

(19)



Europäisches Patentamt
European Patent Office
Office européen des brevets



(11)

EP 1 617 004 A2

(12)

EUROPEAN PATENT APPLICATION

(43) Date of publication:

18.01.2006 Bulletin 2006/03

(51) Int Cl.:

E04B 9/26 (2006.01)**E04B 9/24 (2006.01)**(21) Application number: **05447168.5**(22) Date of filing: **12.07.2005**

(84) Designated Contracting States:

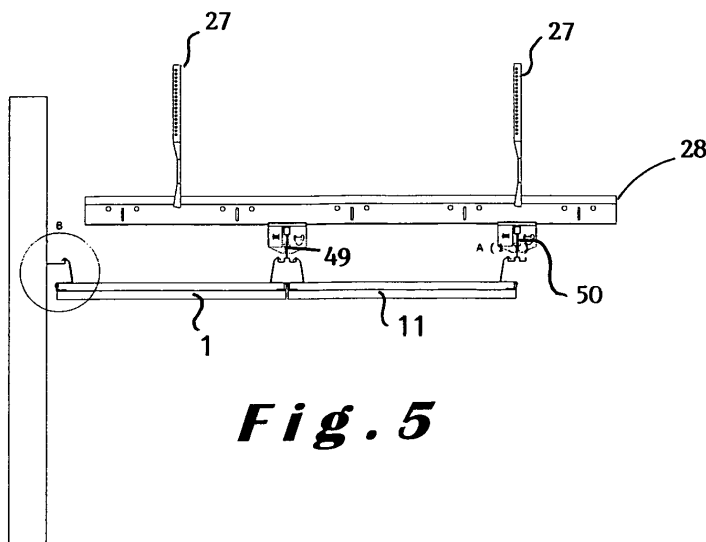
**AT BE BG CH CY CZ DE DK EE ES FI FR GB GR
HU IE IS IT LI LT LU LV MC NL PL PT RO SE SI
SK TR**

Designated Extension States:

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1831 Diegem (BE)**(54) **Suspended ceiling system**

(57) The present invention relates to a suspended ceiling comprising a suspension system with at least one carrier (49, 50), the suspended ceiling comprising at least one ceiling panel (1, 11, 51) connected to at least one spline (3, 23) for suspending the at least one ceiling panel to the at least one carrier, adjacent carriers defining between them a space (9) for receiving at least one ceiling panel between them. The spline extends in upright direction of the at least one ceiling panel and comprises on a first side first suspension means (2) for suspending the spline to the suspension system, and on a second side opposite the first side taken in height direction of the spline, at least one attachment member (10) for attachment of a first ceiling panel (1) to the spline in such a way that the ceiling panel is held and maintained by the at-

tachment member. The first suspension means (2) are disposed at a first distance $d1$ from the attachment member in height direction of the spline, which is sufficiently large to accommodate between the top face (12) of the first ceiling panel (1) and a bottom part (47) of the carrier (49, 50) at least part of a second ceiling panel (11) in upright direction of the second ceiling panel. The first suspension means (2) are disposed at a second distance $d2$ from the upright side of the first ceiling panel attached to the attachment member, which is sufficient to accommodate a part of the second ceiling panel (11) when attached to a second spline (23) in width direction of the ceiling panel to permit suspending the second ceiling panel between the first (1) and a third ceiling panel (51) positioned on opposite upright sides (4, 6, 14, 16) of the second ceiling panel.

**Fig. 5****EP 1 617 004 A2**

Description

[0001] The present invention relates to a suspended ceiling comprising a suspension system with at least one carrier, the suspended ceiling comprising at least one ceiling panel connected to at least one spline for suspending the at least one ceiling panel to the at least one carrier, adjacent carriers defining between them a space for receiving at least one ceiling panel between them, the at least one ceiling panel comprising a top face facing the suspension system, a bottom face opposite the top face and at least one upright side connecting the top and bottom face, the bottom face facing a space to be covered by the suspended ceiling, according to the preamble of the first claim.

[0002] From EP-A-690.183 a concealed suspended ceiling is known which is built up of a multiplicity of ceiling panels that are removably mounted into a suspension grid, opposite upright side walls of each ceiling panel having an upper and a lower part. The upper and lower part are separated from each other by means of a longitudinal groove. The suspension grid comprises a plurality of profiles. A part of each profile is provided to be received in a longitudinal groove of the ceiling panel. The longitudinal groove, and preferably the upper part of the edge of the upright side wall of the ceiling panel are made of an elastic, flexible material, which is capable of deforming when the profile is inserted between adjacent ceiling panels and the profile is pushed into the space formed by the grooves of adjacent panels. The upper part of the ceiling panel may remain deformed or take its original shape after the profile has been inserted.

[0003] The suspension system disclosed in EP-A-690.138 however has the disadvantage that it is only suitable for use with ceiling panels the upper part of which is deformable.

[0004] There is thus a need for a ceiling suspension system which is suitable for use with any type of ceiling panels, regardless of their density, regardless of the presence or absence of any elastic part.

[0005] It is therefore the object of this invention to provide a ceiling suspension system which is suitable for use with ceiling panels which may be made of any material, irrespective of its density or elasticity.

[0006] This is achieved according to the present invention with a suspended ceiling showing the technical features of the characterizing part of the first claim.

[0007] Thereto, the suspended ceiling of this invention is characterized in that the spline extends in upright direction of the at least one ceiling panel; in that the spline comprises on a first side first suspension means for suspending the spline to the suspension system, and on a second side opposite the first side taken in height direction of the spline, at least one attachment member for attachment of a first ceiling panel to the spline in such a way that the ceiling panel is held and maintained by the attachment member; in that the first suspension means are disposed at a first distance $d1$ from the attachment

member taken in height direction of the spline, which first distance $d1$ is chosen such that it is sufficiently large to accommodate between the top face of the first ceiling panel and a bottom part of the carrier to which the spline is suspended, at least part of a second ceiling panel in upright direction of the second ceiling panel; and in that the first suspension means are disposed at a second distance $d2$ from the upright side of the first ceiling panel which is attached to the attachment member, which distance $d2$ is sufficient to accommodate a part of the second ceiling panel when attached to a second spline in width direction of the ceiling panel in such a way as to permit suspending the second ceiling panel between the first and a third ceiling panel positioned on opposite upright sides of the second ceiling panel.

[0008] By defining

- the distance $d1$ such that it is sufficiently large to accommodate in upright direction of the spline, between the top face of the first ceiling panel and a bottom part of the carrier to which the spline is suspended, at least part of a second ceiling panel in thickness or upright direction of the second panel,
- and by defining the second distance $d2$ between the first spline and the upright side of the ceiling panel attached to the attachment member of the first spline such that the distance $d2$ is sufficient to accommodate on top of the first ceiling panel a part of a second ceiling panel attached to a second spline in width direction of the first ceiling panel,

mounting a single ceiling panel to and removing a single ceiling panel from the suspension system is facilitated, without substantially affecting the position of the other ceiling panels of the suspended ceiling, even in case the distance between adjacent ceiling panels is very small and is only sufficient for accommodating the material thickness of the splines attached to the sides of adjacent ceiling panels. In particular with three adjacent ceiling panels, it is permitted to remove the centrally positioned ceiling panel from its position without substantially affecting the position of the two remaining ceiling panels positioned on opposite sides of the central ceiling panel, even in case the distance between adjacent ceiling panels is only sufficient for accommodating the material thickness of the splines attached to the sides of adjacent ceiling panels. Similarly, the present invention permits mounting a ceiling panel in a space left between two ceiling panels positioned on opposite sides of that space. In particular, this permits inserting part of a ceiling panel with opposite sides attached to a spline, in the space left between a first spline attached to an adjacent first ceiling panel and the top face of that first ceiling panel, and thus permits suspending the ceiling panel with its second side opposite the first side to the carrier carrying a third ceiling panel.

[0009] Preferably at least one spline is attached to at least one upright side of the ceiling panel. More prefer-

ably, at least one spline is attached to each of the opposite upright sides of the ceiling panel.

[0010] A preferred embodiment of the suspended ceiling of the present invention permits suspending the ceiling panels in such a way that the suspension system remains hidden when viewed from a position below it, i.e. from the space to be covered by the suspended ceiling. Thereto, the suspended ceiling of this invention is characterized in that the at least one attachment member abuts against at least part of the top face of the ceiling panel and against at least part of an upright side face of the ceiling panel. Since the attachment member of the spline abuts against at least part of the top face and against at least part of an upright side face of the ceiling panel, an improved fit of the spline to the ceiling panel is guaranteed. Besides this it is ensured that connection of the ceiling panels to and positioning of the ceiling panels within the corresponding splines may always be done in the same way, which favors the geometric and aesthetic appearance of the suspended ceiling.

[0011] The attachment of the ceiling panels to the spline may be improved and an economically feasible system is provided with the preferred embodiment where the at least one attachment member comprises an abutment edge which comprises clamping means for clamping at least part of the top face and at least part of the upright side face of the ceiling panel into the abutment edge. Depending on the nature of the material of which the ceiling panel and the spline are made, a removable attachment of the ceiling panel to the spline may thereby be provided.

[0012] According to a preferred embodiment, the at least one spline is slideably mountable to the carrier over at least part of the length of the carrier. This is done to permit positioning of a multiplicity of ceiling panels from a more or less fixed position of the surface to be covered by the suspended ceiling. Or in other words, a first ceiling panel suspended to the suspension grid through its spline may be advanced by inserting a second ceiling panel to the suspension grid, which causes the first ceiling panel to slide over the suspension grid.

[0013] Attachment of the at least one ceiling panel to the corresponding spline is facilitated, strengthened and hidden from the space below the suspended ceiling with the technical feature that the clamping means comprise a first top flange abutting against at least part of the top face of the ceiling panel, a second side flange abutting against at least part of a side face of the ceiling panel, and a third flange which protrudes from the second flange towards the side face of the ceiling panel. Thereby the third flange may be provided to extend along at least part of the bottom face of the ceiling panel, in view of exerting a clamping action to the top and bottom face of the panel, or the third flange may be provided to be received within the interior of the ceiling panel in case it is to be hidden from a position below the suspended ceiling. In the latter case at least one of the upright sides, but preferably at least two opposite sides of the ceiling panel may contain

at least one groove for receiving the third flange.

[0014] In view of providing a suspended ceiling with an improved aesthetic appearance, in which the distance between adjacent panels may be controlled both in longitudinal and transverse direction of the panels, use can be made of an intermediate profile. In that case, facing side faces of adjacent panels connecting the upright sides which are attached to the corresponding splines, are provided to co-operate with a corresponding intermediate profile, which comprises a top flange abutting against the top face of the ceiling panel and a side flange abutting against at least part of a side face of the ceiling panel. The intermediate profile may further comprise a lower flange to be received within the interior of the panel or positioned in such a way that a clamping action is exerted to the top and bottom face of the ceiling panel, by the top and lower flange of the ceiling panel.

