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

(11) **EP 4 141 212 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
01.03.2023 Bulletin 2023/09

(21) Application number: **21192508.6**

(22) Date of filing: **23.08.2021**

(51) International Patent Classification (IPC):
E21B 7/02 *(2006.01)* ***E21B 47/00*** *(2006.01)*
E21D 9/00 *(2006.01)*

(52) Cooperative Patent Classification (CPC):
E21B 47/00; E21B 7/022; E21D 9/006

(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
Designated Validation States:
KH MA MD TN

(71) Applicant: **Sandvik Mining and Construction Oy**
33330 Tampere (FI)

(72) Inventors:
- **SALMINEN, Pekka**
  33330 Tampere (FI)
- **MUONA, Jouko**
  33330 Tampere (FI)
- **LAINE, Pekka**
  33311 Tampere (FI)
- **MYLLYLÄ, Juha-Matti**
  33710 Tampere, Meiramipolku 2 A 1 (FI)

(74) Representative: **Sandvik**
Sandvik Mining and Construction Oy
Patent Department
PL 100
33311 Tampere (FI)

(54) **APPARATUS, METHOD AND SOFTWARE PROGRAM PRODUCT FOR DESIGNING DRILLING PATTERNS**

(57) An apparatus, method and computer program product for designing a drilling pattern for a tunnel. The apparatus (4) is configured to combine data on a drilling pattern (1) and geological data (19) on rock characteristics surrounding a portion of a tunnel (8).

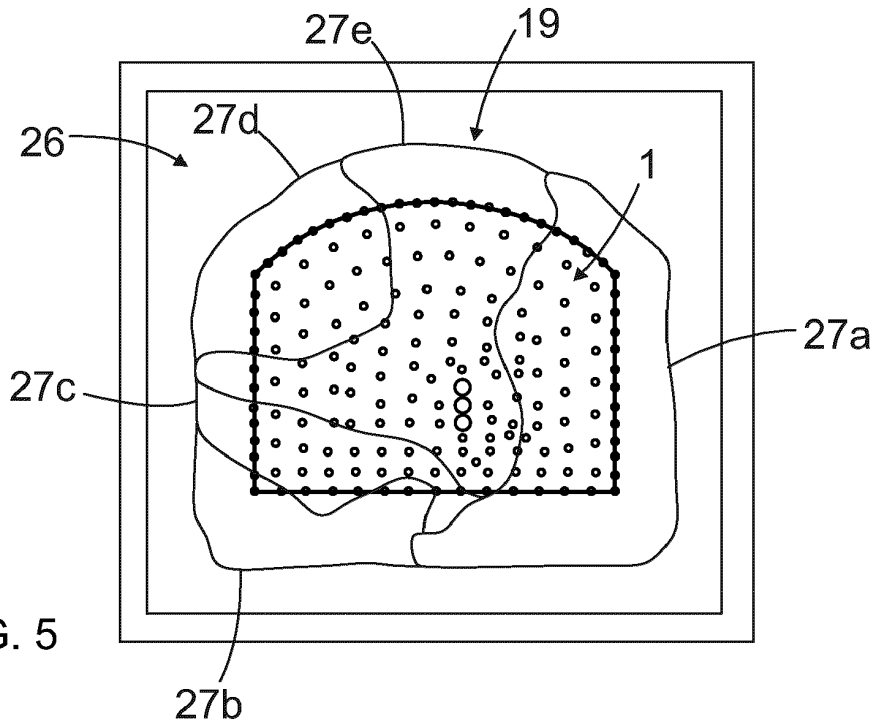

FIG. 5

EP 4 141 212 A1

Description

Background of the invention

[0001] The invention relates to an apparatus for designing or editing a drilling pattern for a tunnel.

[0002] The invention further relates to a method and computer program product for visualizing a drilling pattern of tunnel when designing or editing the drilling pattern.

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

[0004] In mines underground tunnels are excavated by utilizing drilling and blasting method wherein rock material is removed in several successive rounds. The mining tunnel may be a production tunnel or a connection tunnel. Tunnels are also excavated in a so called construction tunneling method wherein tunnel are excavated for road and railway traffic paths. The tunnels are typically created by implementing a drill and blast method, wherein blast holes are first drilled to a rock surface and the blast holes are then charged with explosives and are blasted. Thereafter broken rock material is removed, and a new round is again drilled, charged, and blasted. The tunnel advances in several successive rounds. When designing drilling patterns for the rounds, there is typically a limited amount of data available on properties of rock surrounding the already excavated part of the tunnel. Furthermore, the possible data that is available is difficult to utilize in the design process of the drilling pattern. Thus, the present solutions contain some disadvantages regarding effective design process and ability to provide useful data.

Brief description of the invention

[0005] An object of the invention is to provide a novel and improved solution for planning and editing drilling patterns.

[0006] The apparatus according to the invention is characterized by the characterizing features of the first independent apparatus claim.

[0007] The method according to the invention is characterized by the characterizing features of the independent method claim.

[0008] The computer program product according to the invention is characterized by the characterizing features of the second independent apparatus claim.

[0009] An idea of the disclosed solution is that the disclosed apparatus comprises one or more data processing devices for executing at least one design program for producing drilling pattern data. The apparatus also comprises an input device for feeding data for the apparatus for supporting the design process executed by means of the apparatus. The apparatus is configured to present the produced drilling pattern data on at least one display device for an operator. The apparatus is provided with geological data indicating rock characteristics of rock material at examined location of the tunnel and is configured to combine the geological data with the drilling pattern data. Further the apparatus visualizes the combined data on the display device.

