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(54) **Impact resistant suspended ceiling and attachment member therefor**

(57) Impact resistant suspended ceiling (1) comprising a suspension frame (2) for supporting ceiling tiles (4) in a first position on a first plane (23) and limiting means (5) for limiting an upward movement of the ceiling tiles (4) as a result of the ceiling tiles (4) being impacted wherein the limiting means (5) comprise a stop (3) arranged in a second plane (24) substantially parallel with the first plane (23), wherein the first and second planes (23, 24) are spaced by a distance greater than a thickness of the ceiling tiles such that ceiling tiles (4) can move from the first position to a second position, the ceiling tiles (4) in the first position being spaced from the stop (3) and in the second position being against the stop (3).

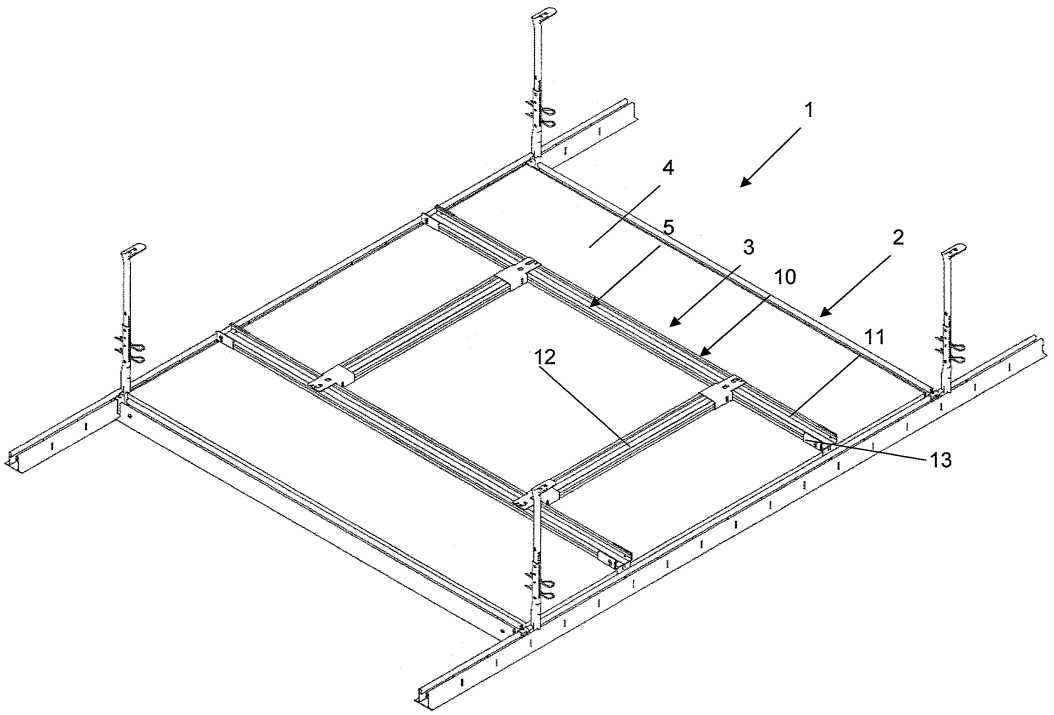

Fig. 1

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Description

[0001] The present invention relates to an impact resistant suspended ceiling, according to the preamble of the first claim.

[0002] The present invention also relates to an attachment member therefor.

[0003] Such impact resistant suspended ceilings are known from US4408428A. US4408428A describes an impact resistant suspended ceiling for covering a building structure such as a ceiling. The suspended ceiling comprises a planar frame for supporting ceiling tiles. The planar frame thereto is in the form of a grid of metal runners. The runners are T shaped and have an upright web and two flanges extending perpendicularly with respect to the upright web towards opposing sides from a first longitudinal edge of the upright web and providing support to the ceiling tiles. The suspended ceiling further comprises limiting means in the form of two-piece retaining clips which are provided to be mounted to a bead along a second longitudinal side of the runner opposing the first longitudinal edge. The clips are provided with spring elements having legs which bear down on the panels when installed and limit an upward movement of the ceiling tiles towards the building structure as a result of an impact from below, for example an impact by a ball when the ceiling is suspended above a gymnasium.

[0004] Such clips in other words offer impact resistant properties to a suspended ceiling, making it possible to mount the suspended ceiling over rooms in which it is likely that the ceiling tiles will be impacted, for example gymnasiums, basketball courts, school corridors, etc. However, such clips are not adapted for use with relative large ceiling tiles and are only adapted for use with relative small ceiling tiles, such as ceiling tiles of 2 by 2 foot. Moreover, the clips can not be used for absorbing relative large impacts since it has been found that relative large impacts increase the risk that the ceiling tiles are broken, especially when relative light and fragile ceiling tiles, such as for example mineral wool panels, are used.

[0005] It is therefore an object of the current invention to provide an impact resistant suspended ceiling in which a wider range of ceiling tiles can be used.

[0006] Thereto, the suspended ceiling is **characterised in that** the limiting means comprise a stop arranged in a second plane substantially parallel with the first plane, wherein the first and second planes are spaced by a distance greater than a thickness of the ceiling tiles such that ceiling tiles can move from the first position to a second position, the ceiling tiles in the first position being spaced from the stop and in the second position being against the stop.

[0007] When the ceiling tiles are impacted from below, i.e. on a side of the ceiling tile not facing a building structure covered by the ceiling tiles, the impact on the ceiling tile will be at least partly transformed to a movement of the impacted ceiling tile towards the building structure. When the impact of the ceiling tile is relatively small, the full impact is absorbed by the movement of the ceiling tile towards the building construction. On the other hand when the impact of the ceiling tile is relatively large, the impact is partly absorbed by the movement of the ceiling tile while the remaining part is absorbed by the stop upon impact of the ceiling tile against the stop in the second position. The inventor in other words has found that the at least part of the impact can be absorbed by the weight of the ceiling tiles. Moreover, the stop has been found to be easily adaptable to different sorts of ceiling tiles and/or expected impacts by changing the distance between the suspension frame and the stop.

[0008] The inventor has also found that since the ceiling tile can move substantially unhindered from the first position to the second position, the risk that the ceiling tiles become damaged, due to for example large impacts or the use of relative light and/or fragile ceiling tiles, such as for example mineral wool ceiling tiles, decreases. Without wanting to be bound by any theory, the inventor believes that since the ceiling tiles in the current invention no longer are held down, as is the case in US4408428A by the legs of the clips, and can move substantially unhindered from the first position to the second position, the impact is more efficiently and/or faster transformed to a movement of the tile, preventing the ceiling tiles from breaking.

[0009] The inventor has found that since the risk for breaking of the ceiling tiles is reduced, ceiling tiles which are relatively light and/or fragile can be surprisingly used such that, for example, mineral wool ceiling tiles can now be used in the impact resistant suspended ceiling according to the invention. Therefore, the range of ceiling tiles which possibly can be used in the impact resistant suspended ceiling is further increased.

[0010] In preferred embodiments according to the invention, the stop is positioned between a building structure covered by the suspended ceiling and the impact resistant suspension frame and is spaced from the suspension frame along a spacing direction from the suspension frame towards the building structure. By increasing the distance between the suspension frame and the stop in this way, it has been found that the ceiling tiles can absorb larger impacts from below before reaching the second position such that more of the impact is absorbed by movement of the ceiling tiles and less by the stop such that the stop, for example, can be made less strong and therefore, for example, less structurally complicated.

[0011] The stop may have any suitable shape or form, such as a central disc or cross bars, however in preferred embodiments according to the current invention, the stop is made up of a substantially planar frame. Since such frames are substantially readily available in construction, no specially devised stops need to be provided, increasing the ease to install the stop according to the invention.

[0012] In preferred embodiments according to the invention, the impact resistant suspended ceiling comprises a cooperating pair of a connector and a disconnector

for mounting and dismounting the stop to or from the suspension frame, the connector connecting the suspension frame and the stop and the disconnector for disconnecting the connection between the suspension frame and the stop of the connector. Also the disconnector is accessible when the ceiling tile is at least partly in the second position at the location of the disconnector for disconnecting the connection of the connector between the suspension frame and the stop. In such embodiments, the stop can be at least partly dismounted from the suspension frame by lifting at least part of the ceiling tile to the second position at the location of the disconnector and subsequently disconnecting the connection of the connector between the suspension frame and the stop. Such embodiments therefore allow the stop to be substantially dismounted from the suspension frame, for example without having to completely remove the ceiling tile, or even all the ceiling tiles, from the suspension frame.