[0015] The present invention also relates to a ceiling panel for use in the above-described suspended ceiling.

[0016] The present invention further relates to a spline for use in the above-described suspended ceiling.

[0017] The present invention is further elucidated in the attached figures and description of the figures.

[0018] Figure 1a-d show a cross section of different embodiments of the spline for suspending a ceiling panel in the suspended ceiling system of this invention.

[0019] Figure 2a shows a view to an embodiment of the spline for use with ceiling panels made of a material with a high density. Figure 2b shows an alternative embodiment of the spline of the present invention.

[0020] Figure 3a and b show a view to a suspended ceiling of the present invention show from the side covered by it.

[0021] Figure 4a-e show a ceiling panel with different embodiments of attached splines.

[0022] Figure 5 shows a cross section of two adjacent ceiling panels, each attached to a corresponding spline, the splines being suspended to a suspension grid.

[0023] Figure 6 shows a view from the top to ceiling panels attached to splines suspended to a suspension grid.

[0024] Figure 7 is a cross section of a spline provided for suspending the ceiling system to an upright wall.

[0025] Figure 8a-f shows different stages in the mounting of the ceiling panels to a suspension grid.

[0026] Figure 9 shows a cross section of a panel having a spline attached to opposite upright sides.

[0027] Figure 10 shows possible embodiments of facing sides of ceiling panels.

[0028] A preferred embodiment of the ceiling suspension system of this invention is shown in figure 5 and 6.

[0029] In the suspended ceiling and suspension system shown in figure 5 and 6, a plurality of splines 3, 23 are suspended to a suspension grid comprising a multiplicity of main carriers 49, 50 suspended to a primary structure 28, which is suspended to the building construction by means of hangers 27. Within the framework of the present invention it is however also possible to di-

rectly suspend the carriers 49, 50 to the building construction without an interfering suspension grid. The carriers 49, 50 function as a means for suspending the ceiling panel 1, 11, 51 to the suspension grid by means of an interfering spline 3, 23. The main runner 28 may take any shape considered suitable by the person skilled in the art. The main runner 28 may for example take the form of the well known longitudinal main runners widely used in the art of suspended ceilings, the main runner may however also take the form of an individual hanger or a loop to which the carrier 49 is to be attached. In modern suspended ceilings there is a tendency to control the distance between adjacent ceiling panels, in such a way that it is virtually constant over the whole ceiling. Often there is even a tendency to keep the distance between adjacent ceiling panels as small as possible as this may improve the aesthetic appearance and assist in improving the heat resistance of the suspended ceiling.

[0030] Preferred embodiments of the ceiling panel 1, 11, 51 for use in the suspended ceiling of the present invention, are shown in figure 4a-e. As can be seen from these figures, each ceiling panel comprises a top face 12 facing the building construction, a bottom face 13 facing the space to be covered by the ceiling panel, two opposite upright longitudinal sides 4, 14 connecting the top and the bottom face, and two opposite upright transverse sides 6, 16 connecting the longitudinal sides 4, 14. The ceiling panels shown have a substantially rectangular shape. However, depending on the envisaged design of the ceiling, the ceiling panel may have any shape considered suitable by the person skilled in the art. The ceiling panel 1, 11 may for example also be substantially square or have the shape of a parallelogram, or any other shape as well. The at least one ceiling panel may be suspended to the carrier 49, 50 along either its transverse or longitudinal sides.

[0031] The at least one ceiling panel of the present invention is suspended to the ceiling suspension system by means of at least one spline 3, 23. A detailed construction of preferred embodiments of the spline is shown in figure 1a-d and 2a-b. Each spline 3, 23 comprises a longitudinally extending upright flange 21, a first end 31 of which is connected to suspension means 2 for suspending the spline 3, 23 to the carrier 49, 50. Usually a spline 3, 23 will be mounted to both opposite sides of a ceiling panel 1, 11 these may either be the transverse 6, 16 or longitudinal sides 4, 14 of the ceiling panel. It is however also possible to mount only a single spline 3 to one side of the ceiling panel, in particular for those panels that are to be positioned along the edges of the suspended ceiling.

[0032] The suspension means 2 may take any form considered suitable by the person skilled in the art as well. The suspension means may for example take the form of a hook-shaped flange or any other suitable form. It is however preferred that the suspension means 2 comprise a fourth and a fifth flange 24, 25 which are angled with respect to each other as is shown in figure 1 a-d,

and which are connected to each other in a top 43. With such a construction, the angle is provided to receive a corresponding upright flange of the carrier 28 to which the suspension means 2 are suspended. Thus, the suspension means 2 are confined in one single, unambiguous position, which permits to minimise the risk to the occurrence of small variations in the distance between adjacent ceiling panels due to an insufficient correct positioning. As a consequence, an improved control of the distance between adjacent panels is provided. The angled positioning of the flanges 24, 25 facilitates sliding of the spline over the carrier to which it is attached. This is important as the slideable mounting permits for example inserting ceiling panels with splines mounted thereto from one side or end of a ceiling suspension system and advancing already mounted ceiling panels by sliding them over the suspension grid as additional ceiling panels are added. The suspension means 2 are provided to suspend the at least one ceiling panel in upright direction of the ceiling panel.

[0033] A second end 32 of the upright flange 21 opposite the first end of the spline is connected to an attachment member 10. The attachment member 10 serves the function of permitting attachment of at least one ceiling panel 1, 11 to the spline 3, 23. Thereby, the first suspension means 2 are disposed at a first distance $d1$ from the attachment member 10 taken in height direction of the spline, which first distance $d1$ is chosen such that it is sufficiently large to accommodate between the top face 12 of the first ceiling panel 1 and a bottom part 47 of the carrier 49, 50 to which the spline is suspended, a second ceiling panel 11 in thickness direction of the second ceiling panel. Thereby, the upright flange 21 may extend virtually perpendicular with respect to the top face 17 of the attachment member 10, or it may slant somewhat. Often the slanting positioning is preferred as this provides resiliency between the attachment member and the upright flange and facilitates mounting and removing of the spline 3, 23 to the suspension grid.

[0034] Thus, the spline used in the suspended ceiling of this invention incorporates three functionalities:

1. it functions as a suspension means for suspending at least one ceiling panel to the suspension grid
2. it provides the possibility of moving a ceiling panel along the suspension grid by means of sliding
3. it functions as a holding means for holding and confining the ceiling panel in a well defined position within the attachment means contained in the spline.

[0035] The spline 3, 23, the suspension means 2, the upright longitudinal flange 21, the attachment member 10 may all run continuously over the entire length of the spline 3 as is shown in figure 4a. This type of spline will mostly be used with materials which involve a risk to deflection due to gravity. The spline 3, the suspension means 2, the upright longitudinal flange 21, the attachment member 10 may all have the same or a different

length. To facilitate mounting of the spline 3 to the carrier 49, 50 and to permit accommodating means 22 for suspending the carrier 49 to the suspension grid 28, it may be considered to cut part of the end part from the upright longitudinal flange 21 and the suspension means 2 of the spline (see figure 4a-4e and figure 6).

[0036] To mount a ceiling panel to the suspension grid, usually a first and a second spline will be mounted to respectively a first and a second opposite side face 4, 14, 6, 16 of the ceiling panel as is shown in figure 4a and figure 9. It is also possible to connect two or more ceiling panels to a single spline. It is further possible to suspend a ceiling panel using multiple splines 3, 23, 33 as is shown in figure 4b. In that case the length of the spline will usually be substantially smaller than the length of the side of the ceiling panel to which it is attached. Also in that case each spline 3, 23 will comprise an upright longitudinal flange 21 and suspension means 2, and attachment means 10 as is shown in figure 4c. This type of spline will mostly be used with ceiling panels showing a limited risk to deflection when suspended. For the sake of simplicity, strength and economic production, and to minimise the risk to deflection of the ceiling panel when suspended due to gravity forces, it is however preferred that the spline 3, the suspension means 2, the upright longitudinal flange 21 and the attachment member 10 of the spline run continuously over virtually the entire length of the ceiling panel.

[0037] The attachment member 10 permits attachment of one or more ceiling panels 1, 11, 51 to a spline 3 in such a way that the ceiling panel is held, maintained and supported by the spline 3 in a well defined, reproducible position. The holding function may be achieved in various ways known to the person skilled in the art. Possible embodiments of this holding function are shown in figure 1 a-d. The ceiling panel 1, 11 may be held by the attachment member 10 in a permanent manner, where removal of the panel cannot be done without substantially damaging the ceiling panel; the ceiling panel can however also be held in a removable manner by the attachment member 10.

[0038] In the preferred embodiment shown in figure 1a, the attachment member 10 comprises an abutment edge 20 which is provided to abut against the top face 12 of the ceiling panel and against at least one upright side face 4, 14, 6, 16 of the ceiling panel. The abutment edge 20 may for example be fastened to part of the top face 12 and/or upright side face 4, 6, 14, 16 of the ceiling panel by means of gluing, stapling, welding, bolting, or any other mechanical connection considered suitable by the person skilled in the art. Gluing may for example be recommendable with ceiling panels made of glass or plastic material. In that case a close fit of the top and side flange 17, 18 of the abutment edge to the top face and upright side face 12, 4, 6, 14, 16 of the ceiling panel to which the abutment edge is fastened, is important. The close fit ensures that a reproducible positioning of the ceiling panel within the spline may be achieved, so that

the ceiling panels of the suspended ceiling may be positioned at virtually the same distance from each other and the aesthetic appearance of the ceiling system may be improved. The embodiment shown in figure 1a, will mostly be used with ceiling panels made of a very high density, for example glass or expanded glass, or a material of a very low density. According to another embodiment, the abutment edge 20 may for example comprise multiple protrusions, which are provided to engage the material of the ceiling panel and in that way hold the ceiling panel attached to the spline 3. Depending on the nature of the material of which the abutment edge 20 and the ceiling panel 1, 11 are made, the protrusions may additionally be glued, welded or molten in the panel.

[0039] Optimum positioning and attachment of the ceiling panel to the spline 3, 23 is achieved with an abutment edge 20 which comprises clamping means for holding the ceiling panel in a clamped manner, the clamping means extending along at least part of the top face 12 and along part of the upright side face 4, 14, 6, 16 of the ceiling panel. The clamping action is a fourth function that may be exerted by the spline. Depending on the shape of the clamping means and the nature of the material of which the ceiling panel 1, 11 and the spline 3 are made, a removable mounting of the panel within the spline may be provided or not.

