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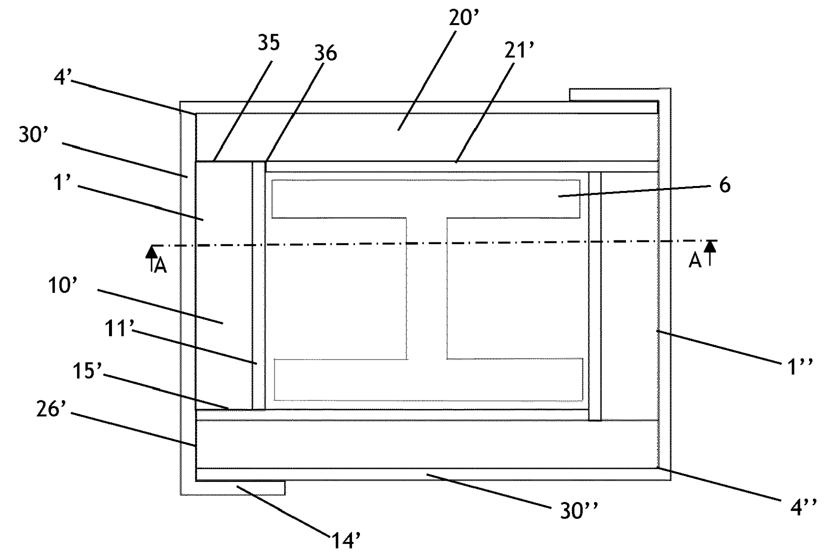
(54) INSULATING PANEL

(57) A foldable insulating panel comprises: a continuous, exterior metal sheet; a first band of mineral wool insulation secured at its external major surface to the exterior metal sheet, the first band of mineral wool insulation extending along a length of the insulating panel and having a first interior metal sheet secured to its interior major surface; and a second band of mineral wool insulation secured at its external major surface to the exterior metal sheet, the second band of mineral wool insulation extending along a length of the insulating panel and having a second interior metal sheet secured to its interior major surface. The second band of mineral wool insulation is spaced from the first band of mineral wool insulation by a first folding gap arranged along a first folding axis of the insulating panel so that the insulating panel can be folded along the first folding axis to a folded configuration, folding of the insulating panel causing closure of the first folding gap such that, in its folded configuration, the first and second bands of mineral wool insulation form an abutting contact across a position previously occupied by the first folding gap with the exterior metal sheet providing an exterior surface of the folded insulating panel.

Fig 4



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Description

[0001] This invention relates to an insulating panel, notably an insulating panel adapted to be arranged or folded around a building structure, particularly a structural metal building beam.

[0002] Thermal and/or fire insulation is often provided for a structural beam of a building, notably a structural metal beam, by securing a single planar insulating panel of mineral wool fibres to each surface of the metal beam or by securing a box shaped mineral wool insulating structure around the periphery of the metal beam. Whilst this provides useful thermal insulation and fire protection, attaching a single panel to each surface of the metal beam is time-consuming and the simple abutment of adjacent panels can result in thermal gaps which represent a point of weakness in the insulation system. A preformed, box shaped mineral wool insulating structure may be used to decrease the number of thermal gaps but is inconvenient to transport.

[0003] One aim of the present invention is to provide an insulating panel which can be arranged around a building structure, for example around a beam or strut of a building, to provide enhanced fire resistance, which facilitates transport, reduces installation time and can preferably be installed by a single worker with few tools. Some preferred embodiments additionally provide enhanced acoustic performance, notably enhanced sound absorption.

[0004] In accordance with one of its aspects, the present invention provides an insulating panel as defined in claim 1. Additional aspects of the invention are defined in independent claims. The dependent claims define preferred and/or alternative embodiments.

[0005] The present invention provides an insulating panel which can be manufactured and transported on site as a flat-pack insulating panel or a pre-folded insulating panel and subsequently folded on site to a folded configuration by the user when installing the insulating panel around the building structure. When installed around a building structure in the insulating panel's folded configuration, the first and second bands of mineral wool insulation are configured to be arranged at or around adjacent surfaces of the building structure, notably at substantially 90° to each other. As used herein, the term "flat-pack panel" is used to indicate an insulating panel whose bands of mineral wool insulation are entirely co-planar or substantially co-planar, for example, each band of mineral wool insulation of the flat-pack insulating panel is preferably co-planar (i.e. in a planar configuration) and, if not perfectly coplanar lies in a plane which intersects the planes of its adjacent bands of mineral wool insulation of the insulating panel at an angle which is within $\pm$ 15°, preferably within $\pm$ 10° and more preferably within $\pm$ 5° of being perfectly coplanar. The term "folded configuration" is used for an insulating panel to indicate a configuration in which the external metal sheet of the insulating panel has been folded around the folding axis or folding axes so each band of mineral wool insulation lies in a plane which intersects the planes of its adjacent bands of mineral wool insulation, the folded configuration being a configuration in which the insulating panel is intended to remain after installation at the building structure to provide fire insulation during an extended period of ordinary use of the building. The term "pre-folded" insulating panel is used for an insulating panel to indicate a configuration in which the external metal sheet of the insulating panel has been folded around the folding axis or folding axes so each band of mineral wool insulation lies in a plane which intersects the planes of its adjacent bands of mineral wool insulation but in which the external metal sheet must be further folded around the folding axis or folding axes to achieve the folded configuration.

In preferred embodiments, in the folded configuration of the insulating panel, each band of mineral wool insulation of the insulating panel lies in a plane which intersects the planes of its adjacent bands of mineral wool insulation of the insulating panel at an angle of 90°, or substantially 90° notably an angle which is $\geq$ 85° and $\leq$ 95; this facilitates providing a square or rectangular box-shaped structure around the beam. The insulating panel is preferably provided as a flat-pack insulation panel; this provides insulating panels which can easily be stacked for transport and handling and which can nevertheless be easily be folded, notably at a building site, to a desired folded configuration. If provided in a pre-folded configuration, each band of mineral wool insulation of the insulating panel preferably lies in a plane which intersects the planes of its adjacent bands of mineral wool insulation of the insulating panel at an angle which is $\geq$ 120°, preferably $\geq$ 135°, more preferably $\geq$ 150° and which is $\leq$ 178°, preferably $\leq$ 175° and more preferably $\leq$ 170°;.

[0006] In the present disclosure, when referring to the first, second, the optional third and the optional fourth band(s) of mineral wool insulation, the bands of mineral wool insulation are referred to in positional order, i.e. the second band is located between the first and the third bands. The term "the last band of mineral wool insulation" is used herein to indicate the exterior band of mineral wool at the opposite transverse edge of the insulating panel to the first band of mineral wool, for example, the second band of mineral wool insulation of an insulating panel having two (and only two) bands of mineral wool insulation, the third band of mineral wool insulation of an insulating panel having three (and only three) bands of mineral wool insulation, and so on.

