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WO-A1-2015/188229
US-A- 2 693 256

DESCRIPTION

Description

Field of the invention

[0001] The invention relates to a building construction with a wall that comprises a sandwich panel comprising metal plates connected by fiber material. Furthermore, the invention relates to a method of fireproofing building constructions with sandwich walls.

Background

[0002] It is known to use sandwich panels comprising pair of steel plates and stone wool between the plates in a wall of a building. The stone wool is glued to the metal plates. Such panel makes it possible to realize a high stiffness against bending. Even a sandwich with relatively thin steel panels of less than one millimeter thickness can thus be made stiffer than a wall made of a much thicker single solid steel panel. The metal plates alone provide for a capability of bearing the weight of objects on the wall, and the sandwich increases this ability. For example, a sandwich panel with steel plates may be capable of bearing objects of thirty kilograms or more. A wall in a building can be construed by mounting one or more of such sandwich panels hanging from a beam, bolted to the beam with bolts through the panel. Subject to certain conditions such sandwich panel walls can also be used to satisfy fire safety requirements for buildings. Fire safety of a building may require that a wall shields off fire at least for a certain minimum time interval when exposed to temperatures of nine hundred up to eleven hundred degrees Celsius due to the fire. When the wall is formed by a sandwich panel comprising stone wool glued between a pair of steel plates, the glue will soon lose its function at such a temperature, so that the stiffness against bending is lost. But the steel plates will still remain intact at such temperatures, ensuring fire shielding. However, dependent on the weight of objects that the sandwich panel is allowed to carry, the steel plates of the sandwich panel wall may need to have a minimum thickness to satisfy fire safety requirements. Otherwise, the weight will drag down the panel in the case of a fire, destroying its shielding function.

[0003] EP 0387934 describes a coupling between edges of sandwich panels that each comprise a layer of insulation material covered on both sides with a metal plate. The coupling is designed to stimulate interior ventilation and vapor transport in the space bounded by the plates.

[0004] Screws are used to couple edges of the panels to each other and to hang the panels on

a building construction. At the edges of connected panels the metal plates are bent inward. The screws that are used to couple the edges of the panels fix a bracket that connects the bent portions. The heads of the screws are located in a depression formed by the bent portions. A protective cover with a U shaped cross-section is pushed into the depression to cover the heads of the screws. The cover extends along the length of the connection between the panels and primarily serves to hide the depression from view.

[0005] The screws that serve as coupling elements to the building construction protrude outside the metal plates are along located above the brackets. These screws are of a relative great length, such that they protrude with the end away from the head outside the panel. As this sandwich panel hangs only from screws at the edges, it can carry only limited weight, and the weight carrying capacity can decrease due to heating of the screws, e.g. by hot air that rises through the depression.. When a fire arises next to the wall the construction of provides only limited protection against failure of the wall.

[0006] EP0595777 discloses an anti-fire panel with parallel metal plates opposite to each other. A self-extinguishing poly-urethane foam layer is provided in a space between the parallel metal plates, with mineral insulating material layers between the foam layer and the two parallel metal plates respectively. The mineral insulating material layers improve thermal resistance, by preventing the self-extinguishing foam material from being heated for a long time, thereby increasing the fire or flame resistance of the panel construction.

[0007] EP0595777 further discloses a joint element between the edges of adjacent panels. Like the panels, the joint element contains a foam layer between mineral insulating material layers. Central bodies are provided on the mineral insulating material layers, with legs extending over the parallel metal plates of the joined panels. Tie rods clamp the central bodies and the legs to the joined panels. Snap covering elements with mineral insulating material layers snap into a loop formed by the central body to form a thermal barrier at the snap covering.

[0008] WO 2015/188229 A1 discloses a building comprising a structural frame of the building, at least one window or door supported by and substantially aligned to the frame, and an external wall formed by at least one insulated sandwich panel, the panel(2) in the external wall being supported by the frame and being offset externally from the frame, wherein the frame is exposed in at least part of the interior of the finished building and wherein at least part of the internal wiring of the building traverses the interior of the building on and/or in the frame.