[0013] In further preferred embodiments according to the invention, the connector is in the form of a lip of the stop for engaging a corresponding opening of the suspension frame and in that the suspension frame can be disconnected from the stop by moving the connector in the spacing direction by pushing the disconnector in the spacing direction. Such an arrangement allows to disengage the connector from the opening of the suspension frame by simply lifting the connector in the spacing direction by lifting the disconnector, for example using a screw driver.

[0014] In further preferred embodiments according to the invention, the substantially planar frame comprises a grid of runners and attachment members, the attachment members attaching runners of the grid to the suspension frame and in that the connector and disconnector are part of the attachment members. The inventor has found that such grids are easy to assemble with relatively readily available materials like runners.

[0015] In further preferred embodiments according to the invention, the attachment member comprises at a first end a first part for receiving an end part of a runner of the grid, the first part comprising a base and two upright sidewalls extending from opposing side edges of the base, the base and the upright sidewalls delimiting a volume provided to receive the end part of the runner and at a second end opposing the first end a second part extending from the base comprising the connector and the disconnector. Such attachment members have been found to be especially easy to install, for example attaching the attachment member to respectively the runner and the suspension frame, and manufacture, for example by folding the sidewalls from the base from a single piece of foldable material, such as for example metal.

[0016] In further preferred embodiments according to the invention, the first and the second part are substantially perpendicular with respect to each other. Such arrangement of the first and the second part allow the runner attached to the attachment member to be relatively easily installed in, preferably on, the second plane by mounting the attachment member to the suspension frame with the second part extending along the spacing direction.

[0017] In further preferred embodiments according to the invention, the attachment member comprises an abutting flange between the first part and the second part, for abutting the end part of the runner received in the first part when the end part of the runner is correctly positioned in the first part. Such an abutting flange has been found to further increase the ease of installation of the runner in the attachment member. Moreover, the correctness of the installation of the runner in the attachment member is further increased.

[0018] In further preferred embodiments according to the current invention, the runners are U-shaped, or in other words have a U-shaped cross-section. Such U-shaped are readily available in construction and therefore increase the ease of installing the stop above the suspended ceiling.

[0019] In preferred embodiments according to the invention, the suspension frame is a bandraster-system. Such a bandraster system has the advantage of being readily available and having an increased strength with respect to, for example, a suspension grid being made of solely T-shaped runners.

[0020] In preferred embodiments according to the present invention, the ceiling panels are impact resistant mineral wool panels provided with a facing. Although it has been found that such ceiling tiles are relatively light and/or fragile, the current invention allows such tiles to be used in situations with an elevated risk for impacts, such as for example in gymnasiums, etc., whereas the risk for breaking or damaging the ceiling tiles due to impacts is kept surprisingly low. Such ceiling tiles however can be provided with improved sound-absorbing properties $\alpha_w \geq 0.9$ (mounting method A, E200) rated according to ISO 11654:1997 and measured according to ISO 354: 2003 and/or reaction to fire properties class A1 according with EN 13501-1:2007, such that surprisingly, when used in the impact resistant suspended ceiling according to the current invention, the sound-absorbing properties and/or reaction to fire properties of the ceiling tiles can be surprisingly employed in situations with an elevated risk for impacts.

[0021] Particularly in gymnasiums sound-absorption is of great importance as such rooms are traditionally subject to high level of sound, and reaction to fire is also an important parameter, as a large number of people may be present in gymnasiums and similar rooms for sports and culture.

[0022] Although the ceiling panels may have any suitable dimension, it is currently preferred that the ceiling panels have a size of at least 600 x 600 mm, preferably at least 1200 x 1200 mm, whereby the installation cost and weight of the suspended ceiling can be kept low.

[0023] The present invention also relates to an attachment member for use in an impact resistant suspended

ceiling according to the present invention, comprising at a first end a first part for connecting to an end part of a first runner and at a second end opposing the first end a second part comprising the connector and the disconnector.

[0024] In preferred embodiments of the attachment member according to the present invention, the first part is provided to receive an end part of a first U-shaped runner and comprises a base and two upright sidewalls extending from opposing side edges of the base, the base and the upright sidewalls delimiting a volume provided to receive the end part of the first U-shaped runner.

[0025] In preferred embodiments of the attachment member according to the present invention, the attachment member comprises a flange between the first and the second part, in that the first and the second part are hingedly connected to each other between a perpendicular position in which the first and the second part are substantially perpendicular with respect to each other and a longitudinal position in which the first and second part are substantially longitudinal with respect to each other, the connector cooperating with the flange as to form a snap-fit connection for attaching a second U-shaped runner to the first U-shaped runner by snap-fitting the snap-fit connection between two parallel walls of the second U-shaped runner. Such attachment members offer the possibility of mounting, using a snap-fit connection, the first runner to the second runner such that a grid can be formed. The same piece in other words can be used to form a grid of U-shaped runners and to connect the grid of U-shaped runners to the suspension frame. Therefore, the grid can be formed by U-shaped runners, readily available, and the attachment members according to the current invention.

[0026] By the wording impact resistant should in the present context be understood a ceiling fulfilling the requirements according to the standard EN 13964;2004 NXD (preferably class 1A or 2A) and/or DIN 18032 part 3. According to EN 13964 suspended ceilings are regarded as resistant to ball impact if they and their supporting structures do not undergo any major permanent change when subjected to mechanical stressing by balls. The most strict class is 1A, according to which a standard ball is fired with an impact speed of 16.5 ± 0.8 m/s repeatedly: 12 times vertically and 12 times each from two different directions at an angle of 60°.

[0027] Other details and advantages of the impact resistant suspended ceiling and attachment member therefore according to the invention will become apparent from the enclosed figure and description of preferred embodiments of the invention.

[0028] Figure 1 shows an overview in perspective of an impact resistant suspended ceiling according to the current invention, viewed from above.

[0029] Figure 2 shows a detail of the stop of the impact resistant suspended ceiling of figure 1.

[0030] Figure 3 shows another detail of the stop of the impact resistant suspended ceiling of figure 1.

[0031] Figure 4 shows a view in perspective of an attachment member according to the current invention in the perpendicular position.

[0032] Figure 5 shows a view in perspective of an attachment member according to the current invention in the longitudinal position.

[0033] Figure 6 shows a side view of an attachment member according to the invention snap-fitted to the second U-shaped runner in a longitudinal position and an attachment according to the invention in the perpendicular position.

[0034] Figure 7 shows a side view of a U-shaped runner mounted to a suspension frame by an attachment member in which a screw-driver is used to disconnect the attachment member from the suspension frame.

[0035] Figure 1 shows one module of an impact resistant suspended ceiling 1 according to the invention.

[0036] The impact resistant suspended ceiling 1 comprises a suspension frame 2 for supporting ceiling tiles 4 in a first position on a first plane 23. The impact resistant suspended ceiling 1 also comprises limiting means 5 for limiting an upward movement of the ceiling tiles 4 as a result of the ceiling tiles 4 being impacted from below.

[0037] The suspension frame 2 shown in more detail in figure 2 and 7 is a bandraster-system. However, any other suspension frame in which ceiling tiles 4 can be supported is possible such as for example a system mainly comprising T-shaped runners. However, bandraster-systems have the advantage that they have increased strength with respect to for example systems comprising mainly T-shaped runners, which is especially desired when using the impact resistant suspended ceiling in situation where relative large impacts may occur such as for example gymnasiums, etc. Bandraster-systems also have the advantage of being easily mountable and/or demountable.

[0038] The ceiling tile 4 provided in the impact resistant suspended ceiling 1 can be any ceiling tile 4 known to the person skilled in the art but preferably is a ceiling tile 4 which is made of impact resistant mineral wool panels provided with a facing. Such mineral wool panels have the advantage of having improved sound absorbing properties, preferably A(E200) and/or reaction to fire and/or incombustibility, preferably class A1.