[0007] The building structure around which the foldable insulating panel is to be arranged may be a metal structural support of a building, for example a beam, strut or pillar. As used herein, unless otherwise clear in the context, the term "beam" is used to denote any elongate building member, notably any elongate metal building member. For example, the beam may be a beam capable of withstanding loads primarily by resisting against bending, for example a substantially horizontal beam, or a column, notably a column resisting compressive axial or eccentric load, for example a substantially vertical column, or a strut. The beam will typically be an I beam, i.e. a beam with an I shaped cross section. Alternatively, the beam may be a hollow section beam, for example a hollow section beam having a square cross section. The beam extends along its length in its elongate direction along an elongate axis; as used herein, the term "length" in relate to the beam denotes the elongate direction of the beam and the terms "length" or "axle direction" in relation to the insulating panel (or parts of the insulating panel) denotes the dimension and/or direction which, in use, will correspond to (i.e. be generally parallel with) the length and elongate axis of the beam. The term "transverse direction", "transversely" or "width" in relation to an insulating panel is used to denote a direction and/or dimension perpendicular to its length. The terms "top" and "bottom" in relation the insulating panel and its constituent parts, for example top edge or bottom edge, are used herein to indicate relative positions along the axle direction of the insulating panel.

[0008] The entire periphery of the beam along the length of the beam may be exposed, for example where the beam is spaced from the walls, floors and ceilings of the building. For example, a vertical beam, for example a vertical I beam, arranged in the middle of an open space within a building between a floor and a ceiling will have its entire periphery exposed along its length from the floor to the ceiling. Where the entire periphery along the length of the beam is exposed, the beam is preferably insulated by using a plurality of pairs of two foldable insulating panels, each such pair of insulating panels being arranged at a position along the length of the beam so as to encircle the entire exposed periphery of the beam, with adjacent, abutting pairs of insulating panels being arranged along the length of the beam. In this way, each pair of insulating panels provides insulation around the entire periphery of the beam at one position along the length of the beam, and the abutting pairs of insulating panels arranged along the length of the beam together provide insulation along the entire length of the beam.

Notably in such an arrangement, each such foldable insulating panel preferably has two (and only two) bands of mineral wool insulation, and two such insulating panels are secured together to form a pair which surrounds the entire periphery the beam.

[0009] Alternatively, the beam may extent along and adjacent to a wall, a floor or a ceiling of the building; particularly in this case, for example if the beam runs along a wall or ceiling, only a portion of the periphery of the beam along the length of the beam may be exposed (with a non-exposed portion of the periphery of the beam abutting a wall, a ceiling or another part of the building). In this case, one or more insulating panels may be arranged to encase the exposed portions of the periphery of the beam. Where only a portion of the periphery along the length of the beam is exposed, the beam is preferably insulated using one or more foldable insulating panel having three bands, each such insulating panel being arranged at a position along the length of the beam to insulate the entire exposed portion of the periphery of the beam, with adjacent panels along the length of the beam abutting so that together the adjacent panels insulate the entire length of the beam. Thus, in a preferred embodiment for arrangement around a beam having only a portion of its periphery along its length exposed, the foldable insulating panel further comprises a third band which is secured at its external major surface to the exterior metal sheet of the insulating panel; the third band of mineral wool insulation extends along a length of the insulating panel and has a third interior metal sheet secured to its interior major surface; the third band of mineral wool insulation is spaced from the second band of mineral wool insulation by a second folding gap which is arranged along a second folding axis of the insulating panel. Such an insulating panel is intended to be folded along the second folding axis to a folded configuration such that, folding of the insulating panel causes closure of the second folding gap such that, in its folded configuration, the second and third bands of mineral wool insulation form an abutting contact across a position previously occupied by the second folding gap with the exterior metal sheet providing an exterior surface of the folded insulating panel.

[0010] A beam whose entire periphery is exposed along its length may be insulated using a foldable insulating panel having four (and only four) bands. In such an embodiment , the foldable insulating panel comprises, in addition to the third band as described above, a fourth band of mineral wool insulation which is secured at its external major surface to the exterior metal sheet of the insulating panel; the fourth band of mineral wool insulation extends along a length of the insulating panel and has a fourth interior metal sheet secured to its interior major surface; the fourth band of mineral wool insulation is spaced from the third band of mineral wool insulation by a third folding gap arranged along a third folding axis of the insulating panel. Such an insulating panel is intended to be folded along the third folding axis to a folded configuration such that, folding of the insulating panel causes closure of the third folding gap such that, in its folded configuration, the third and fourth bands of mineral wool insulation form an abutting contact across a position previously occupied by the third folding gap with the exterior metal sheet providing an exterior surface of the folded insulating panel. Nevertheless, it is preferred to use a pair of insulating panels having two (and only two) bands to insulate such a beam.

[0011] Particularly when the foldable insulating panel comprises only two or only four bands, the continuous exterior metal sheet preferably extends transversely beyond the first band, to form a tongue, notably a foldable tongue. The tongue may project by a distance which is $\geq$ 5 mm and/or $\leq$ 100 mm, notably $\geq$ 10 mm and/or $\leq$ 50 mm. The tongue is intended to be used to overlap and to be secured to the exterior metal sheet at an adjacent band of mineral wool with which the first band of mineral wool abuts when arranged around the periphery of the beam. Notably in such a configuration, the last band of mineral wool insulation of the insulating panel preferably has its exterior edge at a transverse side in the same position as, i.e. aligned with, its associated transverse edge of the exterior metal sheet. This facilitates arranging the tongue which projects transversely beyond the first band of mineral wool insulation over the exterior metal sheet at the transverse edge of an abutting last band of mineral wool, for example: i) over the exterior metal sheet at the transverse edge of the second band of mineral wool of another insulating panel of a pair of insulating panels which each have two (and only two) bands of mineral wool insulation; or ii) over the exterior metal sheet at the side edge of the fourth band of mineral wool insulation when the insulating panel has four (and only four) bands of mineral wool insulation. Such a transverse overlap of the exterior metal sheet, either with the exterior metal sheet of another insulating panel or with the exterior metal sheet of the same insulating panel, is particularly helpful in avoiding or reducing thermal weaknesses in the insulating structure. The tongue may be secured to the exterior metal sheet of an adjacent band over which it has been overlaid by fasteners, e.g. screws and/or by an adhesive. Notably where such a tongue is not provided, a separate joining plate, for example in the form of a strip or L-section corner piece, may be secured to the external metal sheet at each of the first and last bands of mineral wool to form a cover and/or joint over the abutment between the first and last bands of mineral wool; such a joining plate may likewise be secured to the exterior metal sheets of each adjacent band over which it has been overlaid by fasteners, e.g. screws and/or by an adhesive.

[0012] Particularly where the foldable insulating panel has three (and only three) bands, the external metal sheet may extend transversely beyond one or each of the first and last bands to provide a tongue, notably a foldable tongue; such a tongue may be adapted to be secured to a surface of the building. Nevertheless, it is preferred for a foldable insulating panel that has three (and only three) bands of mineral wool for the first and last (i.e. third) bands of mineral wool insulation of the insulating panel to have their respective exterior edges at their respective transverse sides in the same position as, i.e. aligned with, their respective transverse edge of the exterior metal sheet and for the insulating panel to be secured to the building, e.g. to a floor, wall or ceiling by a joining plate, for example in the form of a L-section strip, secured to the external metal sheet and to the building by fasteners, e.g. screws and/or by an adhesive. Such a configuration of insulating panel is particularly suited for use to insulate a building beam which runs adjacent to a planar surface of a building, for example a wall or ceiling. In some other circumstances a building beam is arranged in a corner of a building, for example in a corner between two walls or a corner between a wall and a ceiling. In such a case, a building beam arranged in a corner may be advantageously insulated using a foldable insulating panel which has two (and only two) bands of mineral wool insulation; an insulating panel particularly suitable for such use preferably has each of its first and last (i.e. second) bands of mineral wool insulation of the insulating panel having their respective exterior edges at their respective transverse sides in the same position as, i.e. aligned with, their respective transverse edge of the exterior metal sheet. This facilitates securing the insulating panel in the corner of the building using a joining plate, for example in the form of a L-section strip, secured to the external metal sheet and to the building by fasteners, e.g. screws and/or by an adhesive, one such securing plate being used at each transverse edge of the insulating panel. Alternatively, the external metal sheet may extend transversely beyond one or each of the first and last bands to provide a tongue, notably a foldable tongue adapted to be secured to a surface of the building.

