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(54) **ARRANGEMENT FOR POSITIONING ROCK DRILLING RIG ON DRILLING SITE**

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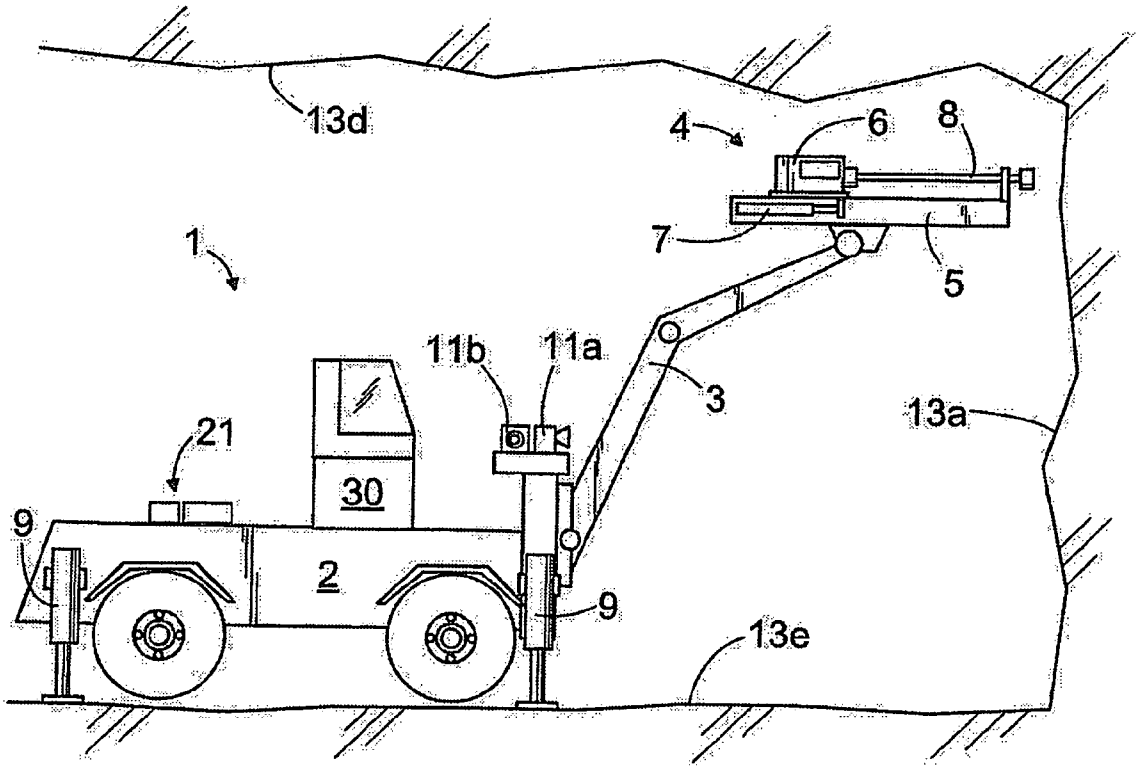
(57) **ABSTRACT**

A method for positioning a rock drilling rig to a drilling site and a rock drilling rig. In positioning the rock drilling rig is driven to the positioning station such that its carrier is at desired distances from wall surfaces surrounding the drilling site. For positioning the rig is provided with distance measuring devices. Navigation is not started until positioning has been performed and in navigation the location of the rock drilling rig is linked to the coordinate system of the drilling site.



