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(54) Title: SUSPENDED CEILING WITH 3 LAYER CEILING PLATES

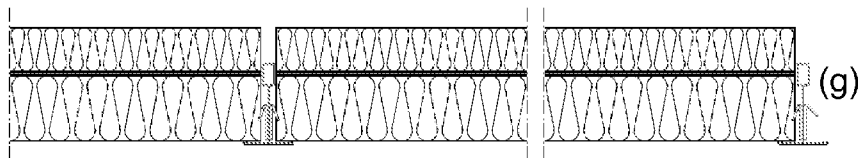


Fig. 8

(57) Abstract: A suspended ceiling arranged below a basic ceiling of a room, such that the basic ceiling and the suspended ceiling is forming a cavity, said suspended ceiling comprising a grid of profiles, said grid forming rectangular or substantially rectangular openings; and further comprising ceiling plates arranged in said openings of the grid, said ceiling plates having two major surfaces and four edge sections, said ceiling plate comprising a first layer comprising fibres, a second airtight sheet layer and a third layer comprising mineral fibres, said three layers are extending parallel or substantially parallel with the two major surfaces. The suspended ceiling further comprising paint applied to the edge sections of the ceiling plates whereby the air flow resistance through the edge sections is increased. The suspended ceiling further comprising means for forming tight connections with a high air flow resistance between either, the ceiling plates and the grid profiles, or, between two adjacent ceiling plates. The invention further concerns a method for manufacturing a suspended ceiling.

Suspended ceiling with 3 layer ceiling plates

This invention relates to a suspended ceiling arranged below a basic ceiling of a room, such that the basic ceiling and the suspended ceiling is forming a cavity, said suspended ceiling comprising a grid of profiles, said grid forming rectangular or substantially rectangular openings. Ceiling plates are arranged in the rectangular openings.

Suspended ceilings with sound absorbing properties and manufactured from fibrous materials are well-known. Such ceilings are prepared for having optimal sound absorption in order to reduce the reverberation time in the room. The known solutions often comprise ceiling plates having one layer of a fibrous material, e.g. mineral fibre, provided with a fleece layer and a layer of paint on the major surface facing the room. These ceiling plates are typically arranged in a supporting grid of profiles.

Suspended ceilings are often used in large rooms divided into two or more smaller rooms by partition walls. The suspended ceiling is installed first and forms a cavity between the suspended ceiling and the basic ceiling. Following this the partition walls are installed. These will typically extend from the floor to the suspended ceiling.

One problem with this type of construction is that sound or noise penetrating the suspended ceiling from one room will propagate in the cavity between the suspended ceiling and the basic ceiling, and may to some extent penetrate into neighbouring rooms.

EP 1 261 782 B1 teaches a method of installing a set of ceiling panels in a room by the use of a supporting grid. The ceiling panels include at least three substantially rectangular panels and the method involves establishing and attaching a supporting grid to a basic ceiling. The supporting grid is

established by mounting two or more carrier profiles and two or more support profiles to each other to provide a grid of at least one rectangle; installing the set of ceiling panels in the carrying grid by applying said ceiling panels in side by side relationship with each other in the rectangle of the grid, so that each panel is supported by support flanges on the supporting profiles, and a first and a second panel are supported by one or more support flanges of one of the carrier profiles constituting the edges of the rectangle.

From US 4,428,454 it is known to have ceiling plates comprising several layers, however in US 4,428,454, a sound obstructing layer is proposed arranged on a face of the ceiling plates facing a cavity formed by the suspended ceiling and the basic ceiling of a room such that sound waves propagating in the cavity are hindered from penetrating the sound absorbing mineral wool, i.e. sound waves propagating in the cavity are continuously reflected by the ceiling plates.

None of the known sound absorbing suspended ceilings is solving the above mentioned problem sufficiently efficient for the demands of buildings.

It has now been found that the problem can be solved by a suspended ceiling with ceiling plates having two major surfaces and four edge sections, said ceiling plate comprising a first layer comprising mineral fibres, a second airflow restricting layer and a third layer comprising mineral fibres, said three layers are extending parallel or substantially parallel with the two major surfaces and the major surface of the ceiling plates facing the cavity is open to air diffusion. The suspended ceiling comprising edge sealing means applied to the edge sections of the ceiling plates whereby the air flow resistance through the edge sections is increased; and said suspended ceiling further comprising connection sealing means arranged at connections between the ceiling plates and the grid profiles, and/or between two adjacent ceiling plates.

By airflow restricting layer is meant a layer having a relatively low permeability to air, such as a permeability of 10 l/m²/s or less.

- 5 By open to air diffusion is meant that sound waves approaching the surface must, at least to some extent, be able to penetrate the surface and enter the fibrous material where it is absorbed.

10 The edge sealing means may be a film, a foil or a layer of paint applied to the edges.

In a preferred embodiment of the invention the connection sealing means comprises a flexible material attached to the profiles. In a further preferred embodiment the connection sealing means formed by a flexible material are
15 arranged as flaps attached to said profiles. Such flaps of a flexible material will provide a reliable airflow restricting connection between the ceiling plate and the grid profile.

In a further embodiment of the invention said second airflow restricting layer
20 is a membrane of aluminium, aluminium/paper composite, paper or polymer material. Other materials could also be used for the membrane, such as paint or water glass. Preferably a non-combustible or low-combustible material should be used in order not to deteriorate any fire preventing properties of the ceiling plates.

25

In a preferred embodiment of the invention said profiles are inverted T-profiles or Z-profiles, comprising a vertical base portion and a horizontal flange portion for supporting said ceiling panels. Inverted T-profiles or Z-profiles offer a mechanical stable grid, and provides a good support for the
30 ceiling plates.