[0039] Preferably, the panels have a thickness of between 20 mm - 40 mm, for example 40 mm.

[0040] Preferably, the panels have a density of between 70 kg/m^3 - 150 kg/m^3, more preferably of between 75 kg/m^3 - 110 kg/m^3 and most preferably of between 70 kg/m^3 - 90 kg/m^3, for example 80 kg/m^3.

[0041] Dimensions of the ceiling panels may be adapted for the specific use of panels, local standards or traditions, and other considerations. Often it will be advantageous to have relatively large dimensions to reduce the installation cost and have a relatively light weight suspended ceiling. For example the ceiling panels may have dimensions of 1200 x 1200 mm or even larger, such as 1500 x 1250 mm.

[0042] Preferably, the back facing of the panels, designed to face the building construction when in use, is made of a mineral fibre non woven tissue.

[0043] Preferably, the front facing, opposing the back facing, is made of a mineral fibre non woven tissue, preferably reinforced with a mineral fibre scrim. The front facing may also be painted.

[0044] The limiting means 5 shown in figure 1 comprise a stop 3 arranged in a second plane 24, preferably on a second plane 24 as shown in figure 7, substantially parallel with the first plane 23. The first and second planes 23, 24 are spaced by a distance greater than a thickness of the ceiling tiles such that the ceiling tiles 4 can move from the first position to a second position, the ceiling tiles 4 in the first position being spaced from the stop 3 and in the second position being against the stop 3. The tile 4 shown in figure 1 for example is positioned in the first position, whereas the tile 4 shown in figure 7 is shown in the second position, at least at the position shown. It is for example possible to lift the ceiling tile 4 only at the position of the attachment member 13 such that part of the ceiling tile 4 is in the second position and part of the ceiling tile 4, for example the part of the ceiling tile 4 opposing the part of the ceiling tile 4 which is in the second position of the ceiling tile 4, is in the first position.

[0045] The stop 3, shown in figure 1 is positioned between a building structure, not shown in the figures, covered by the impact resistant suspended ceiling 1 and the suspension frame 2 and is spaced from the suspension frame 2 along a spacing direction 25 from the suspension frame 2 towards the building structure. This is however not critical for the invention and the stop 3 can also be directly positioned on top of the suspension frame 2, without leaving a distance along the spacing direction 25 between the stop 3 and the suspension frame 2. However, it has been found that preferably the distance between the stop 3 and the suspension frame 2 is adaptable and the stop 3 is not limited to being positioned directly on top of the suspension frame 2 to adapt the stop 3 to the specific ceiling tiles 4 used and the expected impacts onto the ceiling tiles 4.

[0046] In addition, to avoid ceiling tiles 4 being displaced due to a too heavy impact from below, the stop 3 preferably is provided such that the second position of the ceiling tile 4 is on one hand sufficiently close to the suspension frame 2 such that the risk for dislocation is limited or even excluded and on the other hand the second location is far enough from the first location such that relative large impacts can be substantially absorbed by the weight of the ceiling tile 4.

[0047] More preferably, the distance between the first 23 and the second plane 24 is maximally twice the thickness of the ceiling tile 4, more preferably maximally the sum of the thickness of the ceiling tile 4 with the thickness of the suspension frame 2 along the spacing direction 25, when the thickness of the ceiling tiles 4 is larger than the thickness of the suspension frame 2 along the spacing direction 25, as for example shown in figure 7. The inventor has found that in such a construction the ceiling tiles 4 together with the suspension frame 2 itself will prevent the ceiling tiles 4 from dislocating after being impacted from below. When the thickness of the ceiling tiles 4 is less than the thickness of the suspension frame 2 along the spacing direction 25, the distance between the first 23 and the second 24 plane preferably is maximally the sum of the thickness of the ceiling tile 4 with the thickness of the suspension frame 2 along spacing direction 25. In such a construction, the suspension frame 2 limiting the risk that the ceiling tiles 4 dislocate subsequent impact from below.

[0048] Preferably, the stop 3 is substantially made from metal. However, other materials such as for example wood, plastic, etc. are possible. Although the stop 3 can be made from a single material, the material of the parts of the stop are preferably adapted to their function.

[0049] The stop 3 shown in figure 1 covers substantially a single ceiling tile 4 and limits the upward movement of substantially the single ceiling tile 4. However, this is not critical for the invention and the stop 3 can also extend over multiple ceiling tiles 4. However, by providing each ceiling tile 4 with its individual stop 3, the stop 3 can be adapted to the specific requirements depending on for example the location of the ceiling tile 4 and its specific technical characteristics such as for example weight.

[0050] Preferably, the stop 3 is substantially planar. However the stop 3 can alternatively be substantially unplanar. The stop 3 can for example comprise substantially longitudinal elements protruding from the building construction covered by the ceiling tiles 4 towards the ceiling tiles 4. However, it has been found that a substantially planar stop 3 provides a stop having a certain area against which the ceiling tile 4 can move after being impacted, which has been found to decrease the risk that the ceiling tile 4 is dislocated due to an impact from below.

[0051] Such a substantially planar stop 3 can in addition to providing impact resistant properties to the impact resistant suspended ceiling 1, also be used as a structure to which further elements can be suspended. The stop 3 can for example be used to mount lighting, piping, wiring, air-conditioning elements, etc. to the suspended impact resistant ceiling by structurally mounting the further elements to the stop 3. The further elements, such as lighting, air-conditioning outlets and/or inlets, etc., may for example protrude through the suspension frame 2 and/or the ceiling tiles 4 to below the impact resistant suspended ceiling 1.

[0052] Although the substantially planar stop 3 shown in the figures is made up of a substantially planar frame 3, this is not critical for the invention. Alternatively, surfaces could be provided as a stop 3 above the ceiling tiles 4. For example a square, rectangular, oval, round, triangular, trapezoidal, etc. surface could be provided above the ceiling tiles 4 as a stop 3. Such a surface could be for example made from wood, metal, plastic, etc. However, it has been found that it is sufficient to provide a frame 3 as stop 3 for limiting the upward movement of

the ceiling tiles 4 and that it is not necessary, although possible, to provide surfaces to limit the upward movement of ceiling tiles 4 due to an impact from below.

[0053] The substantially planar frame 3 shown in figure 1 preferably comprises a grid 10 of runners 11, 12. More preferably the runners are U-shaped and preferably are made from metal. Other embodiments are however possible with respect to for example form and/or material.

[0054] The grid 10 shown in figure 1 is attached to the suspension frame 2 with attachment members 13, of which an example is shown in more detail in figure 2. However, the stop 3, although not shown in the figures, can also be attached directly to the building structure which is covered by the impact resistant suspended ceiling 1. However, the former is preferred since the building structure often can only be reached in a limited way due to the suspension frame 2 which has already been installed. In such a configuration the stop 3 can be attached to the suspension frame 2 and the difficulty of reaching the building structure is no longer limiting the ease of constructing the impact resistant suspended ceiling 1.

[0055] Although any type of attachment member 13 known to the person skilled in the art is possible, the attachment member 13 preferably comprises at a first end 14 a first part 16 for receiving an end part 22 of a runner 11, 12 of the grid 10 and at a second end 15 opposing the first end 14 a second end part 17 provided to be attached to the suspension frame 2. The first part 16 comprises a base 18 and two upright sidewalls 19, 20 extending from opposing sides of the base 18. The base 18 and the upright sidewalls 19, 20 delimit a volume provided to receive the end part 22 of the runner 11, 12. As can be seen in figure 2, the runner 11 can be further fixed to the attachment member 13 by a screw. However, any other means known to the person skilled in the art are possible, such as for example, nailing, soldering, bolting, welding, gluing, etc.

[0056] The attachment member 13 preferably is made of metal, more preferably steel but can also be aluminium depending on the demand on stability during fires or incombustibility. This is however not critical for the invention and the attachment member 13 can also be made from for example wood, plastic, etc.

[0057] As shown in figure 2 the first and the second part 16, 17 are substantially perpendicular with respect to each other. This is however not critical for the invention and any type of position of the first part 16 with respect to the second part 17 is possible, depending on the desired position of the runners 11, 12 over the ceiling tiles 4.