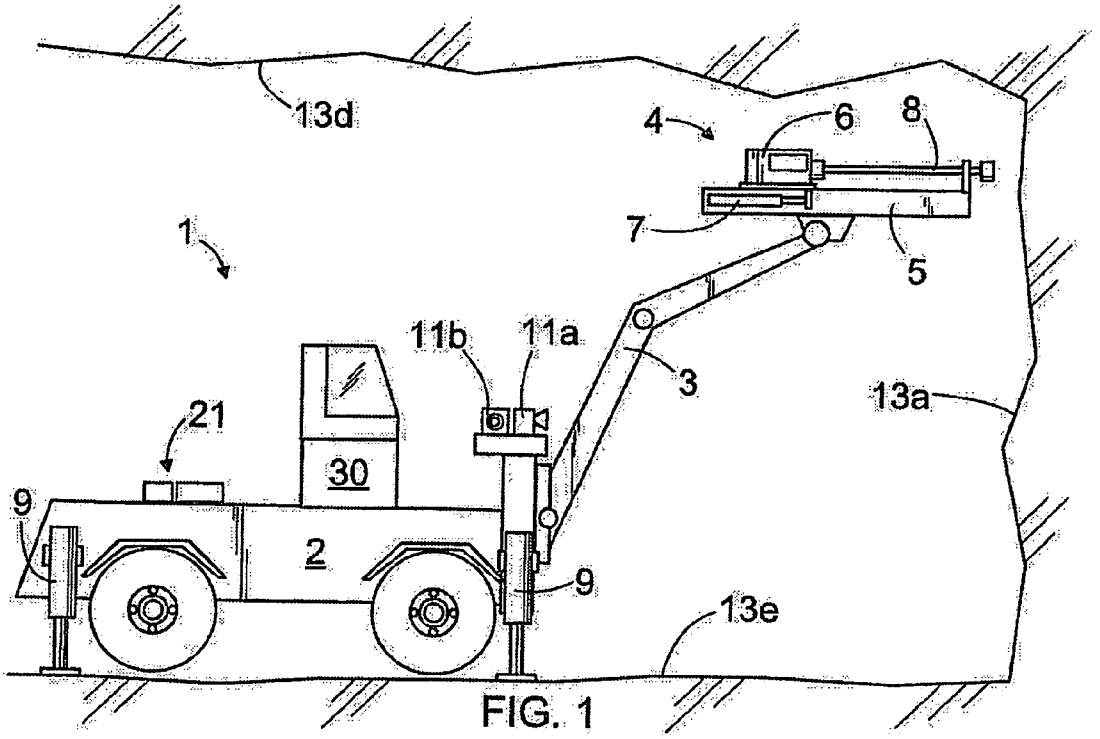

13d
4
6
8
1
7
5
11b
11a
3
13a
21
30
9
2
9
13e

FIG. 1

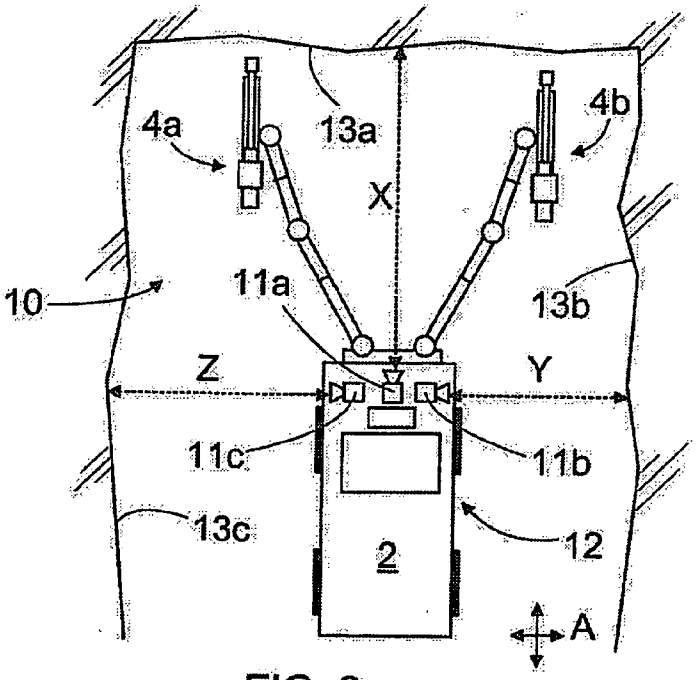

4a
13a
4b
X
10
11a
13b
Z
Y
11c
11b
13c
2
12
A

FIG. 2

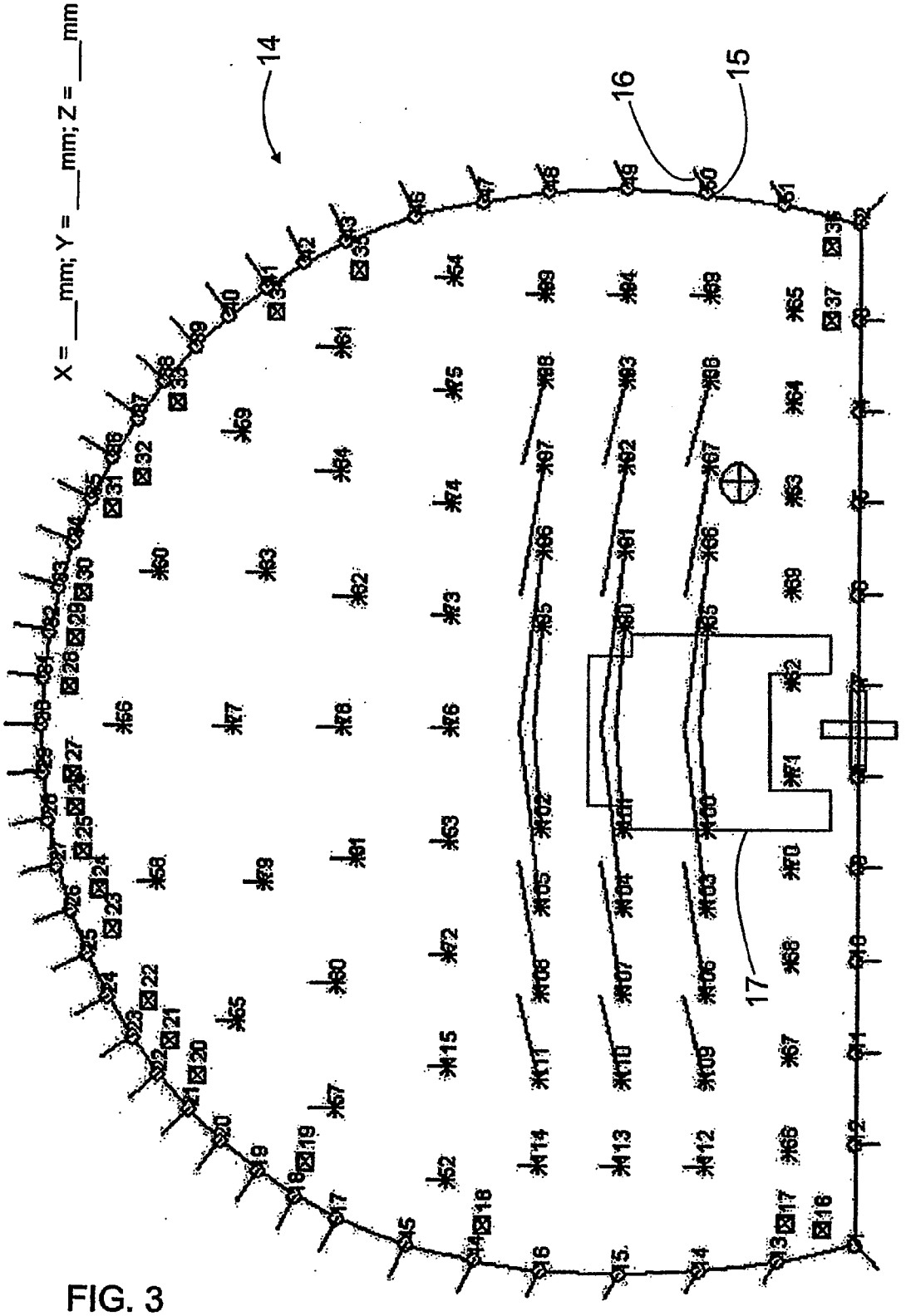


FIG. 3

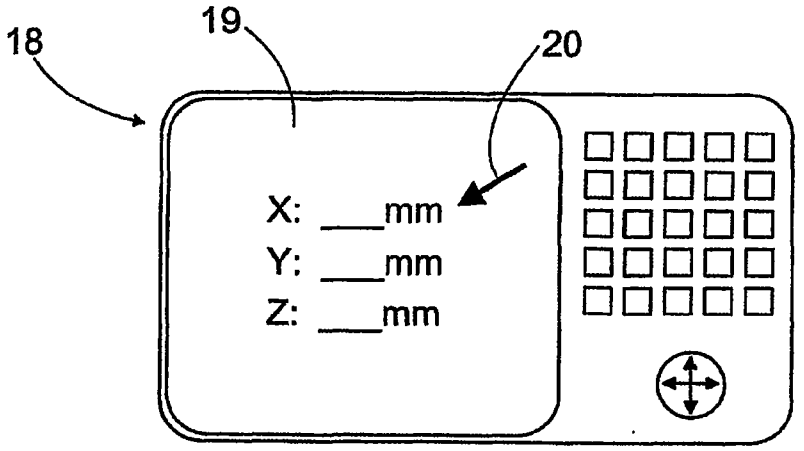

18
19
20
X: ___mm
Y: ___mm
Z: ___mm

FIG. 4

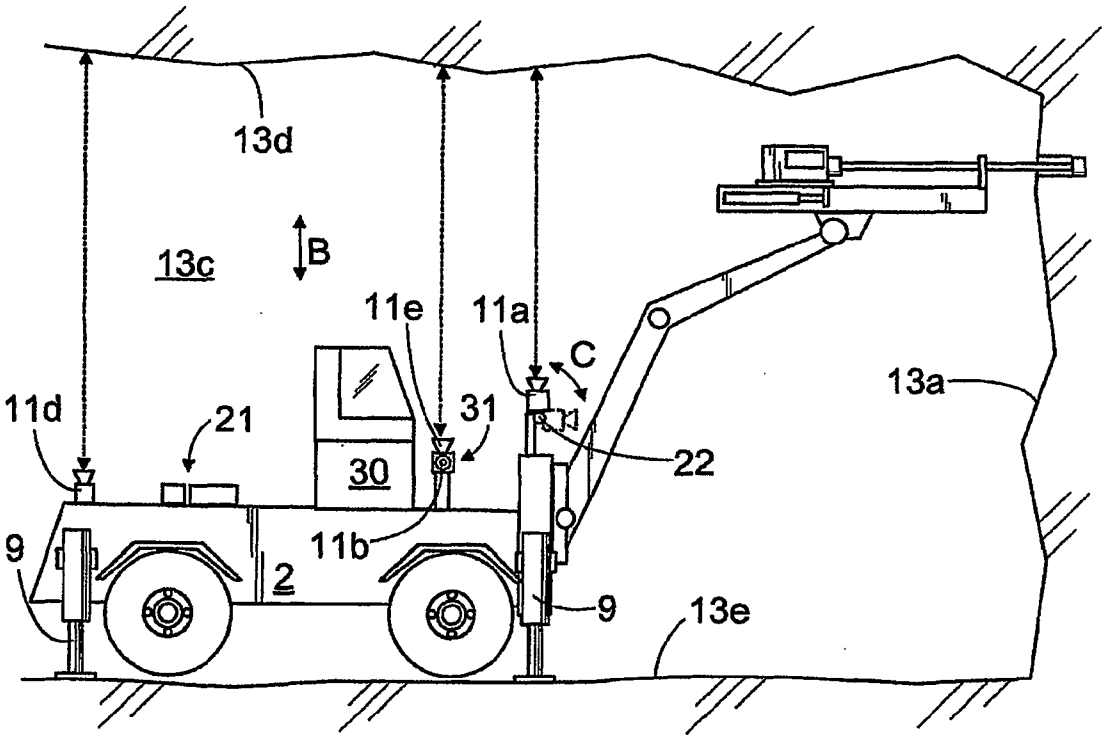

13d
13c
B
11e
11a
C
11d
21
31
30
22
13a
9
11b
2
9
13e

FIG. 5

ARRANGEMENT FOR POSITIONING ROCK DRILLING RIG ON DRILLING SITE

BACKGROUND OF THE INVENTION

[0001] The invention relates to a method for positioning a rock drilling rig on a drilling site, the method comprising: driving the rock drilling rig to a drilling site and positioning the carrier thereof in relation to wall surfaces surrounding the drilling site; performing post-positioning navigation in which the location of a mine vehicle is linked to a coordinate system of the drilling site and to a drilling plan where at least the directions of holes to be drilled are determined; and initiating the drilling of the holes according to the drilling plan after the navigation.

[0002] The invention also relates to a rock drilling rig comprising: a movable carrier; at least one drill boom with a drill unit comprising a feed beam, feeding means and a rock drill machine; at least one control unit, in which it is possible to store a drilling plan in which at least the direction of holes to be drilled are determined; and means for linking the rock drilling rig to the coordinate system of the drilling site by means of navigation.