[0009] US 2 693 256 discloses a panel unit comprising two confronting identical half sections, each half section comprising a facing sheet having one side edge thereof turned inwardly to form a tongue and the other side edge turned inwardly and reversely bent to form a groove, the half sections being disposed with the tongue of one half section adjacent the groove of the other half section and at the same side edge of the unit. The panel unit further comprises identical metal tie pieces of angular shape mounted on the inner face of each of said half sections, each tie piece having one leg disposed parallel to its associated sheet and being

welded thereto and having a second leg disposed at right angles to its associated sheet, the second leg of each tie piece being provided at one with a cut-out portion adjacent the grooved side edge of its associated sheet and extending therebeyond and the other end of the second leg of each tie piece terminating short of the tongue end of its associated sheet, the second leg of each tie piece being provided at its opposite ends with a web portion extending parallel to its associated sheet, the web portions of the tie pieces abutting each other. The panel unit also comprises means extending through the abutting web portions and securing the half sections together.

Summary

[0010] It is an object of the invention to provide for a building construction with a wall that comprises a sandwich panel that is able to shield off fire for a longer time with metal plates of less thickness when loaded with weight. According to the invention a building construction according to claim 1 is provided. Here, a heat isolation layer is provided on at least one side of the sandwich panel, over fasteners from which the sandwich panel hangs from the beam, and over an area of the panel surrounding the fasteners on that side of the panel. The fasteners may be bolts, screws, rivets etc. The earliest failure of the steel plates of the sandwich panel at nine hundred degrees Celsius is at the fasteners, because of the development of cracks in the steel plate upward from the position of the fasteners at high temperature. By using the heat isolation layer over the fasteners and their surrounding, heating of the metal plate of the sandwich panel at the location of the fasteners is delayed, thereby the development of the cracks. In this way, the time interval before the wall will fail can be increased without increasing the thickness of the steel panel, even when the sandwich panel wall bears considerable weight. The heat isolation layer need only be present on the sandwich wall panel at the level of the fasteners and a part of an area of the sandwich panel surrounding that level, e.g. only down to twenty to two hundred mm below the level of the fasteners, and preferably at least fifty mm. Preferably, the heat isolation layer is provided over the whole width of the sandwich panel, but alternatively it may be provided in isolated patches over individual fasteners or groups of fasteners.

[0011] The plurality of fasteners from which a sandwich panel hangs are preferably arranged in a row, wherein the fasteners are located at substantially equal distances from the top of the sandwich panel. A row of more than two fasteners may be used per sandwich panel, preferably with substantially equal distances between the fasteners of the same sandwich panel.

[0012] The fasteners extend through the sandwich panel. Preferably each of these fasteners serves to hang one sandwich panel only, together with one or more other fasteners that serve to hang that sandwich panel.

[0013] The heat isolation layer may be made of ceramic wool for example. In an embodiment, heat isolation layers may be provided over the fastener and the areas of the panel surrounding the fastener on both sides of the sandwich panel. This prolongs shielding of fires from both

sides of the wall. But if there is a need to shield fires only from one side of the sandwich panel, a heat isolation layer on that side may suffice.

[0014] The building construction with the sandwich panel wall may be designed so that the sandwich panel wall is able to bear a predetermined amount of weight at room temperature that the sandwich panel wall is not able to bear at nine hundred degrees Celsius. In this case the heat isolation layer prolongs the time interval before the sandwich panel wall loses its fire shielding effect.

[0015] In an embodiment a further panel with a thicker metal plate is included adjacent the sandwich panel. This makes it possible to hang more weight locally on the wall, without compromising safety or increasing the weight of all panels.

[0016] In an embodiment the surface of the wall comprises surfaces of a plurality of panels and spreading plate attached to the plurality of panels. This makes it possible to hang more weight on the spreading plate than on an individual panel.

[0017] According to another aspect a method of fire proofing a building construction with a sandwich wall according to claim 5 is provided. Herein fire-proofing refers to increasing the time duration before the sandwich wall fails to perform its separation function. The method applies to a building construction comprises a beam, the sandwich panel hanging from said beam on fasteners that extend through the sandwich panel and into said beam. According to the method comprising a heat isolation layer is applied on at least one side of the sandwich panel, over the fasteners and over an area of the panel surrounding the fasteners on that side of the panel. This can done on existing walls to improve protection, or when the wall is built up. In both cases the heat isolation layer provides longer protection against failure of the wall also when objects of considerable weight have been hung on the sandwich wall panel.

Brief description of the drawing

[0018] These and other objects and advantages will become apparent from a description of exemplary embodiments with reference to the following figures.