[0010] An advantage of the disclosed solution is that geological data is visualized in an intuitive manner on the screen whereby the operator is provided with valuable data for making decisions and controlling the designing and editing process of the drilling pattern. The operator is provided with better understanding on surrounding rock material and geological circumstances. Thereby quality of drilling patterns may be improved, and the excavation may be executed more effectively and in accordance with the detected rock characteristics. Further, the design and editing process is facilitated and quickened.

[0011] According to an embodiment, the apparatus and the disclosed solution can be implemented also when designing drilling patterns for excavating other underground spaces than tunnels. Further, the solution may be utilized for production tunnels and spaces in mines as well as for traffic tunnels and spaces. The tunnels, storages and other spaces may or may not be underground structures.

[0012] According to an embodiment, the disclosed solution can be implemented when designing totally new drilling patterns and when editing already existing drilling patterns. Thus, the drilling pattern data may relate to both. In this document the term "design" may relate to new design and to design by editing. In many cases already existing drilling patterns are re-used in edited form.

[0013] According to an embodiment, the mentioned geological data indicating the geological rock characteristics comprises data on at least one of the following features: hardness of the rock material, blastability of the rock material, changes in geological structure or layers. The geological data may also be called as a Rock Mass Mapping (RMM) data.

[0014] According to an embodiment, the apparatus is configured to present one or more rock mass data views (RMM views) on a display screen together with drilling pattern views or profile views of the excavated tunnel or space. The mentioned views may be shown in superimposed manner in one image element.

[0015] According to an embodiment, the apparatus is provided with input geological data. In other words, the apparatus receives geological data which is produced externally to the apparatus and is input for the design program for presenting the geological data together with the drilling pattern data. The externally produced Geocalculus may comprise several and versatile survey methods and analysis and may provide improved understanding of geological circumstances.

[0016] According to an embodiment, the geological data includes manually examined data provided by a geologist. The data may be based on visual examinations, material testing, exploration drillings and other geological methods. The data produced by the geologist may be

presented simultaneously and in a superimposed manner with the drilling pattern data on the display device.

[0017] According to an embodiment, the geological data includes image data or scanned data on surfaces of the tunnel. The produced optical data may be analyzed by means of image processing programs, utilizing photogrammetry techniques and programs, or the image data may be analyzed manually by a geologist. The output of the analysis, or processed images or scanning results may be input to the apparatus which may then display them together with the drilling pattern data and data on selected rounds of the tunnel. Further, the scanning may comprise photo scanning and time-of-flight type scanning.

[0018] According to an embodiment, the apparatus is provided with at least one input geological data set. Then the apparatus extrapolates the geological data for unexcavated rock material surrounding the already excavated realized portion of the tunnel in response to the input data set. In other words, the apparatus executes rock mapping for at least one rock material zone or portion locating outside the realized tunnel portion and implements the outcome of the extrapolation when providing design data for designing the drilling pattern. The apparatus can produce rock mapping view also for areas between drill holes.

[0019] According to an embodiment, the mentioned input geological data set includes measuring while drilling data (MWD) gathered by means of a rock drilling rig during drilling of drill holes of the tunnel. The apparatus detects properties of the drilled rock material at each examined drill hole in response to the measuring while drilling data, and then the apparatus extrapolates properties of rock material at surrounding zones outside the drilled holes in response to the detected properties of the drilled material. In other words, the gathered geological data is thereby based on realized data i.e., it is drilling based data.

[0020] According to an embodiment, the apparatus is provided with measuring while drilling (MWD) data from one or more other rock drilling rigs operating at the same or neighboring work site. Further, the received data may alternatively be any other valuable sensing data relating to the properties of the rock and received from other excavation or exploration vehicles or machines.

[0021] According to an embodiment, the input geological data comprises measuring data on additional drilled holes other than drill holes drilled on a face of a round of the tunnel. This means that the apparatus may be provided with measuring while drilling data gathered from any kind of drill holes. The mentioned drill holes being other than the face drill holes may be probe drill holes drilled longer in the direction of the tunnel than blast holes at the face, injection drill holes drilled angularly outside the round and relating to rock reinforcing, and rock bolting drill holes drilled transversally to the excavated tunnels in fan-shaped patterns. Drilling the mentioned additional drill holes other than the blast holes provides valuable additional data for evaluating properties of the unexcavated surrounding rock material.

[0022] Further, in mines production drill holes are drilled. Measuring data gathered by production rock drilling rigs may also include valuable data on rock characteristics wherefore this data may also be input to the apparatus and be considered when presenting geo data.

[0023] According to an embodiment, the geological data is a combination of at least two different geological data or data sets received from different sources and based on different observed parameters. In other words, the disclosed embodiment can utilize multi source integration of data i.e., data having different origin is implemented. An advantage is that accuracy of the estimation can be improved when several data sets can be used.

[0024] According to an embodiment, the apparatus is configured to extrapolate properties of unexcavated rock material in the direction of the tunnel and to present the output of the extrapolation as the geological data and together with a face drilling pattern data. In other words, geological data is presented on the display for facilitating designing or editing the drilling pattern for blast holes on a face of a new round to be drilled. An advantage of the embodiment is that forthcoming rock material and its layers in the advance direction of the tunnel are estimated more reliably whereby the drilling patterns can be designed more easily and with improved quality and efficiency.