[0040] The clamping action is achieved with an abutment edge 20 which comprises a first top flange 17 provided to abut against at least part of the top face 12 of the ceiling panel. Usually the top flange 17 will abut only against a limited part of the top face 12, seen in the direction perpendicular to the direction in which the top flange extends. Or in other words, a top flange extending and being slideable in longitudinal direction of a ceiling panel, will extend over a limited distance in transverse direction of the panel. The abutment may be direct or indirect through the interference of one or more protrusions 34 protruding from the first flange 17 to the top face of the ceiling panel (fig. 1c). The abutment edge 20 further preferably comprises a second side flange 18 which is provided to abut against part of an upright side face 4, 6, 14, 16 of the ceiling panel or against the whole side face. The clamping abutment edge comprises a second upright flange 18 which extends along the upright side face of the ceiling panel. To provide the clamping function, the abutment edge 20 will usually comprise at least one third flange 19, which protrudes from the second side flange 18 towards the side face of the ceiling panel which is to be clamped within the abutment edge.

[0041] Thereby, the third flange may protrude into the upright side face 4, 6, 14, 16 of the ceiling panel, which extends along the second upright flange 18 of the abutment edge. The third flange 19 may for example run substantially perpendicular (fig. 1 b) with respect to the second flange 18, or extend under a smaller angle if an improved clamping is aimed at (fig. 1 c). In that case, depending on the nature of the material of which the ceiling panel is made, care should be taken that the force exerted

by the third flange to the material is not too high, as this may induce stresses in the material of the ceiling panel and damage the ceiling panel. The third flange 19 may as such also be bent or angled in longitudinal direction if an improved control of the clamping action is required as is shown in fig. 1 c. An angled third flange 19 will usually be clamped within the groove. The third flange 19 may for example also be toothed in longitudinal direction or comprise multiple protrusions along the longitudinal direction to facilitate insertion, especially in case the ceiling panel does not contain a groove (figure 2a). This type of attachment member is very suitable for use with high density materials such as for example wood or gypsum. It is particularly preferred that the third flange 19 is resiliently mounted with respect to the second flange 18 as in that way the clamping action exerted by the abutment edge 20 may be improved. The third flange 19 may further be connected to a fourth flange 39 which is folded back along at least part of the third flange and in that way provides a resilient member. In that way a kind of barb is provided, so that the attachment member can hardly be removed from the ceiling panel (fig 4d). The third flange 19 may as such be a resilient member as well. The third flange 19 may also extend at the position of the bottom face 13 of the panel 1, 11, so that the panel is clamped by the suspension means along part of its top and bottom face 12, 13. This will mostly be used with materials of very high density for example glass, or materials of very low density which get damaged when a flange protrudes into the interior of the material. The width of the top flange and the extent to which the top flange 17 of the abutment edge 20 is attached to the ceiling panel is not critical to the invention and will usually be adapted by the person skilled in the art, depending on the nature and weight of the material of the ceiling panel. Also the nature of the material of which the abutment edge 20 is made will usually be taken into account. The ceiling panel may be clamped within the attachment member over substantially its entire height as is shown in figure 1d or over a part of its height only as is shown in figures 1a-1c.

[0042] To facilitate attachment of the ceiling panel 1, 11 to the attachment means 10 and to provide a concealed suspended ceiling in which the suspension means are hidden from the space below the ceiling, the ceiling panel preferably comprises a first and a second groove 5, 15 in opposite upright sides 4, 14, 6, 16 of the panel. The grooves may either be provided in the longitudinal 4, 14 or transverse sides 6, 16 of the panel or in both (fig. 1c, 2b and 4a). It is however also possible to have ceiling panels that do not contain such grooves (fig. 1a, 1b, 1d, 4b, 4c). In case no groove is provided, the attachment means or part thereof may be attached to the top face 12 and/or the upright side face 4, 14, 6, 16 against which the attachment means 10 abut. It is also possible to use attachment means 10 having a third flange 19 which is provided to be driven into the material of the ceiling panel, in particular in the upright side face of the panel as is

shown in figure 1b, 4b. Especially in that case a close fit of the top flange and upright flange of the abutment edge to the top face and upright side face of the ceiling panel is required. This technique may for example be used with ceiling panels made of a soft material or for example of wood. In that case usually use will be made of a spline 3 as shown in figure 2a, where the protrusions 35 facilitate intrusion of the third flange 19 into the material of the ceiling panel.

[0043] It is however also possible to provide at least one groove 7, 8 in one or both transverse sides 6, 16 of the ceiling panel. This permits mounting the ceiling panels in multiple directions (figure 1c, 2b, 4a) or accommodating the third flange 19 of a spline in one pair of opposite grooves, and a further similar or different profile to be described below, in the other pair of opposite grooves.

[0044] The thickness of the ceiling panel 1, 11 will usually be chosen such that it is sufficiently large to accommodate the above-described groove or grooves 5, 7, 8, 15. The distance between each of the grooves 5, 7, 8, 15 and the top and bottom face 12, 13 of the ceiling panel may be the same or different. The distance between the transverse grooves 7, 8 and the top and bottom face 12, 13 may be the same or different as the distance between the longitudinal grooves 5, 15 and the top and bottom face of the ceiling panel, but is preferably the same to permit using the ceiling panels in any desired orientation. Each groove 5, 7, 8, 15 may extend over virtually the whole length of the side face of the ceiling panel into which it is provided, or over part of this length only. The length of the groove will usually be adapted to the length of the corresponding attachment member 10 of the spline 3 to be received in the groove. It is however preferred that each groove 5, 7, 8, 15 extends over the whole length of the side face of the ceiling panel into which it is provided, as this facilitates insertion of the spline 3 and minimizes the risk to damaging the ceiling panel. It is further remarked that the attachment member shown in figure 1a and 1d is particularly suitable for use with ceiling panels of a limited thickness, whereas the attachment member shown in figure 1b and 1c may only be used with ceiling panels having a sufficient thickness. Usual thicknesses for ceiling panels used in the art are standard thicknesses of 12 and 15 mm.

[0045] From the above given description it follows that the splines are hidden from the surface below the suspended ceiling, in case the third flange 19 of the spline 3 extends within the interior of the ceiling panel. Thus a concealed system is provided, which may look very monolithic if so desired. Thereby, the ceiling panels may be dimensioned such that the distance between adjacent panels is limited to the material thickness of the splines used to suspend the adjacent panels. The monolithic character of the suspended ceiling may be further improved by minimizing the distance between adjacent panels, for example by minimizing the material thickness of the abutment edge 20 and by using suspension means which fit as closely to the ceiling panel 1, 11 as possible.

In the above described system, facing sides of opposite ceiling panels are each attached to a spline. Each spline in turn is suspended, either in a direct manner to the building construction or through the intermediate of a suspension grid. From the above described construction of the splines it follows that along the sides of the ceiling panels bearing the spline, hardly any passage between the ceiling panels is left, so that access to the space between the ceiling panels and the building construction is severely hampered, thus providing a flame safe ceiling with improved heat and fire resistance. The heat and fire resistance may be adapted to any requirements by properly selecting the material of which the panels and the suspension means 2 are made.

[0046] In case the ceiling panel 1, 11 comprises at least one groove 5, 7, 8, 15 the top part 30 of the panel, i.e. the part of the panel located between the groove and the top face of the panel 12 may have the same or different dimensions as the bottom part 40 of the panel (see figure 10 a-c). This means that the top and bottom part 30, 40 may have the same or a different length and/or width. This technical feature may for example be used to provide visible grooves between adjacent panels at the visible side of the suspended ceiling, for example for aesthetic reasons or to provide illumination. Those grooves may extend either in longitudinal or transverse direction of the ceiling only, or in both directions (figure 10).

[0047] Depending on the density of the material of which the ceiling panels 1, 11 are made, the spline 3, in particular the first, second and third flange 17-19 of the spline may have the same length, a smaller or a substantially smaller length as compared to the side 4, 6, 14, 16 of the panel to which it is attached. A spline 3 may either be attached to both longitudinal sides 4, 14 of the ceiling panel or to the transverse sides 6, 16. An improved rigidity, with a minimum risk to deflection of the ceiling panels is however obtained with a first, second and third flange 17-19 having substantially the same length as the upright side 4, 14, 6, 16 of the ceiling panel to which they are attached. With such a construction, optimum leveling of the ceiling panels is achieved, the spline being capable of compensating plastic deformation or deflection of the ceiling panel carried by it. Within the framework of this invention, it is possible to attach multiple splines 3 to one upright side 4 of the single ceiling panel as is shown in figure 4b. Within the framework of this invention, it is also possible to attach to a single spline an upright side of a single ceiling panel or two or multiple ceiling panels. It is however preferred to attach only one single ceiling panel 1, 11 to a spline 3 as this improves the versatility of the system and maximizes design possibilities. Attachment of one single panel will also be preferred for ceiling panels made of a heavy or pliable material, as an improved support is provided. For aesthetic reasons, for example facing bottom edges at a side of the ceiling panel remote from the ceiling suspension system, may be chamfered. It is also possible to cut an edge from the bottom face and part of the upright side face of facing sides of adjacent

panels. This may be of particular importance in case the level in height direction of the ceiling between adjacent panels for one reason or another may vary somewhat. The visibility of such varying level may be reduced by the chamfered edges.

[0048] To improve the monolithic character of the suspended ceiling of this invention and to improve the fire resistant properties of the ceiling, facing side faces 6, 16, 36 of adjacent panels 1, 11 which connect the upright sides 4, 14 to which the splines 3 are attached, preferably have complementary engaging surfaces. This may be achieved in different ways. For example facing side faces of adjacent panels connecting the upright sides attached to the corresponding splines, may have complementary stepped surfaces. According to another embodiment, facing side faces of adjacent panels connecting the upright sides attached to the corresponding splines, are provided to co-operate with a corresponding intermediate profile. Such a profile, may similarly to the spline 3 comprise a top flange abutting against the top face 12 of the ceiling panel and a side flange butting against at least part of a side face of the ceiling panel 11. The intermediate profile may further comprise a flange to be received in a clamped manner in a corresponding groove provided in the side of the ceiling panel against which the abutment edge is abutting. The intermediate profile may also take the form of a flange that is received in facing grooves of facing upright sides of facing ceiling panels or any other suitable flange known to the skilled artisan.

[0049] Positioning of the intermediate profile may be improved by the presence of at least one ridge 29 in spline 3, 23 which protrudes from a bottom face of the first top flange 17 towards the top face 12 of the ceiling panel (figure 2b). This ridge may take the form of a multiplicity of small members provided at specific positions of the flange 17, or of one single member positioned at a fixed distance from the end part of the flange 17. Due to the presence of this ridge, flange 17 is locally lifted from the top face 12 of the panel, and permits insertion of a flange of the intermediate profile between the top face 12 of the ceiling panel and the first top flange 17 of the abutment edge. The distance over which the flange of the intermediate profile may be moved or inserted in the space between the top face 12 of the ceiling panel and the spline 3, 23 is limited by the ridge 29. The presence of this intermediate profile permits controlling the positioning of the ceiling panels in all directions, also in the direction perpendicular to the suspending direction of the ceiling panel, it minimizes the risk to the occurrence of slits, it permits to virtually completely close the ceiling system and improve the fire resistance and to minimise the risk that illumination of the plenum above the ceiling would be visible at a position below the ceiling, and the reverse.