Figure 1

shows a sandwich panel wall

Figure 2, 2a-d

show a connection detail of a sandwich wall panel

Figure 3

shows an embodiment with an intermediate plate

Figure 4

shows an embodiment with a panel comprising a thicker plate

Detailed description of exemplary embodiments

[0019] Figure 1 shows a building construction comprising a succession of sandwich panels 10 suspended from a beam 12. Each sandwich panel 10 is attached to beam 12 by a plurality of bolts 14. In the illustrated embodiment, beam 12 is located at the top of sandwich panels 10. Beam 12 is connected to a framework of the building (not shown). The building construction may comprise further beams, e.g. a bottom beam 16 connected to sandwich panels 10 and one or more further beams to back up sandwich panels 10. Sandwich panels 10 may be connected to each other by interlocking seams to form a continuous wall. Preferably, seams are used that are designed to block penetration of fire or substantial hot air flow through the seams into the space in the wall that contains fiber material.

[0020] Preferably, the interlocking seams connect sandwich panels 10 without use of fasteners that extend through the sandwich panels. This prevents heat transport at the edges between the panels. For example, sandwich panels 10 may be connected to each other with tongue and groove connections with tongues and grooves that extend in parallel with the plane of the sandwich panels at the connected edges.

[0021] The edge of the metal plate of the sandwich panel that forms the main surface plane on one side of the panel can be used to realize a groove. At the groove the metal plate is bent into an S shape at the edge adjoining the adjacent plate, the top of the S being part of the surface of the metal plate and the remainder of the S lying between the planes of the metal plates of the sandwich panel. About half way the bottom of the S, the plate may end with a part perpendicular to the surface, along the edge of the fiber material of the sandwich panel. A tongue can be realized similarly with a bent plate edge to fit with the S shape. Each of the metal plates 20a, b may have bends on both front and back to form a tongue or groove on both the front and back along an edge.

[0022] Figure 2 shows a side view of part of sandwich wall panel 10 not according to the invention but present for illustrations purposes only. Sandwich wall panel 10 comprises parallel metal plates 20a, b and fiber material 21 between parallel metal plates 20a, b. Sandwich panels 10 are known per se. In an embodiment each sandwich panel comprises a pair of parallel steel plates, for example of 0.7 mm thickness each at a distance of 100 mm, with stone wool between the steel plates glued to both plates. In an example, each sandwich panel 10 is at least three meters high and half a meter wide. The surfaces of parallel metal plates 20a, b, form the parallel surfaces of the wall.

[0023] The part of metal plate 20a, b that forms one of the parallel surfaces of the wall will be referred to as the main surface of the metal plate 20a, b. The fiber material is attached to the parts of the metal plates that form the main surface parts. As noted, another part at the edge may be used to connect the panels. The fiber material need not be attached to this other part.

[0024] The use of parallel metal plates with fiber material attached to the metal plates and filling the distance between the plates provides for a stiff, light weight wall, with stiffness to bending that is much larger than the stiffness of the metal plates per se, and equal to the stiffness of a much thicker solid metal wall plate. By way of example a 0.7 mm thickness and a distance of 100 mm may be used, but the thicknesses e.g. in a range of 0.1 mm to 5 mm and distances e.g. in the range of 20-200 mm may be used. Instead of stone wool other fiber material may be used, such as another ceramic or mineral wool, glass or carbon fiber etc. Instead of (stainless) steel plates other metal plates may be used, provided that the metal has a melting temperature above a thousand degrees Celsius.

[0025] Figure 2 schematically shows suspension of a sandwich wall panel 10 from beam 12. By way of example a beam 12 with L-shape cross-section is shown, but other types of beam may be used. Bolts 14 (only one shown) extends through sandwich wall panel 10 and are screwed into beam 12. Bolts 14 may be end within beam 12, or bolts 14 may extend through beam 12. Although an embodiment with bolts is described, it should be understood that equivalent fasteners such as rivets, screws etc. may be used. The fasteners extend through sandwich wall panel 10 between the main surfaces of the metal plates. The head of fastener 14 lies on the metal plate 20a outside the main surface outside of metal plate 20a.

[0026] The head of the fastener may be integral with the fastener or attached to it, e.g. screwed on as a nut, glued on etc. In an embodiment a self tapping bolt, and the hole through which the bolt enters the metal plate is tapped with this bolt. It has been found that this increases the maximum wall panel weight bearing capacity. Preferably both holes where the bolt enters and exits are tapped with the bolt.