[0025] Further, when the rock characteristics of the surrounding rock mass can be estimated properly by means of the rock mass mapping presented in this application, it is possible to recognize ore bodies and ore lodes, and to then orientate the tunnel towards them. The rock mapping may indicate if directions of known ore lodes change. Then new drilling pattern can be updated by making needed amendments in accordance with the detected changes in rock mass. This way more cost effective excavation is possible since amount of gangue can be decreased.

[0026] The disclosed solution may also be implemented in a so called narrow vein mining wherein narrow vein drifts are produced in situations when ore is distributed in narrow veins. Especially in the narrow vein mining it is essential to recognize the changes in the rock mass and to react them quickly.

[0027] According to an embodiment, the apparatus is configured to visualize geological data surrounding the already excavated portion of the tunnel and to thereby provide assisting data for designing a drilling pattern for rock bolts for executing rock reinforcing.

[0028] According to an embodiment, the apparatus may assist an operator in one or more of the following: determining rock bolting density i.e., distances between rock bolt holes; defining directions of the rock bolt holes; and dimensioning lengths of the rock bolt holes. The apparatus may suggest decreasing the distances between the rock bolt holes at areas or zones where soft or fragmented rock material is shown. Further, the apparatus

may suggest correcting directions, and may suggest increasing lengths of the rock bolting holes at zones having poor strength or changes in rock layers.

[0029] According to an embodiment, the apparatus is configured to extrapolate rock characteristics surrounding an already excavated portion of the tunnel in response to measuring while drilling data gathered during the drilling of the realized portion, and the apparatus is configured to display outcome of the extrapolated rock characteristics on the display device together with data on drilling pattern of rock bolting holes. In other words, rock mapping or geological estimation is based on drilling data of blast holes of the examined round, and the results of the rock mapping is utilized when designing or editing the drilling patterns for the rock bolt holes.

[0030] According to an embodiment, the apparatus is configured to display on a display device the geological data surrounding a realized portion of the tunnel at several selectable cross sectional locations in the direction of the tunnel. This way valuable data of the rock characteristics is provided for designing or editing rock bolting fans at desired longitudinal locations along the tunnel.

[0031] According to an embodiment, the apparatus is provided with a feature allowing the operator to scroll the geological data or rock mass mapping data on the display along the realized mining tunnel. In other words, the operator may scroll and provide sliced cross sectional views at desired points in longitudinal direction of the already excavated round or tunnel portion. An advantage of this embodiment is that the scrolling feature provides the operator, in an intuitive manner, with an impression of trends of changes in rock characteristics at surrounding rock material along the tunnel. The notified trends can be taken into consideration when designing drilling patterns for the rock bolt holes. The mentioned scrolling can be done in a graphical user interface or by means of a pointing device, for example.

[0032] According to an embodiment, the disclosed solution relates to a method for visualizing a drilling pattern of a tunnel. The method comprises executing a design program in a processing device for generating the drilling pattern; displaying the generated drilling pattern on a display device; providing the design program with geological data indicating rock characteristics of rock material at examined location of the tunnel; and combining the geological data with the drilling pattern data and visualizing the combined data on the display device.

[0033] According to an embodiment, the method further comprises producing a blast pattern based on the drilling pattern and by means of the design program. Then the geological data is combined with the blast pattern and the combined data is visualized on the display device. Thus, the disclosed solution can be implemented also when creating data for blasting. This way valuable and intuitive data is provided for the operator when designing, editing, and checking the blast patterns.

[0034] According to an embodiment, the disclosed solution relates to a computer program product for visualizing a drilling pattern of a tunnel. The computer program product comprises program code means configured to execute the steps and procedures disclosed in this document when being run on a computer or a data processing device.

[0035] According to an embodiment, the apparatus is configured to shown different areas of zones with different rock characteristic with different colors or fillings and to thereby improve easy understanding of properties of surrounding rock mass.

[0036] The above disclosed embodiments may be combined in order to form suitable solutions having those of the above features that are needed.

Brief description of the figures

[0037] Some embodiments are described in more detail in the accompanying drawings, in which

Figure 1 is a schematic view of some issues relating to excavation of tunnels and designing and editing drilling patterns for the excavation,

Figure 2 is a schematic diagram of some features of an apparatus for designing drilling patterns and providing visualization,

Figure 3 is a schematic top view of a round of a tunnel and rock characteristics,

Figure 4 is a schematic top view of a round provided with some additional drill holes,

Figure 5 is a schematic view of a visualization of a drilling pattern and geological data on a display device,

Figures 6a is a schematic top view of a round and Figure 6b and 6c are sliced views at two different longitudinal points and shown on display device,

Figure 7 is a schematic view of visualization of a combination of a face drilling pattern and two different geological data shown on display device, and

Figure 8 is a schematic view of visualization of a combination of a rock bolt drilling pattern and geological data shown on display device.

[0038] 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

[0039] Figure 1 discloses that drilling patterns 1 comprising data on position, direction, and length of drill holes 2 to be drilled may be designed by operators 3 by means of an apparatus 4 which may be a designing computer or part of control system. The drilling pattern 1 is transmitted to a rock drilling rig 5 comprising a movable carrier 6 and one or more drilling units 7. In a drilling and blasting method a tunnel 8 is produced in several successive rounds R, Ra - Rd. The rock drilling rig 5 is positioned at

a face 9 of a following round and is connected to a coordinate system of the mine. The rock drilling rig drills the blast holes in accordance with the designed drilling pattern 1, where after the round Ra is blasted and the broken rock material is removed. Then a new face is formed and the rock drilling rig 5 is again positioned and navigated for drilling the next round Rb. Several successive rounds Ra - Rd form together a tunnel line 10, which is indicated in a highly simplified manner in Figure 1. The mining tunnel line 10 may be provided with peg numbers 11 indicating distance along the mining tunnel line. As can be noted direction of the mining tunnel line 10 may change, whereby it may comprise curves, for example.