[0003] Currently a rock drilling rig is positioned such that an operator drives the rig to a drilling site using visual positioning estimation. After driving the rock drilling rig to place and fitting the jacks against the ground, it is possible to perform navigation, in which the location of the rock drilling rig is linked to a coordinate system provided for the drilling site. Navigation may be performed such that on the drilling site there is a separate laser that is directed to a known location in a tunnel. Thereafter the location of the carrier or the drill unit of the rock drilling rig is determined with respect to the laser. This can be done by means of sights in the drill unit, for instance. Alternatively, on a carrier there is arranged in accordance with DE publication 3,902,127 a laser receiver that determines the location of the carrier during navigation, whereafter a control unit of the drilling rig may amend the coordination system in view of the location of the drilling rig. Current solutions have a drawback that the actual location of the rock drilling rig on the drilling site is not found out until in the course of navigation at the earliest. If the navigation reveals that the rock drilling rig is positioned on the drilling site such that it is not possible to drill all the holes of the drilling plan, the jacks must be lowered, the carrier must be repositioned and the rig must be navigated again. Problems resulting from erroneous positioning make the drilling considerably slower and more difficult.

BRIEF DESCRIPTION OF THE INVENTION

[0004] The object of the present invention is to provide a novel and improved method for positioning a rock drilling rig on a drilling site, and a rock drilling rig.

[0005] The method of the invention is characterized by using as a basis for the positioning of the rock drilling rig a positioning station which depends on the distance between the rock drilling rig and wall surfaces of the drilling site; determining during positioning the location of the carrier of the rock drilling rig by means of at least one distance measuring device in relation to the wall surfaces of the drilling site; and positioning the rock drilling rig into a positioning station for navigation.

[0006] The rock drilling rig of the invention is characterized by comprising at least one distance measuring device for determining the location of the carrier in relation to wall surfaces surrounding the drilling site; the control unit comprising at least one user interface; arranging the readings of the distance measuring device to be displayed to the operator at least in one user interface; and arranging the rock drilling rig to be driven to a positioning station for navigation.

[0007] The idea of the invention is that the rock drilling rig has a positioning station where it is driven before navigation may be started. The positioning station is determined in relation to wall surfaces surrounding the drilling site. The rock drilling rig comprises one or more distance measuring devices, by means of which the location of the carrier in relation to the wall surfaces may be determined during positioning.

[0008] The invention has an advantage that the rock drilling rig may be positioned in a correct place such that the planned drill holes can be drilled therewith. Thus it is possible to avoid situations where the rig must be repositioned and navigated again due to erroneous original positioning. Further, when the carrier is positioned correctly in view of the boom reach, drill units may be moved efficiently and quickly. The positioning arrangement of the invention is relatively simple to implement and it does not require any complicated systems. In addition, the invention may be applied to the existing rock drilling rigs.

[0009] The idea of one embodiment of the invention is that at least three laser range finders are used for distance measuring.

[0010] The idea of one embodiment of the invention is that a positioning station of the rock drilling rig is determined in connection with a drilling plan.

[0011] The idea of one embodiment of the invention is that a positioning station of the rock drilling rig is determined in a separate file, wherefrom it may be retrieved and displayed to the operator.

[0012] The idea of one embodiment of the invention is to determine a positioning station as distances from wall surfaces of the drilling site. The distances may be indicated to the operator by means of a display device, for instance.

[0013] The idea of one embodiment of the invention is to verify coverage areas of the drill units prior to drilling. It is thus checked that the drill unit reaches to drill the holes assigned to be drilled with said drill unit in the drilling plan.