[0027] A fire resistant heat isolation layer 22 is provided over bolts 14. The purpose of heat isolation layer 22 is to delay heating of the metal plate of sandwich wall panel 10 at and surrounding the part of bolt 14, in the case of fire on the side of the wall on which heat isolation layer 22 is provided.

[0028] In the illustrated embodiment heat isolation layer 22 is applied over and surrounding the bolts 14 on only one of the metal plates 20a of the sandwich wall panel, thus providing fire protection only for fire on a first side of the wall. Such one sided protection is all that is required for fire safety in many applications. The head of bolts 14 extends beyond the main surface of the metal plate 20a over which heat isolation layer 22 is applied. If delay of collapse of the wall protection due to fire on either side of the wall is required, a further heat isolation layer 23 may be provided over beam 12 on the right side of the drawing as well, as shown in figure 2a, which is also not according to the invention.

[0029] It has been found that, when sandwich wall panel is loaded with a significant weight (e.g. thirty kilograms), an early cause of collapse of the panel in the case of fire is due to high temperature failure of the metal plate 20a of the sandwich panel from the holes through which sandwich wall panel 10 is suspended on bolts 14. Because the holes and their surrounding are covered by heat isolation layer 22 the metal plate 20a around the hole will heat more slowly.

Thus, heat isolation layer 22 delays this form of failure, thus providing for a longer time of escape. Preferably heat isolation layer 22 is selected so that failure from the holes due to direct heating of the wall surrounding bolts 14 is no longer the earliest cause of failure. A much larger delay does not add to safety. Of course there are other causes of failure that may eventually result in collapse of the wall, such as ascent of heated air through a space between parallel metal plates 20a,b, or heat diffusion through metal plate 20a from the part of metal plate 20a that is exposed to the fire.

[0030] Preferably, bolts 14 are connected to beam 12 only on the second side, opposite the first side, at the metal plate 20b on the second side. Thus, heating through bolts 14 from the fire on the first side is avoided. In an embodiment, the part of beam 12 that faces the same space as heat isolation layer 22 is also embedded in further heat isolation material 220, as shown in figure 2b. This slows down heat diffusion through beam 12 to the other side of the wall and its possible effect on wall failure. However, such an embedding is may not be needed.

[0031] Preferably, as shown, the part of the inner surface of heat isolation layer 22 above and below fastener is parallel to the main surface of metal plate 20a., preferably from the highest to the lowest edges of height of heat isolation layer 22, The parallel part of the inner surface extends in contact with the surface of metal plate 20a of sandwich panel 10 both above and below the place where the head of fastener 14 extends from the surface of metal plate 20a. This prevents that fastener 14, or the part of the main surface of metal plate 20a can be heated by flow of heated air between the surface of metal plate 20a and heat isolation layer 22. Preferably, heat isolation layer 22 is also in contact with the surface of metal plate 20a left and right of the head of fastener 14.

[0032] The thickness and extent of heat isolation layer 22 is selected so that the cumulative heat flow to the wall part surrounding bolts 14 through heat isolation layer 22 during one hour, when the air temperature adjacent the heat isolation layer is 1100 degrees Celsius, is less than the heat flow needed to heat the wall part surrounding bolts to a level where the wall fails at bolts 14 when the wall is loaded with a weight up to thirty kilograms. Preferably, the heat flow through the wall part through heat isolation layer 22 to the part surrounding bolts 14 is smaller than heat flow due to other processes of heating that wall part.

[0033] In an embodiment, heat isolation layer 22 may comprise a layer of a ceramic or mineral wool, such as stone wool for example. Preferably, all bolts 14 from which a sandwich wall panel 10 is suspended are covered by a heat isolation layer 22 that extends over all these bolts 14. Alternatively, separate heat isolation layers 22 may be applied over individual bolts 14, or subsets of the bolts. On an embodiment a single heat isolation layer 22 may be used that extends over a plurality of wall panels. Preferably heat isolation layer or layers 22 extends at least twenty mm from the edge of each bolt 14 over the surrounding surface of metal plate 22a, and preferably at least fifty mm from the edge. Preferably, heat isolation layer is at least twenty mm thick. Preferably, heat isolation layer 22 is designed so that its heat conduction coefficient is less than $0,04 \text{ W/(m}^2\text{Kelvin)}$. Preferably all bolts 14 from which a sandwich panel 10 is suspended are covered by a heat isolation layer as described. But of course, in addition to the

covered bolts that suffice to keep up sandwich wall panel, there may be additional bolts that are not covered. It suffices that the covered bolts per se are able to carry the sandwich panel at least during a limited time interval that allows for escape from the fire.