In a further embodiment of the invention said flaps of a flexible material are arranged on the base portion of said T-profiles. This gives a close and airflow restricting connection between the ceiling plates and the profiles of the grid.

- 5 In a further embodiment of the invention the density of said first layer (facing the basic ceiling) comprising mineral fibre is in the range $80 - 200 \text{ kg/m}^3$

In a further embodiment of the invention the density of said third layer (facing the room) comprising mineral fibre is in the range $80 - 300 \text{ kg/m}^3$. These

- 10 density ranges for both the first and the third layers have been found to give optimal acoustic properties with respect to absorption and reduced sound transmission. Again layers of mineral fibres have a high sound absorption coefficient compared to e.g. a wetfelt or gypsum material.

- 15 In a further embodiment of the invention the edge sealing means is one or more layers of paint applied to the edge sections of the ceiling plates. Preferably the layer(s) of paint constitute minimum 1500 g/m^2 of wet paint having a dry matter content of 60%, i.e. 900 g/m^2 applied to the edge sections of the ceiling plates. This will result in an improved airflow restriction
- 20 and an improved strength of the edge sections. This is a very cost efficient way of providing edge sealing means, but other choices may equally be applied, such as applying a film, foil or coating or similar to the edge sections of the ceiling plates.

- 25 The invention also concerns a method for manufacturing a suspended ceiling according to the above mentioned embodiments. The method comprises the steps of forming a three layer ceiling plate by gluing two layers of mineral wool together with an intermediate airflow restricting layer, said plate having two major surfaces at least one of which being open to air diffusion and four
- 30 edge sections, said three layers of the ceiling plates are extending parallel or substantially parallel with the two major surfaces.

The method further comprise the step of applying edge sealing means to the edge sections of the ceiling plates whereby the air flow resistance through the edge sections is increased.

The method further comprises the step of arranging a suspended grid of profiles below the basic ceiling of a room; the grid forms rectangular or substantially rectangular openings.

The method further comprise the step of arranging the ceiling plates in the openings of the grid, with the major surface of the ceiling plate being open to air diffusion facing a cavity formed by the suspended ceiling and the basic ceiling. The openings comprises connection sealing adapted to form tight connections with high air flow resistance between either the ceiling plates and the grid profiles, and/or between two adjacent ceiling plates.

In a further embodiment of the method said profiles are selected to be inverted T-profiles or Z-profiles, comprising a vertical base portion and a horizontal supporting portion for supporting said ceiling panels.

In a further embodiment of the method tight connections between the ceiling plates and the T-profiles are provided and formed by a flexible material arranged as flaps attached to the T-profiles.

Embodiments of the invention will now be described in further details with reference to the figures, where

Figure 1 illustrates a suspended ceiling seen from below.

Figure 2 illustrates a suspended ceiling seen from below with some of the ceiling plates removed.

Figure 3 illustrates a suspended ceiling seen from above, with some ceiling plates removed.

Figure 4 illustrates a ceiling plate comprising 3 layers.

Figure 5 illustrates a cross sectional view of a suspended ceiling with one
5 embodiment of the three layer ceiling plate.

Figure 6 as figure 5 but in a different embodiment of the three layer ceiling panel.

10 Figure 7 illustrates a construction of a suspended ceiling with a partition wall.

Figure 8 a-g illustrates different examples of a cross sectional view of a suspended ceiling.

15 Figure 9 illustrates perspective views of examples of T-beams for a grid for a suspended ceiling provided with one set of means for obtaining tight connections.

Figure 10 illustrates perspective views of examples of T-beams for a grid for
20 a suspended ceiling provided with two set of means for obtaining tight connections.

Figure 11 illustrates cross sectional views of the examples of T-beams in
figure 9.

25

Figure 12 illustrates cross sectional views of the examples of T-beams in figure 10.

Figure 1 shows a suspended ceiling with ceiling plates 1 or ceiling panels
30 arranged in a supporting grid 2. The supporting grid is made from carrier beams 3, extending along several rectangles for ceiling plates. Supporting

beams 4 are arranged between two neighbouring carrier beams 3 in order to fix the distance between these and to form rectangles where one or more ceiling plate can be arranged. Both the carrier beams and the supporting beams are often formed as inverted T-profiles made from a metal, such as aluminium or steel.

The inverted T-profiles have a flange part for supporting the ceiling plates. The carrier beams 3 are attached to the basic ceiling (not shown) e.g. by hangers or wires 5. Adjustment means (not shown) for adjusting the height and flatness of the suspended ceiling are usually cooperating with the wires 5.

In figure 2 the same suspended ceiling as in figure 1 is shown with some of the ceiling plates removed, thereby showing the open rectangles of the supporting grid.

Figure 3 shows a suspended ceiling from above. It is seen that in this example the thickness of the ceiling plates 1 exceeds the height of the inverted T-profiles 3, 4.

Figure 4 shows an exploded view of an example of a ceiling plate 1 for a suspended ceiling according to the invention. It is seen that this ceiling plate 1 comprises three layers: A first upper layer 10 comprising mineral fibres, a second airflow restricting layer 11, and a third lower layer 12 comprising mineral fibres. The application of such a ceiling plate as compared to the standard type of ceiling plate with one single layer comprising mineral fibres has the advantage that the airflow restricting layer 11 will reduce the noise transmission through the ceiling plate 1. Good results have been obtained with a paper membrane constituting the airflow restricting layer 11. The paper membrane of the test had a permeability of 5 l/m²/s.

The upper layer 10 and/or the lower layer 12 may be open to air diffusion such that the upper and/or lower layers 10, 12, may be able absorb sound waves hitting the surfaces of the of the ceiling plate 1.

- 5 The ceiling plate shown in figure 4 has three purposes when it is installed in a suspended ceiling.