[0014] The idea of one embodiment of the invention is to determine after navigation the vertical position of the carrier by means of at least one distance measuring device. For this task it is possible to use separate vertically directed distance measuring devices or, alternatively, it is possible to use at least one distance measuring device used for positioning and able to be turned from horizontal direction to vertical direction. Vertical measurement makes it possible to detect whether the carrier moves during drilling, for instance, as a result of sinking jacks. Inclination of the carrier may be measured by using a plurality of upwardly or downwardly directed distance measuring devices or one or more inclinometers.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] In the following some embodiments of the invention will be described in greater detail in connection with the attached drawings, in which

[0016] FIG. **1** a schematic side view of a rock drilling rig in accordance with the invention, which rig is positioned on a drilling site and navigated in a coordinate system of the drilling site,

[0017] FIG. **2** is a schematic top view of an arrangement in accordance with the invention for determining the location of the rock drilling rig on the drilling site,

[0018] FIG. **3** is a schematic view of a drilling plan,

[0019] FIG. **4** is a schematic view of a control unit and a user interface thereof, and

[0020] FIG. **5** is a schematic view of an arrangement for monitoring the vertical position of the rock drilling rig during drilling.

[0021] For the sake of clarity, some embodiments of the invention are presented in a simplified manner in the figures. Like reference numerals refer to like parts in the figures.

DETAILED DESCRIPTION OF SOME EMBODIMENTS OF THE INVENTION

[0022] A rock drilling rig **1** of FIG. **1** comprises a movable carrier **2**, at least one drill boom **3** and a drill unit **4** arranged on the drill boom **3**. The drill unit **4** comprises a feed beam **5**, onto which there is arranged a rock drill machine **6** that may be moved on the feed beam **5** by means of a feeding device **7**. The rock drill machine **6** comprises at least one percussion device wherewith it is possible to give impact impulses to a tool **8** connected to the rock drill machine **6**, and by the effect of said impact impulses the tool breaks rock and creates a drill hole. In connection with the carrier **2** there may also be jacks **9**, by means of which the rock drilling rig **1** driven to a drilling site **10** may be set to a desired position, typically to a horizontal position for navigation and drilling. The rock drilling rig **1** may additionally comprise a plurality of distance measuring devices **11**, such as laser range finders, which may be utilized in positioning the rock drilling rig **1**.

[0023] In FIG. **2** the rock drilling rig **1** is driven to the drilling site **10**, in this case in the rear of a tunnel. The rock drilling rig **1** may be positioned in a predetermined positioning station **12**, where the carrier **2** is at predetermined distances X, Y and Z from wall surfaces **13***a*, **13***b*, **13***c* confining the drilling site **10**. During positioning the distance between the carrier **2** and the rear wall **13***a* may be measured with a first distance measuring device **11***a*, further, the distance between the carrier and the side walls **13***b*, **13***c* may be measured with a second and a third distance measuring devices **11***b* and **11***c*. Not until the carrier **2** has been positioned in a determined positioning station **12** are the jacks **9** set against the ground and navigation is initiated to link the accurate location of the rock drilling rig **1** to the coordinate system of the drilling site **10**. In some cases measurement of distances to the wall surfaces **13** may be carried out by means of only one distance measuring device **11**, or on the other hand, there may be more than three distance measuring devices **11**. The distance measuring device **11** may be arranged to turn to predetermined measurement positions or it may rotate such that if measures distances in a plurality of directions.

[0024] FIG. **3** shows a drilling plan **14**, in which there may be determined the directions **16** of drill holes and the locations of starting points **15**. For instance in so-called longhole drilling, in which the holes may be drilled in a fan-shaped pattern, it may be sufficient that the drilling plan **14** only determines the hole directions **16**. In addition, the drilling plan **14** may also determine a positioning station of the rock drilling rig **1** as measurements in directions X, Y and Z. A planned location of the rock drilling rig in the positioning station may be illustrated on the drilling plan **14** by a symbol **17**. When the drilling plan **14** is designed the symbol **17** may be placed in the drilling plan **14**, whereafter a design program may calculate distances in directions X, Y and Z for the positioning station and may arrange them to be part of the drilling plan **14** or to be a separate file that may be retrieved in the memory of the control unit **30** of the rock drilling rig **1**. The drilling plan **14** may also be displayed on the display device of the control unit **30** of the rock drilling rig **1**. Prior to positioning the operator may retrieve a drilling plan **14** created for each drilling cut onto the display of the control unit. Readings of the distance measuring devices **11** may be displayed to the operator on common or separate display devices. By monitoring the readings of the display devices and by comparing them with the positioning station **12** indicated in the drilling plan **14**, it is possible to drive the rock drilling rig **1** in a sufficiently accurate manner to the planned location on the drilling site **10**. For measurements of the positioning station **12** in directions X, Y and Z there may be determined tolerances within which the carrier **2** driven in the positioning station must be located before navigation may start.

