(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 2 921 640 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
23.09.2015 Bulletin 2015/39

(51) Int Cl.:
E21B 41/00 *(2006.01)* ***E21B 7/02*** *(2006.01)*

(21) Application number: **14160473.6**

(22) Date of filing: **18.03.2014**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME

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(54) Protection cage, rock drilling unit, levelling arrangement and method for rock drilling

(57) The invention relates to a protection cage, a levelling arrangement and a method for rock drilling. The protection cage (13) is intended to encapsulate a mining device. The cage (13) has a grid-like configuration (24) whereby it comprises several mesh openings (27) and intermediate portions (30) between them. The intermediate portions are in transverse direction as compared to a longitudinal axis of the protection cage. In the levelling arrangement and method the disclosed protection cage is being implemented.

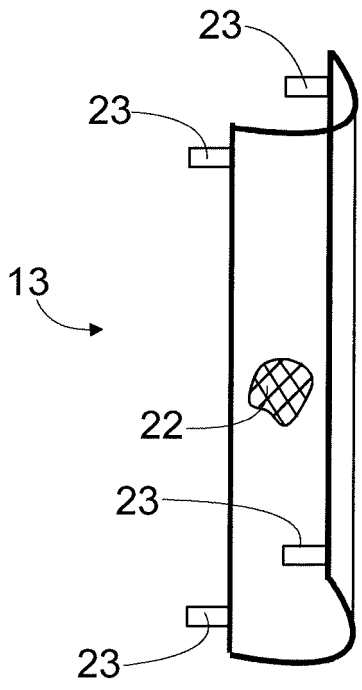

FIG. 4

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Description

Background of the invention

[0001] The invention relates to a protection cage for encapsulating a mining device. The protection cage has a grid-like configuration and is provided with several mesh openings.

[0002] The invention further relates to a levelling arrangement, a rock drilling unit and a method of rock drilling.

[0003] The field of the invention is defined more specifically in the preambles of the independent claims.

[0004] In mines and at other work sites, drilling machines are used for drilling bore holes into rock surfaces and soil. The rock drilling machine comprises a rotating device for rotating a drilling tool during drilling. Moving machine parts may cause a safety risk, wherefore a protection cage may be used to prevent access to the moving machine parts. However, the present protection cages may cause problems when levelling the machines.

Brief description of the invention

[0005] An object of the invention is to provide a novel and improved protection cage for encapsulating a mining device. A further object is to provide a novel and improved levelling arrangement and a method for rock drilling.

[0006] The protection cage according to the invention is characterized in that the intermediate portions of the mesh openings are in transverse direction relative to a longitudinal axis of the elongated protection cage.

[0007] The rock drilling unit and the levelling arrangement according to the invention are characterized in that the protection cage is as disclosed in this patent application and as specifically claimed in claims 1 to 10.

[0008] The method according to the invention is characterized by enclosing the rock drilling machine by means of at least one protection cage in accordance with claims 1 to 10.

[0009] An idea of the disclosed solution is that a mining device is encapsulated by means of a protection cage. The protection cage has a grid-like configuration whereby it comprises several mesh openings and intermediate portions between them. The intermediate portions are in transverse direction as compared to a longitudinal axis of the protection cage, which is a longitudinal object. The grid-structure of the protection cage is without horizontally directed intermediate portions.

[0010] An advantage of the disclosed solution is that when the intermediate portions of the mesh openings are diagonal, they cause less blocking of light rays and signals utilized in a levelling process. A levelling beam may be horizontal. When the intermediate portions deviate clearly from the direction of the levelling beam, then the levelling beam does not align with longitudinal direction of the intermediate portion. Thus, there exists a clear angular difference between directions of all intermediate portions confining a mesh opening and the levelling beam. A more blocking free structure may be achieved.

[0011] According to an embodiment, directions of all intermediate portions of a protection cage differ from a direction of a levelling beam.

[0012] According to an embodiment, all of the mesh openings of the protection cage have the same shape.

[0013] According to an embodiment, all of the mesh openings of the protection cage have the same dimensions.

[0014] According to an embodiment, the protection cage has at least two portions. The protection cage may comprise two or more longitudinally successive portions, for example.

[0015] According to an embodiment, the protection cage comprises a base structure and at least one limited penetration area, wherein the penetration area is provided with a grid-structure, which is in accordance with the features disclosed in this patent application.

[0016] According to an embodiment, a transverse section of the protection cage is U-shaped. The cross-sectional shape may be curved, or the shape comprises at least two portions in angular position relative to each other. The U-shaped protection cage may be fastened to a feed beam belonging to a mining unit, whereby the protection cage and the feed beam limit together a space, where a mining device may be safely moved.

[0017] According to an embodiment, the mesh openings are defined by means of four elongated intermediate portions and four edges between the intermediate portions. The intermediate portions may be straight lines. Alternatively, the intermediate portions may be slightly curved.

[0018] According to an embodiment, the protection cage comprises several square-shaped mesh openings. The square-shaped mesh opening has two diagonal lines, namely a first diagonal line and a second diagonal line. The first diagonal line is in a transverse direction relative to the longitudinal axis of the protection cage and the second diagonal line is parallel with the longitudinal axis of the protection cage.

[0019] According to an embodiment, the protection cage comprises several square-shaped mesh openings and the mesh opening size is 30 * 30 mm.

[0020] According to an embodiment, the protection cage comprises several square-shaped mesh openings and the mesh opening size is 40 * 40 mm.

[0021] According to an embodiment, the protection cage comprises several diamond-shaped mesh openings. Thus, the mesh openings are composed of four edges, four linear elongated intermediate portions, two opposite acute edges, two opposite obtuse edges.

[0022] According to an embodiment, all of the mesh openings are diamond-shaped.

[0023] According to an embodiment, the protection cage comprises several diamond-shaped mesh openings. Each of the diamond-shaped mesh openings have a maximum mesh height transverse to the longitudinal

axis of the protection cage. Further, the diamond-shaped mesh opening has a maximum mesh width in the direction of the longitudinal axis of the protection cage. The height of the mesh opening is greater than the width.

[0024] According to an embodiment, the protection cage has several mesh openings defined by means of intermediate portions. The intermediate portions confining the mesh openings are angled 45° or substantially 45° relative to a longitudinal axis of the elongated protection cage.

[0025] According to an embodiment, the protection cage has grid-like configuration, which is composed of a wire-net. The wire-net is provided with wires, which serve as intermediate portions confining mesh openings of the grid structure.

[0026] According to an embodiment, the protection cage has grid-like configuration, which is composed of a woven wire-net. The woven wire-net structure comprises several wires crossing each other and being connected to each other utilizing a weaving pattern.

[0027] According to an embodiment, the protection cage has grid-like configuration, which is composed of a welded wire-net. The welded wire-net structure comprises several wires crossing each other and being connected to each other by means of welded joints.