[0034] Figure 2b shows an embodiment according to the invention wherein heat isolation layer 22 is part of pre-form part, which further comprise a cover 24, e.g. of metal such as steel, which may be directly or indirectly coupled to beam 12, or to further heat isolation material 220 into which beam 12 is embedded, as shown in figure 2c also showing an embodiment according to the invention. Optionally, cover 24 encloses heat isolation layer 22 on the outside, as shown in figure 2d, this prevents that heat isolation layer 22 can be disturbed. Optionally, screws are used to connect cover 24 to the metal plate 20a at a level below heat isolation layer 22, as shown in figure 2d showing a further embodiment according to the invention. When the preformed part is mounted over sandwich wall panel 10, heat isolation layer 22 is located between the metal cover 24 and the metal plate 22a of sandwich wall panel 10 with which heat isolation layer 22 is in contact. In another embodiment, heat isolation layer 22 may be attached to metal plate 20a first and optionally subsequently covered by a metal cover 24. Alternatively, heat isolation layer 22 itself may be attached by screws through heat isolation layer 22 into the metal plate 20a on which heat isolation layer 22 is provided, at a distance from bolts 14 (e.g. at least twenty mm distant). As such screws bear only heat isolation layer 22, they do not form a significant source of wall failure.

[0035] In other embodiments, from a beam 12, a sandwich panel 10 may be suspended from a plurality of beams at different heights, attached to each of these beams by a plurality of bolts. Preferably bolts connected to each of these beams are covered by a heat isolation layer in a way described in the preceding.

[0036] The capability of the wall to carry weight without significantly decreasing fire safety can be increased further in a number of ways. For example, a panel with thicker metal plates may be included between other sandwich panels. Figure 3 shows an embodiment wherein an intermediate plate 30 is attached to a plurality of sandwich panel of a wall. When weight is attached to intermediate plate 30, intermediate plate 30 will distribute the weight over the plurality of sandwich panels. Thus a weight carrying capacity can be realized that is a sum of the weight carrying capacity of individual sandwich wall panels.

[0037] Figure 4 shows an embodiment of a wall comprising first sandwich wall panels 10 as described in the preceding, with metal plates of a first thickness. A further panel 40 (preferably also a sandwich panel) with a metal plate or plates of the same metal (e.g. steel) as sandwich wall panels 10, is included between the first panels. The metal plate or plates of further panel 40 have a second thickness greater than the first thickness (e.g. at least twice the first thickness). This makes it possible to increase the weight bearing capacity of the wall locally at the further panel, without increasing the weight of all panels in the wall.

REFERENCES CITED IN THE DESCRIPTION

Cited references

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Patent documents cited in the description

- EP0387934A [0003]
- EP0595777A [0006] [0007]
- WO2015188229A1 [0008]
- US2693256A [0009]

PATENTKRAV

1. Bygningskonstruktion med en væg, der omfatter

- en sandwichplade (10) omfattende et par parallelle metalplader (20a,b), der danner væggen
5 modstående parallelle flader (20a,b), og fibermateriale (21) mellem metalpladerne (20a,b), limet
til metalpladerne (20a,b);

- en lægte (12), hvor sandwichpladen (10) hænger fra lægten (12) på fastgørelseselementer (14),
der strækker sig ind i lægten (12); hvor fastgørelseselementerne (14) strækker sig gennem
sandwichpladen (10) mellem de parallelle flader (20a,b) ind i lægten (12);

10 **kendetegnet ved, at** væggen omfatter

- et varmesoleringslag (22) på mindst én side af sandwichpladen (10), over
fastgørelseselementerne (14) og over et område af pladen (10), der omgiver
fastgørelseselementerne (14) på denne side af pladen (10), og

ved, at bygningskonstruktionen endvidere omfatter et varmesoleringselement, der omfatter
15 varmesoleringslaget (22), og en afdækning (24) fastgjort over varmesoleringslaget (22),
hvilken afdækning (24) fungerer som en mekanisk kobling af varmesoleringslaget (22) direkte
eller indirekte til lægten (12) og/eller metalpladen (20a) på den mindst ene side af
sandwichpladen (10).

20 **2.** Bygningskonstruktion ifølge krav 1, hvor varmesoleringslaget (22) strækker sig over
samtlige fastgørelseselementer (14).