[0013] The major surfaces of each band of mineral wool insulation is preferably rectangular. In preferred embodiments, the major surface of each band of mineral wool insulation has a length which is slightly less than the length of the exterior metal sheet. Preferably, the top edge of the exterior metal sheet projects slightly beyond the top edge of the band of mineral wool insulation in a lengthwise direction and/or the bottom edge of the exterior metal sheet projects slightly beyond the bottom edge of the band of mineral wool insulation in a lengthwise direction. This facilitates abutment of the mineral wool bands of adjacent insulating panels arranged along the length of a beam.

[0014] In order to facilitate the folding of the foldable insulating panel, particularly manual folding at its site of installation, a folding weakness is preferably provided, notably at the continuous exterior metal sheet, the folding weakness defining the position of a folding axis and a position at which the exterior metal sheet will preferentially fold. Preferably, a folding weakness is provided at the continuous exterior metal sheet for each folding axis of the insulating panel. Such a folding weakness facilitates the folding of the insulating panel along the folding axis, notably by the user on site, without requiring tools. Preferably, the folding weakness is provided by scoring the exterior metal sheet and/or providing a groove or cut in the surface layer of the exterior metal sheet; such a folding weakness is preferably provided in the surface layer of the exterior metal sheet at which the mineral wool is or will be secured; in this way folding of the insulating panel will tend to close as opposed to open such a folding weakness. The scoring, cutting or providing a groove in the exterior metal sheet may be performed when the exterior metal sheet is in a planar configuration, without bending of the exterior metal sheet. This facilitates manufacture. The bands of mineral wool are preferably secured to the exterior metal sheet after provision of the folding weakness(es). Alternatively, the folding weakness may be provided by bending the exterior metal sheet of the insulating panel along each folding axis to provide the insulating panel in a pre-folded configuration. Such pre-folding of the exterior metal sheet is preferably carried out during manufacture of the insulating panel, preferably using a bending machine, notably a hydraulic or pneumatic bending machine.

[0015] Preferably, after being provided with the folding weakness, the flat-pack insulating panel is subsequently transported to the site at which it will be installed (for example to insulate a beam), preferably packaged as part of a stack of flat-pack insulating panels; at the installation site, the flat-pack insulating panel can then be folded, preferably manually folded, to its folded configuration during its installation.

[0016] The folding weakness preferably extends along the entire length of the folding axis; this facilitates folding of the insulating panel from its flat-pack configuration to its folded configuration.

[0017] The folding weakness may comprise a folding weakness formation in the form of a groove or a cut or another form of folding weakness formation provided at the top and bottom edges of the insulating panel. This facilitates the desired folding of the insulating panel at the top and bottom edges of the insulating panel. For example, the exterior metal sheet may comprise a border, perpendicular to the folding axes, for example a portion of the exterior metal sheet which is folded over itself to provide a folded edge. A portion of the fold may be provided with a recess, said recess providing a folding weakness formation of the exterior metal sheet.

[0018] Preferably the same sheet material is used for the continuous exterior metal sheet and the interior metal sheet of each band; this facilities logistics and manufacture. The metal sheet(s) are preferably steel though use of aluminium is possible. Preferably, each metal sheet provides a continuous surface which is free from perforations. Nevertheless, notably where it is desired to improve acoustic performance, the exterior metal sheet may be provided with a pattern of perforations, preferably extending substantially over its entire surface; such perforations allow enhanced sound absorption which is desired in some preferred embodiments.

[0019] The sheet material of the exterior metal sheet and/or the interior metal sheet(s), notably when of steel, may have a thickness which is ≥ 0.3 and/or ≤ 2mm, and preferably is ≥ 0.35 and/or ≤ 1 mm.

[0020] The exterior metal sheet and each interior metal sheet is preferably secured to the mineral wool insulation by an adhesive, notably an adhesive selected from: a polymer adhesive, a non-combustible adhesive, waterglass. In a preferred embodiment, each metal sheet is secured to the mineral wool insulation by a polymer adhesive, preferably a PU adhesive.

[0021] For any band of mineral wool insulation, the interior metal sheet which is secured to the interior major surface of the band of mineral wool insulation may cover substantially the entire interior major surface. Alternatively, the interior metal band may cover only a portion of the interior major surface, particularly a portion spaced from the folding gap so to provide an exposed strip of the band of mineral wool insulation, notably an exposed strip running adjacent to the folding gap. In some preferred configurations, notably where the folding gap between adjacent bands of mineral wool has a square or rectangular cross section, one band of mineral wool insulation of an adjacent pair of bands of mineral wool insulation may have its interior metal sheet covering its entire interior major surface with the other band of mineral wool insulation having its interior metal band coving only a portion of its interior major spaced from the folding gap so to provide an exposed strip of the band of mineral wool insulation. Such a configuration may be used to facilitate folding of the insulating panel into its folded configuration whilst also allowing abutment of the adjacent interior metal sheets in the folded configuration. In preferred embodiments of the invention, the interior metal sheets are provided on the major interior surfaces of the bands of mineral wool such that, in the folded configuration of the insulating panel, each interior metal sheet forms an abutting contact with its adjacent interior metal sheet(s). This facilitates installation on site, facilitates fabrication tolerances and provides good performance.

[0022] Preferably, the folding gap(s) are provided by a separation between adjacent bands of mineral wool insulation. Preferably, the separation provides a square or rectangular cross-sectioned folding gap but it may provide a triangular cross-sectioned folding gap or other forms of cross-section for the folding gaps. The cross-section for the folding gap(s) facilitates folding of the foldable insulating panel from its flat-pack or pre-folded configuration to its folded configuration. In preferred embodiments, the folding gap is arranged such that, in the folded configuration of the insulating panel, adjacent bands of mineral wool insulation contact each other with no or substantially no gap between them. Generally, each band of mineral wool insulation will have the same thickness; particularly in this case, when the separation of each folding gap is provided as a square cross-sectioned folding gap, the separation between the adjacent bands of mineral wool insulation across the folding separation is preferably equal to the thickness of the bands of mineral wool insulation material; this facilitates abutment of adjacent bands of mineral wool insulation in the folded configuration of the insulating panel.

[0023] Where a series of insulating panels are arranged along the length of a building structure, for example along the length of a beam, the insulating panel positioned in direct contact with the building, for example in contact with a floor, wall or ceiling, may be designed differently to the other insulating panels, notably in a way that enables fast replacement. This is notably due to the potential mechanical damage from vehicles or fork-lifts. Such an insulating panel may also comprise a reinforcement portion adapted to resist mechanical damage. The insulating panel positioned in direct contact with the building may be secured to the building, e.g. to a floor, wall or ceiling by a joining plate, for example in the form of a

L-section strip, secured to the external metal sheet and to the building by fasteners, e.g. screws and/or by an adhesive.