[0050] As can be seen from figure 1c and figure 4a, the upright second flange 18 and the upright flange of the intermediate profile may comprise at least one notch which protrudes from the flange towards an adjacent panel. Preferably notches on facing flanges are positioned

in such a way that they take corresponding positions to touch one another. By giving facing notches co-operating, engaging surfaces, an additional fixation of the position of adjacent panels is provided, which permits to position adjacent panels at fixed positions with respect to each other in longitudinal direction of the spline. The engagement is preferably releasable. In stead of co-operating engaging notches however, each notch on a first spline may be provided to engage a recess on a second facing splines. In that case the distance between adjacent panels may be limited to the material thickness of the spline or the off-set distance of the spline as is shown in fig. 1c.

[0051] The above described suspension means 2 or intermediate profile may also be used for suspending panels extending along a wall or beam, to that wall or beam, as is for example shown in figure 5 and 7. The suspension may be direct or indirect by means of an interfering carrier, generally known to the skilled person.

[0052] The ceiling panels used in the suspended ceiling of the present invention can be made of a single material or of a plurality of materials. They can be made of a single layer or multiple layers adhered to each other. The ceiling panel of this invention can be made of any material considered suitable by the person skilled in the art, for example wood, cement, plastic, fibrous reinforced plastic, gypsum, glass or any other material or combination of materials.

[0053] In the embodiment shown in the figures described above, the ceiling panels are provided to be slideable in the direction in which the spline 3, 23, 33 extends. Within the framework of this invention, the spline 3, 23, 33 may however also be designed in a way that it is slideable in a direction perpendicular to the direction in which it extends. This embodiment, where the spline is slideable in the direction of the arrow, is shown in figure 2b. Recess 37 is provided to receive an edge of the carrier in a direction perpendicular to top flange 41. Flange 42 is provided to run parallel with and to contact the carrier and to function as a kind of sliding guiding.

[0054] Thus, with the present invention a suspended ceiling is provided which comprises a multiplicity of ceiling panels, whereby a next ceiling panel is capable of advancing a previously inserted ceiling panel by means of a sliding movement. Thus, a limited number of mounting positions is needed to insert the panels. The panels may be positioned in line, in a staggered configuration or any other desired configuration. The suspended ceiling may be conveniently formed as a substantially flat ceiling extending at one single level or multiple levels. However, opposite sides of a ceiling panel may be positioned at different levels and thus permit constructing a waved or rounded ceiling.

[0055] Mounting of the panels to a suspension grid is done as is shown in figure 8a-f. As can be seen from figure 8a, a first and third panel 1, 51 have been mounted to opposite first and second main carriers 49, 50. A first spline 3 of the panel to be inserted, is mounted to a first

longitudinal side 4 of panel 1, a second spline 23 is mounted to a second longitudinal side 14 of panel 1, opposite the first longitudinal side 4. The abutment edge 20 of the spline 3 abuts against part of the top and side face 12, 13 of the panel 1. In the grooves 5, 15 provided on opposite longitudinal sides 4, 14, each time a third flange 19 of splines 3, 23 is received.

[0056] In figure 8b and 8c part of a first side of panel 1 is inserted

- in thickness direction in the space $d1$ left between the top face 12 of adjacent panel 11 and a bottom side 47 of the carrier 49 to which the adjacent panel is connected
- and in width direction in the space $d2$ between the upright side face 14 of the adjacent panel and the spline 3 attached to the adjacent panel

in such a way that spline 23 mounted to the opposite second side of panel 1 may be suspended to carrier 50. After the first side of the ceiling panel 11 has been inserted in $d1$ and $d2$ of the adjacent ceiling panel 1, spline 23 is lifted to a position above the upright flange of carrier 50, and lowered until the upright flange 46 of carrier 50 is received within the edge formed by flange 24 and 25 of the spline 23. At that point upright side face 14 of panel 1 runs along upright side face 4 of adjacent panel 11 (fig. 8e). Simultaneously, spline 3 mounted to the first side of panel 1 is lowered and suspended to carrier 49 in a similar manner, whereby upright side face 4 of panel 1 runs along upright side face 14 of adjacent panel 11.

[0057] Removal of a panel from the ceiling can be done, by applying the above described steps in the reversed order.

[0058] After having mounted panel 1 as described above, panel 1 may be displaced over carriers 49 by sliding the edges 24, 25 on opposite sides of the panel over the upright flanges of main carrier 49 in longitudinal direction of the spline 3, 23 and the carrier 49, 50. In that way space may be created for inserting one or more further panels from the same position. As can be seen from figure 3a and 3b, panels of adjacent rows may take any position with respect to each other. They may be aligned or take a staggered position or any position between those. By varying the distance between opposite carriers 49, the appearance of the ceiling may be further changed. For example in a first row panels may be suspended along their longitudinal sides to the carriers 49, whereas in an adjacent row they are suspended with their transverse sides. Within one row, panels may be used which have the same or a different dimension in the sliding direction of the panel. By varying the distance between the main carriers, adjacent rows may be created which are suitable for accommodating panels having different dimensions.

Claims

1. A suspended ceiling comprising a suspension system with at least one carrier (49, 50), the suspended ceiling comprising at least one ceiling panel (1, 11, 51) connected to at least one spline (3, 10, 17-20) for suspending the at least one ceiling panel to the at least one carrier, adjacent carriers defining between them a space (9) for receiving at least one ceiling panel between them, the at least one ceiling panel comprising a top face (12) facing the suspension system, a bottom face (13) opposite the top face and at least one upright side (4, 6, 14, 16) connecting the top and bottom face, the bottom face (13) facing a space to be covered by the suspended ceiling, **characterised in that** the spline (3) extends in upright direction of the at least one ceiling panel (1, 11, 51); **in that** the spline (3) comprises on a first side first suspension means (2) for suspending the spline to the suspension system, and on a second side opposite the first side taken in height direction of the spline, at least one attachment member (10) for attachment of a first ceiling panel (1) to the spline in such a way that the ceiling panel is held and maintained by the attachment member; **in that** the first suspension means (2) are disposed at a first distance $d1$ from the attachment member (10) taken in height direction of the spline, which first distance $d1$ is chosen such that it is sufficiently large to accommodate between the top face (12) of the first ceiling panel (1) and a bottom part (47) of the carrier (49, 50) to which the spline is suspended, at least part of a second ceiling panel (11) in upright direction of the second ceiling panel; and **in that** the first suspension means (2) are disposed at a second distance $d2$ from the upright side of the first ceiling panel which is attached to the attachment member, which distance $d2$ is sufficient to accommodate a part of the second ceiling panel (11) when attached to a second spline (23) in width direction of the ceiling panel in such a way as to permit suspending the second ceiling panel between the first (1) and a third ceiling panel (51) positioned on opposite upright sides (4, 6, 14, 16) of the second ceiling panel.
2. A suspended ceiling as claimed in claim 1, **characterised in that** the at least one attachment member (10) comprises an abutment edge (20) which is provided to abut against at least part of the top face (12) and at least one upright side face (4, 14) of the ceiling panel.
3. A suspended ceiling as claimed in claim 1 or 2, **characterised in that** the abutment edge (20) comprises clamping means for clamping the ceiling panel along at least part of the top face (12) and part of the upright side face (4, 14) of the ceiling panel.
4. A suspended ceiling as claimed in claim 3, **characterised in that** the clamping means comprise a first top flange (17) abutting against the top face (12) of the ceiling panel, a second side flange (18) abutting against at least part of a side face of the ceiling panel (4, 14, 6, 16).
5. A suspended ceiling as claimed in claim 4, **characterised in that** the clamping means further comprise a third flange (19) which protrudes from the second flange (18) at a position which corresponds to the bottom face (13) of the ceiling panel, and is provided to clamp the at least one ceiling panel between the first top flange (17) and the third bottom flange (19) along part of respectively the top and bottom face of the ceiling panel (12, 13).
6. A suspended ceiling as claimed in claim 4, **characterised in that** the clamping means further comprise a third flange (19) which protrudes from the second flange (18) towards the panel and is provided to be received within an interior part of the panel, at a position between the top and bottom face of the ceiling panel (12, 13).
7. A suspended ceiling as claimed in claim 6, **characterised in that** at least one upright side face of the ceiling panel comprises at least one groove (5, 7, 8, 15) at a position between the top and bottom face (12, 13) of the panel for receiving the third flange (19), in view of clamping the ceiling panel within the clamping means between at least part of the top face of the ceiling panel and the at least one groove.
8. A suspended ceiling as claimed in claim 7, **characterised in that** the at least one groove (5, 6, 15, 16) extends over a substantial length of the side face of the ceiling panel and **in that** the clamping means (17-19) extend over a substantial length of the groove (5, 15).
9. A suspended ceiling as claimed in claim 8, **characterised in that** the third flange (19) is connected to the second flange (18) in a resilient manner.
10. A suspended ceiling as claimed in any one of claims 1-9 **characterised in that** the spline comprises an upright flange (21) connecting the suspension means (2) and the attachment member (10), the upright flange being resiliently mounted with respect to the attachment member.
11. A ceiling suspension system as claimed in any one of claims 1-10, **characterised in that** the at least one spline (3, 23) is slideably mountable to the carrier (49, 50).
12. A ceiling suspension system as claimed in claim 11,

characterised in that the at least one spline (3, 23) is slideable in a direction parallel to or perpendicular to the longitudinal direction of the spline.

13. A suspended ceiling as claimed in any one of claims 1-12, **characterised in that** the suspension means (2) are provided to suspend the at least one ceiling panel in upright direction of the ceiling panel.
14. A suspended ceiling as claimed in any one of claims 1-13, **characterised in that** the suspension means (2) comprise a first and a second flange (24, 25) which slant with respect to each other and are connected to each other along a top (43), the top (43) being provided to receive an upright edge (46) of the at least one carrier (49, 50) to control sliding of the spline (3, 23) over the carrier (49, 50).
15. A ceiling suspension system as claimed in any one of claims 1-14, **characterised in that** at a bottom side (13) of the ceiling panel remote from the ceiling suspension system, facing bottom edges of facing ceiling panels are chamfered.
16. A suspended ceiling as claimed in any one of claims 1-15, **characterised in that** all ceiling panels have the same or a different length.
17. A suspended ceiling as claimed in any one of claims 1-16, **characterised in that** all ceiling panels have the same or a different width.
18. A suspended ceiling as claimed in any one of claims 1-17, **characterised in that** opposite first and second upright side faces (4, 14, 6, 16) of the at least one ceiling panel are connected to respectively at least one first and at least one second spline (3, 23).
19. A suspended ceiling as claimed in any one of claims 1-18, **characterised in that** facing side faces (6, 16, 36) of adjacent panels (1, 11, 51) connecting the upright side faces (4, 14) to which the corresponding splines (3) are attached, have complementary engaging surfaces.
20. A suspended ceiling as claimed in any one of claims 1-19, **characterised in that** facing side faces (5, 15) of adjacent ceiling panels (1, 11, 51) connecting the upright sides faces (4, 14) to which the corresponding splines (3) are attached, have complementary stepped surfaces.
21. A suspended ceiling as claimed in any one of claims 1-19, **characterised in that** facing side faces (5, 15) of adjacent ceiling panels (1, 11, 51) connecting the upright side faces (4, 14) to which the corresponding splines are attached, are provided to co-operate with a corresponding intermediate profile comprising a

top flange abutting against the top face (12) of the ceiling panel and a side flange abutting against at least part of a side face of the ceiling panel.