[0025] FIG. **4** shows a user interface **18**, on the display **19** of which appear planned distances between the positioning station **12** and rock walls **13**. The user interface **18** may also present at the same time or at different times readings of the distance measuring devices **11**. The user interface **18** may further indicate, with a suitable indicator **20** or in some other manner, the distances in directions X, Y and Z that still deviate from the predetermined distances. After the carrier **2** has been driven to a determined positioning station the control unit **30** may acknowledge by means of the user interface **18** the positioning and permit the initiation of navigation. This can be done visually or by a sound signal, for instance. Further, the control unit **30** and the user interface **18** may be arranged to guide the operator to carry out the positioning.

[0026] It is also possible to automate the driving of the rock drilling rig **1** to the positioning station **12**. In that case the control unit **30** may be provided with a steering mode that may be switched on after the mine vehicle **1** has first been driven close to the drilling site **10**. Thereafter the control unit **30** may steer the rock drilling rig **1** automatically to a predetermined positioning station **12**, set the carrier **2** in a horizontal position by means of the jacks **9** by utilizing a clinometer **21** and thereafter allow initiation of navigation.

[0027] The positioning station **12** may be determined in advance, for instance, in connection with drawing up the drilling plan, as described in the above, or the positioning station **12** may be determined on the basis of the operator's experience, the user instructions of the rock drilling rig or some other guidelines.

[0028] FIG. **5** shows the rock drilling rig **1** in a drilling situation. On the carrier **2** of the rock drilling rig **1** there may be a plurality of distance measuring devices **11** directed to a surface confining the drilling site **10** in the vertical direction during drilling, i.e. a roof surface **13***d*, or alternatively, a floor surface **13***e*. By monitoring the vertical movements of the carrier by means of these distance measuring devices **11** it is possible to detect if the jacks **9** sink in the floor surface **13***e*, for instance. In situations where all jacks **9** sink in the floor surface **13***e*, a vertical movement B is not necessarily detected by means of inclination measuring device **21** or the like, because the carrier may then retain its horizontal position. Instead, by means of each distance measuring device **11** it is possible to detect deviations from the original measurement results and thus it is possible to detect both inclination and vertical transfer of the carrier **2**. On the carrier **2** there may be arranged one or more individual laser measuring devices **11***d*

fixedly pointing upwardly or downwardly or alternatively in connection with the distance measuring device **11***b* used in positioning there may be arranged a distance measuring device **11***e* pointing upwardly or downwardly, whereby the distance measuring devices **11***b* and **11***e* constitute a kind of measuring unit **31**. In some cases the beam of the laser measuring device may be diverted with a prism from horizontal direction A to vertical direction B after the carrier **2** has been driven to the positioning station. Yet another option is that the distance measuring device **11***a* used for positioning is arranged on the carrier **2** by means of a turning member **22** such that it may be turned in direction C to a horizontal A measuring position and to a vertical B measuring position in accordance with a measuring operation to be carried out at any particular time. It is also possible that just one distance measuring device **11** is arranged to monitor the vertical B position of the rock drilling rig **1** so as to detect the sinking of the rig and that one or more clinometers **21** are arranged to monitor the inclination of the carrier **2**. Monitoring results may be conveyed from the distance measuring device **11** and the clinometer **21** to a control unit **30** for analyzing. If the measurements detect a change in the vertical B position of the rock drilling rig, the position may be corrected by adjusting the jacks **9**. Further, it is possible to carry out new navigation if substantial changes have taken place in the vertical position. The control unit **30** may be arranged to notify the operator of a change in the vertical position and the control unit may further suggest to the operator a jack reset or a new navigation. It is also possible that on the basis of the changed vertical position adjustments will be made in the control unit to the coordinate system to be used. It is further possible that the control unit is arranged to perform the above-described adjustment operations automatically after a change exceeding the predetermined conditions in the vertical position has taken place. The monitoring of the vertical position and the relating measuring devices need not necessarily be associated with the positioning of the positioning station but they may be utilized independently.