[0024] In preferred embodiments of the invention, in order to facilitate connection between two folded insulating panels which are arranged adjacent to each other along the length of a building structures, for example along the length of a beam, the top edge of the exterior metal sheet and the bottom edge of the exterior metal sheet are configured to provide an interacting connection between the top edge of the exterior metal sheet of one folded insulating panel and the bottom edge of the exterior metal sheet of another insulating panel. The interacting connection may be a friction fit and/or an interlocking fit. For example, the insulating panel may be configured such that the top edge of the exterior metal sheet lies in a plane parallel to but spaced from the plane of the major surface of the external metal sheet, notably spaced towards the interior of the insulating panel, preferably with the bottom edge of the exterior metal sheet lying in the same plane as the plane of the major surface of the exterior metal sheet. In such a configuration, when the insulating panel is in its folded configuration, the top edge of the exterior metal sheet of one insulating panel can be fitted inside the bottom exterior edge of an adjacent insulating panel along the length of the beam. It is preferable for each of the top and bottom edges of the exterior metal sheet to be provided with a folded edge provided by the metal sheet being folded through 180° to provide a folded flange on the interior surface of the metal sheet. This facilitates the interacting connection and handling of the insulating panels. Preferably, an interacting connection is also provided between the top edge of the interior metal sheets of an insulating panel and the bottom edge of the interior metal sheets of adjacent insulating panels along the length of a beam, for example in the same way. Such an interacting connection, particularly when provided at both the exterior and interior metal sheets, provides enhanced stability and fire resistance. Preferably a plug and socket type connection is provided between two folded insulating panels which are arranged adjacent to each other along the length of a building structures, for example along the length of a beam. Such a plug and socket type connection is advantageously achieved by i) configurating the top edge of the exterior metal sheet and the top edge of the interior metal sheet so that, together they form a plug portion of the plug and socket type connection and ii) configurating the bottom edge of the exterior metal sheet and the bottom edge of the interior metal sheet so that, together they form a socket portion of the plug and socket. In this way, the plug type connection at the top edge of one insulating panel is received in and, in use retained in, the socket type connection at the bottom edge of another insulating panel. In a preferred arrangement, the plug and socket type connection comprises an interference fit and/or a resilient spring fit to facilitate retentions together of two insulating panels; such a fit may be provided by suitable configuration e.g. bending of the exterior and/or interior metal sheet at the top and/or bottom edge.

[0025] The mineral wool insulation may comprise or consist of mineral wool fibres selected from the group consisting of glass wool fibres, rock wool fibres, slag wool, ceramic fibres or combinations thereof. Rock wool fibres are preferred, notably for fire resistance properties.

[0026] The rock mineral fibres may comprise: between 30 and 55 wt-% SiO_2 and/or between 10 and 30 wt-% Al_2O_3; and/or an alkali/alkaline-earth ratio of their composition which is < 1; and/or a combined quantity of CaO and MgO ranging from 20 to 35 wt-%; and/or a combined quantity of Na_2O and K_2O < 8 wt%; and/or a total iron content expressed as Fe_2O_3 of between 4 and 10 wt-%. Notably when the mineral wool fibres are rock wool fibres, the mineral wool insulation preferably has a "minimum melting point of 1000°C" as defined and tested according to German standard DIN 4102 Part 17 of December 1990.

[0027] The term "consists essentially of" is intended to limit the scope of a claim to the specified materials or steps and those that do not materially affect the basic and novel characteristic(s) of the claimed invention.

[0028] Particularly when the mineral wool insulation material comprises rock wool fibres, the fibres may be oriented substantially parallel to the major surfaces of the bands; this provides good thermal resistance.

[0029] The fibres of the mineral wool insulation material may have an average diameter of less than 8μm, preferably less than 6μm.

[0030] The band(s) of mineral wool insulation may have a thickness of ≥40mm, ≥50mm, ≥60mm or ≥100mm and/or ≤ 200mm, ≤ 150mm, or ≤120mm. In some embodiments, the band(s), notably all bands of the insulating panel, have a thickness in the range 40-70mm, notably in the range 50-60mm. In some other embodiments, the band(s), notably all bands of the insulating panel, may have a thickness in the range 90-150 mm, notably in the range 100-120mm. Particularly when the thickness of the insulating panel is in the range 40-70 mm, the insulating panel may have or provide a fire resistance of at least 20 minutes or at least 30 minutes or at least 60 minutes. Particularly when the thickness of the insulating panel is in the range 90-200 mm, the insulating panel have or provide a fire resistance of at least 20 minutes or at least 30 minutes, at least 45 minutes, at least 60 minutes or at least 90 minutes or at least 120 minutes. The fire resistance is notably determined according EN 13381-4, particularly EN13381-4 rev (WI=00127401).

[0031] The band(s) of mineral wool insulation may have at least one or more of the following features:

- a density in the range 60-150 kg/m^3, preferably in the range 80-120 kg/m^3; and/or
- a compression strength of at least 20 kPa, preferably at least 25 kPa, or more preferably least 30 kPa; and/or
- a tensile strength of at least 5 kPa, preferably at least 7 kPa, more preferably at least 10 kPa.

[0032] The insulating panel may have a lambda value of less the 42 mW/m.K., preferably less the 40 mW/m.K., more preferably less the 37 mW/m.K and even more preferably less the 36 mW/m.K when measured at 10°C.

[0033] The band(s) of mineral wool insulation preferably comprises an organic binder, notably having a binder content of ≥ 1 wt% and/or ≤ 6 wt%.

[0034] Each band of mineral wool insulation may have one or more of the following features:

- a length which is ≥ 700 mm and/or ≤ 1500 mm;
- a width which is ≥ 100mm and/or ≤ 600 mm;
- a thickness which is ≥ 10 mm and/or ≤ 200 mm.

[0035] In a some embodiments, notably when intended for the insulation of I beams, adjacent bands of mineral wool insulation of the insulating panels have different widths, the width of each band corresponding to the width of the apparent surface of the I beam or other building structure at which the band it intended to be arranged.

[0036] An embodiment of the invention will now be described, by way of example only, with reference to the accompanying drawings of which:

Fig 1 is a plan view of the interior side of an insulating panel in a planar, flat-pack configuration;
Fig 2 is a side view corresponding to Fig 1;
Fig 3 is a schematic cross section of two assembled insulating panels;
Fig 4 is a schematic plan view of a pair of insulating panels of Fig 1 in their folded configuration; and
Fig is a cross section of a further alternative insulating panel in its folded configuration.