[0058] Preferably, the attachment member 13 comprises an abutting flange 21 between the first part 16 and the second part 17. The abutting flange 21 abuts the end part 22 of the runner 11 received in the first part 16 when the end part 22 of the runner 11 is correctly positioned in the first part 16. Although such an abutting flange 21 is not critical for the invention, it allows the runner 11 to be more easily and more correctly positioned in the attachment member 11.

[0059] Preferably, the impact resistant suspended ceiling 1 comprises a cooperating pair of a connector 6 and a disconnector 7 for mounting and dismounting the stop 3 to or from the suspension frame 2. The connector 6 connects the suspension frame 2 and the stop 3. The disconnector 7 is provided for disconnecting the connection between the suspension frame 2 and the stop 3 of the connector 6. Such a pair is for example shown in figure 7. The connector 6 allows the stop 3 to be mounted to the suspension frame 2, whereas the disconnector 7 allows to disconnect the connection between the suspension frame 2 and the stop 3 for dismounting the stop 3 from the suspension frame 2, in this case by pushing the disconnector 7 in the spacing direction 25. The connector 6 and the disconnector 7 are, in figure 7, provided to the attachment member 13, more particularly to the second part 17. However, other cooperating pairs of connectors and/or disconnectors 6, 7 are possible. For example, the disconnector 7 can also alternatively allow disconnecting the connection of the connector 6 by pushing, pulling, etc. and/or the cooperating pair of the connector and the disconnector 6, 7 are provided on a different part of the stop 3 or attachment member 13, etc.

[0060] As shown in figure 7, the disconnector 7 is accessible when the ceiling tile 4 is at least partly in the second position at the location of the disconnector 7 for disconnecting the connection of the connector 6 between the suspension frame 2 and the stop 3. In the case of figure 7, when the ceiling tile 4 is lifted along the spacing direction 25 towards the second position, enough space is available between the ceiling tile 4 and the first plane 23 for accessing the disconnector 7 with for example a screw-driver such that the connection of the connector 6 can be disconnected. Depending on the type and location of the disconnector 7, the ceiling tile 4 will have to be lifted more or less along the spacing direction 25 to leave sufficient space for manipulating the disconnector 7. Such a construction allows the stop 3 to be at least partly dismounted from the suspension frame 2 by simply partly lifting part of a ceiling tile 4 near the cooperating pair of the connector and the disconnector 6, 7.

[0061] When each ceiling tile 4 is provided with its own stop 3, as described above, the cooperating pair of the connector 6 and the disconnector 7 allows to reach the plenum substantially directly above each individual ceiling tile 4 by sufficiently dismounting the stop 3 from the suspension frame 2 by disconnecting at least one connection between a connector 6 and the suspension frame 2 by using the corresponding disconnector 7 such that the ceiling tile 4 can be pushed out of the suspension frame 2 and for example over an adjacent ceiling tile 4. The stop 3 in that case does not substantially increase the difficulty with which the plenum above a specific ceiling tile 4 can be reached.

[0062] Preferably, the connector 6 is in the form of a lip 8 of the stop 3 engaging a corresponding opening 9 of the suspension frame 2. Preferably, the lip 8 is provided to openings 9 in a bandraster-system, preferably stand-

ard openings 9 provided in the bandraster-system. More preferably, the lip 8 has a shape which allows it to sufficiently interlock the stop 3 and the suspension grid 3, more preferably the attachment member 13 and the suspension grid 2, along a substantially horizontal direction but allows the connection of the connector 6 to be broken by moving the lip 8 along the spacing direction 25. A lip 8 with such a shape is for example shown in figure 7.

[0063] Preferably, the disconnector 7 is provided to allow a tool, such as the srew-driver shown in figure 7, to interlock with it such that the disconnector 7 can move the connector 6 along the spacing direction 25 to disconnect the connection between the suspension frame 2 and the stop 3. More preferably, the disconnector 7 thereto is a protruding lip, as shown in figure 7 although this is not critical for the invention.

[0064] Figure 4 shows a detail of the preferred embodiment of the attachment member 13 according to the current invention. The attachment member 13 comprises at the first end 14 the first part 16 for connecting to an end part 22 of a first runner 11 and at the second end 15 opposing the first end 14 the second part 17 comprising the connector 6 and the disconnector 7.

[0065] Preferably, the attachment member 13 is provided to be bent such that the second part 17 is bent towards the first part, preferably when subjected to an action by a tool such as a screw-driver as shown in figure 7, when moving the connector 6 out of the corresponding opening 9 in the suspension frame 2 to facilitate removal of the connector 6 from the opening 9. More preferably, the first 16 and the second 17 part of the attachment member 13 thereto are hingeably connected.

[0066] Preferably, the first part 16 is provided to be mounted to and more preferably to receive an end part of a first U-shaped runner 11, 12 and more preferably, although not critical for the invention, thereto comprises a base 18 and two upright sidewalls 19, 20 extending from opposing side edges of the base 18, the base 18 and the upright sidewalls 19, 20 delimiting a volume provided to receive the end part of the first U-shaped runner 11, 12. However, the first part 16 could, alternatively and for example, only comprise a base 18 and/or only one of the two upright sidewalls 19, 20, as deemed appropriate by the person skilled in the art. As can be seen from figure 4, the second part 17 preferably extends from the base 18.

[0067] As can be seen from figures 4, the attachment member 13 preferably comprises a flange 21 between the first and the second part 17 and, as can be seen from comparing figure 4 and 5, the first 16 and the second part 17 are hingedly connected to each other between a perpendicular position in which the first and the second part 17 are substantially perpendicular with respect to each other and a longitudinal position in which the first 16 and second part 17 are substantially longitudinal with respect to each other. The connector 6 cooperates with the flange 21 as to form a snap-fit connection for attaching a second U-shaped runner 12 to the first U-shaped runner 11 by snap-fitting the snap-fit connection between two parallel walls of the second U-shaped runner 12.

[0068] When the first part 16 and the second part 17 are hingedly connected to each other between the perpendicular position shown in figure 4 and used for attaching runners of the grid 10, as for example shown in figure 2, and a longitudinal position in which the first 16 and the second part 17 are substantially longitudinal with respect to each other, as shown in figure 5, the attachment member 13 can also be used to interconnect runners 11 and 12 as shown in detail in figure 3. In such case, the flange 21 in the perpendicular position and the connector 6 cooperate as to form a snap-fit connection for attaching a second U-shaped runner 12 to the runner 11 by snap-fitting the snap-fit connection between two parallel walls of the second U-shaped runner 12. Such a snap-fit connection is for example shown in the side view of figure 6.

[0069] More preferably, the flange 21 is the abutting flange 21 described above when the attachment member 13 is in the perpendicular position, as can be seen in figure 4.

[0070] As can be seen from comparing figures 4 and 5, the flange 21 can be bent between two positions. In a first position of the flange 21, shown in figure 4, the flange 21 is substantially coplanar with the second part 17 of the attachment member 13 and preferably is the abutting flange 21. In a second position of the flange 21, shown in figure 5, the flange 21 is bent out of the plane of the second part 16 and is part of the snap-fit connection. The bending of the flange 21 preferably can be done by manually pushing against the flange 21 such that no tools are needed to change the position of the flange 21.

[0071] With the attachment members 13 according to the invention and standard U-shaped members, the stop 3 can be fully assembled without having to use substantial additional components which are less commonly available. Moreover, by changing the length of the U-shaped members, the stop 3 can be fully adjusted to any size of the ceiling tiles 4 and/or the suspension frame 2.

[0072] As an example tests have been carried out with ceiling panels made of mineral wool (Rockfon Boxer 40x1200x1200 mm) mounted in a suspended ceiling system as outlined above with a distance between the stop and the panel of 5 to 8 mm. The impact resistance of the tested ceiling was rated to class 1A. Based on the test results it is expected that the same rating can be achieved with panels of 40x1500x1225 mm.

Claims

1. Impact resistant suspended ceiling (1) comprising a suspension frame (2) for supporting ceiling tiles (4) in a first position on a first plane (23) and limiting means (5) for limiting an upward movement of the ceiling tiles (4) as a result of the ceiling tiles (4) being impacted from below, **characterised in that** the limiting means (5) comprise a stop (3) arranged in a

second plane (24) substantially parallel with the first plane (23), wherein the first and second planes (23, 24) are spaced by a distance greater than a thickness of the ceiling tiles such that ceiling tiles (4) can move from the first position to a second position, the ceiling tiles (4) in the first position being spaced from the stop (3) and in the second position being against the stop (3).