[0040] As it is discussed in this document, geological data on surrounding rock mass is examined and visualized for assisting the operator 3 in design and editing process of different drilling patterns 1. The drilling units 7 may be provided with sensors S or measuring devices for producing measuring while drilling (MDW) data 12 during the drilling. The MWD data 12 can be input to the apparatus 4 for providing drilling based data on hardness and other properties of the rock material at the examined round R. Further, a geologist 13 may execute different geological surveys and may produce geological data and data sets, such as a geo map 14 or geological chart or views covering the examined tunnel 8 and its surroundings. The data produced by the geologist 13 may be input to the apparatus 4 and may be utilized therein. The rock drilling rig 5 may be provided with a camera or scanning device 15 for producing data on surfaces of the face 9 and contour surfaces of the excavated rounds R. The produced image or scanning data 16 may also be input to the apparatus 4. The data can be processed and analyzed in the apparatus 4 or externally before the input phase.

[0041] Figure 2 discloses a possible basic setting of an apparatus 4 for implementing the disclosed solution. The apparatus 4 comprises a data processing device 17 or a processor for executing a design program or algorithm and capable to assist an operator to design and edit drilling and blasting patterns. The apparatus 4 comprises an input device 18 by means of which geological data 19 and data sets can be input. The input device 18 may be used also for feeding required parameters and basic design data 20 for the process. The apparatus 4 may further comprise a user interface UI by means of which an operator may communicate with the apparatus and can make selections and control commands. The apparatus 4 may communicate with external electric devices, such as sensors, servers, and computers, by means of a data communication device DC. There may also be a memory device M for storing programs and data.

[0042] The disclosed apparatus 4 is configured to combine 21 the geological data and the drilling pattern data and is capable to show to show the produced combination on one or more display devices for visualizing 22 it.

[0043] The apparatus 4 may be located at an office, or alternatively it may in connection with an on-board control unit of rock drilling rig.

[0044] Figure 3 discloses a round R and combined geological data 19 shown as lines 23 indicating changes between different rock characteristics in rock mass. Thus, Figure 3 provides an illustration of a geo-changing layout and drilling technical information in the same view. At time point t face drilling holes (t-1) are drilled for the round R and an operator or designer of the drilling patterns is considering a new drilling pattern for a face (at t) or is planning bolting measures for t-1. Without the visualized geological data, it is very difficult for the operator to know what is ahead of a face of the following round R+1 (at time point t) when planning the face drilling pattern, or to know what kind of rock mass is there in lateral direction when planning the bolting drilling pattern.

[0045] In Figure 3 already excavated part of the tunnel 8 is shown with thicker lines compared to portions which have not yet been excavated. Drill holes 2 of a face drilling pattern are also shown in a simplified manner in Figure 3.

[0046] Figure 4 discloses that when drilling face drill holes 2a, sensing data can be produced and utilized for determining properties of rock mass at a round R. Further, when rock bolting drill holes 2b are drilled, also then measuring while drilling data can be produced and recorded. In addition to this, rock mass data in advance direction of the round R can be explored by drilling relatively long probe holes 24. When the rock mass is fragmented or very soft, or comprises voids, there may be a ned drill injection holes 25 for injecting reinforcing material. The drilling of the injection holes 25 may also generate valuable measuring while drilling data which may be utilized as the geological data or data set.

[0047] Figure 5 is a display view 26 showing a face drilling pattern 1 and geological data 19. As can be seen there may be several areas or zones 27a - 27e with different rock properties. The zones 27 may be shown on the display with different colours for improving easy understanding.

[0048] Figure 6a discloses a tunnel 8 and a round R wherein face drilling holes 2 are drilled. On the basis of measuring while drilling data gathered during the drilling of the drill holes 2, geological data 19 is produced for the round R. The apparatus disclosed in this document comprises a scrolling feature allowing it to provide sliced views S1, S2 at desired points of the drilled round R. In this example two sliced points S1 and S2 are shown.

[0049] Figure 6b shows a display view 26a of the sliced point S1 and Figure 6c shows a display view 26b of the sliced point S2. When examining the views 26a and 26b it can be seen that shape and coverage of zones of graphical data 19 have changes. This provides valuable indication on trends and intensity of changes in rock characteristics.

[0050] Figure 7 is a display view 26 showing a drilling pattern 1 and two different type of geological data 19a, 19b superimposed on the drilling pattern. A first geological data 19a may be based on measuring while drilling

data and a second geological data 19b may be based on geo mapping produced by a geologist.

[0051] Figure 8 discloses a display view 26 showing a drilling pattern 1 for bolting drill holes 2b. Geological data 19 with different zones is also presented. Figure 8 shows that at right side distance between the drill holes is minor than at left side because zone 27a indicates softer rock mass.

[0052] 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 (4) for designing or editing a drilling pattern (1) for a tunnel (8);
   and wherein the apparatus (4) comprises:

   at least one data processing device (17) for executing at least one design program for producing drilling pattern data;
   an input device (18) for feeding data for the apparatus (4) for supporting the design process;
   and wherein the apparatus (4) is configured to present the produced drilling pattern data on at least one display device;
   characterized in that
   the apparatus (4) is provided with geological data (19) indicating rock characteristics of rock material at examined location of the tunnel (8); and
   the apparatus (4) is configured to combine (21) the geological data (19) with the drilling pattern data and is configured to visualize (22) the combined data on the display device.

