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(54) **Apparatus and method for designing and modifying drilling pattern for bench drilling**

(57) The invention relates to an apparatus for creating and modifying a drilling pattern for drilling a vertical bench, to a method of drilling a vertical bench round and

to a computer program product. An initial drilling pattern is modified

Description

Background of the invention

[0001] The invention relates to an apparatus for designing and modifying a drilling pattern intended for vertical bench drilling. The produced drilling pattern comprises at least determined positions of drill holes for a desired area to be drilled by means of one or more rock drilling rigs.

[0002] The invention further relates to a method of drilling pattern a vertical bench round of a bench, and to a software product for executing the disclosed method and solution.

provided with blasting technical data. Based on blasting technical rules and data, basic spacing and burden are defined for an initial drilling pattern. However, in the modified drilling pattern it is allowed to deviate from basic spacing and burden determined by blasting technical parameters.

[0018] According to an embodiment, the apparatus executing drilling pattern creation and amendments is located in a rock drilling rig. The rock drilling rig may comprise one or more control units provided with needed processing means for implementing the disclosed measures for placing drill holes to a drilling pattern and allowing amendments to the drilling pattern. The on-board control unit may comprise one or more display devices and one or more input means allowing interaction between an operator of the rock drilling rig and a computer program being executed in the processing means. By means of the input means measuring data from on-board and external measuring devices may be input to the system, as well as data elements comprising design or blasting data on the bench under operation.

moved two-dimensionally. Thus, the drill holes may be moved in a longitudinal direction of the row and also in transverse direction. Thereby the created or modified row may deviate from a straight line. Positions of drill holes in one drill hole row affect to positions of one or more other drill holes in one or more other drill hole rows. An advantage of use of the drill hole rows is that inserting charges and arranging detonators is easier and faster.

[0031] According to an embodiment, the apparatus is configured to create and modify a drilling pattern having a grid-like configuration. The drilling pattern has two or more drill hole rows and two or more drill holes placed in each row. Drill holes of adjacent rows may be initially located at same positions in the rows, or alternatively, drill holes of adjacent rows may initially be located at different positions

hole may be an additional drill hole determined by an operator when executing the drilling pattern. Alternatively a designer of a drilling pattern may place one or more independent additional drill holes in the drilling pattern. The apparatus disclosed in this patent application does not take into account the defined independent drill hole when performing the disclosed adjusting measures.

[0039] According to an embodiment, a shape of a free face of a bench is determined. The face of the bench is seldom straight because rock material is detached by blasting. The face may comprise notches and protrusions, and it may be slanting too. The realized face of the bench may be determined before drill holes locating closest to the outer edge are drilled. The disclosed apparatus, control unit or control system is configured to take the determined face shape and profile into consideration when creating a drilling pattern and modifying the drilling pattern.

drilled and blasted bench located above the current bench under operation. The system may utilize drilling data of the previous bench plane. Then, the drill holes of the currently operated bench may be positioned so that their start points are positioned at positions different than positions of end points of the previous bench plane. This embodiment ensures that new drill holes are not drilled to locations where the rock material is already damaged due the drilling and blasting of the previous bench. Thanks to this, collapse of upper end portions of the drill holes may be avoided and charging may be executed without problems. Further, the embodiment may improve safety when it is ensured that no drilling is executed to positions where charging material of the previous blasting could possibly be located.

[0048] According to an embodiment, the apparatus is configured to take into consideration data on measured vibration induced by already drilled and blasted drill

an alarm for the operator if the carrier is driven close to the edge of the bench. One or more limit distances may be given for the monitoring system, and if the carrier is moved to distance closer than the limit value, then the operator is informed or the carrier is stopped by the monitoring system. An advantage of this embodiment is that risk of falling rock drilling rig may be decreased

[0055] In this patent application vertical drill holes of a vertical bench drilling mean drill holes being vertical or close to vertical. Thus, the drill holes may be slightly inclined, for example 10 - 20°. However, such vertical drill holes clearly differ from horizontal drill holes.

[0056] The above disclosed

drilling unit 4 may be provided with one or more receivers 16 for receiving signals from several satellites 17. The sensing data is provided to the control unit 8, which may execute needed calculations.