2. Impact resistant suspended ceiling according to claim 1, **characterised in that** the stop (3) is positioned between a building structure covered by the impact resistant suspended ceiling (1) and the suspension frame (2) and is spaced from the suspension frame (2) along a spacing direction (25) from the suspension frame (2) towards the building structure.

3. Impact resistant suspended ceiling according to claim 1 or 2, **characterised in that** the stop (3) is made up of a substantially planar frame (3).

4. Impact resistant suspended ceiling (1) as claimed in any one of the preceding claims, **characterised in that** the impact resistant suspended ceiling (1) comprises a cooperating pair of a connector (6) and a disconnector (7) for mounting and dismounting the stop (3) to or from the suspension frame (2), the connector (6) connecting the suspension frame (2) and the stop (3) and the disconnector (7) for disconnecting the connection between the suspension frame (2) and the stop (3) of the connector (6) and **in that** the disconnector (7) is accessible when the ceiling tile (4) is at least partly in the second position at the location of the disconnector (7) for disconnecting the connection of the connector (6) between the suspension frame (2) and the stop (3).

5. Impact resistant suspended ceiling (1) as claimed in claim 4, **characterised in that** the connector (6) is in the form of a lip (8) of the stop (3) for engaging a corresponding opening (9) of the suspension frame (2) and **in that** the suspension frame (2) can be disconnected from the stop (3) by moving the connector (6) in the spacing direction (25) by pushing the disconnector (7) in the spacing direction (25).

6. Impact resistant suspended ceiling (1) as claimed in any one of claims 4 - 5, **characterised in that** the substantially planar frame (3) comprises a grid (10) of runners (11, 12) and attachment members (13), the attachment members (13) attaching runners (11, 12) of the grid (10) to the suspension frame (2) and **in that** the connector (6) and disconnector (7) are part of the attachment members (13).

7. Impact resistant suspended ceiling (1) as claimed in claim 6, **characterised in that** the attachment member (13) comprises at a first end (14) a first part (16) for receiving an end part (22) of a runner (11, 12) of the grid (10), the first part (16) comprising a base (18) and two upright sidewalls (19, 20) extending from opposing side edges of the base (18), the base (18) and the upright sidewalls (19, 20) delimiting a volume provided to receive the end part (22) of the runner (11, 12) and at a second end (15) opposing the first end (14) a second part (17) extending from the base (18) comprising the connector (6) and the disconnector (7).

8. Impact resistant suspended ceiling (1) as claimed in claim 7, **characterised in that** the first (16) and the second part (17) are substantially perpendicular with respect to each other.

9. Impacts resistant suspended ceiling (1) as claimed in claim 7 or 8, **characterised in that** the attachment member (13) comprises an abutting flange (21) between the first part (16) and the second part (17), for abutting the end part (22) of the runner (11, 12) received in the first part (16) when the end part (22) of the runner (11, 12) is correctly positioned in the first part (16).

10. Impact resistant suspended ceiling (1) as claimed in any one of claims 6 - 9, **characterised in that** the runners (11, 12) are U-shaped.

11. Impact resistant suspended ceiling (1) for covering a building structure as claimed in any one of the preceding claims,
characterised in that the suspension frame (2) is a bandraster-system.

12. Impact resistant suspended ceiling (1) according to any one of the of the preceding claims, **characterised in that** the ceiling panels (4) are impact resistant mineral wool panels provided with a facing.

13. Impact resistant suspended ceiling (1) according to claim 12, **characterised in that** the ceiling panels (4) have a size of at least 600 x 600 mm, preferably at least 1200 x 1200 mm.

14. An attachment member (13) for use in an impact resistant suspended ceiling (1) according to any one of claims 6 - 10, comprising at a first end (14) a first part (16) for connecting to an end part (22) of a first runner (11) and at a second end (15) opposing the first end (14) a second part (17) comprising the connector (6) and the disconnector (7).

15. An attachment member (13) as claimed in claim 14, **characterised in that** the first part (16) is provided to receive an end part of a first U-shaped runner (11, 12) and comprises a base (18) and two upright sidewalls (19, 20) extending from opposing side edges

of the base (18), the base (18) and the upright sidewalls (19, 20) delimiting a volume provided to receive the end part of the first U-shaped runner (11, 12).

16. An attachment member as claimed in claim 14 or 15, **characterised in that** the attachment member (13) comprises a flange (21) between the first and the second part (17), **in that** the first (16) and the second part (17) are hingedly connected to each other between a perpendicular position in which the first and the second part (17) are substantially perpendicular with respect to each other and a longitudinal position in which the first (16) and second part (17) are substantially longitudinal with respect to each other, the connector (6) cooperating with the flange (21) as to form a snap-fit connection for attaching a second U-shaped runner (11) to the first U-shaped runner (11) by snap-fitting the snap-fit connection between two parallel walls of the second U-shaped runner (12).