[0029] It should be noted that the location of the positioning station may depend on the excavation method used. In typical tunnelling the rock drilling rig is to be positioned on the centre line of the tunnel. Alternatively the positioning station may be determined on a border of the drilling site, for instance, in situations where the rear of the tunnel will be excavated in two or more stages. Determination of the positioning station may also take into account obstacles as well as rock drilling and mining apparatuses found on the drilling site.

[0030] The invention is not limited to tunnel drift drilling alone, but it may be utilized in any rock drilling method, in which there is a need for positioning a rock drilling rig to a predetermined drilling station for drilling holes determined in the drilling plan.

[0031] In some cases features of the present document may be used as such irrespective of other features. On the other hand, features of the present document may be combined, where necessary, to provide various combinations.

[0032] The drawings and the relating description are only intended to illustrate the inventive idea. The details of the invention may vary within the scope of the claims.

1. A method for positioning a rock drilling rig on a drilling site, the method comprising:

driving the rock drilling rig to a drilling site and positioning the carrier thereof in relation to wall surfaces surrounding the drilling site;

performing post-positioning navigation in which the location of a mine vehicle is linked to a coordinate system of the drilling site and to a drilling plan where at least the directions of holes to be drilled are determined;

initiating the drilling of the holes according to the drilling plan after the navigation;

using as a basis for the positioning of the rock drilling rig a positioning station which depends on the distance between the rock drilling rig and wall surfaces of the drilling site;

determining during positioning the location of the carrier of the rock drilling rig by means of at least one distance measuring device in relation to the wall surfaces of the drilling site; and

positioning the rock drilling rig into a positioning station for navigation.

2. The method of claim **1**, comprising determining the positioning station of the rock drilling rig in connection with a drilling plan.

3. The method of claim **1**, comprising

displaying the measurement results of the distance measuring devices at least on one user interface, and

driving the rock drilling rig manually to the positioning station taking into account the predetermined drilling station and the distance measurement results.

4. The method of claim **1**, comprising determining the positioning station as distances from the wall surfaces of the drilling site.

5. The method of claim **1**, comprising

measuring the location of the rock drilling rig with at least three laser distance measuring devices,

measuring with a first laser distance measuring device the distance between the carrier and the wall surface ahead and,

measuring with a second and a third laser measuring devices distances between the carrier and the lateral wall surfaces.

6. The method of claim **1**, comprising verifying prior to drilling in a control unit of the rock drilling rig that the drill unit reaches to drill the holes that are determined to be drilled with said drill unit in the drilling plan.

7. The method of claim **1**, comprising determining after navigation a vertical position of the carrier by means of at least two distance measuring devices.

8. The method of claim **1**, comprising

determining after navigation a vertical position of the carrier by means of at least two distance measuring devices, and

using at least one distance measuring device employed in the positioning for detecting post-navigation changes in the vertical position of the carrier.

9. The method of claim **1**, comprising driving the rock drilling rig automatically to the positioning station steered by the control unit.

10. A rock drilling rig comprising:

a movable carrier;

at least one drill boom with a drill unit comprising a feed beam, feeding means and a rock drill machine;

at least one control unit, in which it is possible to store a drilling plan in which at least the direction of holes to be drilled are determined;

means for linking the rock drilling rig to the coordinate system of the drilling site by means of navigation; and

at least one distance measuring device for determining the location of the carrier in relation to the wall surfaces surrounding the drilling site,

wherein the control unit comprises at least one user interface,

and wherein the readings of the distance measuring devices are arranged for display to the operator in at least one user interface, and

the rock drilling rig is arranged to be driven for navigation in the positioning station that depends on the distance between the rock drilling rig and wall surfaces of the drilling site.

11. The rock drilling rig of claim **10**, wherein the control unit is given at least one positioning station to which the distances between the carrier and the wall surfaces surrounding the drilling site are determined, and

wherein the control unit is arranged to display the measurements of the positioning station to the operator in the user interface.

12. The rock drilling rig of claim **10**, wherein

the control unit is given at least one positioning station to which the distances between the carrier and the wall surfaces surrounding the drilling site are determined,

the control unit is arranged to display the measurements of the positioning station to the operator in the user interface, and

the control unit is arranged to accept initiation of navigation only after positioning the rock drilling rig to the positioning station.

* * * * *