[0062] In Figure 1 a bench 18 and a face 19 of the bench 18 are shown. Drill holes 20 are drilled in vertical direction for a round 21 of a bench 18. As it is mentioned earlier in this patent application, the drill holes 20 may be inclined but are still considered to be substantially vertical.

[0063] Figure 2 shows a principle of a bench excavation. Several successive bench rounds 21 a, 21 b are formed in a same bench plane. A

determine position data on the realized drill holes during the drilling and may update the drilling pattern 27 simultaneously. The system may also determine positions of neighbouring drill holes and may generate a complete drilling pattern for a drilling area. The drilling pattern may be updated always when new data is received from drilling and positioning processes.

[0073] Figure 8 shows a display device 31, wherein is indicated for an operator shortest distances 32 between drill holes 20 of a first drill hole row 24a and a detected realized face 19 of a bench. The face may be detected by means of bench scanning, for example, and a control unit may visualize the face 19 on the display device 31. The operator may place a drilling pattern 27 so that it best matches to the face

plurality of computer-readable storage devices in a distributed network, so that the program instructions are stored in a plurality of computer-readable storage devices and executed in a distributed fashion. The program instructions may be executed by one or more processors or processing devices.

[0081] 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.

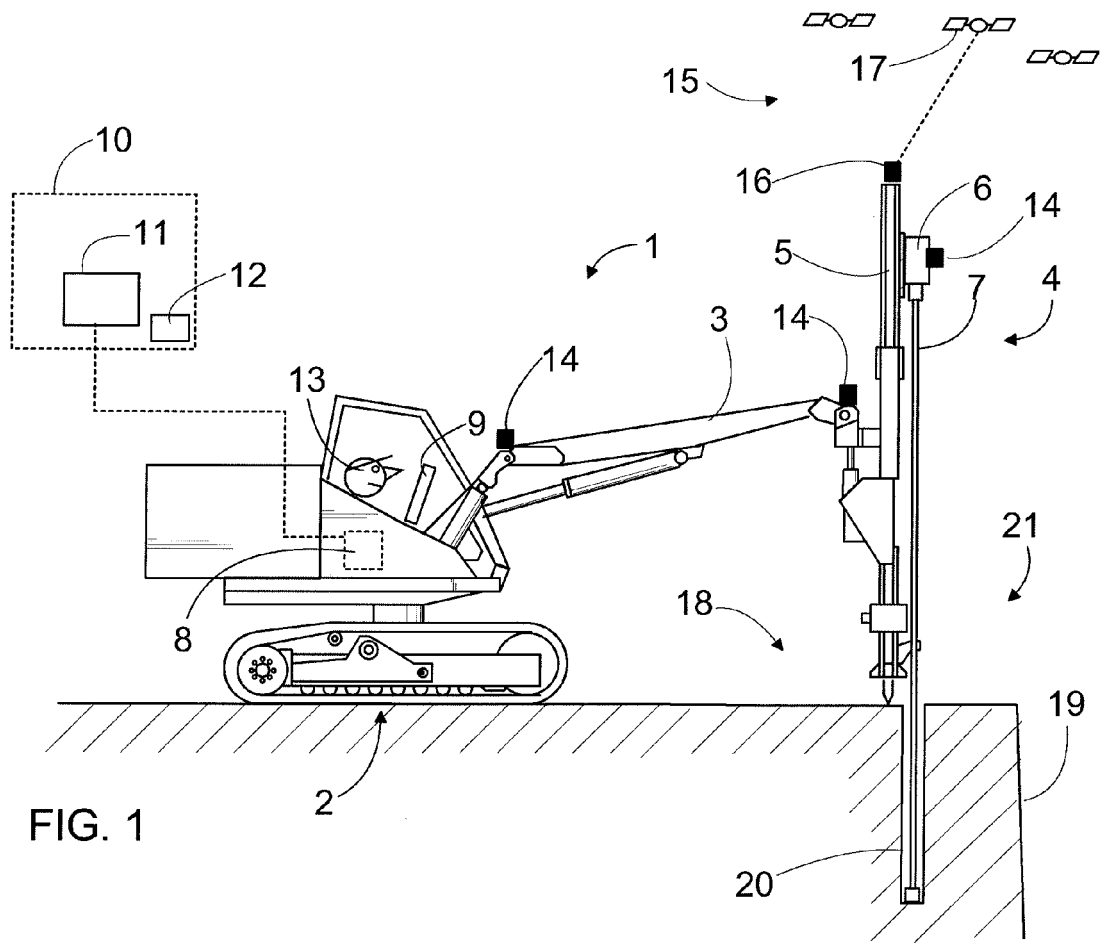
Claims

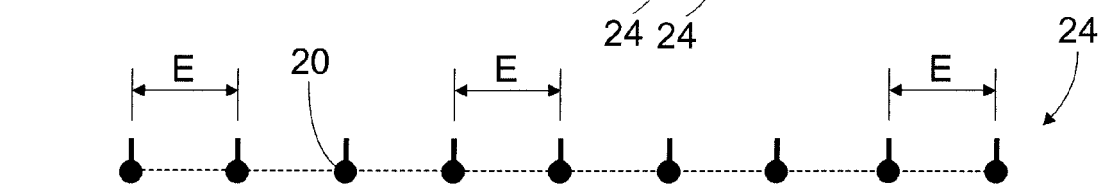
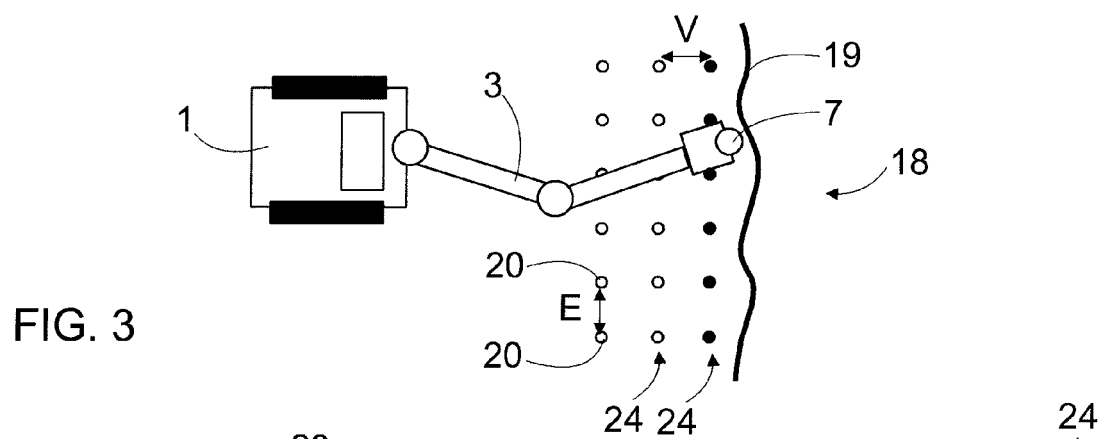
1. An apparatus comprising at least one data processing device for creating and modifying a drilling pattern for drilling a vertical bench round of a bench by means of a rock drilling rig, wherein