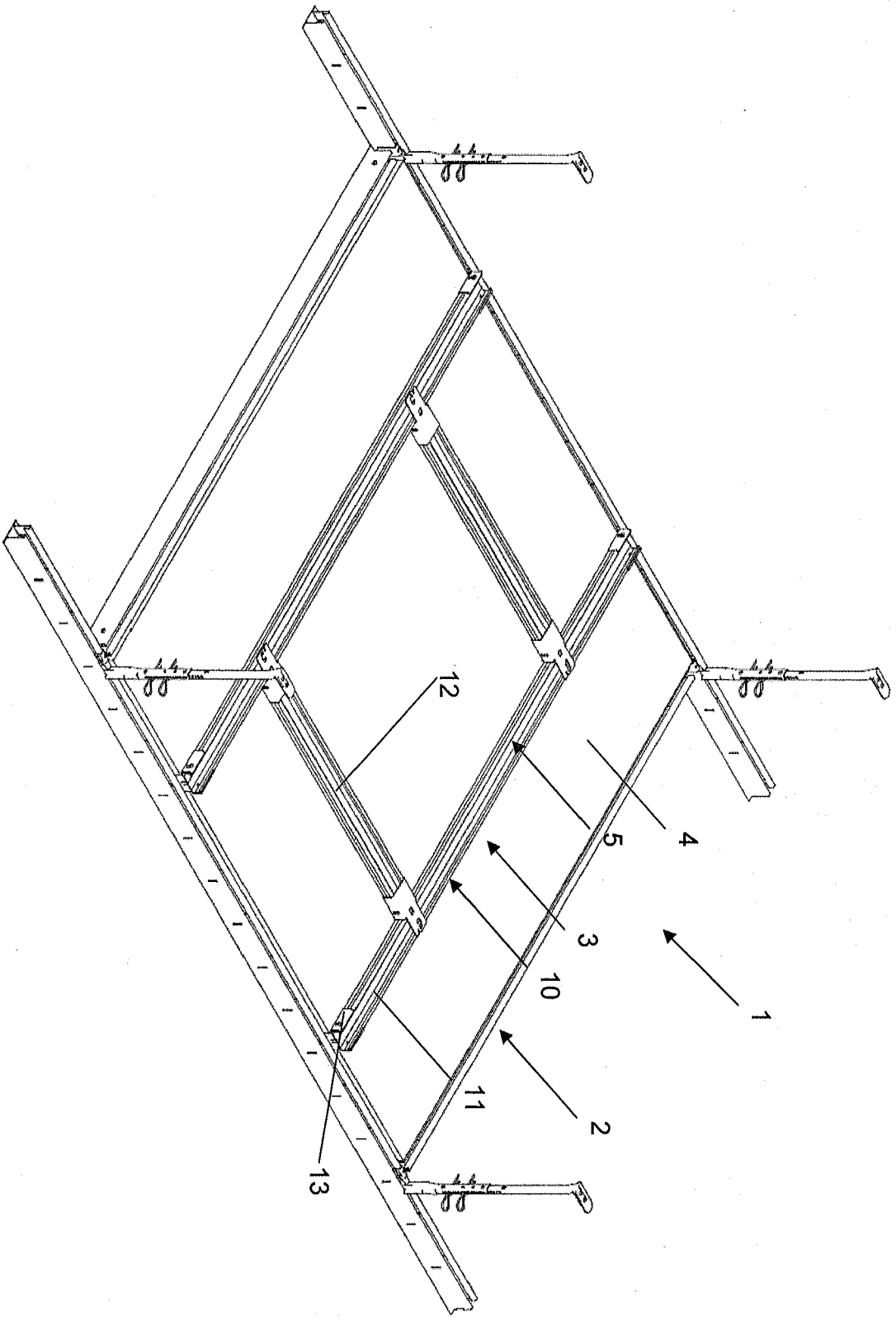

Fig. 1

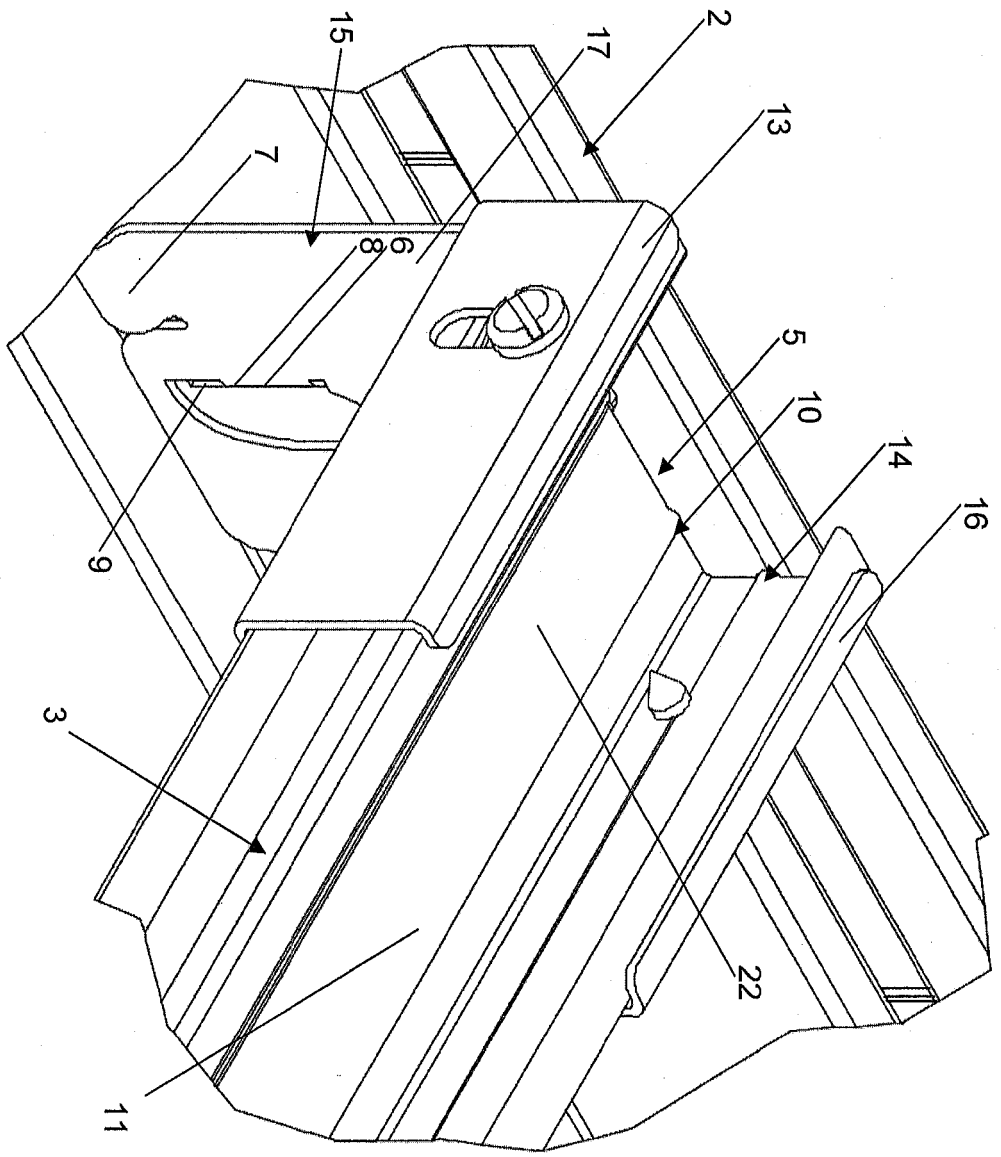

Fig. 2

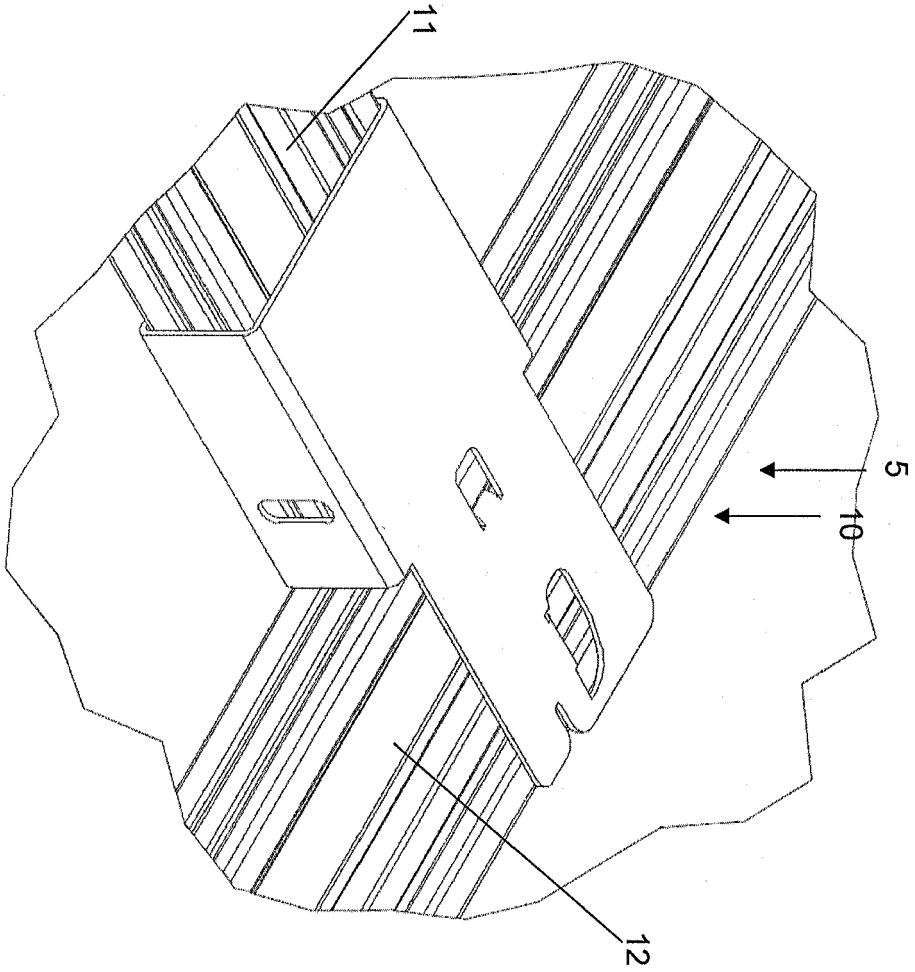

Fig. 3

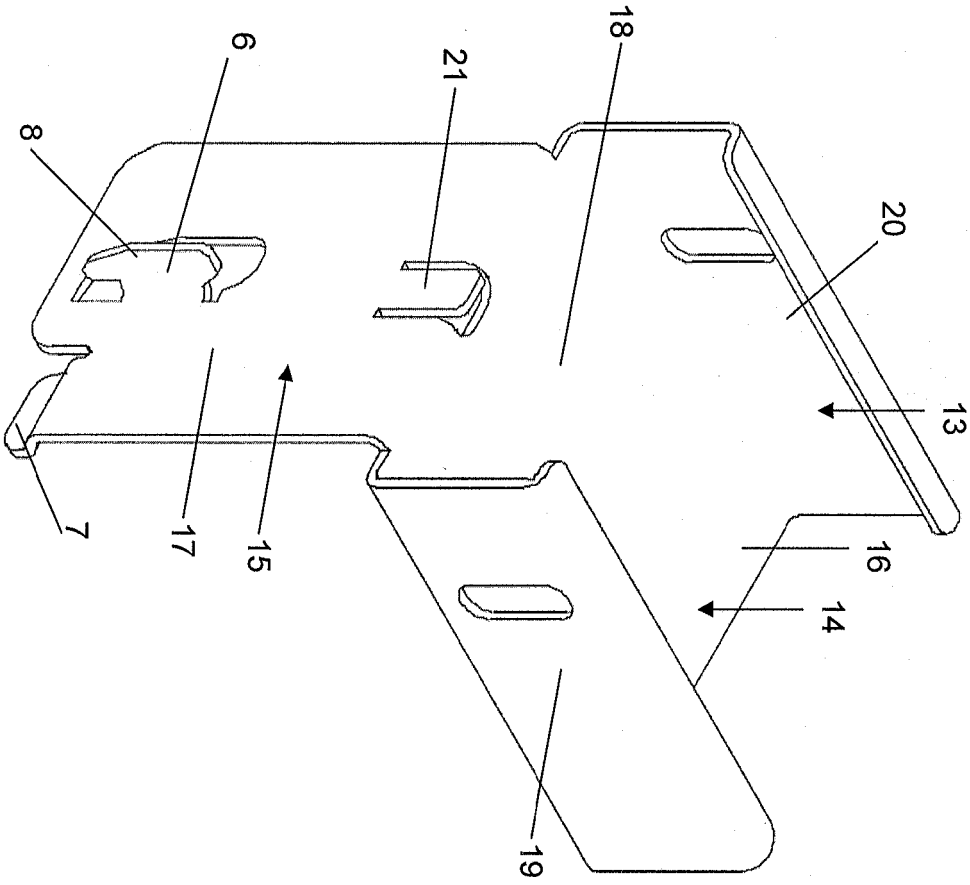

Fig. 4

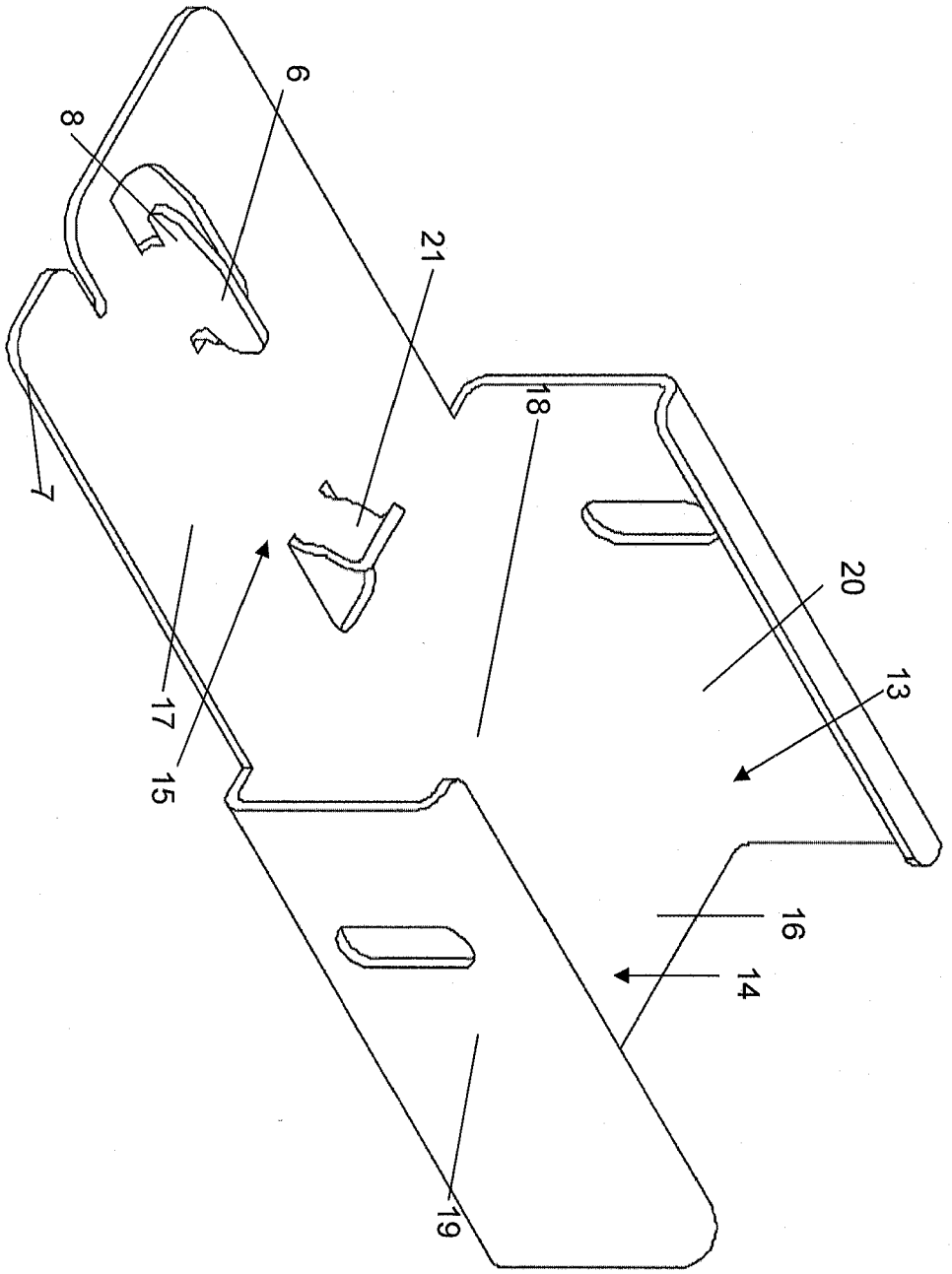

Fig. 5

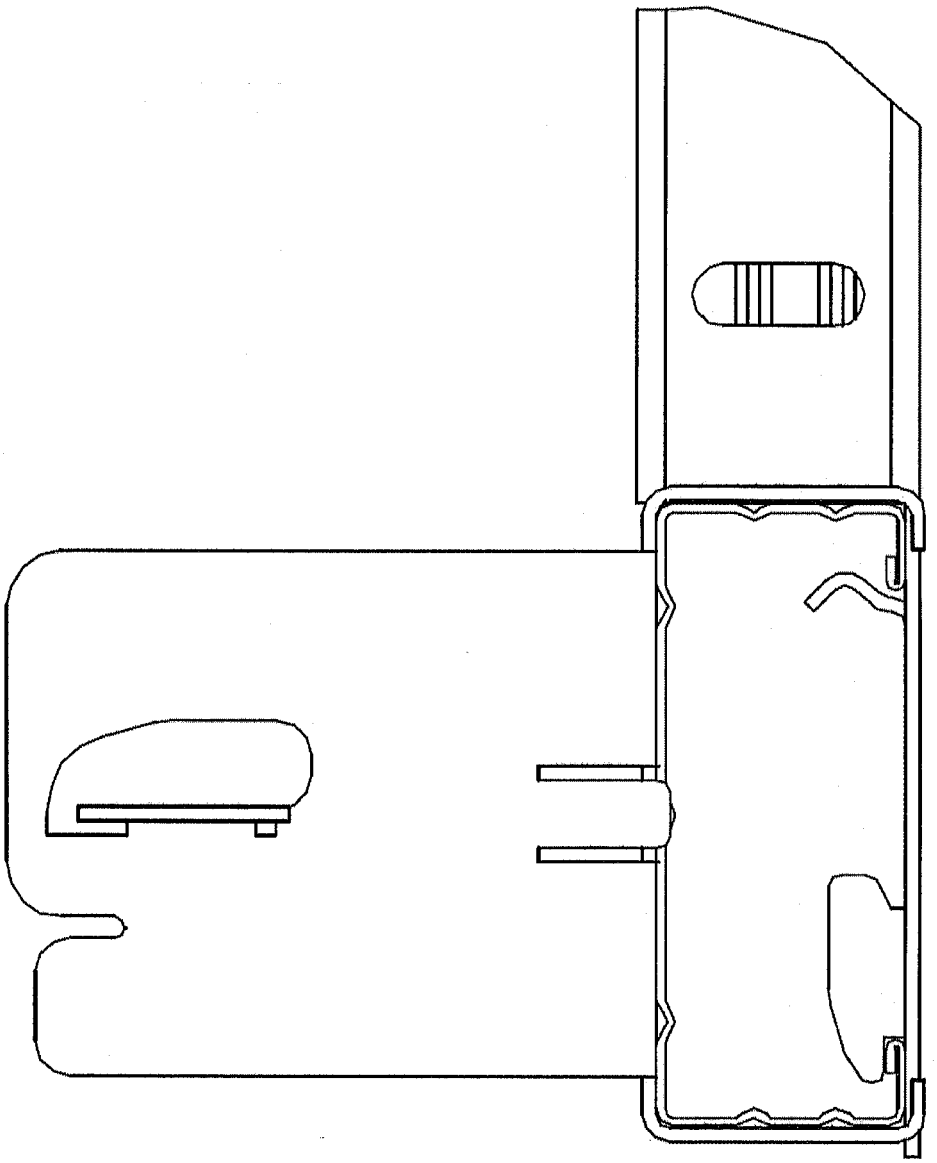

Fig. 6

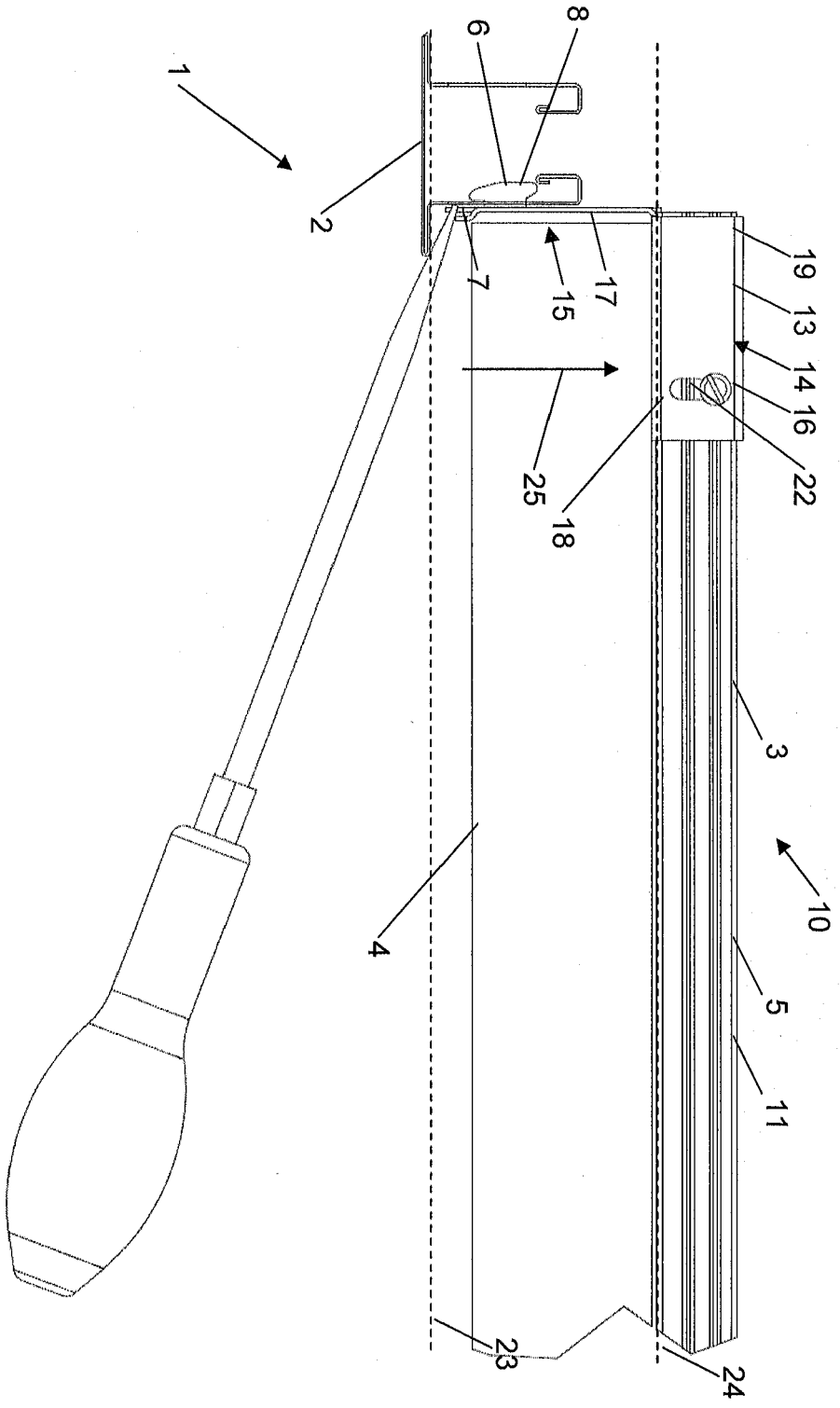

Fig. 7

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EUROPEAN SEARCH REPORT

Application Number
EP 09 15 7318

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2 667 667 A (VICTOR JACOBSON) 2 February 1954 (1954-02-02) * figures 1-5 * * column 5, lines 7-31 * * column 4, lines 20-34 *	1-3, 11-13	INV. E04B9/24 E04B9/06 E04B9/12
A	* figures 1-5 * -----	4-10	
X	US 5 603 193 A (KOERTGE RICHARD J [US] ET AL) 18 February 1997 (1997-02-18) * figures 1-5 * * column 2, line 48 - column 3, line 3 * * column 3, lines 31-43 * -----	1-3, 11-13	
A	EP 0 652 338 A (RICHTER SYSTEM GMBH & CO KG [DE]) 10 May 1995 (1995-05-10) * figures 1-5 * * claims 1-3,6 * * column 1, lines 18-33 * * column 2, lines 33-43 * * column 4, lines 22-26 * * column 5, lines 14-18 * -----	1-13	TECHNICAL FIELDS SEARCHED (IPC)
D,A	US 4 408 428 A (BROOKE MICHAEL E [US] ET AL) 11 October 1983 (1983-10-11) * the whole document * -----	1-13	E04B
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X	DE 94 01 415 U1 (VOGL ERICH R [DE]) 10 March 1994 (1994-03-10) * figure 1 * * figures 1-3 * * claims 1,6,7 * -----	14-16	