[0028] According to an embodiment, the protection cage has grid-like configuration, which is composed of a perforated plate. In the perforated plate there are several intermediate portions confining mesh openings. The intermediate portions are of plate material. The protection cage may be manufactured in an automated sheet metal working station utilizing punching, lase cutting, water jet cutting and bending techniques, for example. This embodiment allows shape and dimensions of the mesh openings to be tailored.

[0029] According to an embodiment, the protection cage has grid-like configuration, which is composed of a perforated plate. In the perforated plate there are several intermediate portions confining mesh openings. Each mesh opening of the perforated plate comprises several edges. At least one of the edges is bent in transverse direction relative to a plane surface of the perforated plate, whereby the mesh opening is provided with at least one stiffening flange. Thanks to the stiffening flange the structure may be stiff and still light in weight. The intermediate portion may then have a three dimensional structure. Thickness of the plate material may be chosen to be minor, when the structure has the stiffening flanges, as compared to a structure without the flanges. Thanks to the stiffening flanges width of the intermediate portions may be small, whereby a risk of blocking a levelling beam is decreased. The protection cage may be self-supporting, whereby no separate supporting frame is needed.

[0030] According to an embodiment, the protection cage comprises fastening elements for fastening the protection cage to a mining unit provided with the mining device. The fastening elements allow the protection cage to be moved a limited movement relative to the mining device inside the protection cage.

[0031] According to an embodiment, fastening elements of the protection cage comprise moving members allowing a limited linear movement for the protection cage in the longitudinal direction of the protection cage.

[0032] According to an embodiment, the protection cage is movable in both longitudinal directions.

[0033] According to an embodiment, fastening elements of the protection cage comprise moving members allowing a limited linear movement for the protection cage in a transverse direction of the protection cage.

[0034] According to an embodiment, the protection cage may be moved relative to a mining unit. Thus, the protection cage may comprise one or more actuators for moving the protection cage. The actuator may be a hydraulic actuator, which is beneficial since in the mining unit hydraulic power is normally available. The actuator may be a hydraulic cylinder. Alternatively, the actuator may be a hydraulic motor. Between the hydraulic motor and the protection cage may be transfer means for converting the rotation of the motor into linear movement of the protection cage. The transfer means may comprise one of the following: gear rack and pinion; gearing; eccentric sleeve or linked arm system.

[0035] According to an embodiment, the protection cage may be moved by means of an actuator. The actuator may be remote controlled by an operator or, alternatively the actuator is automatically controlled by means of a control unit in response to detection signals received from at least one detection device.

[0036] According to an embodiment, the protection cage may be moved relative to a mining unit. A mining device of the mining unit is arranged movably inside the protection cage and the movement of the mining device is configured to produce a movement for the protection cage by means of at least one force transmission element or device. A need for any separate actuator generating moving is avoided since the movement of the mining device is utilized as is disclosed.

[0037] According to an embodiment, the protection cage is of metal. Thus, the protection cage may be formed of metal wires or metal plate. Suitable metals are steel and aluminum, for example.

[0038] According to an embodiment, the protection cage is of plastic material. Then the protection cage may be molded, injection molded or rotation molded. Alternatively the cage may be a molded plastic net or a wire-net made of plastic yarns. Further, the protection cage may be made of a plastic sheet by machining mesh openings by means of water jet cutting, laser cutting or punching. An advantage of the plastic protection cage is that it is light in weight. The protection cage may be made of plastic material totally or at least partly.

[0039] According to an embodiment, at least a grid portion or penetration area of the protection cage is of composite material comprising at least one polymeric binding material and reinforcing fibers. The protection cage made of composite material may have an extremely good stiff-

ness per weight ratio.

[0040] According to an embodiment, at least a grid portion or penetration area of the protection cage is made of transparent material allowing passage of light rays. When intermediate portions between mesh openings allow passage of light rays at least in some extend, receiving of measuring signals is improved, of course. The transparent protection cage, or portion of it, may be made of transparent plastic or composite material, for example.

[0041] According to an embodiment, the protection cage is arranged to surround at least partly a mining device. In this patent application the mining device is a device for processing undetached rock, rock material or soil. The mining device may be connected to a boom of a rock drilling rig, or corresponding mining vehicle. The mining device may be used in mines and at other work sites. The mine may be an open pit mine or quarry, or it may be an underground mine. The mining device may be utilized also at house and road construction sites.

[0042] According to an embodiment, the protection cage is intended to encapsulate a rock drilling machine. The rock drilling machine is a mining device, which may be surrounded at least partly by means of the protection so that safety is guaranteed. The rock drilling machine may comprise a rotating shank and a drilling tool connected to the shank. Access close to the shank and the tool may be prevented by means of the protection cage.

[0043] According to an embodiment, the protection cage is intended to encapsulate a rock bolting device, which is a mining device. The rock bolting device may comprise a rock drilling machine, a bolt feeding device, a rock bolt handling device and a rock bolt magazine, which all may be surrounded at least partly by means of the protection cage so that access to them may be prevented.

[0044] According to an embodiment, the protection cage is intended to encapsulate a charge feeding device or an injection device, which are both mining devices. The feeding device and the injection device may comprise movable machine parts, which may be surrounded at least partly by means of the protection cage so that access to them may be prevented.

[0045] According to an embodiment, the protection cage is arranged in a mining unit comprising an elongated feed beam. The protection cage comprises intermediate portions between mesh openings, and the intermediate portions are in transverse direction relative to a longitudinal axis of the feed beam.

[0046] According to an embodiment, the protection cage is arranged in a mining unit comprising an elongated feed beam. The protection cage is movable in a longitudinal direction of the feed beam.

[0047] According to an embodiment, a space defined by means of the protection cage is provided with at least one light for illuminating at least a mining device operating inside the space. The mining device may be a rock drilling machine. The lightning improves visibility and facilitates operation of an operator.

[0048] According to an embodiment, color of the protection cage is dark and color of a mining device, such as a rock drilling machine, is light. Thus, there exists a clear contrast between the protection cage and the rock drilling machine for improving visibility and work of an operator.

[0049] According to an embodiment, a levelling arrangement comprises at least one beam projector for projecting a levelling beam, which may be used as a reference level for mining measures executed at a work site. The beam projector comprises a beam source arranged to sweep the levelling beam around vertical axis. The beam source may be a laser device. The arrangement further comprises a mining unit provided with one or more sensors for detecting the levelling beam. The sensor may be a laser receiving device.

[0050] According to an embodiment, a levelling arrangement comprises at least one beam projector for projecting a horizontal levelling beam.

[0051] According to an embodiment, a levelling arrangement comprises at least one beam projector for projecting a substantially horizontal levelling beam. The substantially horizontal levelling beam may be slanting 5 - 25°, for example.