First, the ceiling plate must absorb noise from the room below the suspended ceiling. This means that sound waves approaching the surface of the ceiling
10 plate must be able to penetrate the surface to some degree and to enter into the fibrous material where it is absorbed. For this purpose the surface must, to some extent, be porous. Therefore, any fleece and paint layer, applied e.g. for aesthetic purposes and/or for durability, should also be open to air diffusion.

15

A second purpose of the ceiling plate is to reduce the transmission of noise from the side of the ceiling plate facing the room to the side of the ceiling plate facing the basic ceiling, i.e. to the space formed between the suspended ceiling and the basic ceiling. One problem with noise entering this
20 space is that e.g. large office areas in buildings are often arranged as illustrated in figure 7 with a suspended ceiling and one or more partition walls extending between the floor and the suspended ceiling. Thereby, the space between the basic ceiling and the suspended ceiling (often called the plenum) over one office will be in open connection with the equivalent space
25 over a neighbouring office. There will be nothing preventing sound and noise from propagating in this space, and this space will therefore often be the major route of transmitting noise from one office to a neighbouring office. By having an airflow restricting layer in the ceiling panel the transmission of noise or sound through the ceiling plate will be reduced.

30

A third purpose of the ceiling panel is to absorb sound waves approaching the surface facing the basic ceiling (absorption in the plenum), thereby reducing the noise level in the space between the basic ceiling and the suspended ceiling. This will also contribute to a reduction in the noise level transmitted from one room to a neighbour room.

The first upper layer facing the plenum is often made from mineral wool, such as stone wool, with a density of between 80 – 200 kg/m³. The density should normally be chosen as low as possible, as low density mineral wool gives a better sound absorption in the plenum. However the density of the first layer may be chosen higher for other reasons, e.g. depending on the density of the third layer or the airflow restricting capabilities of the second layer. Higher densities, such as 300 kg/m³ may be chosen for specific reasons, but it will normally increase the weight and price of the plate, which is a disadvantage. In specific embodiments the density may be chosen lower, e.g. 50 kg/m³, but often this will mean more difficult handling of the plates. The thickness of the first upper layer is below 30 mm, preferably below 25, and even more preferably below 20 mm.

The second airflow restricting layer 11 is often made from a plastic sheet material or from a metal foil such as aluminium. It may also be a metal foil provided with a paper layer in order to strengthen it.

The third lower layer 12 is often made from mineral wool with a density of between 80 – 300 kg/m³. The density may be chosen to fit the needs. Again the choice of density is a balance of the properties of the three layers of the plate, the price and the ease of handling which is influenced by the weight, strength and stiffness of the plate. Often a higher density will be suitable for the third layer compared to the first layer. The thickness of the first upper layer is below 40 mm, preferably below 35, and even more preferably below 30 mm.

The edge portions of the panels may be provided with shapes or profiles making them fit with different types of grid profiles, or into suspended ceilings where the grid beams are covered by the ceiling plates, i.e. so-called
5 concealed edges.

Further, the ceiling plate in figure 4 is often provided with a fleece layer. The fleece layer is preferably a standard glass fibre fleece, comprising glass fibres and a binder. The amount of binder will often be 10 – 30 %. The fleece
10 will preferably not comprise any oil, which is typically added to the mineral fibre material. The surface weight of the fleece will be in the range 60 – 200 g/m². Example of an applicable fleece material of glass fibres is the product A75 from Owens Corning in US having a binder content of 25 %, and a calorie value of 5.3 MJ/kg.

15 Usually, such a fleece layer is provided on the surface visible from the room, i.e. on the surface of the third lower layer 12. However, often a fleece layer is also provided on the surface facing the basic ceiling, i.e. on the surface of the first upper layer 10. This has the purpose of reducing the emission of mineral
20 fibres e.g. during installation of the suspended ceiling.

The fleece layer is often provided with a paint layer also on the major surface visible from the room below the suspended ceiling. An example of a useful paint is water based paint with approximately 50 % dry material and
25 approximately 10 % binder, e.g. known under the trade name Rofa 8 which is manufactured by Soframap in France. The amount of wet paint applied will preferably be in the range 50-300 g/m².

30 In order to be sufficiently sound absorbing the sound absorbing panel should be open to air diffusion. This means that the applied paint layer on the major surface also must be open to air diffusion. This will be the case if e.g. small

holes are formed in or by the paint during application and/or drying up.

Contrary, the paint layer applied to the edge portions should, preferably, be relatively closed to air diffusion in order to limit the transmission of sound or noise through the edge portions into the space between the basic ceiling and the suspended ceiling.

Examples of ceiling plates for the suspended ceiling will now be described.

In a first example the first upper layer 10 is made from stone wool with a density of 150 kg/m^3 . The thickness of this layer is 20 mm. The mineral wool is manufactured according to WO 2005/095727. The second airtight sheet layer 11 is an aluminium foil. The third lower layer 12 is made from stone wool with a density of 150 kg/m^3 . The thickness of this layer is 30 mm. The mineral wool is manufactured according to WO 2005/095727. A suspended ceiling in an embodiment of the invention with this type of ceiling plate will have a room to room sound insulation $D_{\text{nfw}} = 44 \text{ dB}$. This value has been measured according to standard ISO 10848-2 and calculated as a weighted suspended ceiling normalized level according to ISO 717-1, and gives the reduction of noise transmitted from a room into a neighbouring room. The sound absorption coefficient for such a suspended ceiling is $\alpha_w = 0.90$ measured according to standard EN ISO 354. This value gives the fraction of incident noise to the suspended ceiling absorbed by the ceiling.