3. Bygningskonstruktion ifølge et hvilket som helst af de foregående krav, hvor
varmesoleringslaget (22) strækker sig i kontakt med metalpladens (20a) flade på den mindst ene
25 side af sandwichpladen (10) over og under det sted, hvor fastgørelseselementernes (14) hoveder
strækker sig fra metalpladens (20a) flade.

4. Bygningskonstruktion ifølge et hvilket som helst af de foregående krav omfattende en
yderligere plade (10) stødende op til sandwichpladen (10), hvor pladens (10) og den yderligere
30 plades (40) flader danner tilstødende dele af en flade af væggen, hvor den første plades (10)
metalplader (20a) har en første tykkelse og den yderligere plade (40) har en metalplade eller
metalplader med en anden tykkelse, der er større end den første tykkelse.

5. Fremgangsmåde til brandsikring af en bygningskonstruktion med en væg, der omfatter en sandwichplade (10), som omfatter et par parallelle metalplader (20a,b), og som danner væggens modstående parallelle flader, og fibermateriale (21) mellem metalpladerne (20a,b), limet til metalpladerne (20a,b), hvor bygningskonstruktionen omfatter en lægte, hvilken fremgangsmåde omfatter ophængning af sandwichpladen (10) fra lægten (12) på fastgørelseselementer (14), der strækker sig ind i lægten (12), hvor fastgørelseselementer (14) strækker sig gennem sandwichpladen (20) mellem de parallelle flader (20a,b) og ind i lægten (12), **kendetegnet ved, at** fremgangsmåden omfatter anvendelse af et varmeisoleringslag (22) på mindst én side af sandwichpladen (10), over fastgørelseselementerne (14) og over et område af pladen (10), der omgiver fastgørelseselementerne (14) på denne side af pladen (10), og **ved, at** bygningskonstruktionen endvidere omfatter et varmeisoleringselement, der omfatter varmeisoleringslaget (22), og en afdækning (24) fastgjort over varmeisoleringslaget (22), hvilken afdækning (24) fungerer som en mekanisk kobling af varmeisoleringslaget (22) direkte eller indirekte til lægten (12) og/eller metalpladen (20a) på den mindst ene side af sandwichpladen (10).
6. Fremgangsmåde ifølge krav 5, hvor fastgørelseselementerne (14) er selvskærende bolte, og et hul gennem metalpladen på den mindst ene side, hvorigennem den selvskærende bolt trænger ind i metalpladen, tilspidises med den selvskærende bolt før anvendelse af varmeisoleringslaget (22).