[0052] According to an embodiment, a levelling arrangement comprises a beam source for creating a reference level and one or more sensors arranged to a mining device for detecting the reference level. The arrangement comprises adjusting means for creating a mutual adjusting movement between the sensor and a levelling beam. Thanks to the mutual adjusting movement, the reference beam may be detected by the sensor in case problems occur in receiving reference signals despite of the disclosed structure of the protection cage. The adjusting movement may have a predetermined magnitude, whereby the system is always aware of the changed positions and the system may produce needed corrective calculations for controlling operation of the mining device.

[0053] According to an embodiment, a levelling arrangement comprises a beam source for creating a reference level and one or more sensors arranged to a mining device for detecting the reference level. The protection cage may be movable at least in a longitudinal direction of a feed beam of a mining unit in response to a detection data that the sensor is unable to receive the levelling beam. A control unit may be configured to control the disclosed adjusting movement.

[0054] According to an embodiment, a levelling arrangement comprises a beam source for creating a reference level and one or more sensors arranged to a mining device for detecting the reference level. The levelling beam of a beam projector is vertically movable in response to detection that the sensor is unable to receive the levelling beam. The realized vertical movement of the beam projector is detected and is being taken account when utilizing the horizontal levelling beam.

[0055] According to an embodiment, a levelling arrangement comprises means for moving a levelling beam

vertically. The levelling beam is generated by a beam projector, which is provided with a stand, such as a tripod_stand. The stand may be provided with height adjusting means. The stand may comprise an integrated lifting device, such as an electrical motor, and suitable transmission elements.

[0056] According to an embodiment, a levelling arrangement comprises a means for moving a levelling beam vertically. The levelling beam is generated by a beam projector, which is provided with a stand, such as a tripod_stand. The stand may be arranged on a support surface or plate, which is provided with height adjusting means. The support surface may be a kind of lifting table, for example.

[0057] According to an embodiment, a levelling arrangement comprises a means for moving a levelling beam vertically. The levelling beam is generated by a beam projector. The levelling beam of the beam projector is vertically movable in response to detection that a sensor of a mining unit is unable to receive the levelling beam. The height of the levelling beam may be adjusted by height adjusting means arranged in a stand, in a support surface below the stand or integrated in the beam projector structure. The levelling arrangement further comprises at least one control unit, which is configured to control the height adjusting means in response to sensing data received from the sensor. The height adjusting means may be controlled automatically by means of the control device.

[0058] According to an embodiment, a levelling arrangement comprises a means for moving a levelling beam vertically. The levelling beam is generated by a beam projector. The levelling beam of the beam projector is vertically movable. The height of the levelling beam may be adjusted by height adjusting means arranged in a stand, in a support surface below the stand or integrated in the beam projector structure. The height adjusting means may be remote controlled by means of a manual remote controller. An operator of the mining device may perform the height adjusting measures.

[0059] The above-disclosed embodiments can be combined to form desired solutions provided with necessary features disclosed.

Brief description of the figures

[0060] Some embodiments are described in more detail in the accompanying drawings, in which

Figure 1 is a side view of a rock drilling rig provided with a drilling unit,

Figure 2 is a schematic view showing a bench and a rock drilling rig utilizing a horizontal reference level when drilling vertical or close to vertical drill holes for a bench round,

Figure 3 is a schematic top view showing detection of a levelling beam by a sensor arranged in a mining device,

Figure 4 is a schematic view an elongated protection cage,

Figure 5 is a schematic top view a protection cage mounted to a feed beam,

Figure 6 is a schematic view of a grid-structure of a protection cage, wherein the grid has horizontal intermediate portions between mesh openings,

Figure 7 is a schematic view of a grid-structure of a protection cage, wherein the grid has intermediate portions which are angled relative to a horizontal plane,

Figure 8 is a schematic view of a grid structure of a protection cage, wherein the grid is a wire-net,

Figure 9 is a schematic view showing a detail of a wire-net,

Figure 10 is a schematic view of a diamond shaped mesh opening;

Figures 11 and 12 are schematic views of grid-structures made of perforated plates and comprising two alternative mesh opening patterns,

Figure 13 is a schematic view of a mesh opening provided with edges, which are being bend in a transverse direction relative to a surface plane of a perforated plate,

Figure 14 is a schematic view of a protection cage provided with dedicated moving actuators allowing the protection cage to be moved in a longitudinal direction,

Figure 15 is a schematic view of a protection cage provided with transmission or connection members allowing a linear movement of a mining device to cause an adjusting motion for the protection cage, and

Figure 16 is a schematic view of a beam projector arrangement allowing vertical adjustment for a beam source and levelling beam.

[0061] For the sake of clarity, the figures show some embodiments of the disclosed solution in a simplified manner. In the figures, like reference numerals identify like elements.

Detailed description of some embodiments

[0062] Figure 1 shows a rock drilling rig 1, comprising a rock drilling unit 2 which may be connected by means of a boom 3 to a movable carrier 4. The drilling unit 2 may comprise a feed beam 5 and a rock drilling machine 6 supported on it. The rock drilling machine 6 may be moved on the feed beam 5 by means of a feed device. The rock drilling machine 6 comprises a shank at a front end of the rock drilling machine 6 for connecting a tool 7. The rock drilling machine 6 may comprises a rotating device for rotating the tool 7 and a percussion device for generating impact pulses to the tool 7. At a drilling site, one or more drill holes 8 are drilled with the drilling unit 2. The boom 3 may be instrumented, whereby it is provided with one or more sensors 9. In addition to, the rock

drilling machine 6 is provided with one or more sensors 10. Measuring data of the sensors 9 and 10 is transmitted to a control unit 11 for determining position and direction data of the boom 3 and the drilling unit 2. The position and direction data may be indicated to an operator 12 in order to assist operation at a work site.

[0063] Since the drilling unit 2 comprises movable machine parts, a need exists to encapsulate it by means of a protection cage 13 so that no access is possible to the movable machine parts without first opening or removing the protection cage. The protection cage 13 is an elongated object, which may be a uniform piece, or it may be formed of two or more pieces connected to each other. Height of the protection cage 13 may be designed so that in operative use it is not possible to reach to the movable machine parts of the rock drilling unit.

[0064] Figure 2 shows a principle of a bench excavation. Bench blasting is the most common blasting work. Bench blasting is used in open pit mines and quarries. The method is also implemented widely at different construction sites. Several successive bench rounds are formed in a same bench plane. A rock drilling rig 1 may drill several vertical or close to vertical drill holes 8 to a bench 14 and after the drilling the holes are charged and blasted. The bench 14 has a face 15 and an upper surface 16. Since rock material is detached by means of a blasting, the face 15 and the upper surface 16 may be uneven surfaces. The upper surface 16 may comprise two or more portions 16a - 16c having different height position. Further, the upper surface 16 may comprise notches and slanting portions. Therefore, a levelling system may be utilized for producing a reference level or levelling beam 17. A beam projector 18 may project the horizontal levelling beam by means of a beam source 19 arranged to sweep the levelling beam 17 around vertical axis V. The beam source 19 may be a laser device arranged to rotate R in a horizontal plane. The beam projector 18 may be supported on the upper surface 16 of the bench 14 by means of a support 20, such as a tripod support. The drilling unit 2 may be provided with one or more sensors for receiving the levelling beam 17 or levelling signal transmitted by the beam projector 18. The sensor 10 detects the reference level 17 and provides a control unit of the rock drilling rig 1 with the detection data, so that a height position relative to the reference level 17 may be determined and drilling length H may be adjusted in accordance with the received data. Then, lengths of the drill holes 8 can be determined so that a desired bottom surface 21 shape is achieved. The drilling unit 2 is provided with a protection cage 13, which may cause problems for receiving the levelling beam 17. These issues and solutions for avoiding blocking problems are discussed below.