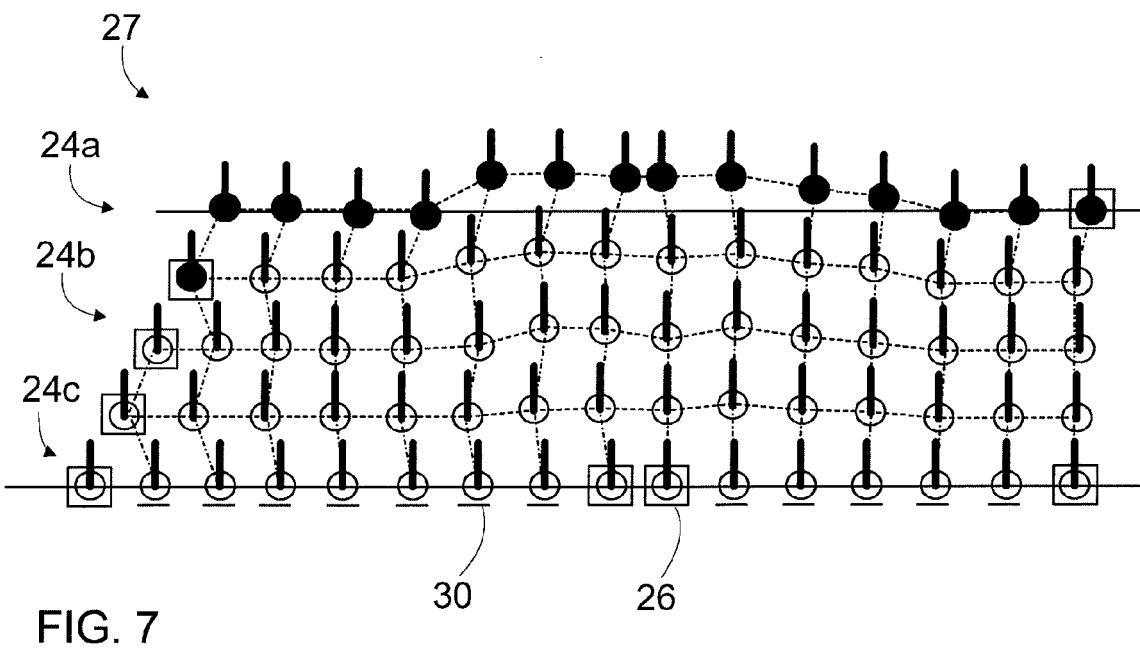
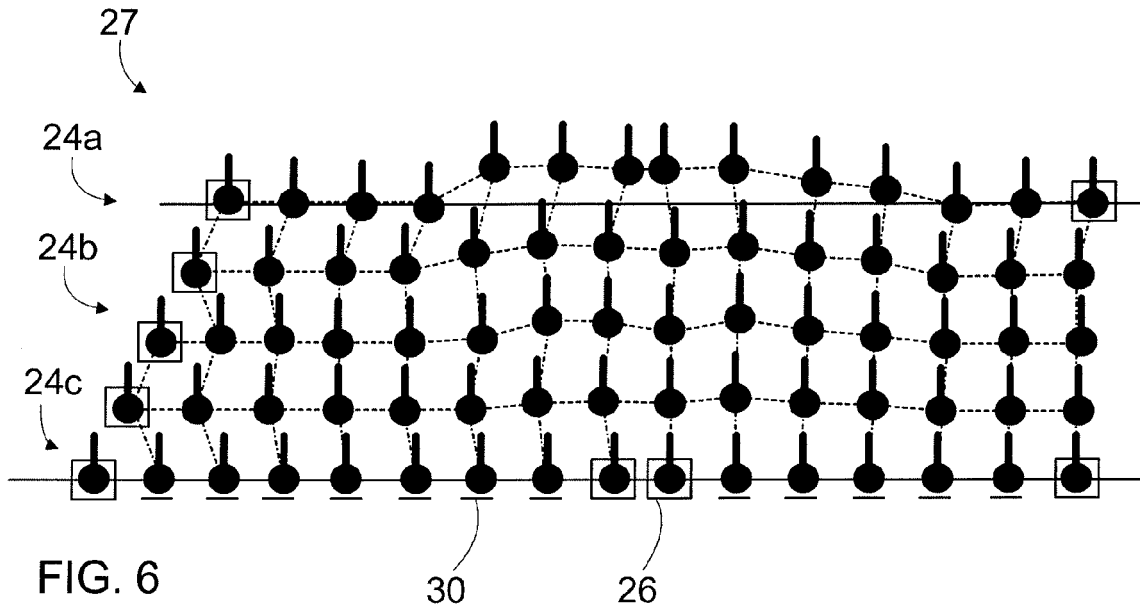
the apparatus is configured to even out the executed change of at least one drill hole in one drill hole row by modifying at least one property of at least one drill hole in at least one other drill hole row.

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12. The apparatus as claimed in any one of the preceding claims 1 - 11, **characterized in that** the initial drilling pattern defines directions of the drill holes;
the apparatus is configured to modify direction of at least one drill hole on the basis of received updated control data; and
the apparatus is configured to even out the executed change in direction by changing directions of several other drill holes of the initial drilling pattern.