22. A suspended ceiling as claimed in claim 21, **characterised in that** the intermediate profile further comprises a protruding flange which protrudes from the side flange towards the side face (5, 15) of the panel against which the side flange is abutting, to be received within the interior of the panel.
23. A suspended ceiling as claimed in claim 22, **characterised in that** the protruding flange is provided to be received in a clamped manner in a corresponding groove provided in the side of the ceiling panel against which the side flange is abutting.
24. A suspended ceiling as claimed in claim 23, **characterised in that** the abutment edge (22) of the at least one spline comprises a ridge (29) protruding from a bottom face of the abutment edge of the first top flange (17) facing the ceiling panel onto the top face (12) of the ceiling panel, which ridge is provided at a distance d3 from the end part of the first top flange (17) which is sufficient to accommodate between the ridge and the end part of the first top flange, the intermediate profile in a direction perpendicular to the direction into which the spline extends.
25. A suspended ceiling as claimed in any one of claims 1-24, **characterised in that** first and second splines mounted to facing sides of the first and second ceiling panel each comprise at least one co-operating notch and recess which are provided to engage each other in pre-defined positions of the first and second spline.
26. A suspended ceiling as claimed in any one of claims 1-25, **characterised in that** adjacent ceiling panels are positioned at a distance which is sufficient to accommodate the material thickness of a first and a second spline attached to facing sides of adjacent ceiling panels.
27. A suspended ceiling as claimed in any one of claims 1-26, **characterised in that** adjacent ceiling panels are positioned at a distance which is virtually equal to the material thickness of a first and a second spline attached to facing sides of adjacent ceiling panels.
28. A ceiling panel for use with the suspended ceiling as claimed in any one of claims 1-27.
29. A spline for use with the suspended ceiling as claimed in any one of claims 1-26.