[0065] Figure 3 discloses detection of a levelling beam 17 by a sensor 10 arranged in a rock drilling machine 6. As can be seen, the protection cage 13 may limit together with a feed beam 5 of a drilling unit 4 a space inside which the rock drilling machine 6 and the sensor 10 are located.

[0066] Figure 4 shows an elongated protection cage 13, which may resemble letter U when seen in a longitudinal direction. Ends of the protection cage 13 may be open. The protection cage 13 may have a grid like configuration as it is shown in a detail 22. The structure of the protection cage 13 may be self-supporting, whereby no separate support structure is needed. However, the protection cage 13 comprises fastening elements 23 allowing fastening to a feed beam or corresponding base structure. In Figure 5 the protection cage 13 is mounted to the feed beam 5.

[0067] Figure 6 shows a grid-structure 24 of a conventional protection cage 13. The grid 24 has vertical intermediate portions 25 and horizontal intermediate portions 26 between mesh openings 27. The horizontal intermediate portions 26 may prevent receiving of a levelling beam 17. A receiving sensor 10 may move together with a mining device along line 28 in both directions. The sensor 10 has a detection area 29, which may have a limited width. Typically height of the detection are 29 may be greater than the width.

[0068] Figure 7 shows a grid-structure 24 of a protection cage 13 in accordance with the present solution. The grid 24 has intermediate portions 30, which all are angled relative to a horizontal plane and a levelling beam 17. Since the intermediate portions 30 are in an angle position, they are never aligned with the levelling beam 17. Further, width of a detection area 29 of a sensor 10 is greater than horizontal distances of the angled intermediate portions at crossing points between the levelling beam 17 and the intermediate portions 30, whereby the sensor 10 is able to receive levelling signals despite of the intermediate portions 30. Only in intersections of the intermediate portions there may be a wider section with a greater horizontal distance compared to the width of the detection area 29. However, the sensor 10 is rarely moved exactly along line 28a, whereby occurring of the disclosed problem is not probable.

[0069] Further, it is possible to arrange two parallel sensors 10 and 10a inside a space defined by the protection cage 13 for ensuring receive of levelling signal.

[0070] Figure 8 discloses a wire-net, which may serve as a grid structure 24 of a protection cage. The wire net is composed of wires 31 and 32 which cross each other and confine mesh openings 27. The wires 31 and 32 serve as intermediate portions, and they are diagonally oriented relative to a horizontal direction. Figure 9 is a detailed view of a wire-net. Cross-section of the wires 31 and 32 may be rectangular or round.

[0071] Figure 10 shows a diamond shaped mesh opening. The diamond shaped mesh opening 27 has four angles 33 and two diagonal lines 34, as well as square-shaped mesh openings shown in Figures 7 and 8. However, in the diamond shaped mesh opening the diagonal lines 34 differ in length. Width of the mesh opening is minor than height.

[0072] Figures 11 and 12 disclose two alternative grid-structures 24 made of a perforated plate. They both utilize

diamond shaped mesh openings 27. However, the mesh openings 27 are positioned in a different manner, in other words, two alternative mesh opening patterns are disclosed. In Figure 11 neighboring mesh openings are arranged diagonally, which is illustrated by means of slanting lines 35 in Figure 11. In Figure 12 the neighboring mesh openings are positioned according to horizontal lines 36.

[0073] Figure 13 shows a mesh opening 27 provided with edges being bend in a transverse direction relative to surface plane of a perforated plate 37. Thus, the bend edges may form stiffening flanges 38.

[0074] Figure 14 shows a protection cage 13 provided with moving actuators so that the protection cage may be moved in a longitudinal direction. A limited adjusting movement A may be formed by means of a cylinder 39 or by means of a turning element 40 comprising a cam 41, for example.

[0075] Figure 15 shows in a greatly simplified manner a principle of a protection cage provided with transmission or connection members 42 allowing a linear movement of a mining device to cause an adjusting motion A for the protection cage 13. Alternatively, transmission or connection members 43 may connect a feed device 44 to cause the adjusting movement A.

[0076] Figure 16 is a schematic view of beam projector arrangement allowing vertical adjustment for a beam source 19 and levelling beam 17. The levelling arrangement may comprise means for moving B the levelling beam 17 vertically. A beam projector 18 may be provided with a stand 45, such as a tripod stand. The stand 45 may be provided with a height adjusting actuator or device 46. Alternatively, or in addition to, the stand 45 may be arranged on a support surface or plate 47, which is provided with a height adjusting device. Thus, in connection with the beam projector may be moving devices 46, 47 for causing vertical movements B1 and B2.

[0077] Figures 1 - 3 disclose rock drilling applications, but it should be understood that the same principles apply also for other mining devices than the rock drilling unit and the rock drilling device.

[0078] Further, an optional solution is disclosed. A protection cage may be provided with mesh openings having any suitable shape, orientation and dimensions, and the blocking problem caused by horizontal intermediate portions is solved by arranging the protection cage movably. The protection cage can be moved in a longitudinal direction, transverse direction or in both directions so that a levelling beam is received. The same applies also for the disclosed embodiments, wherein the levelling arrangement comprises means for adjusting height of the reference beam.

[0079] The drawings and the related description are only intended to illustrate the idea of the invention. In its details, the invention may vary within the scope of the claims.

Claims

1. A protection cage for encapsulating a mining device; wherein
the protection cage (13) is an elongated object;
the protection cage has a grid-like configuration and is provided with several mesh openings (27); and
the mesh openings (27) being defined by means of intermediate portions (30);
characterized in that
the intermediate portions (30) of the mesh openings (27) are in transverse direction relative to a longitudinal axis of the elongated protection cage (13).

2. The protection cage as claimed in claim 1, **characterized in that**
the mesh openings (27) are defined by means of four elongated intermediate portions and four edges between the intermediate portions (30).

3. The protection cage as claimed in claim 1 or 2, **characterized in that**
the protection cage (13) comprises several square-shaped mesh openings;
the square-shaped mesh opening has two diagonal lines; and
a first diagonal line of the mesh opening is in transverse direction relative to the longitudinal axis of the protection cage (13) and a second diagonal line is parallel with the longitudinal axis of the protection cage (13).

4. The protection cage as claimed in claim 1 or 2, **characterized in that**
the protection cage (13) comprises several diamond-shaped mesh openings (27).