In a third example the first upper layer 10 is made from stone wool with a density of 150 kg/m^3 . The thickness of this layer is 20 mm. The mineral wool is manufactured according to WO 2005/095727. The second airtight sheet layer 11 is an aluminium foil. The third lower layer 12 is made from stone wool with a density of 300 kg/m^3 . The thickness of this layer is 30 mm. A suspended ceiling in an embodiment of the invention with this type of ceiling plate will have a room to room sound insulation $D_{\text{nfw}} = 49 \text{ dB}$. The sound absorption coefficient for the suspended ceiling in this example is $\alpha_w = 0.60$.

The lower value is caused by the higher density of the mineral wool facing the room below the suspended ceiling.

The adhesive applied for gluing the three layers of the ceiling plate 1 together
5 is often a hot melt adhesive or powder glue of e.g. polyamide. The adhesive should preferably be able to function even though the temperature is raised to approximately 140 degree Celsius or more, before the adhesive has dried up. This temperature is often necessary in order to dry the paint applied to the fleece and to the edge sections, and in order to have an efficient
10 production line, drying of this paint may be necessary before the adhesive has dried completely. The adhesive could be a hot melt adhesive based on a block copolymer with a viscosity (according to ASTM D-3236) of 1500 – 2100 mPa s at a temperature of 177 degree Celsius, and a softening point (according to ASTM E-28) of 94 – 104 degree Celcius.

15 A random sampling of a standard back fleece DH 50/20, carried out by a supplier, showed air porosity of around 4100 l/m²s under 200 Pa pressure.

Figure 5 shows a cross sectional view of a suspended ceiling in which the
20 first upper layer 10 together with the second airflow restricting layer 11 of the ceiling plate 1 is extending over the edge of the third lower layer 12. The purpose of this embodiment is that this extending portion can establish an airflow restricted connection with the inverted T-profile, and/or with the neighbouring ceiling plate.

25 Figure 6 shows a cross sectional view of a suspended ceiling in which a notch is provided in the first upper layer 10 such that only an upper part of this first upper layer 10 is extending over the edge of the third lower layer 12. This means that it will be possible to let two neighbouring ceiling plates abut
30 each other over the inverted T-profile. The second airflow restricting layer 11 will, in this embodiment, often extend to the edge of the third lower layer 12,

which will also be the edge of the first upper layer 10 where the notch is made. The second airflow restricting layer may also follow the side walls of the notch, and thereby extend to a position where it may abut the profile. However, an airflow restricting layer of paint covering the edge section 15
5 and being in contact with the airflow restricting layer will provide the same result concerning the edge section 15 being sealed.

As mentioned, figure 7 shows a suspended ceiling and a partition wall extending between the floor (not shown) and the suspended ceiling. In this
10 typical construction there is no partition in the space between the basic ceiling 8 and the suspended ceiling. As can be seen in the figure, the suspended ceiling is suspended from the basic ceiling 8 by means of hangers or wires 5.

15 Figure 8 shows seven (a-g) different embodiments for arranging the inverted T-profile 3 with the edge sections of the ceiling plate 1 or panel. The difference between 8a, 8b, 8c and 8d lies within the shape of the edge sections of the ceiling plates 1. Figure 8a shows a simple straight cut off edge section. Figure 8b shows the principle also illustrated in figure 6, where
20 two neighbouring ceiling plates abut over the inverted T-profile in order to reduce sound transmission through the suspended ceiling. Figure 8c illustrates the design of having the flange portion of the inverted T-profile in an indent of the two abutting ceiling plates. Figure 8d shows an example where the grid profiles of the suspended ceiling is concealed, such a
25 suspended ceiling is described in EP 1 261 782 B1. Figure 8e shows simple straight cut off edge portions of ceiling plates abutting over an inverted T-profile provided with flaps arranged on the base of the base part as well as on the upward facing part of the flange portion of the inverted T-profile. Figure 8f shows simple straight cut off edge portions of ceiling plates abutting
30 over an inverted T-profile provided with flaps arranged on the upward facing part of the flange portion of the inverted T-profile. Figure 8g shows simple

straight cut off edge portions of ceiling plates abutting over an inverted T-profile provided with flaps arranged on the base of the base part. The flaps shown in the embodiments according to the figures 8e – 8g serves a purpose of forming a airflow restricting seal between the T-profile and the ceiling plates.

Figure 9 shows perspective examples of inverted T-profiles 3 provided with flaps for obtaining a sealed connection with restricted airflow between the T-profile and the ceiling plates. The flaps can be arranged either on the base part or on the upward facing part of the flange portion of the inverted T-profile.

Figure 10 shows in perspective that flaps 20, 21 can be arranged on both the base part and on the flange portion, such that the ceiling plate will be in contact with two flaps on each inverted T-profile 3. It has been found that the extra effect of two flaps 20, 21 is relatively limited. Also, it has been found that a flap 20 on the flange portion of the inverted T-profile may have the effect that a small visible gap occurs between the ceiling plate and the Inverted T-profile. A flap 21 on the base portion has in some tests been found to result in the best reduction of sound transmission. This may be caused by the compression of the ceiling plate against the flap.

Figure 11 and 12 shows, in cross sectional views, the embodiments according to figure 9 and 10 of the inverted T-profiles 3 with flaps 20, 21 for providing sealed connections between the inverted T-profiles 3 and the ceiling plates 1.