[0037] The foldable insulating panel 1 of Figs 1 and 2 is shown in a flat-pack configuration, which in this embodiment is a planar configuration, and comprises a first 10 and a second band 20 of stone wool mineral wool insulation, each of which has a thickness t of 30 mm and each of which extends along the axial length l of the insulating panel from a position adjacent to the top edge 2 to a position adjacent to the bottom edge 3. Although the top edge 2 is illustrated above the bottom edge 3 and this is the preferred position of use when insulating a vertical beam, the insulating panel may be used with its top edge 2 below its bottom edge 3, or, for example when insulating a horizontal beam, with the top 2 and bottom 3 edges at the same vertical level with the length l of the insulating panel arranged horizontally. Each band 10, 20 of mineral wool insulation is secured at its external major surface to a continuous exterior metal sheet 30, in this example a 1mm thick steel sheet, by an adhesive. The continuous exterior metal sheet 30 is configured to be the exposed surface once the insulating panel 1 has been folded into its folded configuration and installed around part of a metal beam forming a building structure which it is desired to insulate. A first interior metal sheet 11 is secured to and covers the entire interior major surface of the first band of stonewall insulation 10. A second interior metal sheet 21 is secured to and covers a portion of the interior major surface of the second band of mineral wool insulation 20.

[0038] The first band 10 of the mineral wool insulation is arranged towards a first transverse edge 13 of the insulating panel 1 with a portion of the exterior metal sheet 30 projecting transversely beyond the first band 10 to form an abutment surface 17 and a foldable tongue 14. The second band of mineral wool insulation 20, which in this embodiment is the last band of mineral wool, is arranged with is external transverse edge 22 aligned with the second external transverse edge 26 of the insulating panel. The adjacent transverse edges 16,24 of the first 10 and second 20 bands of mineral wool are separated by a square cross-sectioned folding gap 31 at which, in this embodiment, no mineral wool insulation is provided at the exterior metal sheet 30. The folding gap 31 runs continuously along the length l of the insulating panel and has a transverse dimension v which corresponds to the thickness of the first 10 and second 20 bands of mineral wool insulation.

[0039] The second interior metal sheet 21 is arranged on the second band of mineral wool insulation such that: i) a first transverse edge 23 of the second interior metal sheet 21 is spaced from a first transverse edge 24 of the second band of mineral wool, this edge 24 being adjacent to the folding gap 31, so that an exposed portion of the interior major surface of the second mineral wool panel 20 forms an exposed strip 32 having a dimension in the transverse direction equal to the thickness t of the first band of mineral wool insulation, the exposed strip 32 running adjacent to the folding gap 31 in the lengthwise direction of the insulating panel; and ii) a second transverse edges 25 of the second interior metal sheet is aligned with a second transverse edge 26 of the insulating panel.

[0040] At the top edge 2 of the insulating panel the exterior metal sheet 30 is folded over itself towards the inside of the insulating panel to provide a folded edge with the folded over portion providing a border 33 (not shown in Fig 2); the border 33 runs continuously along the entire top edge 2 other than at i) a recess 34 provided in the form of a notch positioned at the side of the folding gap 31 adjacent to the second band of mineral wool insulation 20 and ii) the top edge of the abutment surface 17 and tongue 14. The bottom edge 3 of the insulating panel is arranged in the same way with a folded edge having a notch 34 likewise positioned at the side of the folding gap 31 adjacent to the second band of mineral wool insulation.

[0041] The insulating panel of Figs 1 and 2 has a panel folding axis 4 which extend the length of the insulating panel at the side of the folding gap 31 adjacent to the second band of mineral wool insulation 20. A folding weakness (not shown) at the folding axis 4 is provided by scoring the interior surface of the exterior metal sheet 30 along the folding axis 4 so that when it is desired to fold the insulating panel 1 from its flat-pack configuration to its folded configuration, the insulating panel will preferentially bend around the folding axis 4. The notches 34 in the folded top 2 and bottom 3 edges, each of which is positioned at the folding axis 4, also contribute to providing the folding weakness.

[0042] The tongue 14 provided by a portion the exterior metal sheet is similarly provided with a scoring on the interior surface of the exterior metal sheet 30 running the length of the insulating panel at a position adjacent to the abutment surface 17 to facilitate subsequent folding of the tongue 14 along a tongue folding axis 5.

[0043] Fig 3 illustrates the connection between two folded insulating panels arranged adjacent to each other along the length of a building beam (not shown). The view corresponds to a cross section along line A-A of Fig 4 but without I-beam 6 being shown. The insulating panels 1', 1‴ are configured such that

i) the top edge 2', 2‴ of the exterior metal sheet 30', 30‴ of each respective insulating panel 1', 1‴ lies in a plane parallel to but spaced towards the interior of the insulating panel with respect to the plane of the major surface of the exterior metal sheet 30', 30‴;
ii) the top edge 2', 2‴ of the interior metal sheet 21', 21'" of each respective insulating panel 1', 1‴ each lies in a plane parallel to but spaced towards the interior of the insulating panel with respect to the plane of the major surface of the interior metal sheet 21', 21‴;
iii) the bottom edge 3', 3‴ of the exterior metal sheet 30', 30‴ lies in the same plane as the plane of the major surface of the exterior metal sheet 30', 30‴; and
iv) the bottom edge 3', 3‴ of the interior metal sheet 21', 21‴ lies in the same plane as the plane of the major surface of the interior metal sheet 21', 21‴.

[0044] The top of each insulation panel 2', 2‴ thus provides a plug connection which, when each of the insulating panels 1, 1‴ is in its folded configuration, fits inside a socket connection provided by the bottom 3′,3‴ of another, adjacent insulating panel 1‴. This plug and socket connection runs around the entire connection between insulation panels arranged adjacent to each other along the length of the building beam. The socket connection at the top edge 2', 2‴ of the insulating panel is provided, in this preferred embodiment, by folding of the exterior 30 and interior 21 metal sheets. The socket connection is preferably provided as a sprung, interference fit for the plug connection; this facilitates retention once assembled and desired insulating performance.

[0045] As illustrated schematically, each of the top 2', 2‴ and bottom 3', 3‴ edges of the exterior and interior metal sheets is provided with a folded edge provided by the metal sheet being folded through 180° to provide a folded flange on the interior surface of each metal sheet.

[0046] Fig 4 shows a pair of insulating panels 1' 1" which have been arranged at one position along the length of an I shaped structural metal beam 6 of a building. Each of the first 1′ and second" insulating panels has been folded from its flat-pack configuration (as shown in Figs 1 and 2) to its folded configuration shown in Fig 4 by folding the exterior metal sheet 30', 30" of each insulating panel around its respective folding axis 4', 4", using the panel folding weakness provides at each folding axis 4', 4" to facilitate this, so that the first 10 and second 20 bands of mineral wool insulation are arranged at the interior of the folded insulating panel with the planes in which they lie intersecting at 90°. In this configuration, the folding gap 31 has been closed so that the first 10' and second 20' band of mineral wool form an abutting contact 35 with the exterior metal sheet 30' providing an exterior surface of the folded insulating panel. In addition:

- the second transverse edge 16 of the first band 10 of mineral wool insulation fits in to the gap provided (in the flat-pack configuration of Fig 1) by the exposed strip of mineral wool 32 between the first transverse edge 23 of the second interior metal sheet 21 and the first transverse edge 24 of the second band of mineral wool insulation 20; and
- an interior metal sheet abutting connection 36 is formed between the first 11 and second 21 interior metal sheets.