5. The protection cage as claimed in claim 1 or 2, **characterized in that**
the mesh openings (27) are diamond-shaped;
each of the diamond-shaped mesh opening has a maximum mesh height transverse to the longitudinal axis of the protection cage (13);
the diamond-shaped mesh opening has a maximum mesh width in the direction of the longitudinal axis of the protection cage (13); and
the height of the mesh opening is greater than the width.

6. The protection cage as claimed in any one of the preceding claims 1 to 5, **characterized in that**
the grid-like configuration (24) is composed of a wire-net wherein the intermediate portions (30) confining the mesh openings (27) are wires (31, 32).

7. The protection cage as claimed in any one of the preceding claims 1 to 5, **characterized in that**
the grid-like configuration (24) is composed of a per-

forated plate wherein the intermediate portions (30) confining the mesh openings (27) are of plate material.

8. The protection cage as claimed in any one of the preceding claims 1 to 8, **characterized in that** the intermediate portions (30) confining the mesh openings (27) are angled 45° relative to a longitudinal axis of the elongated protection cage (13).

9. The protection cage as claimed in any one of the preceding claims 1 to 8, **characterized in that** the protection cage (13) comprises fastening elements for fastening the protection cage (13) to a mining unit provided with the mining device; and the fastening elements comprise moving members allowing a limited linear movement for the protection cage (13) in the longitudinal direction of the protection cage (13).

10. The protection cage as claimed in claim 9, **characterized in that** the protection cage (13) comprises at least one actuator (39, 40) for moving the protection cage (13).

11. A rock drilling unit, comprising:

a feed beam (5);
a rock drilling machine (6) supported to the feed beam (5);
a feed device (44) for moving the rock drilling machine (6) relative to the feed beam (5), whereby the rock drilling machine (6) has a movement range; and
at least one protection cage (13) connected to the feed beam (5) and enclosing the rock drilling machine (6) at least for a limited portion of the movement range of the rock drilling machine (6);
characterized in that
the protection cage (13) is in accordance with claims 1 to 10.

12. The rock drilling unit as claimed in claim 11, **characterized in that** the intermediate portions (30) of the mesh openings (27) of the protection cage (13) are in transverse direction relative to a longitudinal axis of the feed beam (5).

13. The rock drilling unit as claimed in claim 11 or 12, **characterized in that** the protection cage (13) is movable in a longitudinal direction of the feed beam (5).

14. A levelling arrangement comprising:

at least one rock drilling unit (2) provided with a feed beam (5), a rock drilling machine (6) supported to the feed beam (5), a feed device (44) for moving the rock drilling machine (6) relative to the feed beam (5), and a protection cage (13) mounted to the feed beam (5) and encapsulating the rock drilling machine (6);
at least one beam projector (18) for projecting a horizontal levelling beam (17) and comprising at least one beam source (19) arranged to sweep the horizontal levelling beam (17) around vertical axis; and
at least one sensor (10) arranged to the rock drilling machine (6) for detecting the horizontal levelling beam (17);
characterized in that
the protection cage (13) is in accordance with claims 1 to 10.

15. The levelling arrangement as claimed in claim 14, **charac- terized** in that
the protection cage (13) is movable relative to the feed beam (5) in response to a detection that the sensor (10) is unable to receive the levelling beam (17).

16. The levelling arrangement as claimed in claim 14 or 15, **char- acterized** in that
the horizontal levelling beam (17) of the at least one beam projector (18) is vertically movable in response to a detection that the sensor (10) is unable to receive the levelling beam (17); and
the realized vertical movement of the beam projector (18) is detected and is being taken account when utilizing the horizontal levelling beam (17).

17. A method of rock drilling, the method comprising:

implementing a rock drilling unit (2) comprising: a feed beam (5), a rock drilling machine (6) supported to the feed beam (5), a feed device (44) for moving the rock drilling machine (6) relative to the feed beam (5), and a protection cage (13) mounted to the feed beam (5);
positioning the rock drilling unit (2) at a start point of the drill hole (8) to be drilled and directing the feed beam (5) vertically;
detecting a horizontal levelling beam (17) of at least one beam projector (18) external to the rock drilling unit (2) by means of at least one sensor (10) of the rock drilling machine (6); and
drilling at least one vertical drill hole (8) by means of the rock drilling unit (2) and determining length (H) of the drilling relative to the horizontal levelling beam (17);
characterized by
enclosing the rock drilling machine (6) by means of at least one protection cage (13) in accordance with claims 1 to 10.