Claims

1. A suspended ceiling arranged below a basic ceiling of a room, such that the basic ceiling and the suspended ceiling is forming a cavity,
5 said suspended ceiling comprising:
- a grid of profiles, said grid forming rectangular or substantially rectangular openings,
 - ceiling plates arranged in said openings of the grid, said ceiling plates having two major surfaces and four edge sections, said
10 ceiling plate comprising a first layer comprising mineral fibres, a second airflow restricting layer and a third layer comprising mineral fibres, said three layers are extending parallel or substantially parallel with the two major surfaces and wherein the major surface of said ceiling plates facing said cavity is open to air diffusion,
15
 - edge sealing means applied to the edge sections of the ceiling plates, whereby the air flow resistance through the edge sections is increased,
 - connection sealing means arranged at connections between
20 the ceiling plates and the grid profiles, and/or, between two adjacent ceiling plates.
2. A suspended ceiling according to claim 1, wherein said connection sealing means comprises a flexible material attached to said grid
25 profiles.
3. A suspended ceiling according to claim 2, wherein said flexible material is arranged as flaps attached to said grid profiles.
- 30 4. A suspended ceiling according to any one of the previous claims, wherein said second airflow restricting layer is a metal foil.

- 5 5. A suspended ceiling according to any one of the previous claims,
wherein said profiles are inverted T-profiles, comprising a vertical base
portion and a horizontal flange portion for supporting said ceiling
panels.
6. A suspended ceiling according to claim 5, wherein said connection
sealing means are arranged on the base portion of said T-profiles.
- 10 7. A suspended ceiling according to any one of the previous claims,
wherein the density of said first layer comprising mineral fibre is in the
range 80 – 200 kg/m³.
- 15 8. A suspended ceiling according to any one of the previous claims,
wherein the density of said third layer comprising mineral fibre is in the
range 80 – 300 kg/m³.
- 20 9. A suspended ceiling according to any one of the previous claims,
wherein said edge sealing means is one or more layers of paint
applied to the edge sections of the ceiling plates.
- 25 10. Method for manufacturing a suspended ceiling according to any one of
the previous claims, said method comprising the steps
- forming a three layer ceiling plate by gluing two layers of
mineral wool together with an intermediate airflow restricting
layer, said plate having two major surfaces at least one of
which being open to air diffusion and four edge sections, said
three layers of the ceiling plates extending parallel or
substantially parallel with the two major surfaces,

- applying edge sealing means to the edge sections of the ceiling plates whereby the air flow resistance through the edge sections is increased,
 - arranging a suspended grid of profiles below the basic ceiling of a room, said grid forming rectangular or substantially rectangular openings,
 - arranging said ceiling plates in said openings of said grid with said major surface of said ceiling plate being open to air diffusion facing a cavity formed by the suspended ceiling and the basic ceiling, said openings comprises connection sealing means adapted to form tight connections with high air flow resistance between either the ceiling plates and the grid profiles, and/or between two adjacent ceiling plates.
11. A method according to claim 10, wherein said profiles are selected to be inverted T-profiles, comprising a vertical base portion and a horizontal supporting portion for supporting said ceiling panels.
12. A method according to claim 11, wherein tight connections between the ceiling plates and the T-profiles are provided and formed by a flexible material arranged as flaps attached to the T-profiles.

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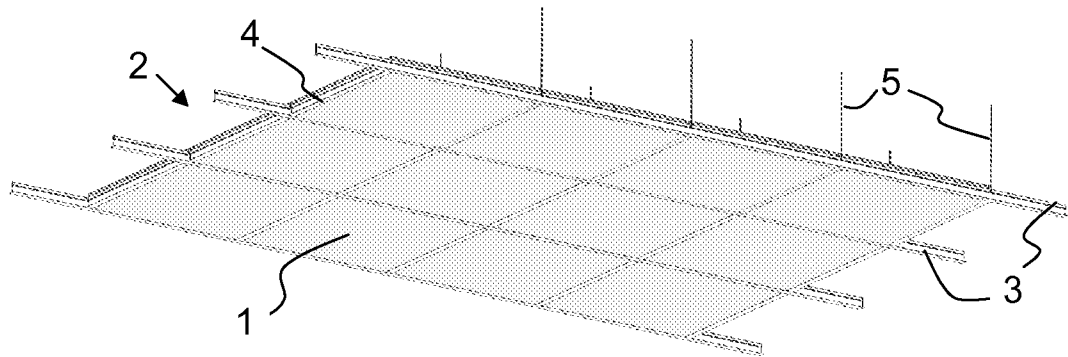