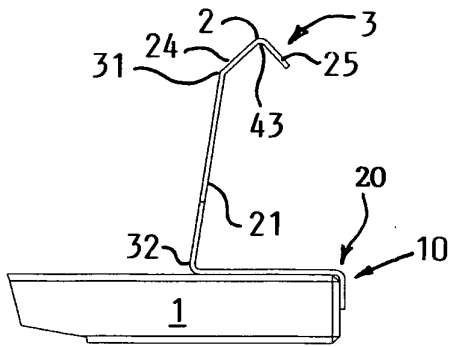


Fig. 1a

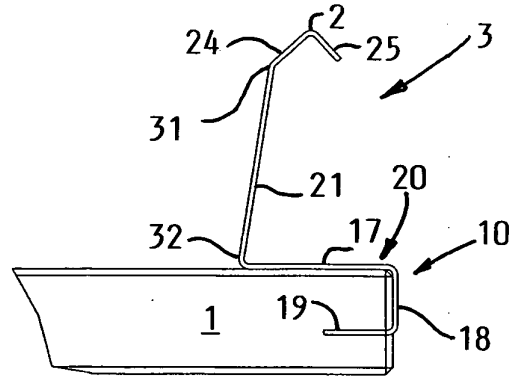


Fig. 1b

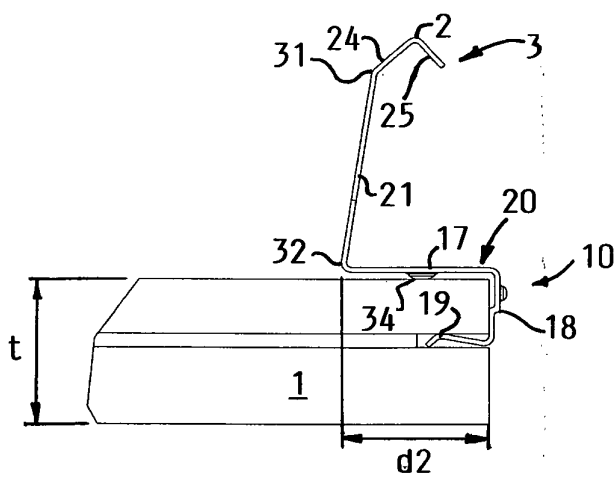


Fig. 1c

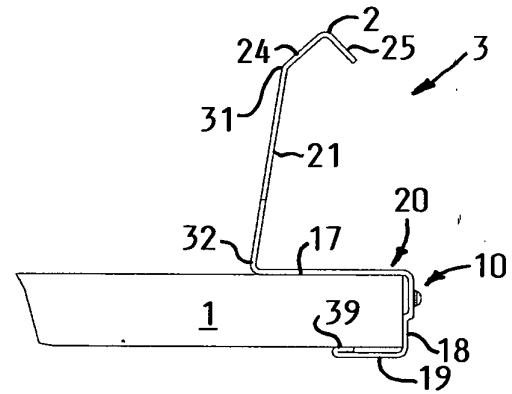


Fig. 1d

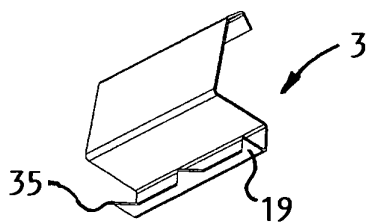


Fig. 2a

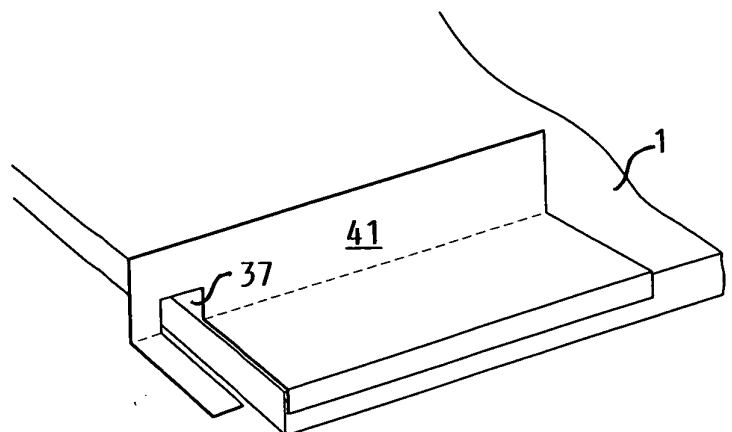


Fig. 2b

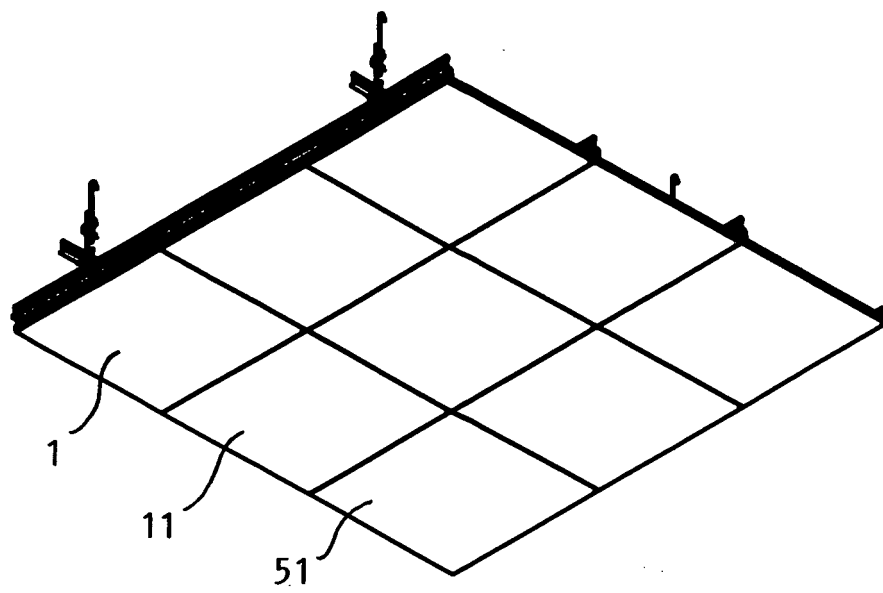


Fig. 3a