2. The apparatus as claimed in claim 1, **characterized in that**
   the geological data (19) indicating the geological rock characteristics comprises data on at least one of the following features: hardness of the rock material, blastability of the rock material, changes in geological structure or layers.

3. The apparatus as claimed in claim 1 or 2, **characterized in that**
   the apparatus (4) is provided with input geological data (19) .

4. The apparatus as claimed in claim 1 or 2, **characterized in that**

   the apparatus (4) is provided with at least one input geological data set;
   the apparatus (4) is configured to extrapolate the geological data (19) for unexcavated rock material surrounding the already excavated realized portion of the tunnel in response to the input data set.

5. The apparatus as claimed in claim 4, **characterized in that**

   the input geological data set includes measuring while drilling data (12) gathered by means of a rock drilling rig (5) during drilling of drill holes (2) of the tunnel (1) ;
   the apparatus (4) is configured to detect properties of the drilled rock material at each examined drill hole (2) in response to the measuring while drilling data (12); and
   the apparatus (4) is configured to extrapolate properties of rock material at surrounding zones outside the drilled holes (2) in response to the detected properties of the drilled material.

6. The apparatus as claimed in claim 4 or 5, **characterized in that**
   the input geological data comprises measuring data on additional drilled holes (2b, 24, 25) other than drill holes drilled on a face 89) of a round (R) of the tunnel (1) .

7. The apparatus as claimed in any one of the preceding claims 1 - 6, **characterized in that**
   the geological data (19) is a combination of at least two different geological data or data sets received from different sources and based on different observed parameters.

8. The apparatus as claimed in any one of the preceding claims 1 - 7, **characterized in that**
   the apparatus (4) is configured to extrapolate properties of unexcavated rock material in the direction of the tunnel (8) and to present the output of the extrapolation as the geological data (19) and together with a face drilling pattern (1) data.

9. The apparatus as claimed in any one of the preceding claims 1 - 8, **characterized in that**
   the apparatus (4) is configured to visualize geological data surrounding the already excavated portion of the tunnel and to thereby provide assisting data for designing a drilling pattern for rock bolts for executing rock reinforcing.

10. The apparatus as claimed in any one of the preceding claims 1 - 9, **characterized in that**
    the apparatus (4) is configured to extrapolate rock characteristics surrounding an already excavated portion of the tunnel in response to measuring while drilling data (12) gathered during the drilling of the realized portion, and the apparatus (4) is configured to display outcome of the extrapolated rock characteristics on the display device together with data on

drilling pattern (1) of rock bolting holes (2b).

11. The apparatus as claimed in any one of the preceding claims 1 - 10, **characterized in that**
the apparatus (4) is configured to display (22) on a display device the geological data (19) surrounding a realized portion of the tunnel at several selectable cross sectional locations (S1, S2) in the direction of the tunnel (1) .

12. The apparatus as claimed in any one of the preceding claims 1 - 8, **characterized in that**
the apparatus (4) is configured to provide geological data (19) for production excavation of a mine tunnel and to assist in recognizing ore bodies or ore lodes by means of visual presentation of different zones of the geological data (19).

13. A method for visualizing a drilling pattern (1) of a tunnel (8),
wherein the method comprises:

executing a design program in a processing device (17) for generating the drilling pattern (1); and
displaying the generated drilling pattern (1) on a display device;
characterized by
providing the design program with geological data (19) indicating rock characteristics of rock material at examined location of the tunnel (8); and
combining (21) the geological data (19) with the drilling pattern data (1) and visualizing (22) the combined data on the display device.

14. The method as claimed in claim 13, **characterized by**

producing a blast pattern based on the drilling pattern (2) and by means of the design program; and
combining the geological data (19) with the blast pattern and visualizing the combined data on the display device.

15. A computer program product for visualizing a drilling pattern of a tunnel,
wherein the computer program product comprises program code means configured to execute the steps and procedures disclosed in the previous claims when being run on a computer or a data processing device.