Fig. 1

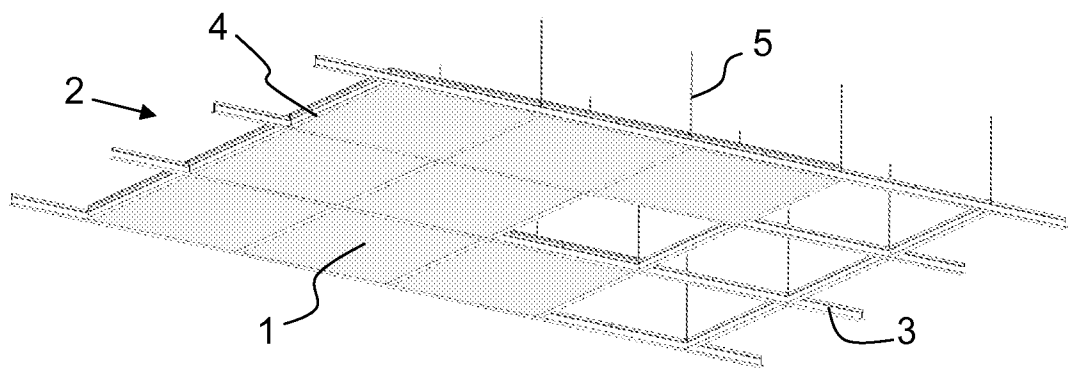


Fig. 2

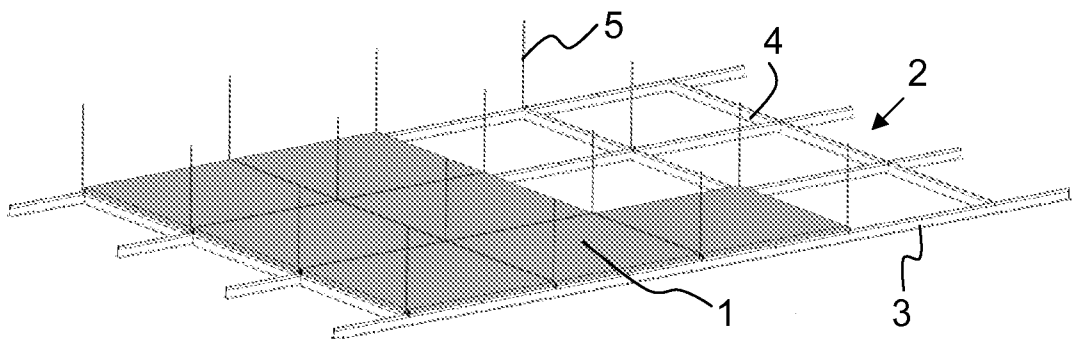


Fig. 3

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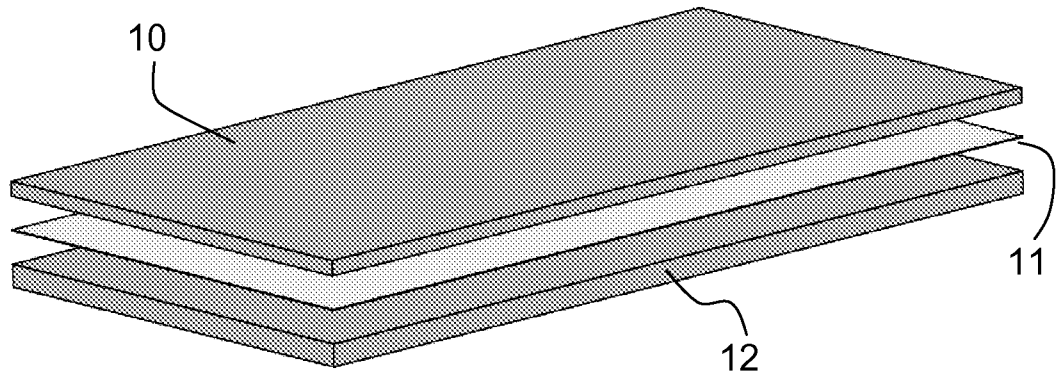