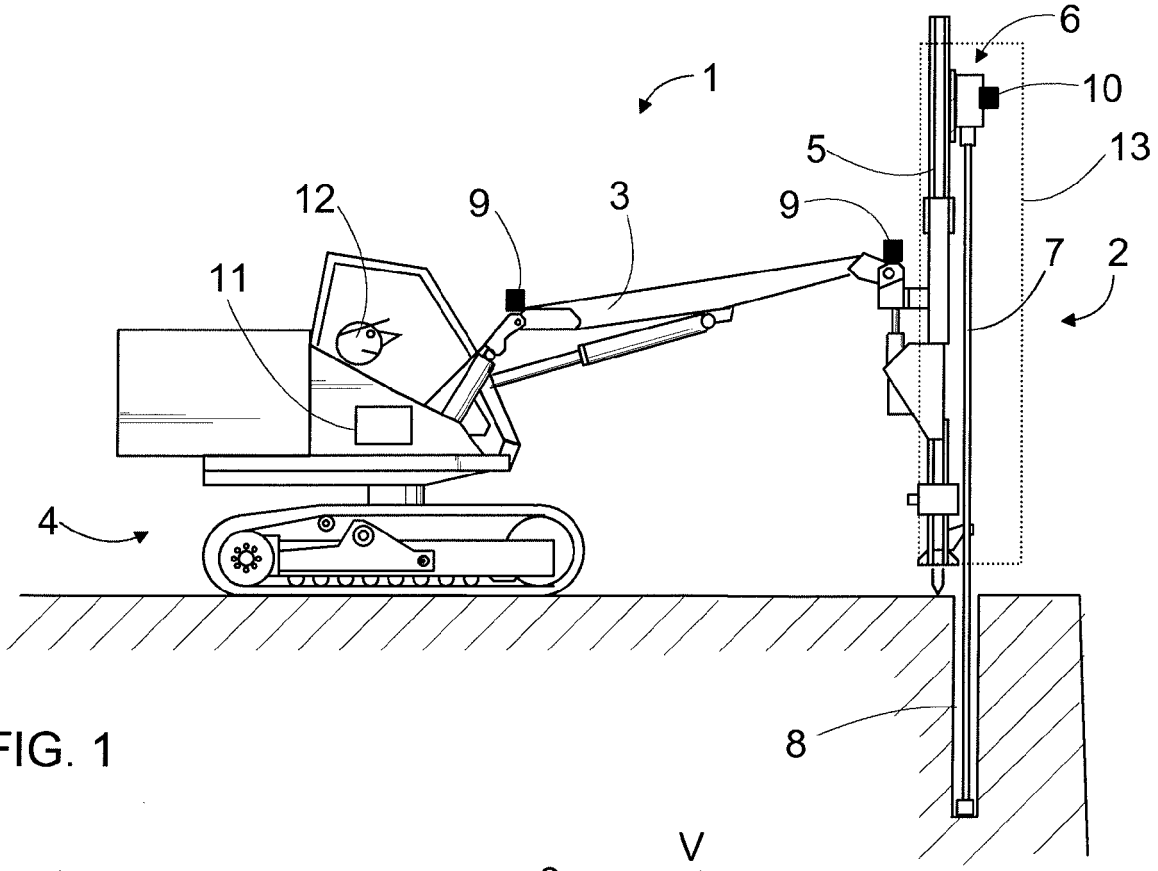
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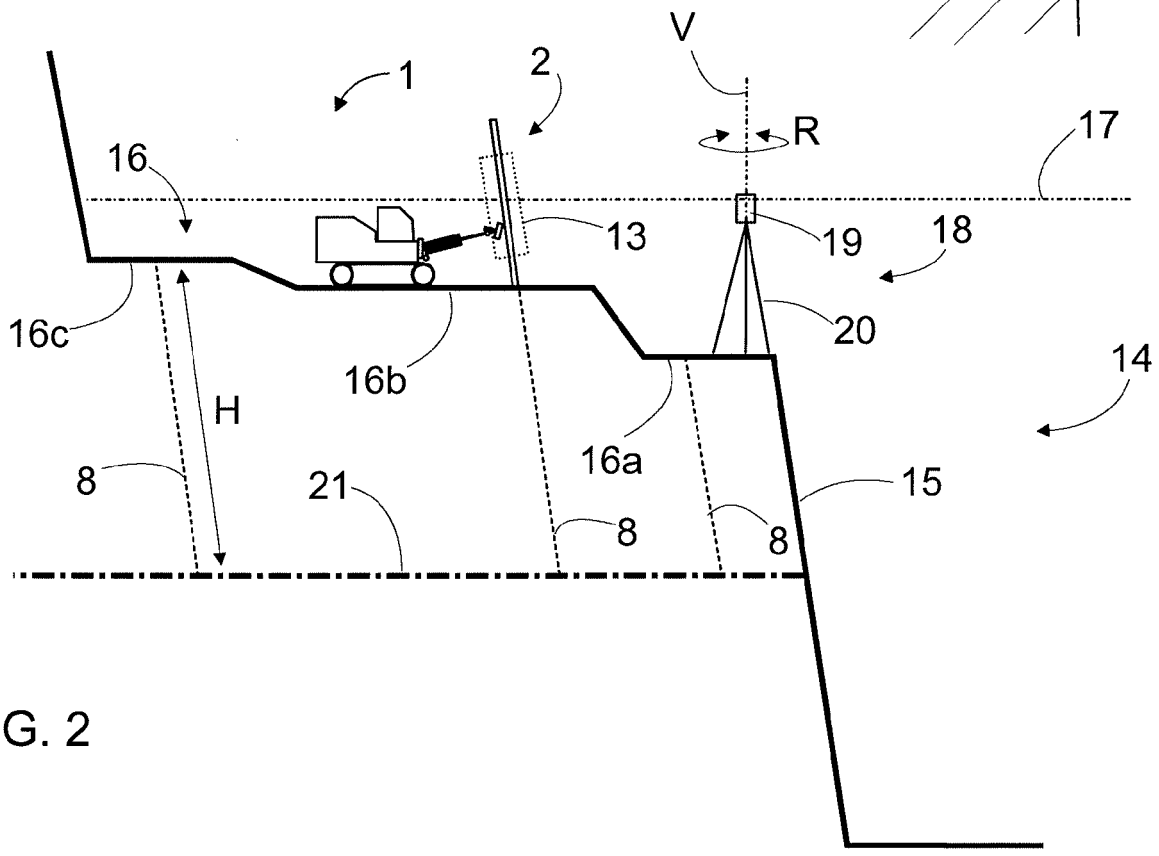
FIG. 1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16a
16b
16c
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21
H
R
V