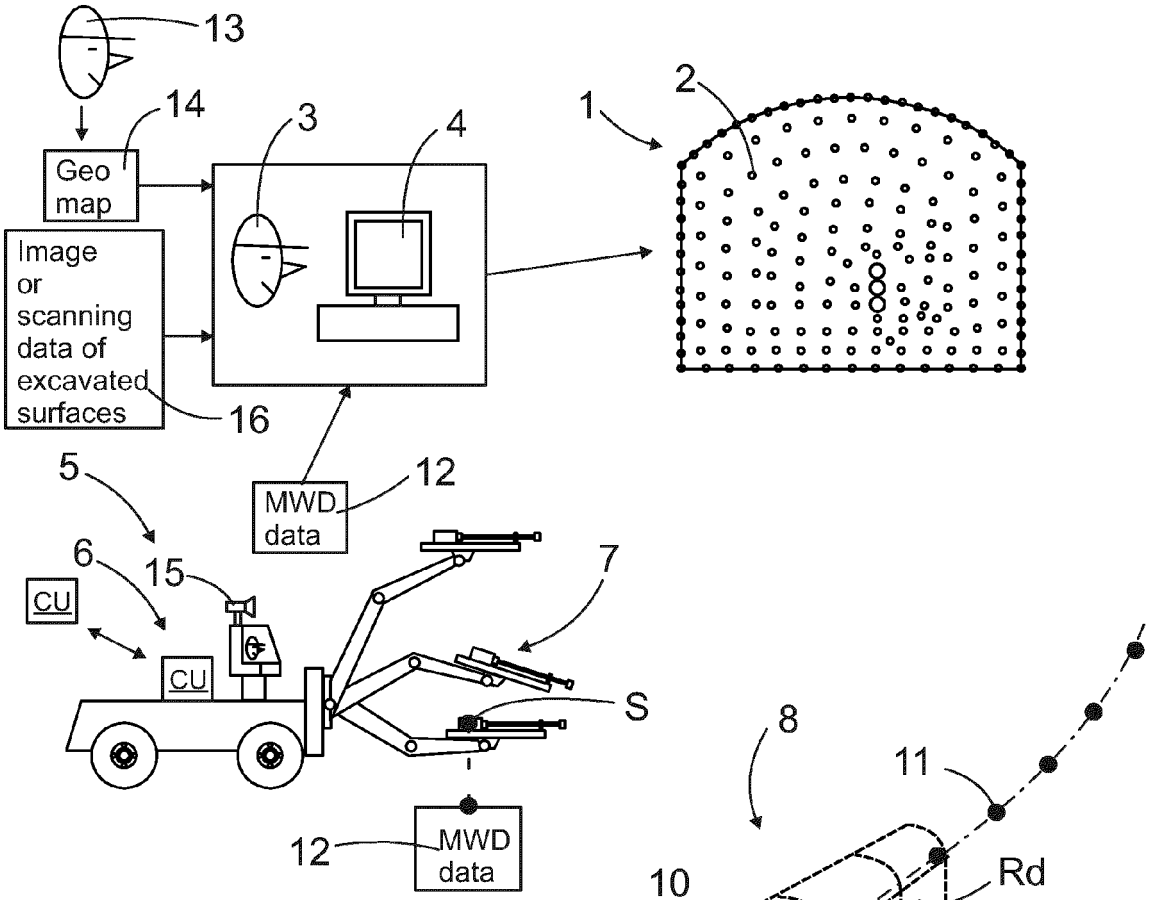
13
14
Geo map
3
4
1
2
Image or scanning data of excavated surfaces
16
MWD data
12
5
6
15
7
CU
CU
S
12
MWD data
8
11
10
Rd
Rc
9
Rb
R
1
Ra

FIG. 1

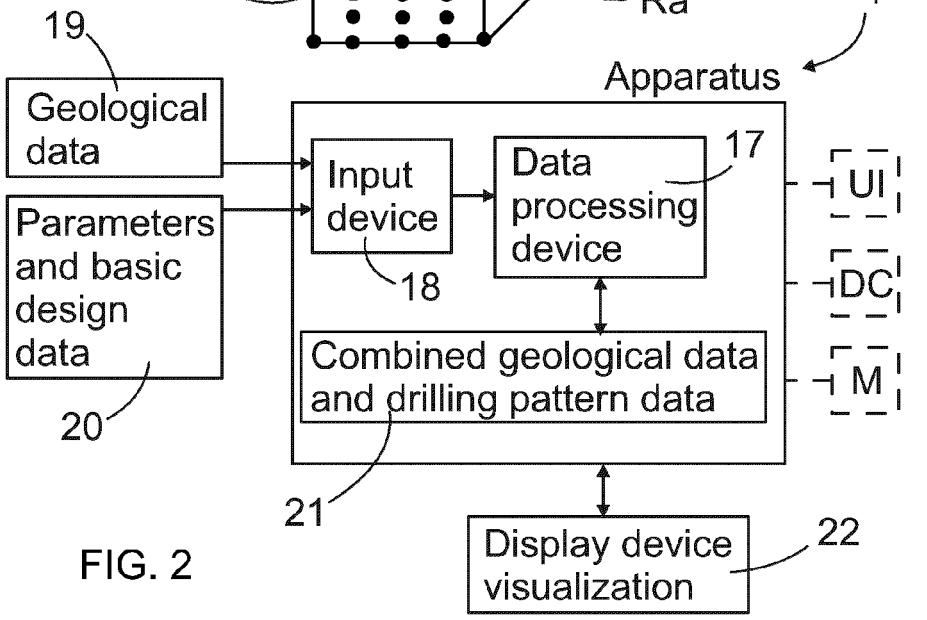
19
Geological data
4
Apparatus
Parameters and basic design data
Input device
Data processing device
17
UI
18
DC
Combined geological data and drilling pattern data
M
20
21
Display device visualization
22