Fig. 4

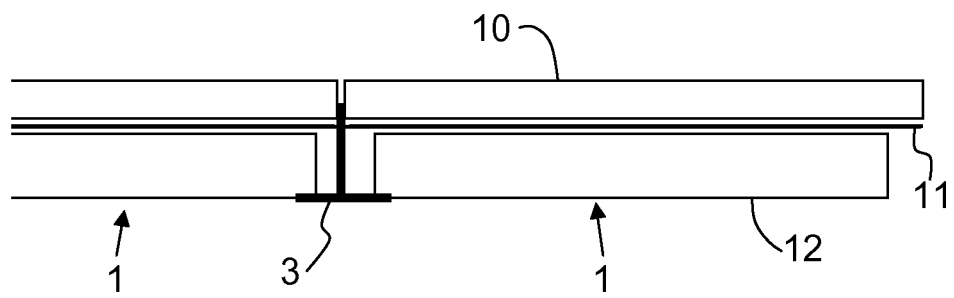


Fig. 5

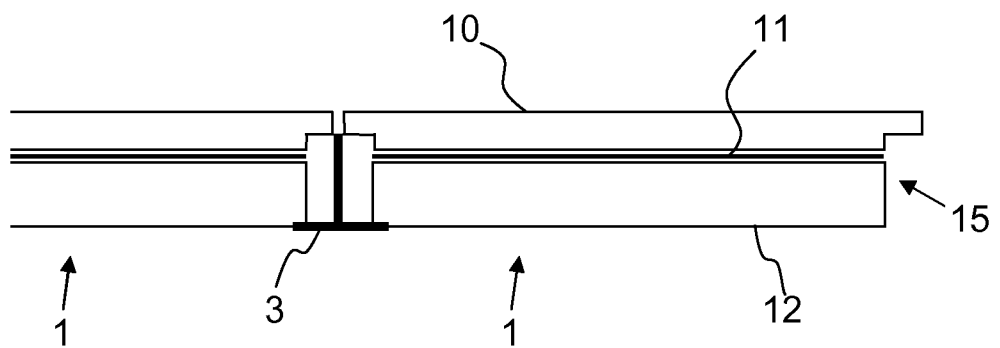


Fig. 6

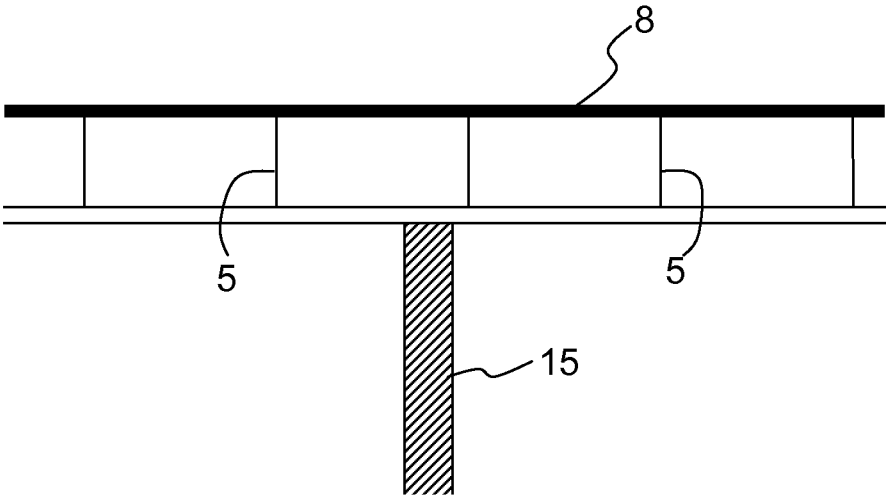


Fig. 7

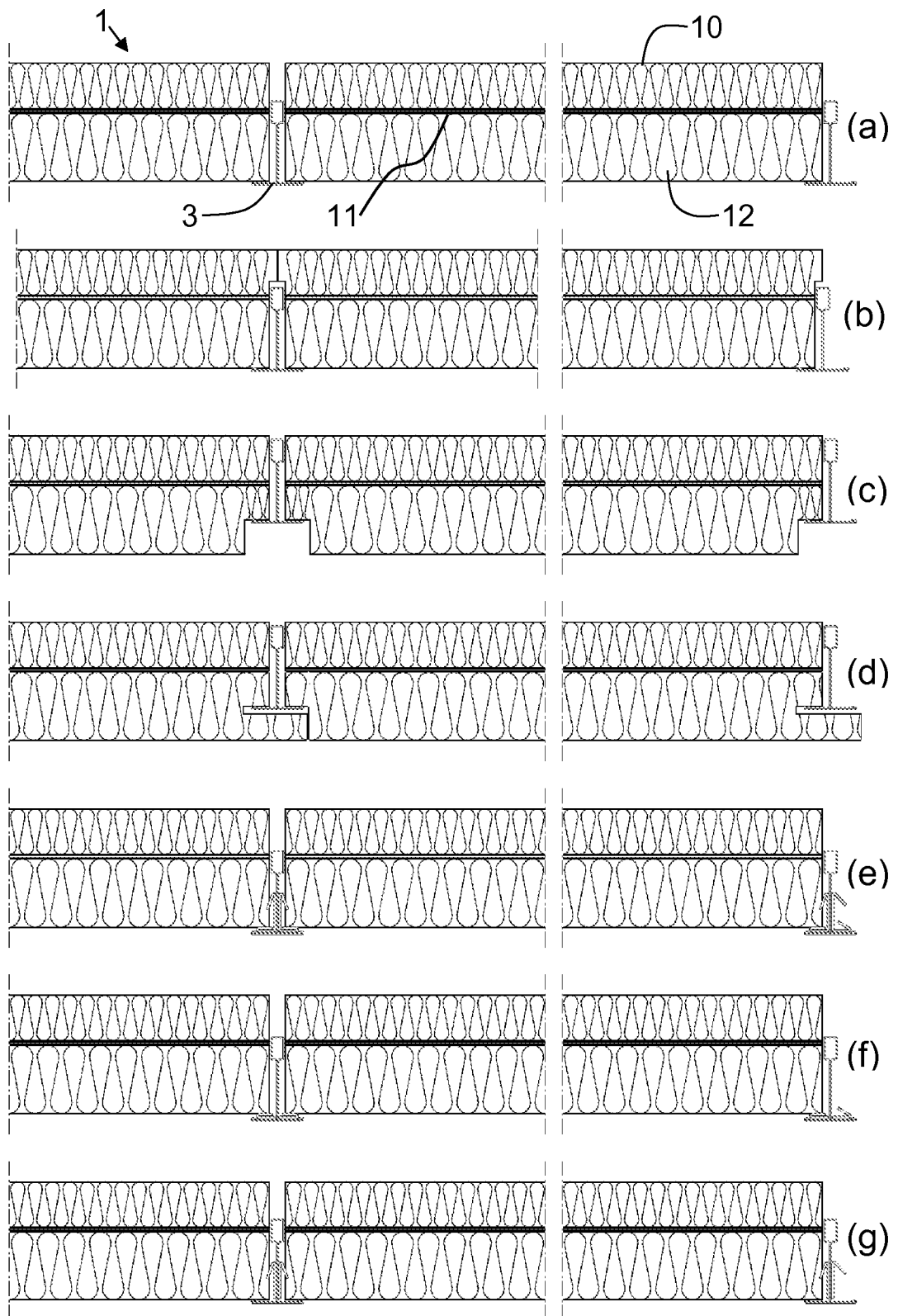


Fig. 8

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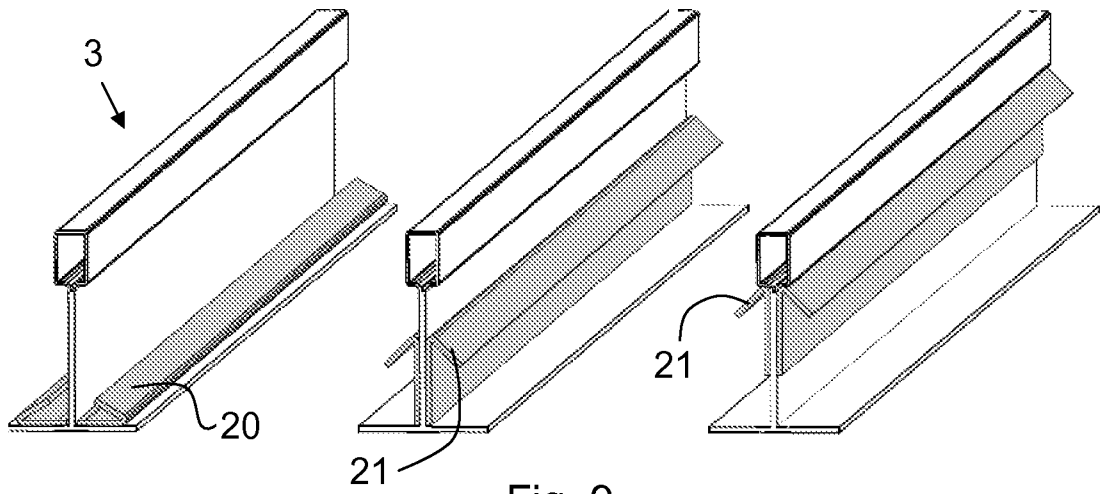