FIG. 2

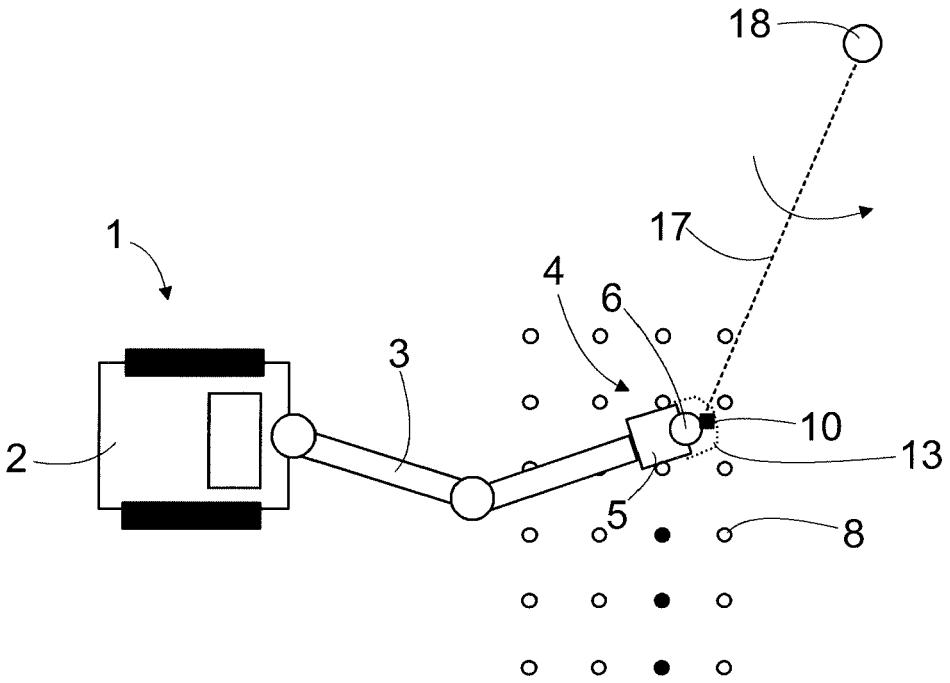

FIG. 3

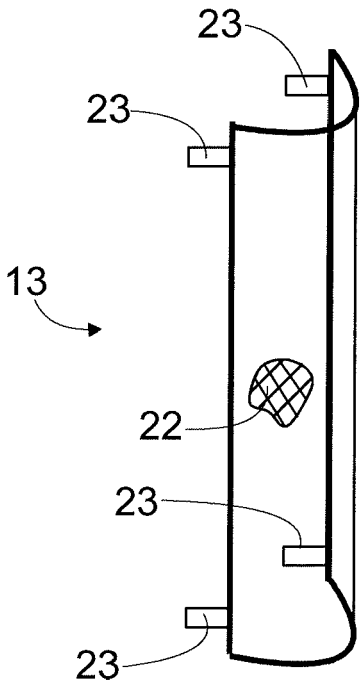

FIG. 4

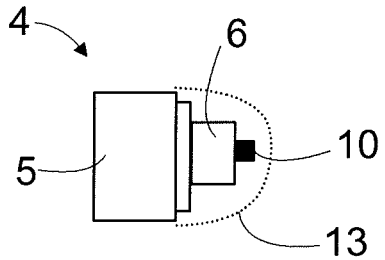

FIG. 5

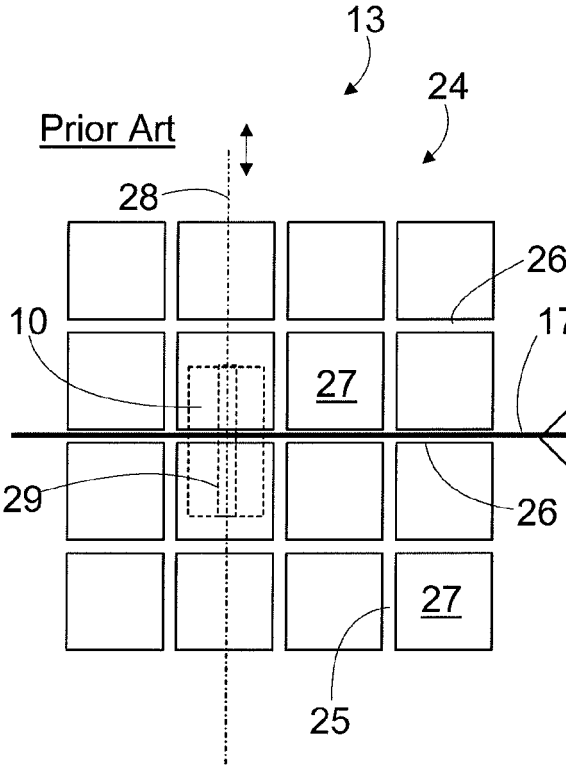

FIG. 6

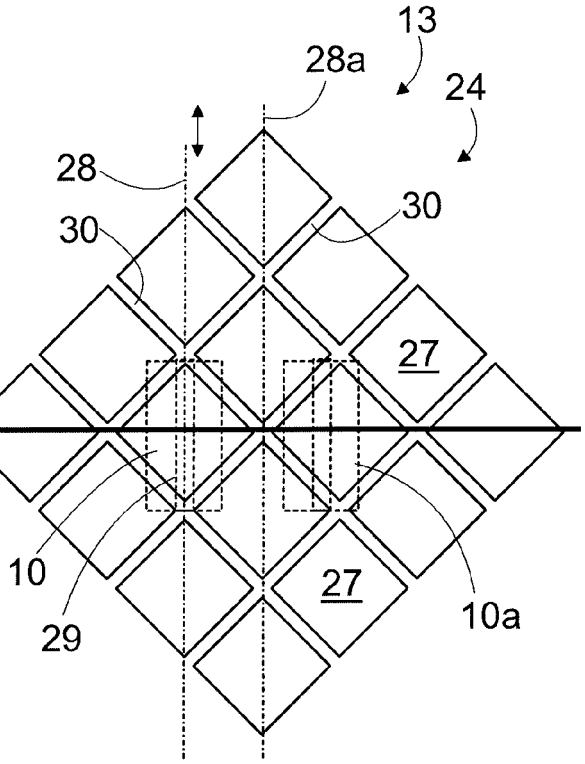

FIG. 7

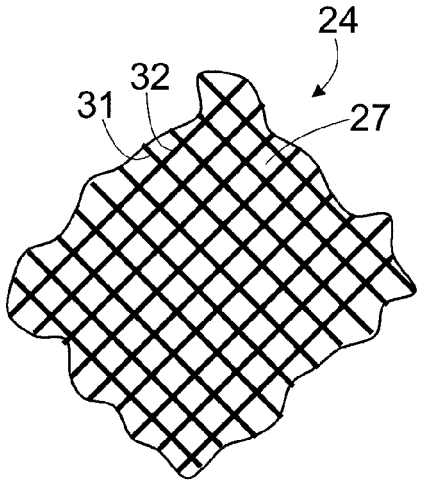

FIG. 8

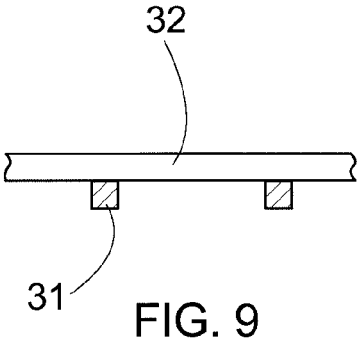

FIG. 9

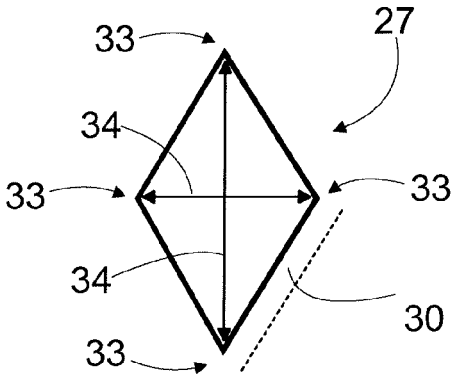

FIG. 10

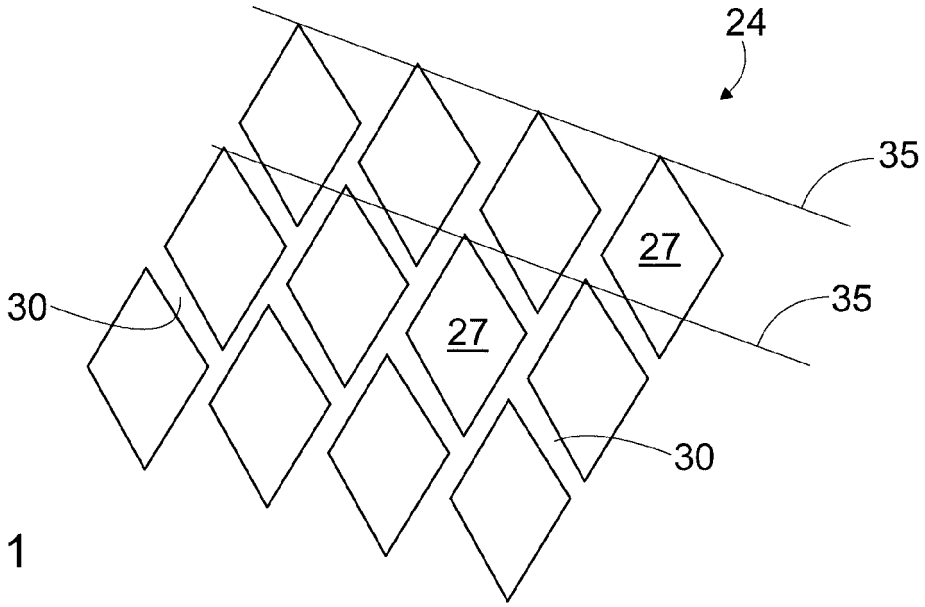

FIG. 11

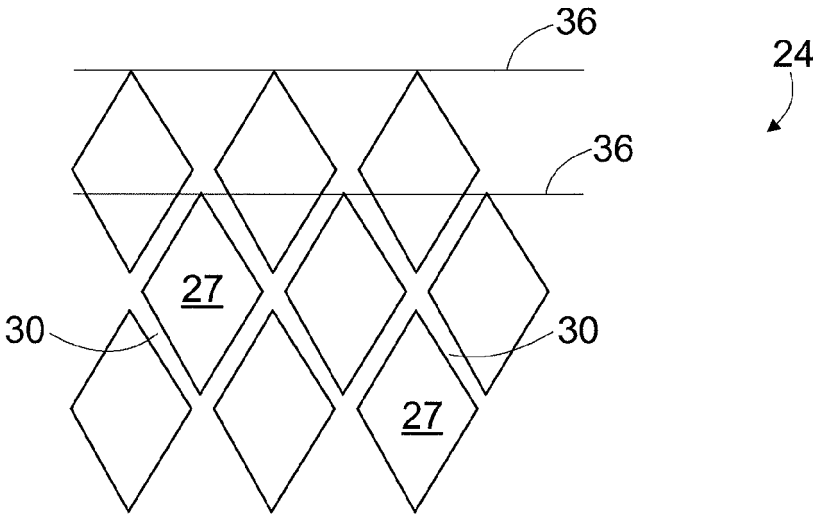

FIG. 12

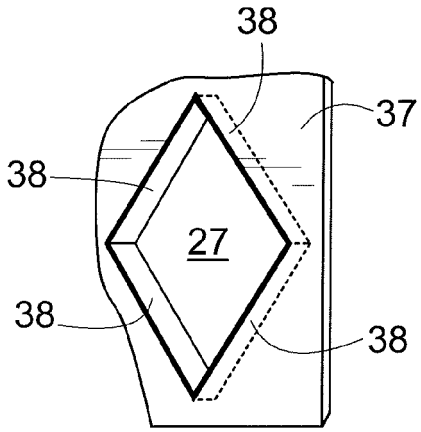