FIG. 2

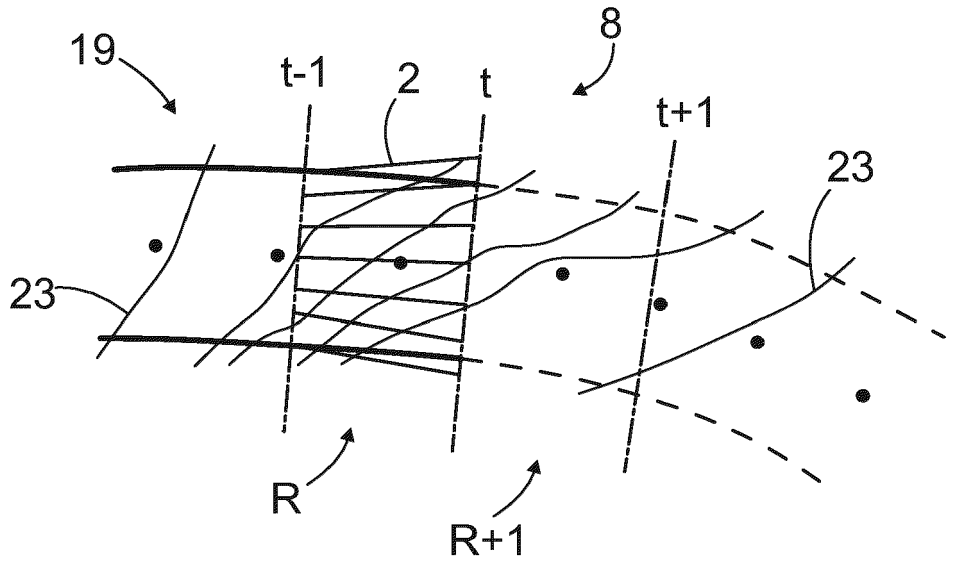

FIG. 3

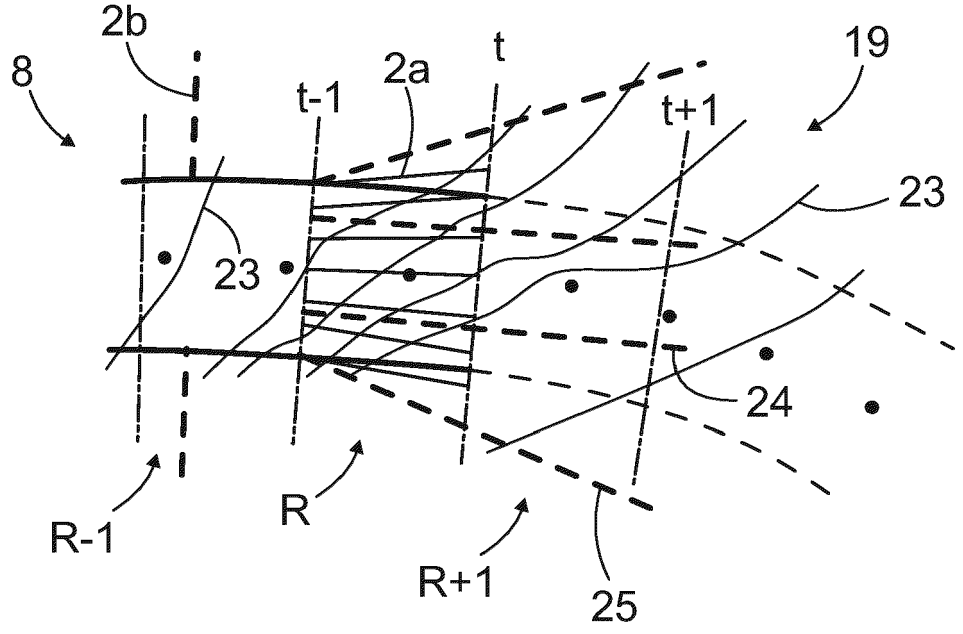

FIG. 4

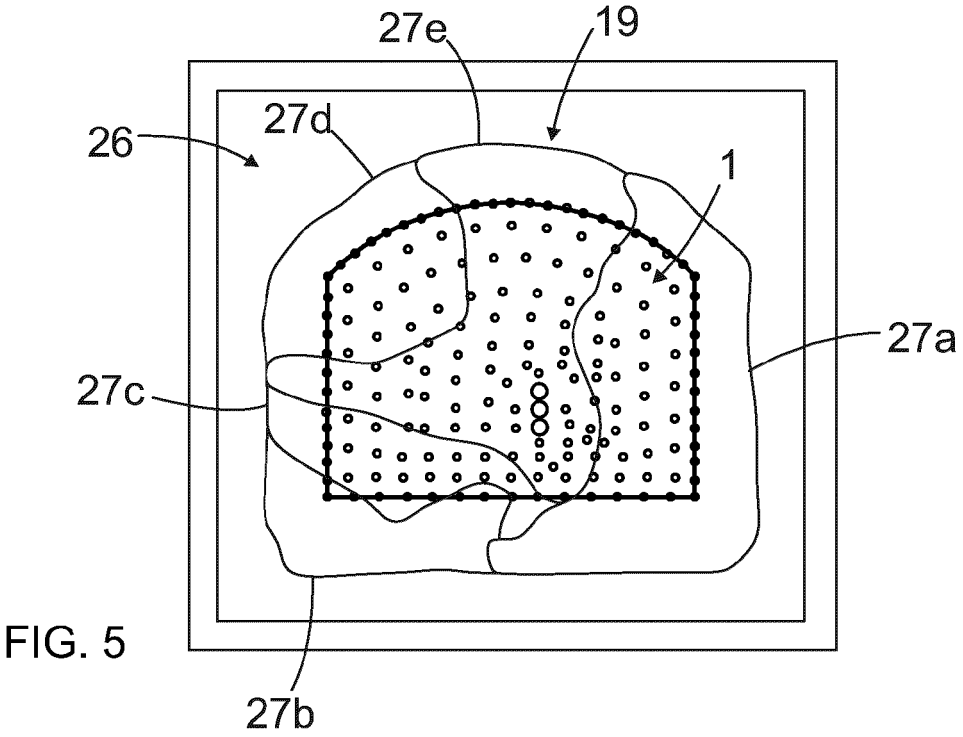

FIG. 5