Fig. 9

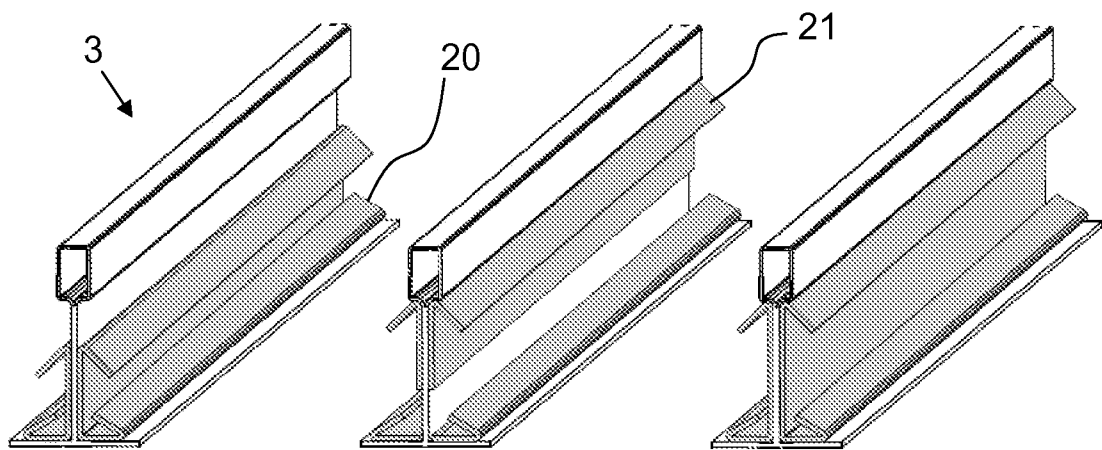


Fig. 10

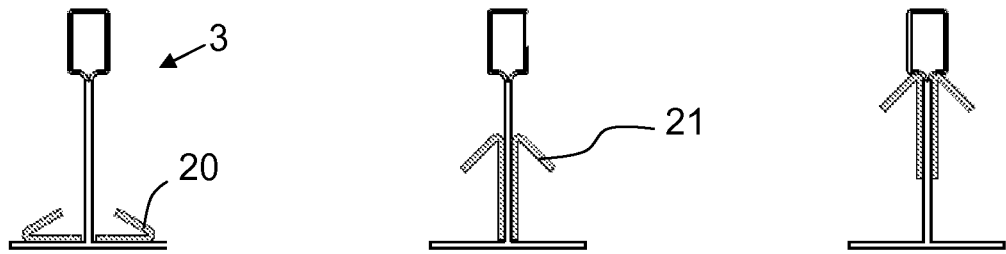


Fig. 11

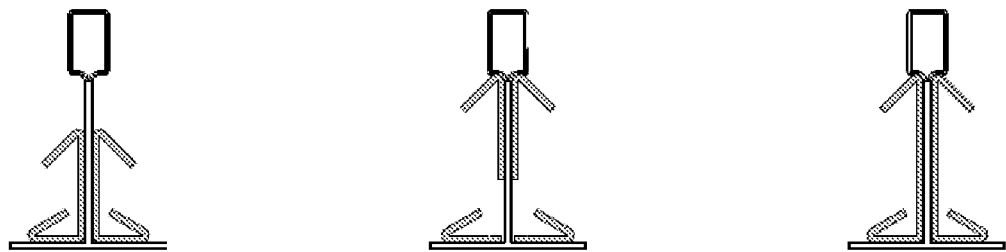


Fig. 12

INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2009/055333

A. CLASSIFICATION OF SUBJECT MATTER

INV. E04B9/00

E04B9/24

E04B9/04

E04B9/06

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

E04B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	EP 0 092 684 A (H. WENGER) 2 November 1983 (1983-11-02) page 3, line 8 - page 4, line 19 page 9, paragraph 1 - paragraph 2 page 11, line 12 - line 14; figures 1-5	1-12
Y	US 4 428 454 A (CAPAUL ET AL.) 31 January 1984 (1984-01-31) cited in the application column 2, line 8 - line 15 column 3, line 39 - line 41 column 4, line 49 - line 64 column 6, line 35 - column 7, line 22 figures 1-6,8,9	1-12
A	US 6 701 686 B1 (PLATT) 9 March 2004 (2004-03-09) abstract; figures 3-8	1-3,5,6, 11,12
	-/--	



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

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O document referring to an oral disclosure, use, exhibition or other means

P document published prior to the international filing date but later than the priority date claimed

T later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

X document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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Z document member of the same patent family

Date of the actual completion of the international search

25 August 2009

Date of mailing of the international search report

01/09/2009

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INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2009/055333

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	GB 1 237 396 A (NATIONAL GYPSUM COMP.) 30 June 1971 (1971-06-30) page 1, line 42 - page 2, line 27; figures -----	1, 10

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2009/055333

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
EP 0092684	A	02-11-1983	DE 3215811 A1	03-11-1983
US 4428454	A	31-01-1984	NONE	
US 6701686	B1	09-03-2004	CN 1519443 A	11-08-2004
			FR 2850123 A1	23-07-2004
			GB 2397311 A	21-07-2004
			TW 232258 B	11-05-2005
GB 1237396	A	30-06-1971	DE 1772119 A1	28-01-1971
			FR 1561847 A	28-03-1969
			NL 6804539 A	16-12-1968
			US 3480104 A	25-11-1969