FIG. 13

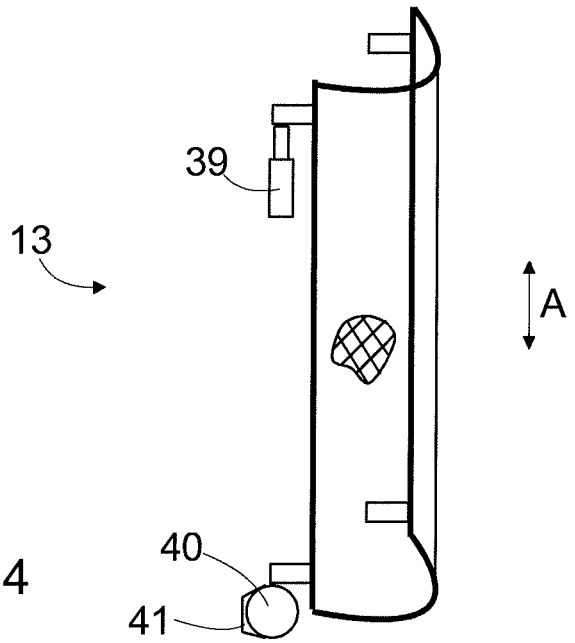

FIG. 14

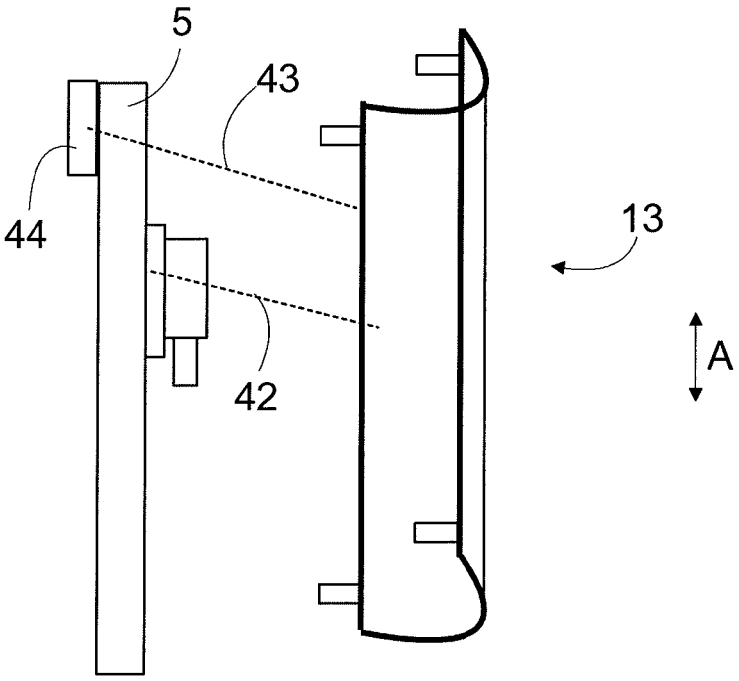

FIG. 15

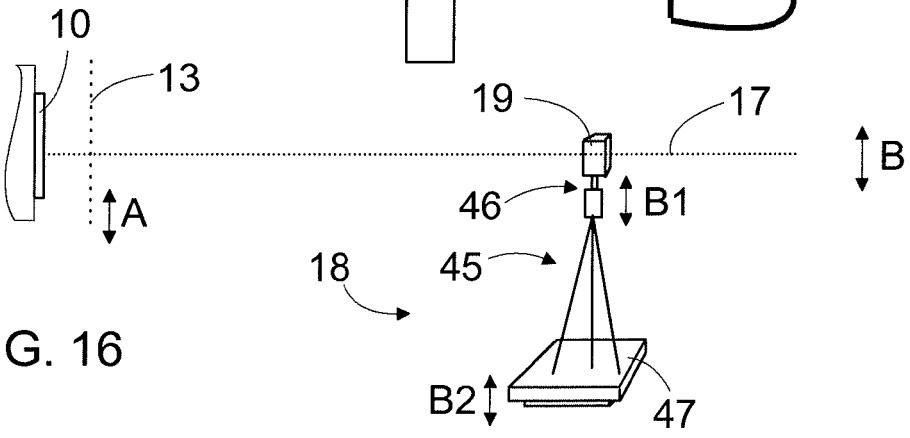

FIG. 16

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EUROPEAN SEARCH REPORT

Application Number
EP 14 16 0473

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E21B
E21C
E21D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	23 June 2014	Strømmen, Henrik

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23-06-2014

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