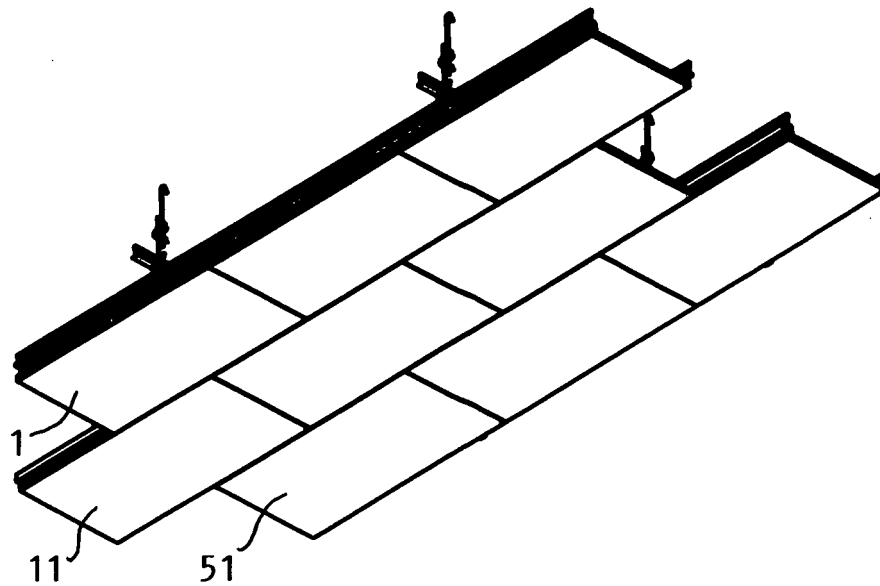
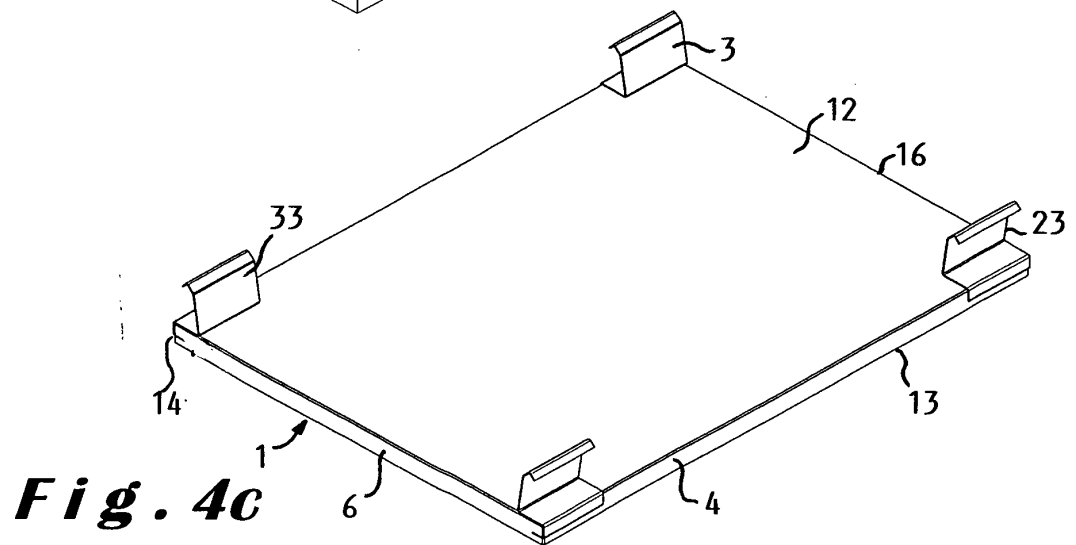
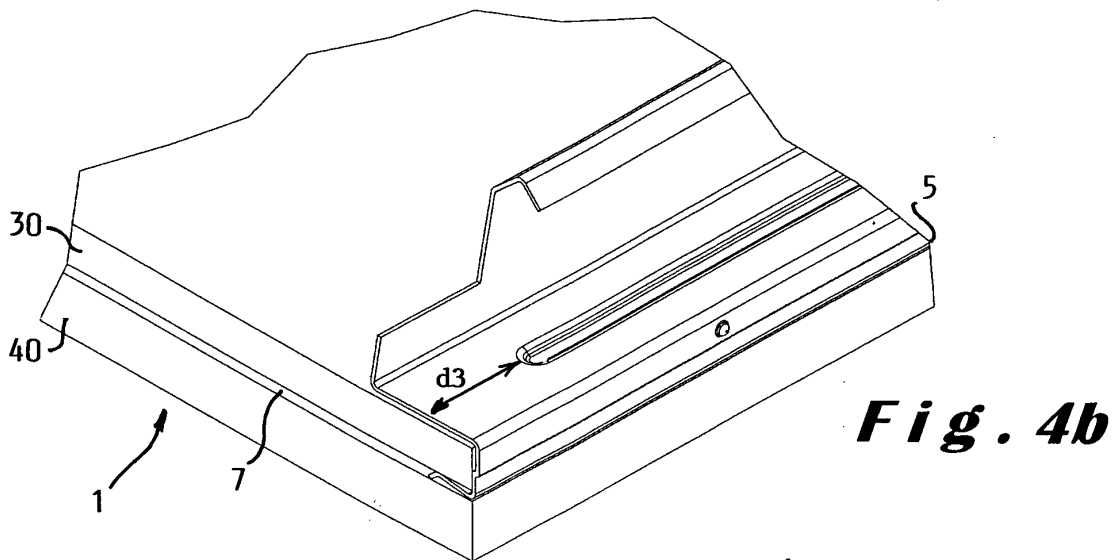
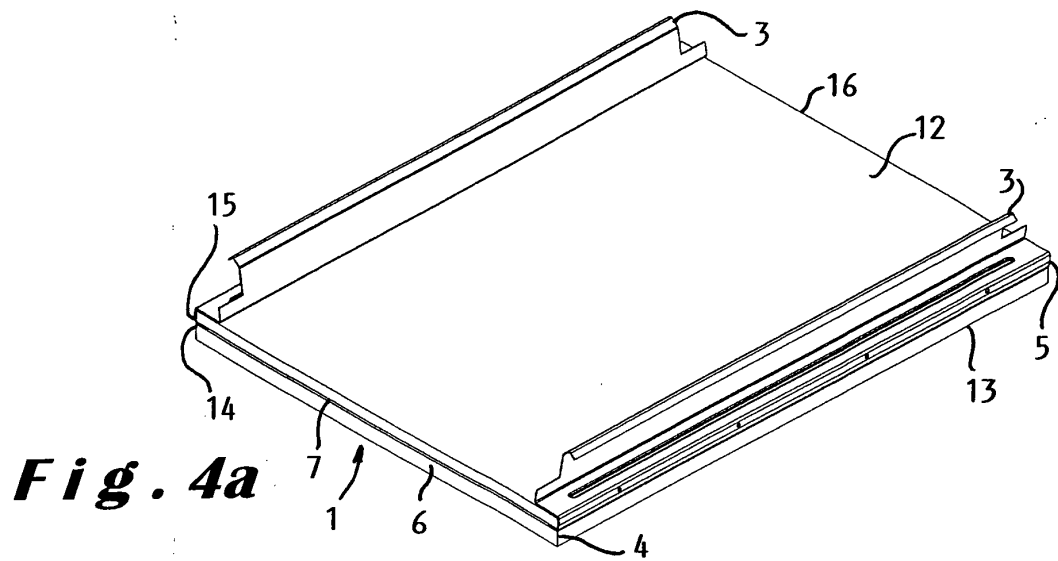


Fig. 3b



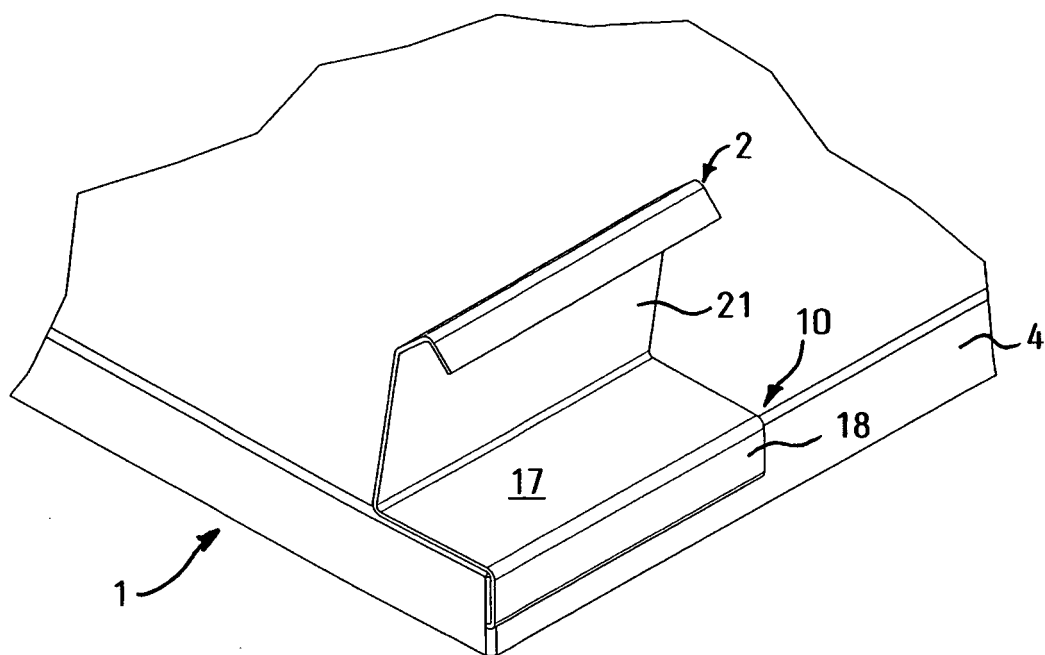


Fig. 4d

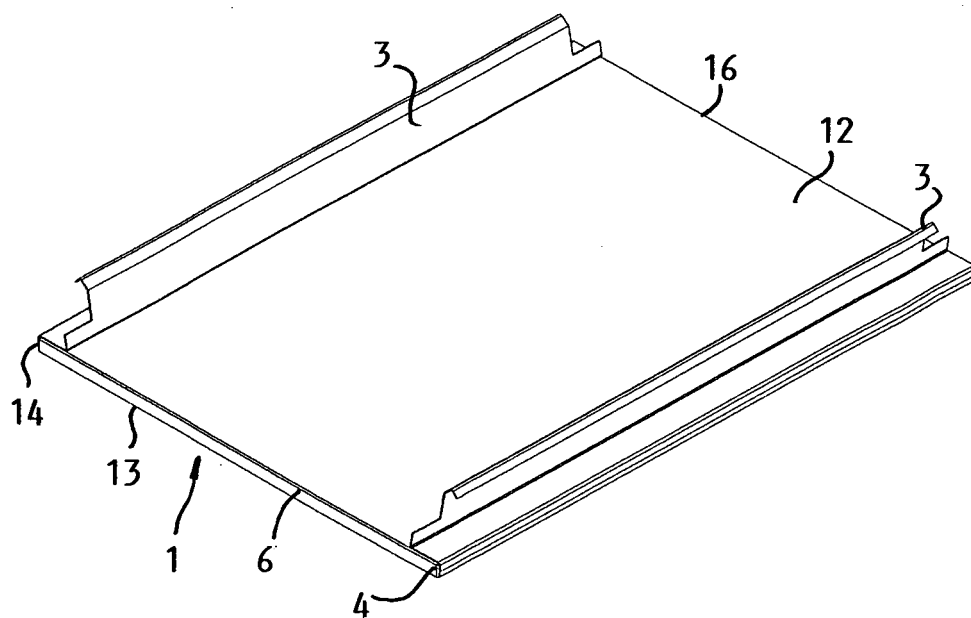
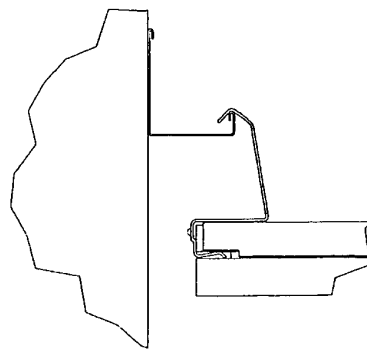
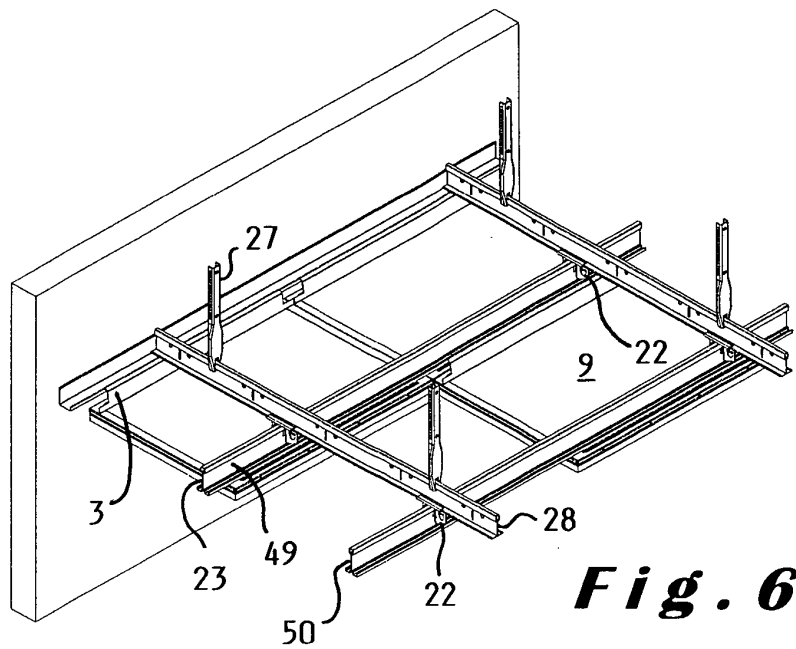
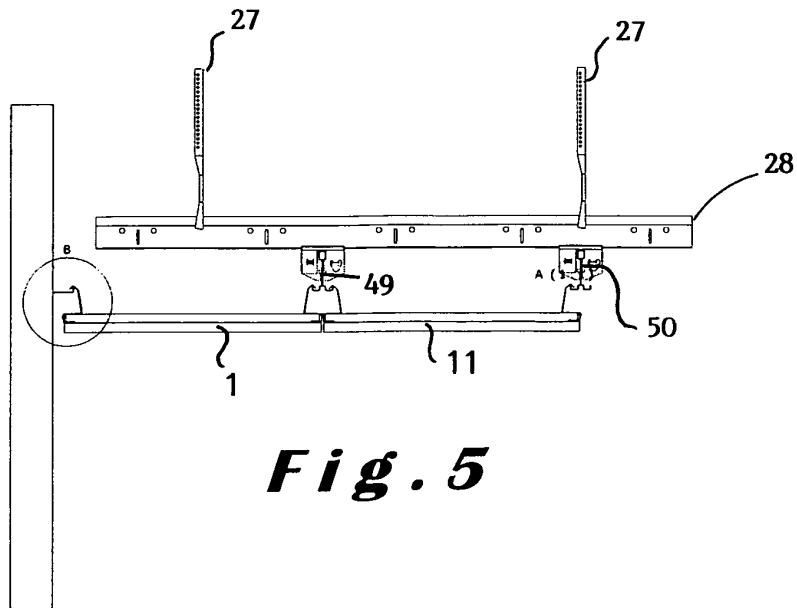