DRAWINGS

Drawing

Fig.1

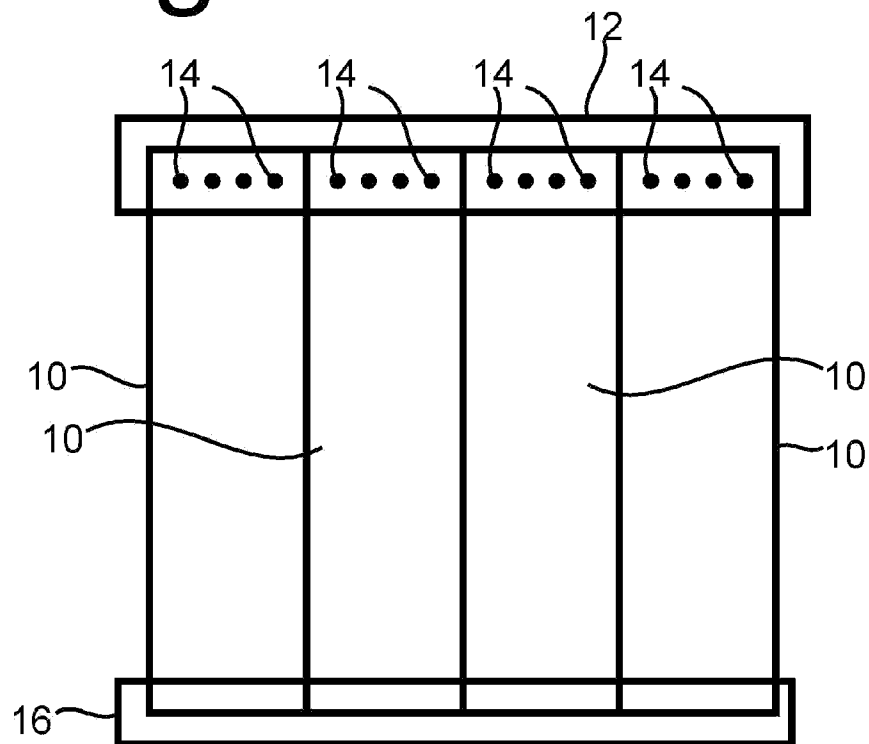


Fig.2

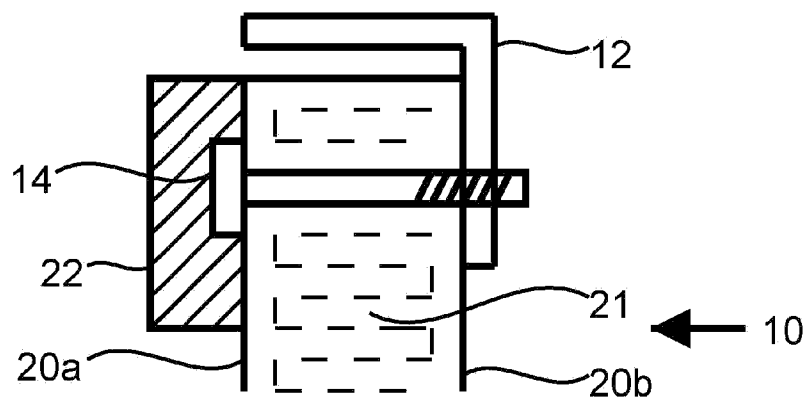


Fig.2a

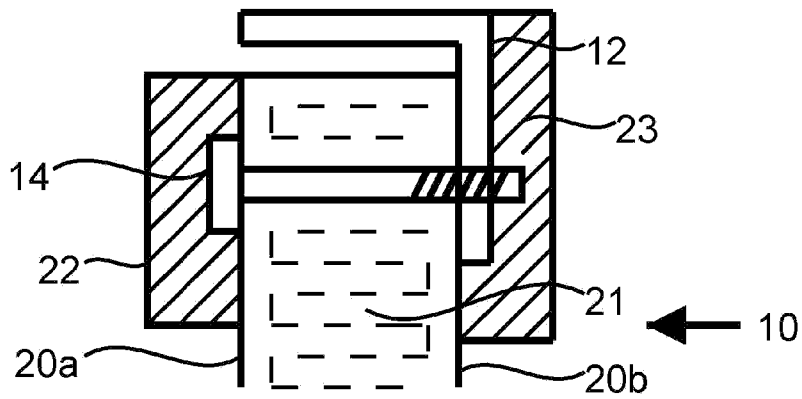
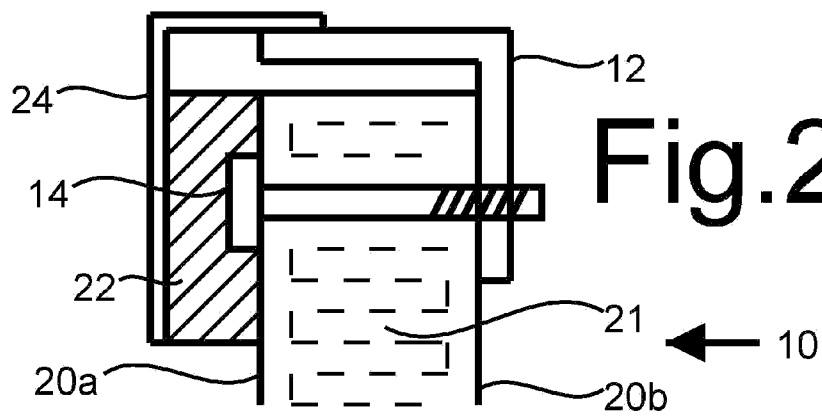