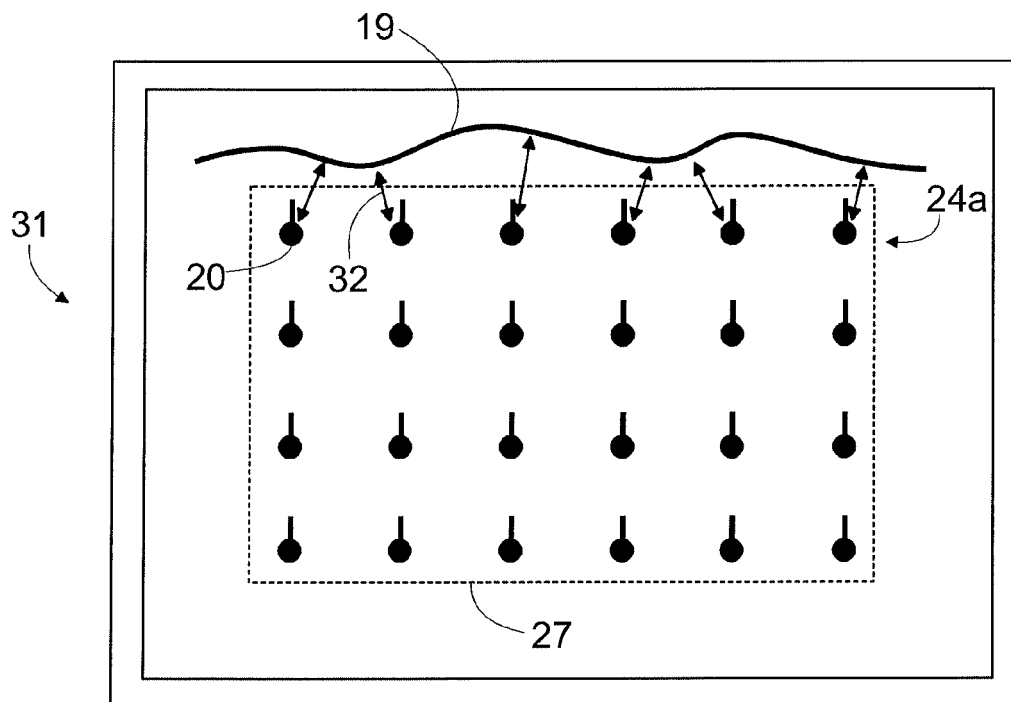
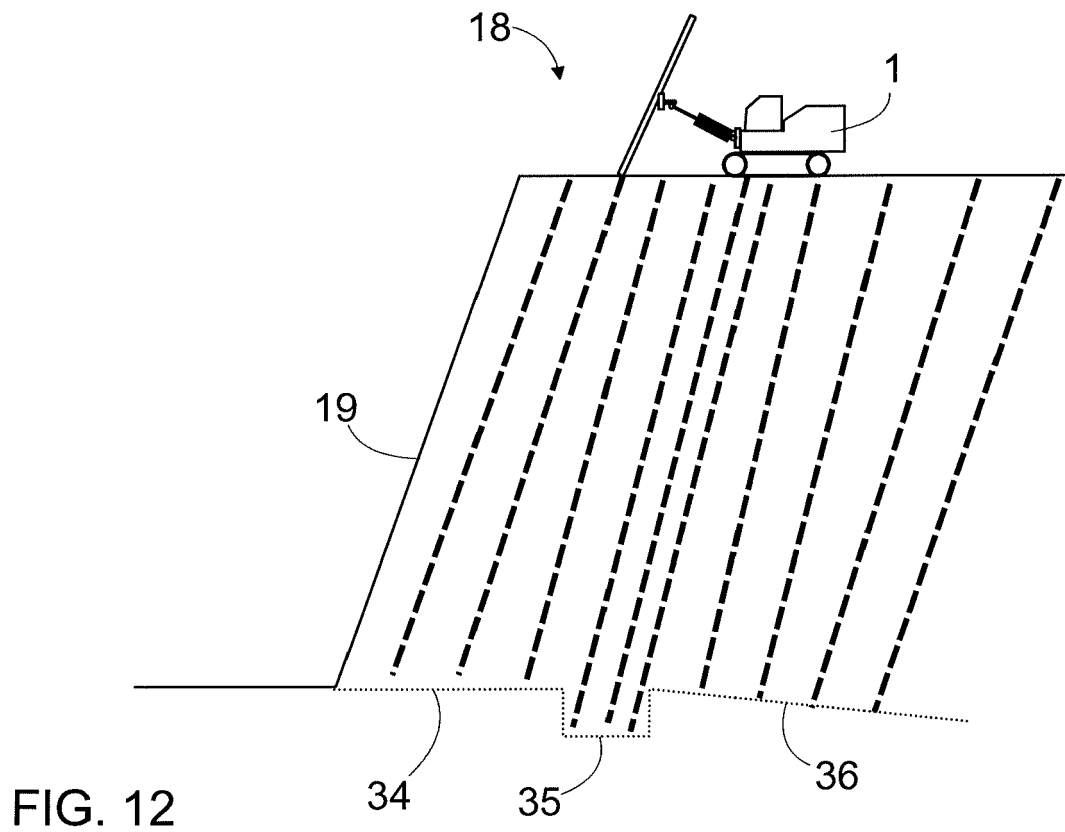
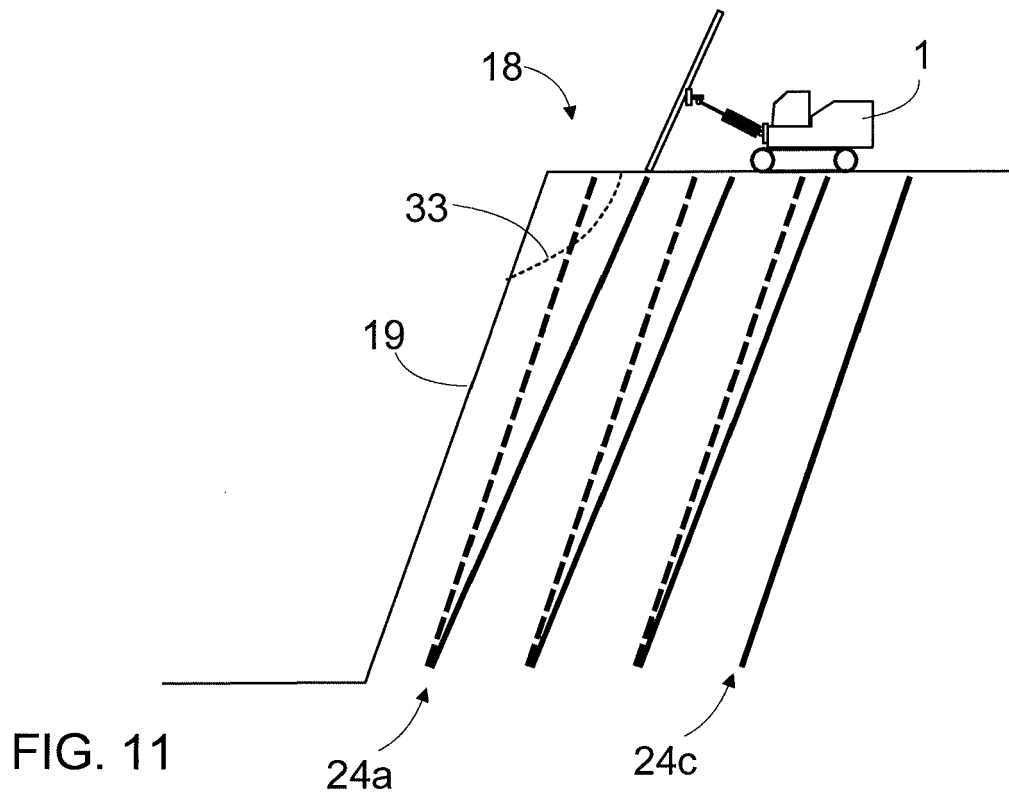


FIG. 8





EUROPEAN SEARCH REPORT

 Application Number
EP 14 15 7661

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	WO 00/34623 A1 (SANDVIK TAMROCK OY [FI]; AHTOLA UNTO [FI]; LISLERUD ARNE [FI]) 15 June 2000 (200		

**ANNEX TO THE EUROPEAN SEARCH REPORT
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