Fig. 4e



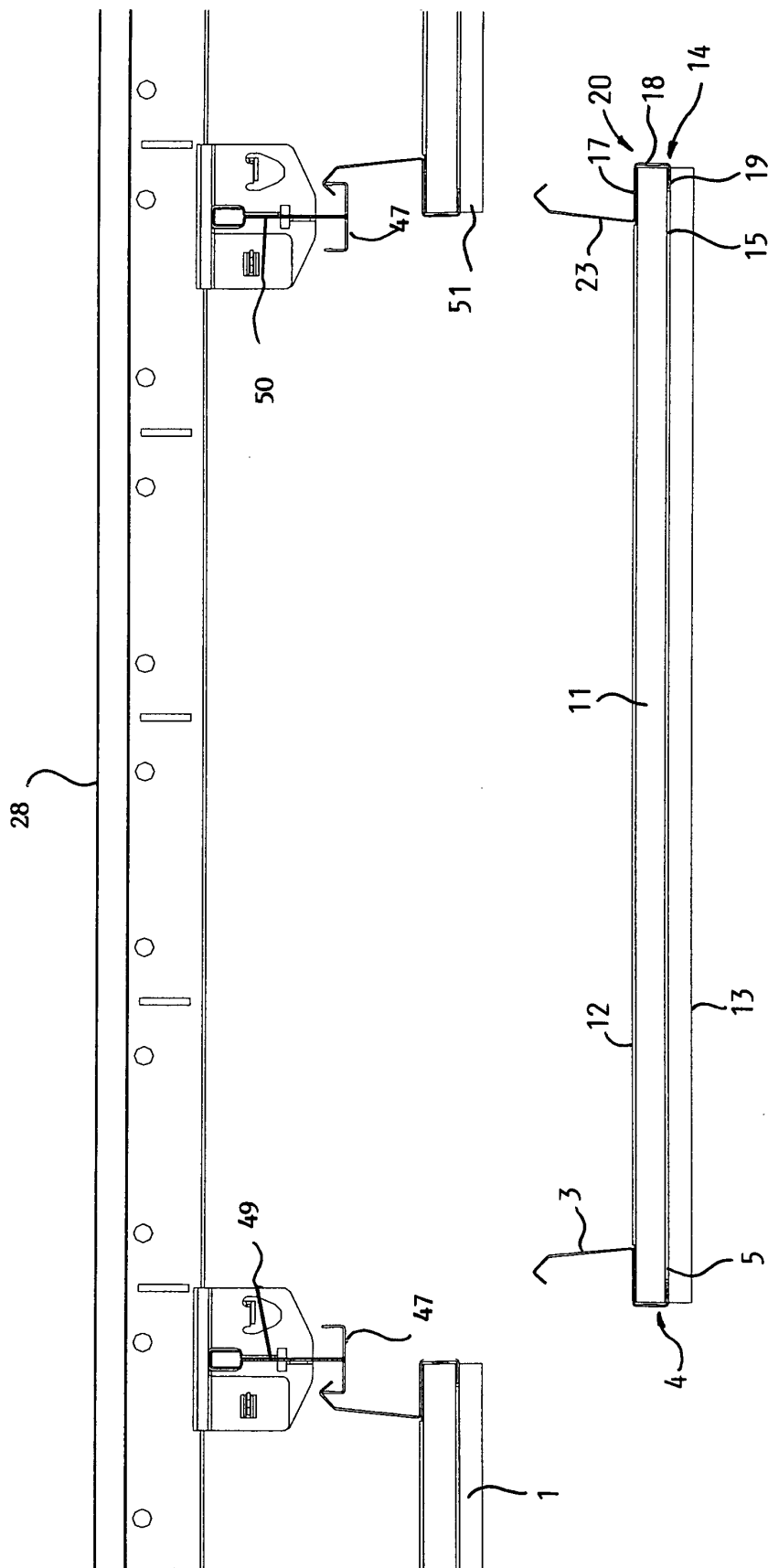


Fig. 8a

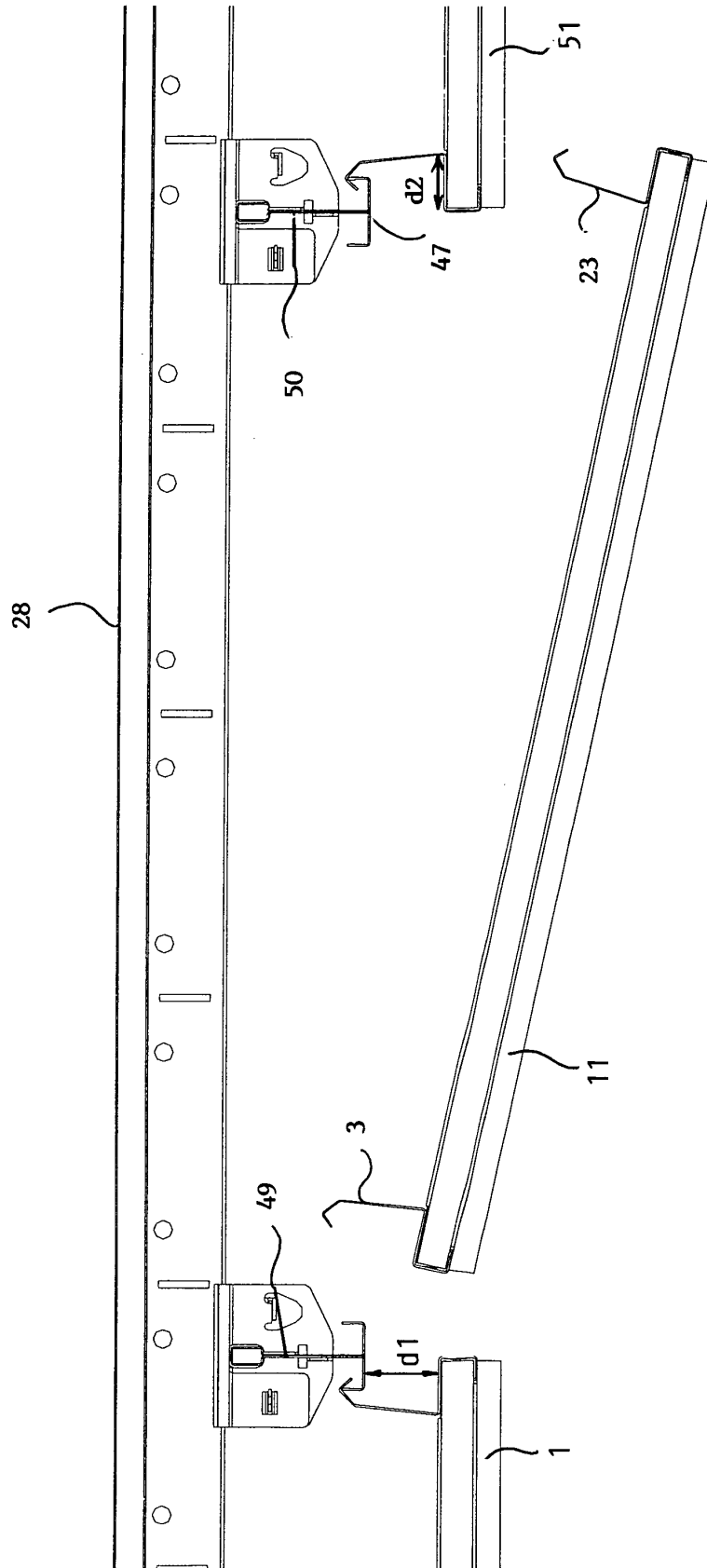


Fig. 8b

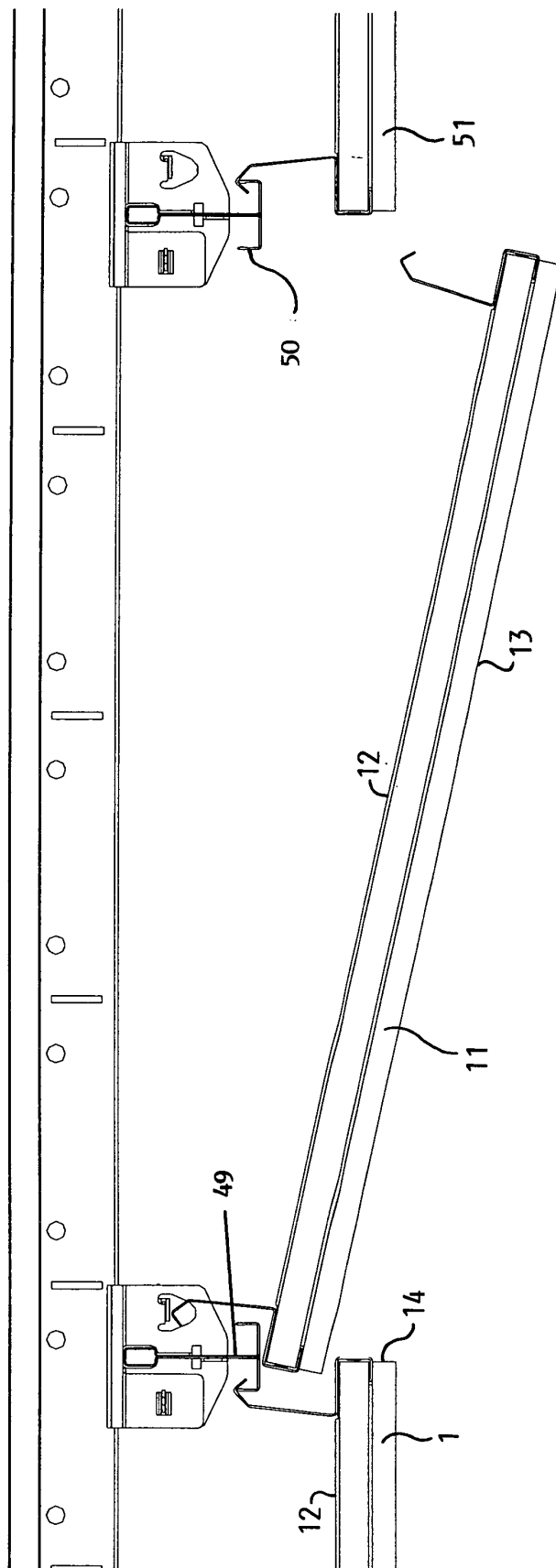


Fig. 8C

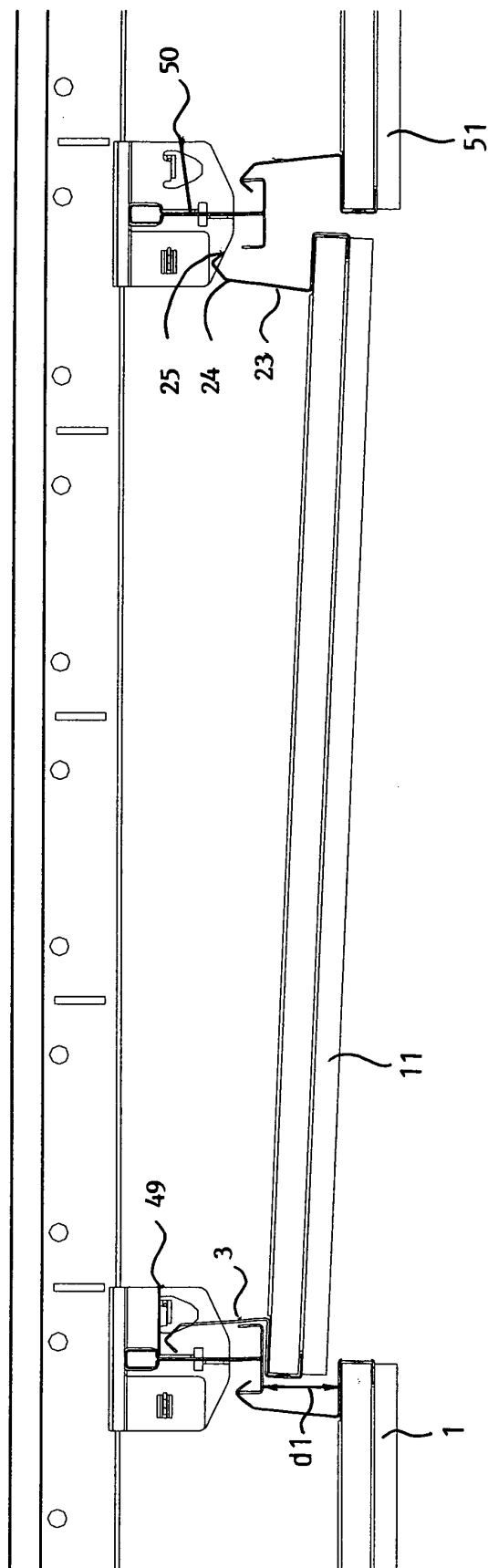


Fig. 8d

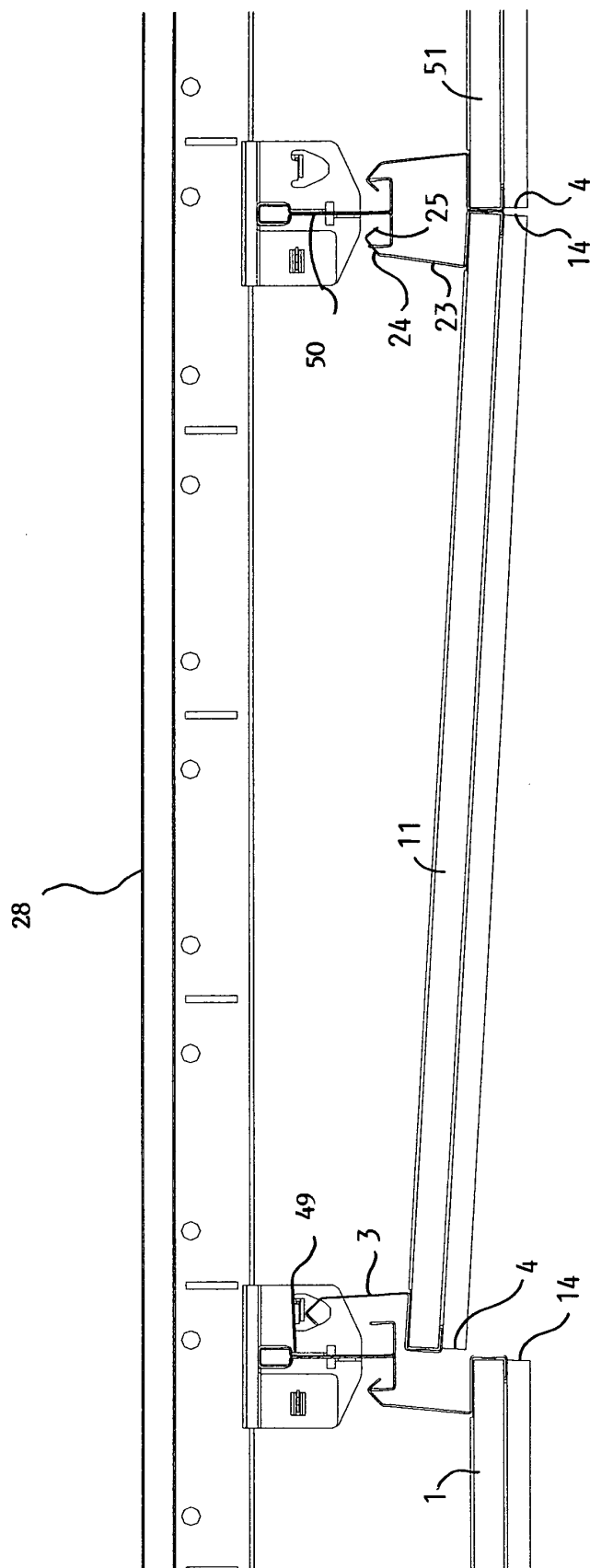


Fig. 8e

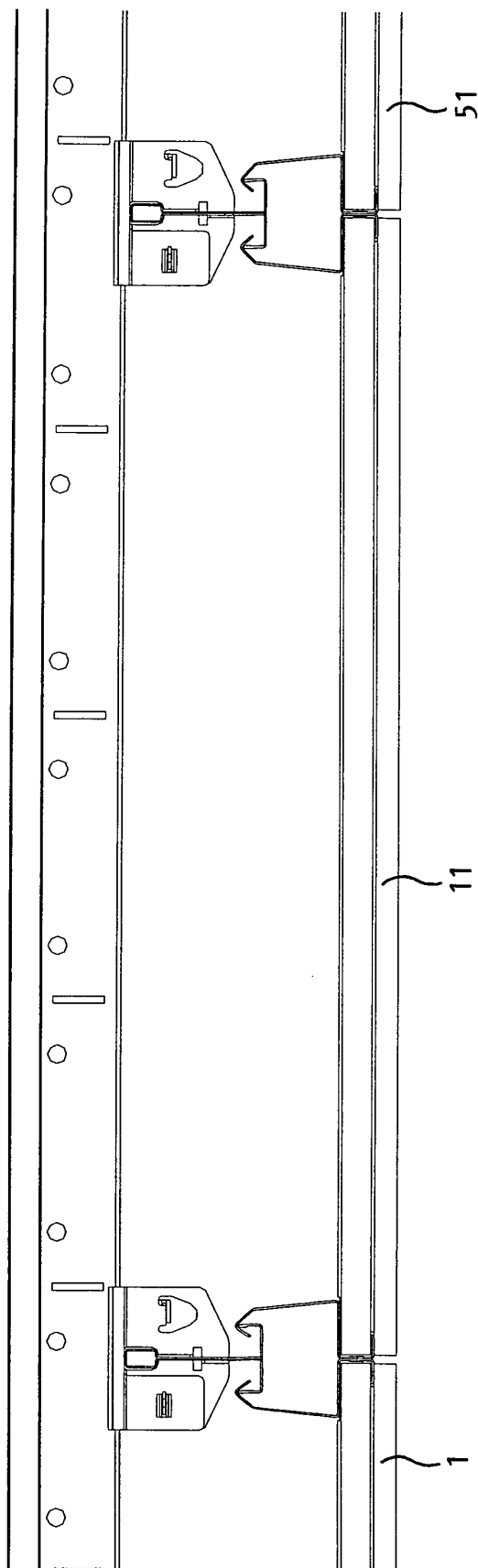


Fig. 8f

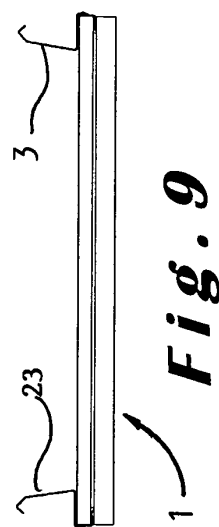


Fig. 9