[0047] The two insulating panels 1',1" are assembled together as a pair of insulating panels around the entire periphery at one position along the length of the I beam 6 by, a) forming one corner of the assembly by i) arranging the second transverse edge 26' of the second insulating panel 1" adjacent to the first transverse edge 15 of the first band of mineral wool insulation 10' of the first insulating panel 1' so as to abut the interior face of the external metal sheet 30' of the first insulating panel 1′ at the abutment surface 17 and ii) securing the folded tongue 14' of the first insulating panel 1′ to the exterior metal sheet 30" of the second insulating panel, for example with screws (not shown) and b) forming the opposite corner of the assembly in an equivalent way.

[0048] The pair of insulating panels 1', 1" of Fig 4 are connected to a further, adjacent pair of insulating panels at an adjacent position along the length of the I beam 6 by means of the connections illustrated and described with reference to Fig 3.

[0049] Fig. 5 shows an insulating panel 51 having three bands of mineral wool 52, 53, 54 in a folded configuration. This configuration is used to provide fire protection and insulation around a portion of a metal beam (not shown) enclosed within the interior 55 of the folded insulating panel 51. L section metal profiles 56 arranged at each transverse edge of the insulating panel 51 are used to secure the insulating panel 51 to, for example a wall 57 along which the metal beam to be insulated runs. Each metal profile 56 is attached by fasteners (not shown) to the wall 57 and to the exterior metal sheet of the insulating panel. In an alternative (non-illustrated) embodiment similar to that of Fig 5, the exterior metal sheet 30 of the insulating panel 51 projects transversely beyond each of the first 52 and last 54 bands of mineral wool, each such projection forming a tongue which is folded about a folding axis to lie flat against the wall so that each tongue, and thus the insulating panel itself, may be secured to the wall 57 fastening each tongue to the wall, for example with screws. This avoids the need for separate attachment profiles 56.

Reference numbers:

[0050]

1	insulating panel
2	top edge of insulating panel
3	bottom edge of insulating panel
4	panel folding axis
5	tongue folding axis
6	I beam
10	first band of mineral wool insulation
11	first interior metal sheet
13	first transverse edge of insulating panel
14	tongue
15	first transverse edge of first band of mineral wool insulation
16	second transverse edge of first band of mineral wool insulation
17	abutment surface
20	second band of mineral wool insulation
21	second interior metal sheet
22	external transverse edge of second band of mineral wool
23	first transverse edge of second interior metal sheet
24	first transverse edge of second band of mineral wool insulation
25	second transverse edge of the second interior metal sheet
26	second transverse edge of insulating panel
30	exterior metal sheet
31	folding gap
32	exposed strip of mineral wool
33	border of top edge
34	notch
35	abutting contact between bands of mineral wool insulation
36	abutting contact between interior metal sheets
51	insulating panel
52	first band of mineral wool insulation
53	second band of mineral wool insulation
54	third band of mineral wool insulation
55	interior of folded insulating panel
56	L section profile
57	wall
l	length
t	thickness
v	transverse dimension of folding gap

Claims

1. A foldable insulating panel comprising:

a continuous, exterior metal sheet;

a first band of mineral wool insulation secured at its external major surface to the exterior metal sheet, the first band of mineral wool insulation extending along a length of the insulating panel and having a first interior metal sheet secured to its interior major surface; and

a second band of mineral wool insulation secured at its external major surface to the exterior metal sheet, the second band of mineral wool insulation extending along a length of the insulating panel and having a second interior metal sheet secured to its interior major surface,

wherein the second band of mineral wool insulation is spaced from the first band of mineral wool insulation by a first folding gap arranged along a first folding axis of the insulating panel; and

wherein the insulating panel is configured to be folded along the first folding axis to a folded configuration such that, folding of the insulating panel causes closure of the first folding gap such that, in its folded configuration, the first and second bands of mineral wool insulation form an abutting contact across a position previously occupied by the first folding gap with the exterior metal sheet providing an exterior surface of the folded insulating panel.

2. A foldable insulating panel in accordance claim 1, further comprising a third band of mineral wool insulation secured at its external major surface to the exterior metal sheet, the third band of mineral wool insulation extending along a length of the insulating panel and having a third interior metal sheet secured to its interior major surface; and

wherein the third band of mineral wool insulation is spaced from the second band of mineral wool insulation by a second folding gap arranged along a second folding axis of the insulating panel; and

wherein the insulating panel is configured to be folded along the second folding axis to a folded configuration such that, folding of the insulating panel causes closure of the second folding gap such, in its folded configuration, the second and third bands of mineral wool insulation form an abutting contact across a position previously occupied by the second folding gap with the exterior metal sheet providing an exterior surface of the folded insulating panel.

3. A foldable insulating panel in accordance with any preceding claim, wherein the insulating panel is provided as a flat-pack insulating panel, notably a planar flat-pack insulating panel, more notably as part of a stack of flat-pack insulating panels.

4. A foldable insulating panel in accordance with any preceding claim, wherein i) the position of each folding axis is defined by one or more folding weakness(es) provided at the exterior metal sheet, notably in which each folding weakness is provided by scoring the exterior metal sheet of the insulating panel and preferably ii) wherein the top and/or bottom edge of the exterior metal sheet comprises a border which comprises a portion of the exterior metal sheet which is folded over itself to provide a folded edge, and wherein the folding weakness comprises a recess provided in the border.

5. A foldable insulating panel in accordance with any preceding claim, wherein the exterior metal sheet has a thickness which is ≥ 0.3 mm and, preferably wherein the interior metal sheets have a thickness which is ≥ 0.3 mm.

6. A foldable insulating panel in accordance with any preceding claim, wherein, when arranged in its folded configuration, each interior metal sheet forms an abutting contact with its adjacent interior metal sheet(s).

7. A foldable insulating panel in accordance with any preceding claim, wherein each folding gap is provided by a separation between adjacent bands of mineral wool insulation, the separation providing a rectangular cross-sectioned folding gap such that the separation between the adjacent bands of mineral wool insulation across the folding separation is equal to the thickness of at least one of the adjacent bands of mineral wool insulation material.

8. A foldable insulating panel in accordance with any preceding claim, wherein the top edge of the exterior metal sheet lies in a plane parallel to but spaced from the plane of the major surface of the external metal sheet, notably spaced towards the interior of the insulating panel, preferably with the bottom edge of the exterior metal sheet lying in the same plane as the plane of the major surface of the exterior metal sheet.

9. A foldable insulating panel in accordance with any preceding claim, notably a foldable insulating panel having two (and only two) bands of mineral wool insulation, wherein the continuous exterior metal sheet extends transversely beyond the first band to form a tongue, notably a foldable tongue, and the last band of mineral wool insulation of the insulating panel has its exterior edge at a transverse side aligned with its associated transverse edge of the exterior metal sheet.

10. Use of an insulating panel in accordance with any preceding claims to insulate a structural metal building beam, notably to provide fire protection.

11. A method of insulating a metal building beam, notably a structural metal building beam, comprising:

- providing one or more foldable insulating panel(s) in accordance with any of claims 1 to 9;
- folding each of the one or more insulating panel(s) along each of its folding axes, notably in which the folding provokes plastic deformation of the exterior metal sheet(s); and
- arranging the one or more folded insulating panel(s) around at least a portion of the periphery of the building beam at a first position along the length of the building beam.