Fig.2b



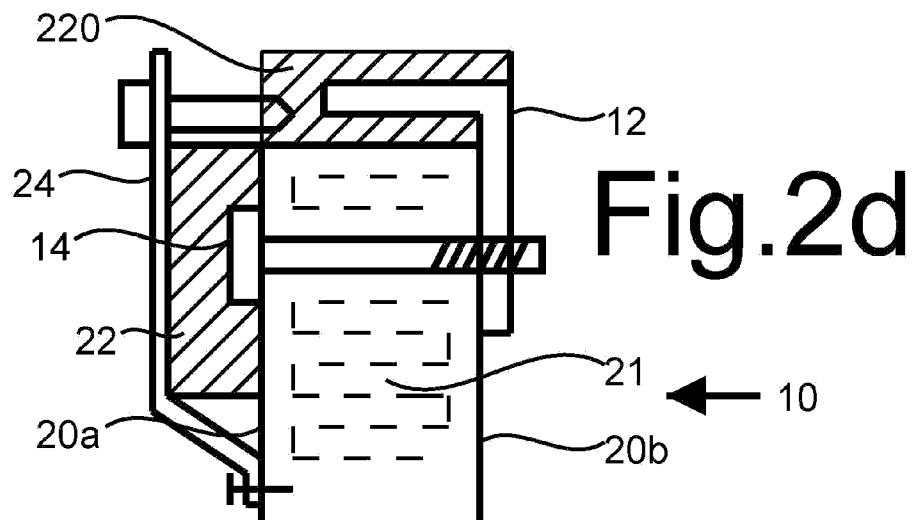
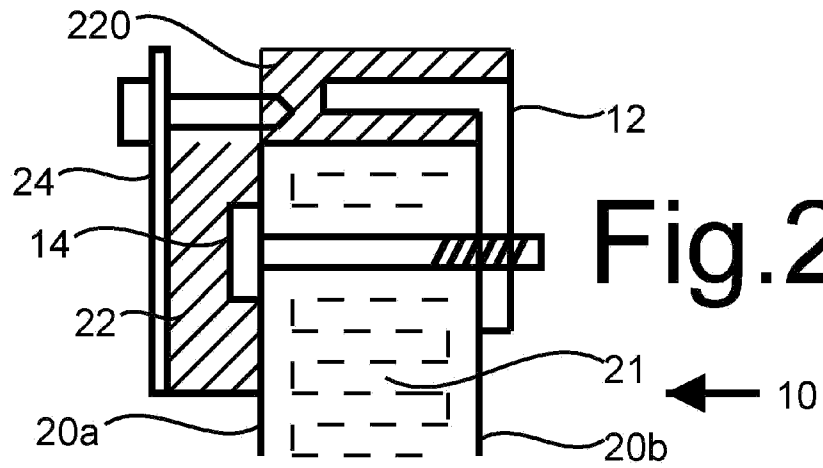


Fig.3

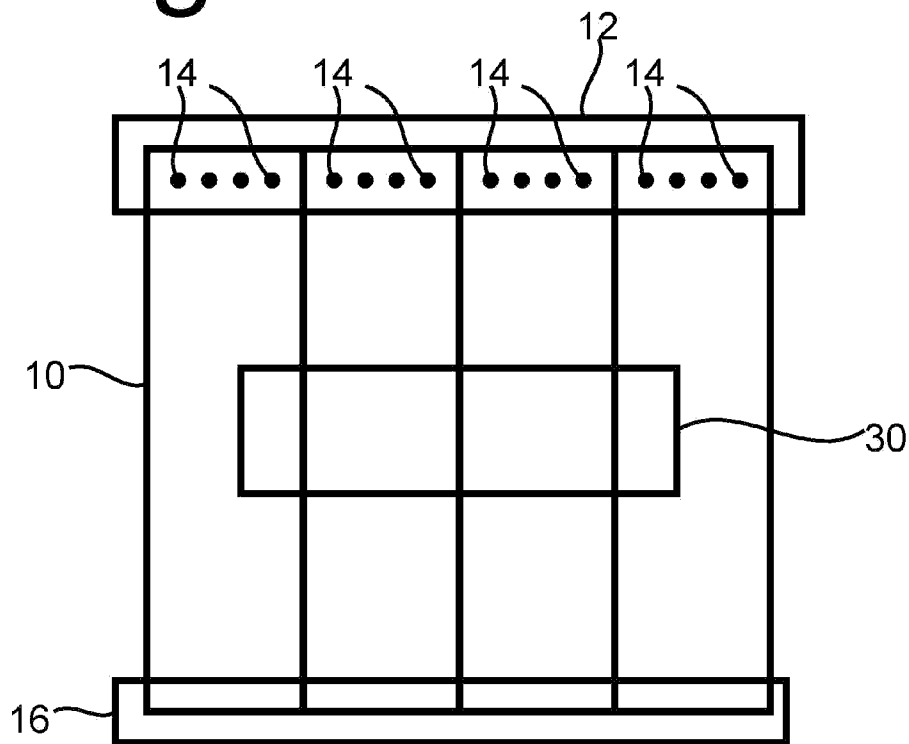


Fig.4

