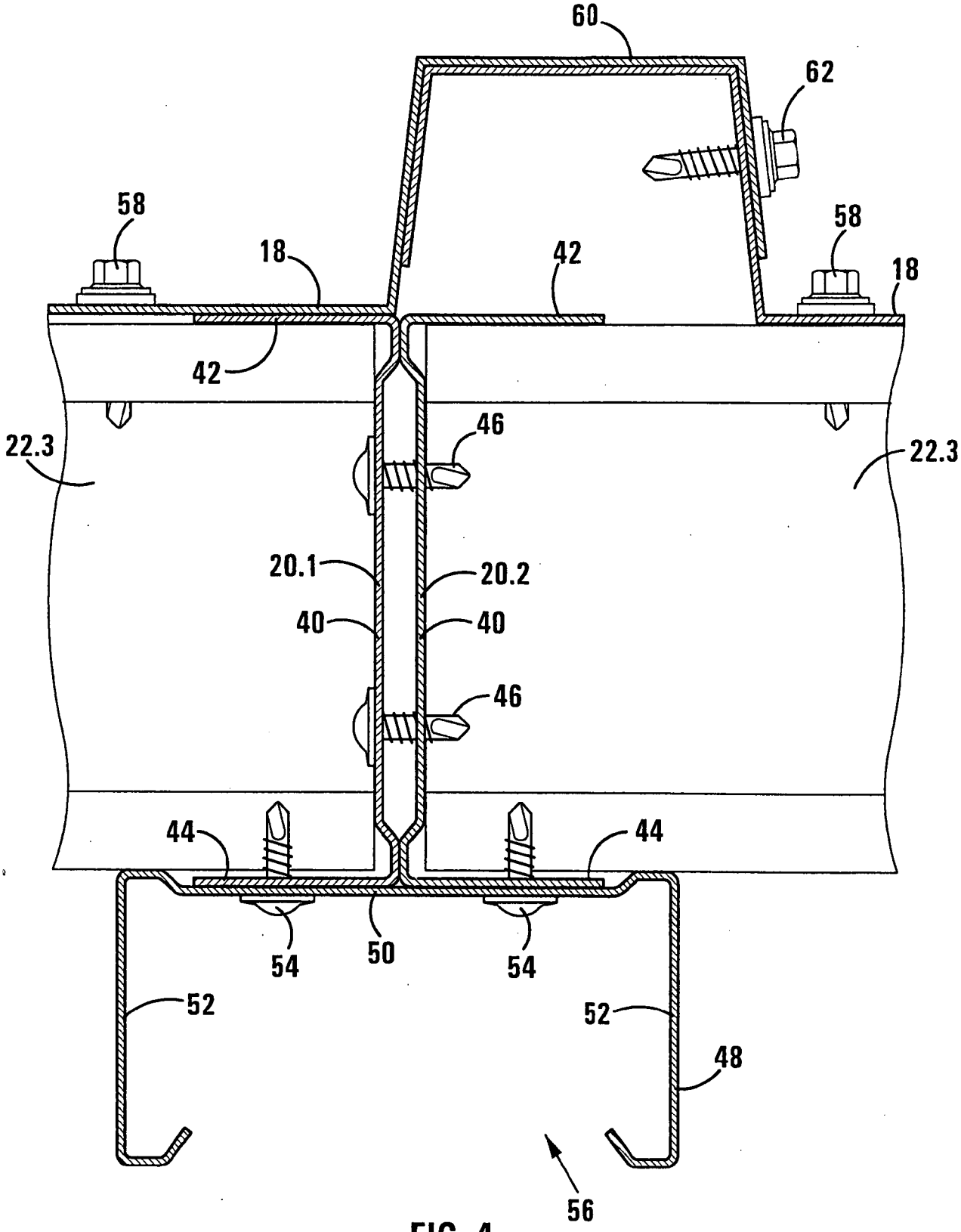

FIG. 4

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