12. A method in accordance with claim 11, comprising:

- providing two foldable insulating panel in accordance with any of claims 1 to 9, notably two foldable insulating panel each having two (and only two) bands of mineral wool insulation;
- folding each of the two insulating panel along each of its folding axes; and
- arranging the two folded insulating panel as a pair around at least a portion of the periphery of the building beam at a first position along the length of the building beam; and preferably:
- providing two further foldable insulating panel in accordance with any of claims 1 to 9, notably two foldable insulating panel each having two (and only two) bands of mineral wool insulation;
- folding each of the two further insulating panel along each of its folding axes; and
- arranging the two further folded insulating panel as a pair around at least a portion of the periphery of the building beam at a second position along the length of the building beam so that the first and second pairs of folded insulating panels abut each other.

13. A method in accordance with claim 11 or claim 12, comprising:

- securing together opposed edges of one or more exterior metal sheets or one or more insulating panels.

15. A method in accordance with any of claims 11 to 13, comprising:

- arranging the insulating panel(s) around the entire periphery of the building beam to encircle the building beam.

Fig. 1

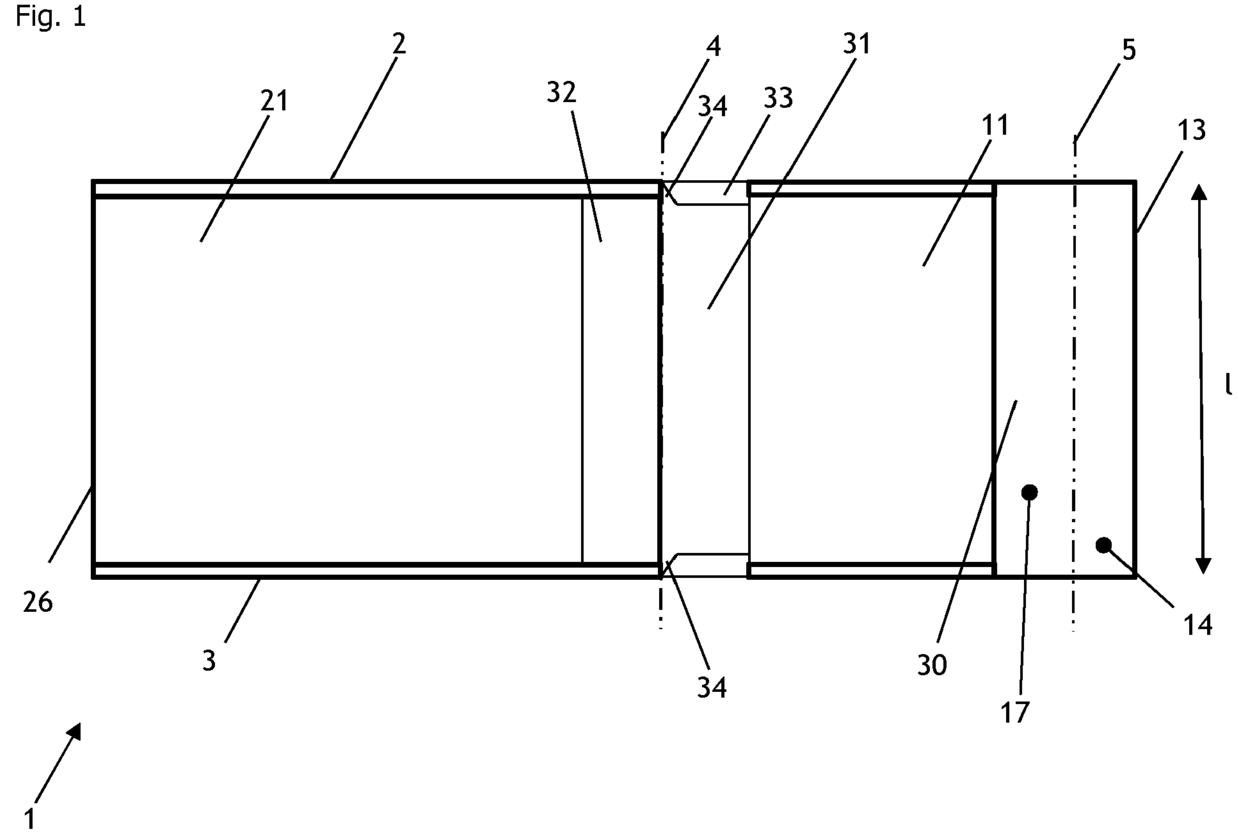
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Fig. 2

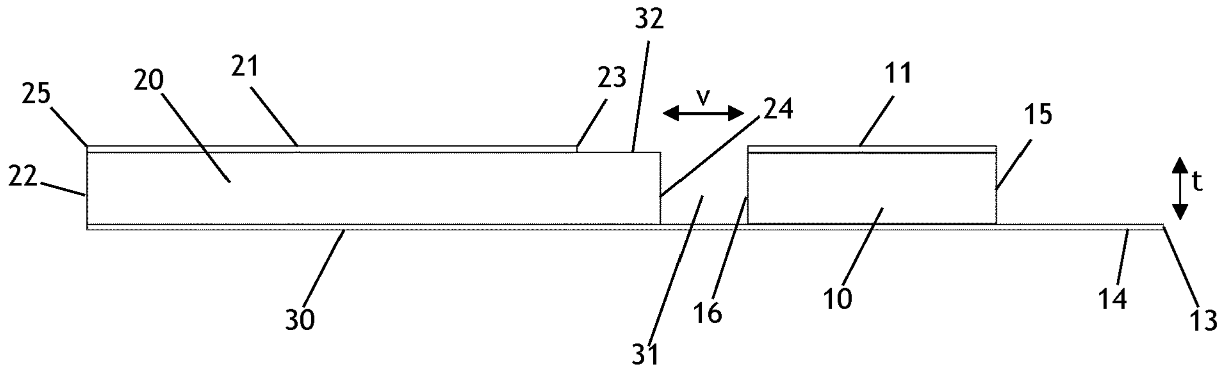
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Fig 3