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	30 December 2009	Schnedler, Marlon

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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EUROPEAN SEARCH REPORT

Application Number
EP 09 15 7318

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	FR 2 657 379 A (PLACOPLATRE SA [FR]) 26 July 1991 (1991-07-26) * figures 1,4,5 * * claim 1 * * page 4, line 15 - page 5, line 15 *	14	
A	* figures 1,4,5 * * claim 1 * -----	15,16	
			TECHNICAL FIELDS SEARCHED (IPC)

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	30 December 2009	Schnedler, Marlon

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Application Number
EP 09 15 7318

CLAIMS INCURRING FEES

The present European patent application comprised at the time of filing claims for which payment was due.

☐ Only part of the claims have been paid within the prescribed time limit. The present European search report has been drawn up for those claims for which no payment was due and for those claims for which claims fees have been paid, namely claim(s):

☐ No claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for those claims for which no payment was due.

LACK OF UNITY OF INVENTION

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

see sheet B

☒ All further search fees have been paid within the fixed time limit. The present European search report has been drawn up for all claims.

☐ As all searchable claims could be searched without effort justifying an additional fee, the Search Division did not invite payment of any additional fee.

☐ Only part of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the inventions in respect of which search fees have been paid, namely claims:

☐ None of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims, namely claims:

☐ The present supplementary European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims (Rule 164 (1) EPC).

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LACK OF UNITY OF INVENTION
SHEET B

Application Number
EP 09 15 7318

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

1. claims: 1-13

An impact resistant suspended ceiling

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2. claims: 14-16

An attachment member of a U-shaped runner in a suspended ceiling

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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 09 15 7318

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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30-12-2009

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FR 2657379 A	26-07-1991	NONE	

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

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