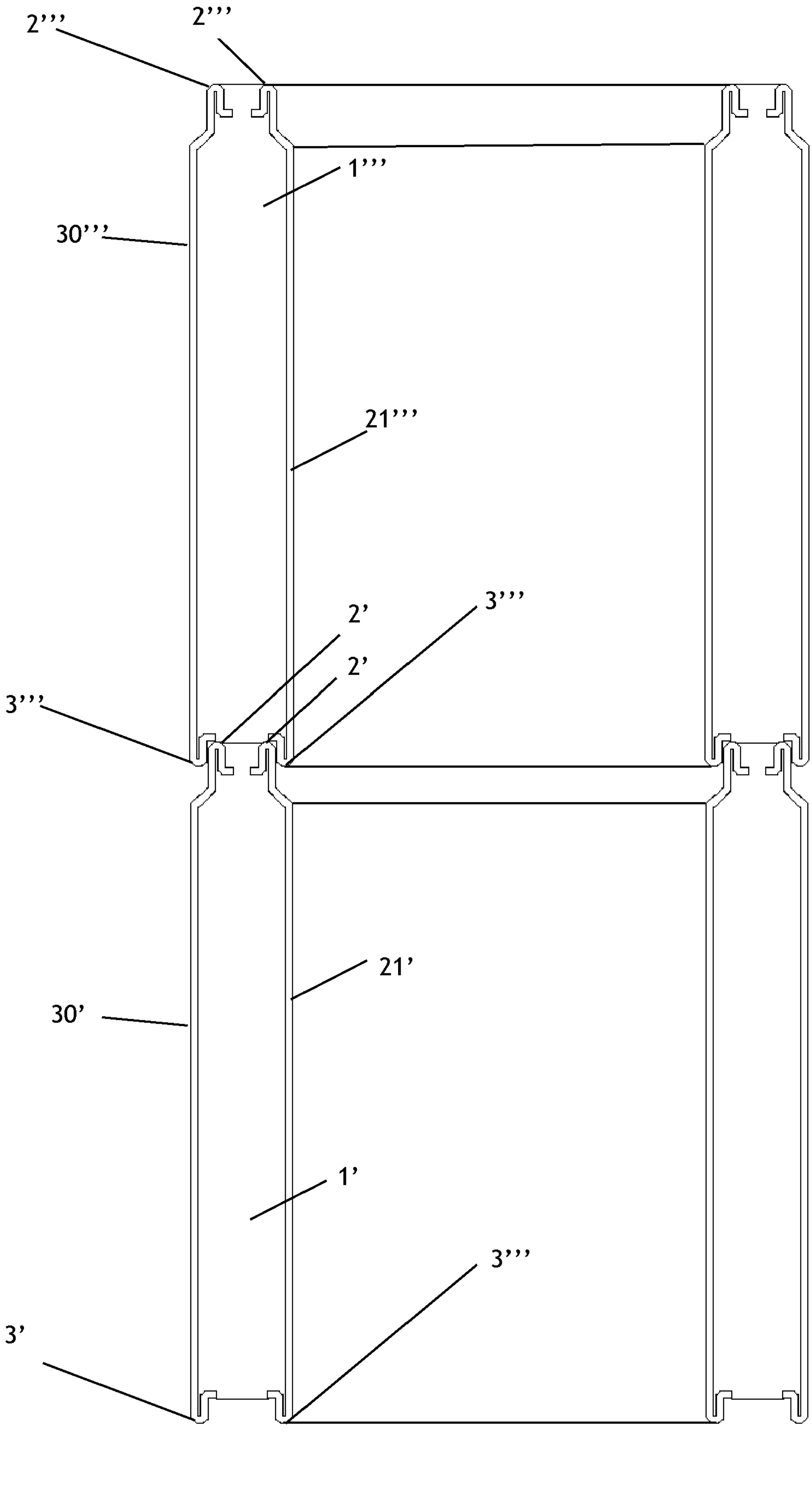


Fig 4

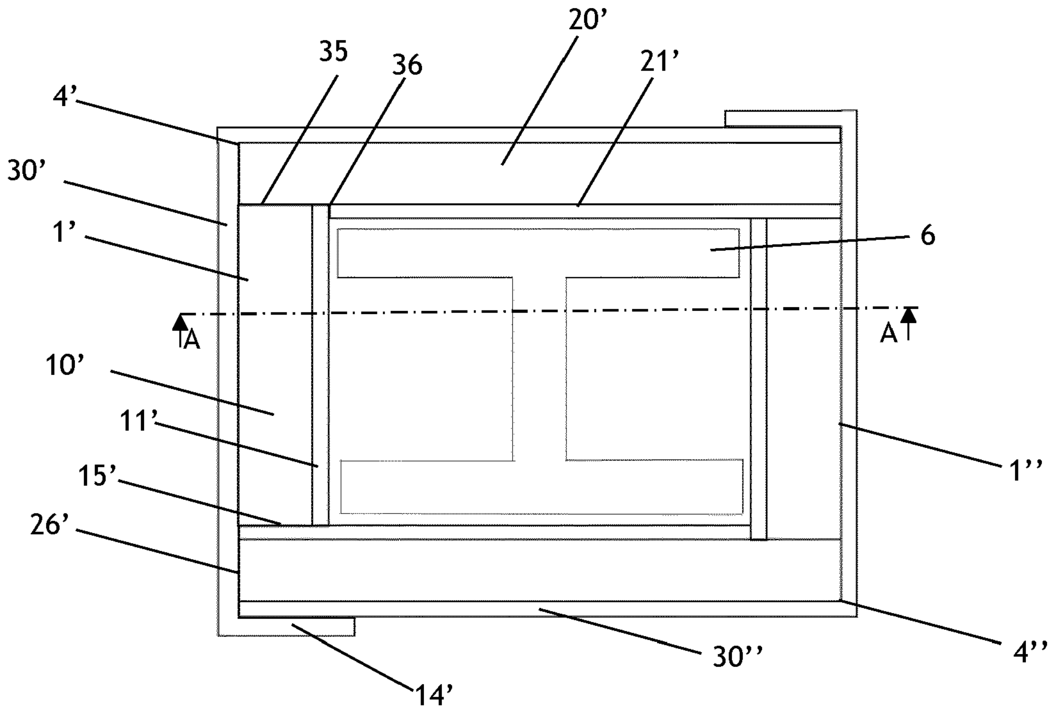
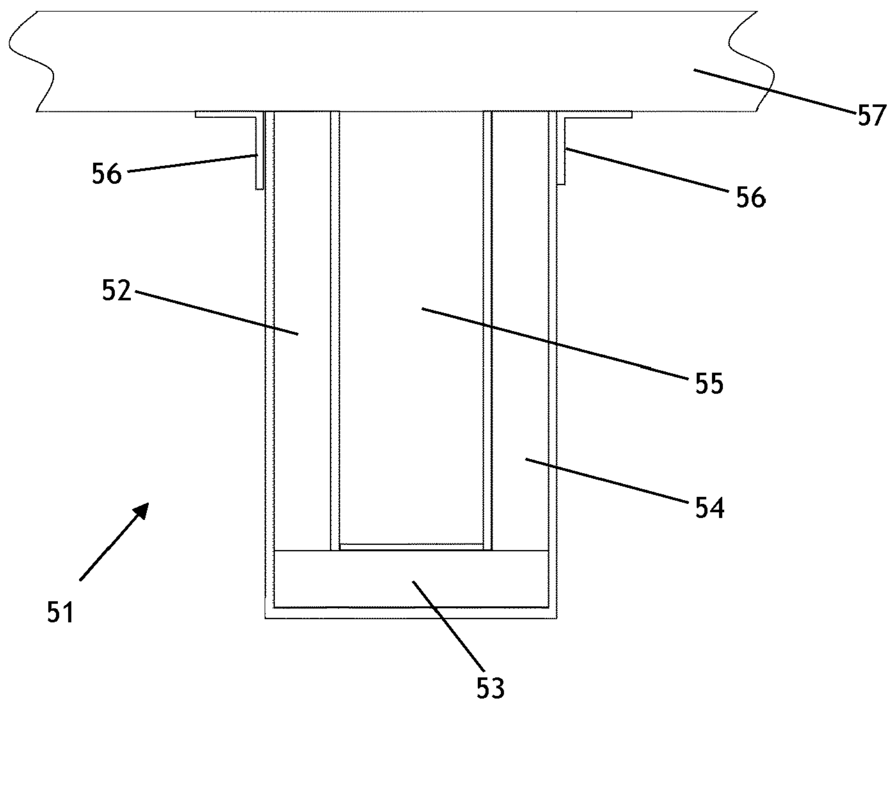


Fig 5



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EUROPEAN SEARCH REPORT

Application Number
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1 The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	17 March 2022	Melhem, Charbel

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