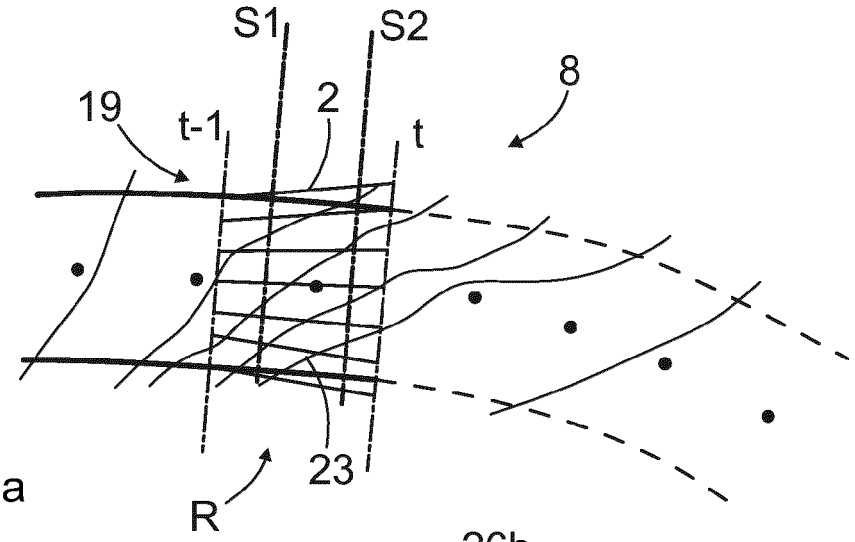

FIG. 6a

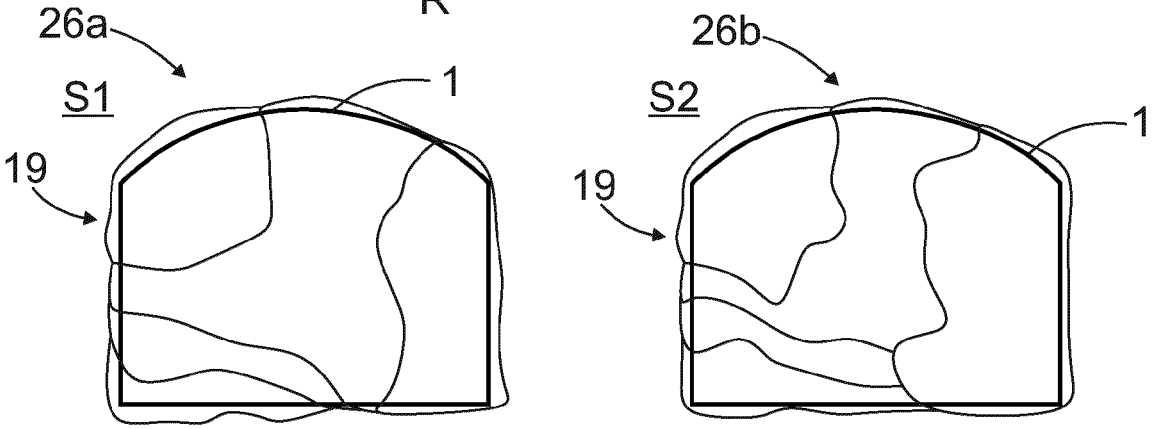

FIG. 6b

Scroll

FIG. 6c

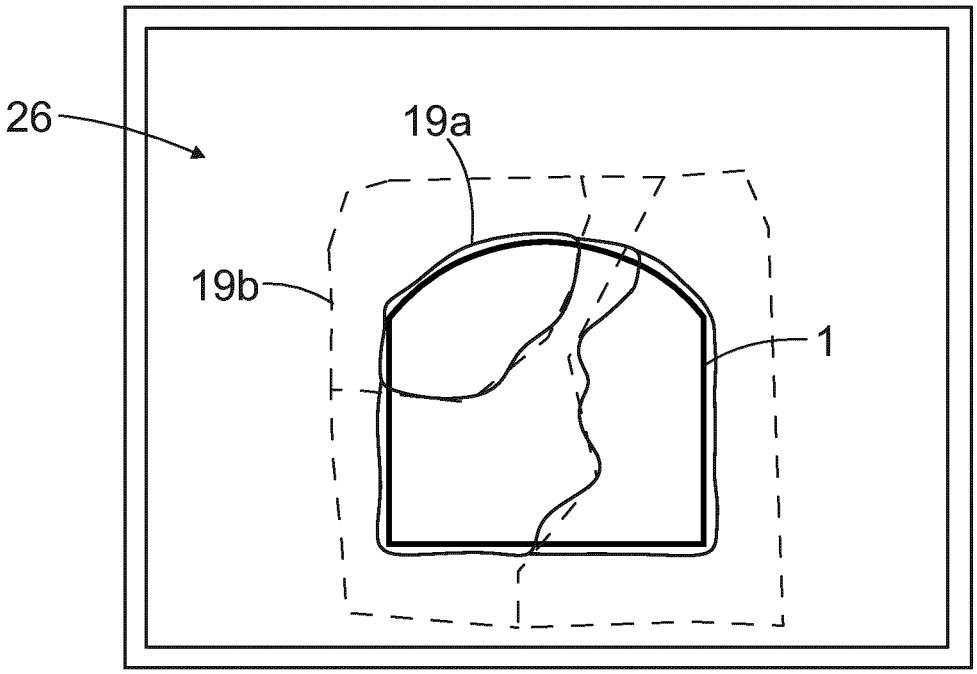

FIG. 7

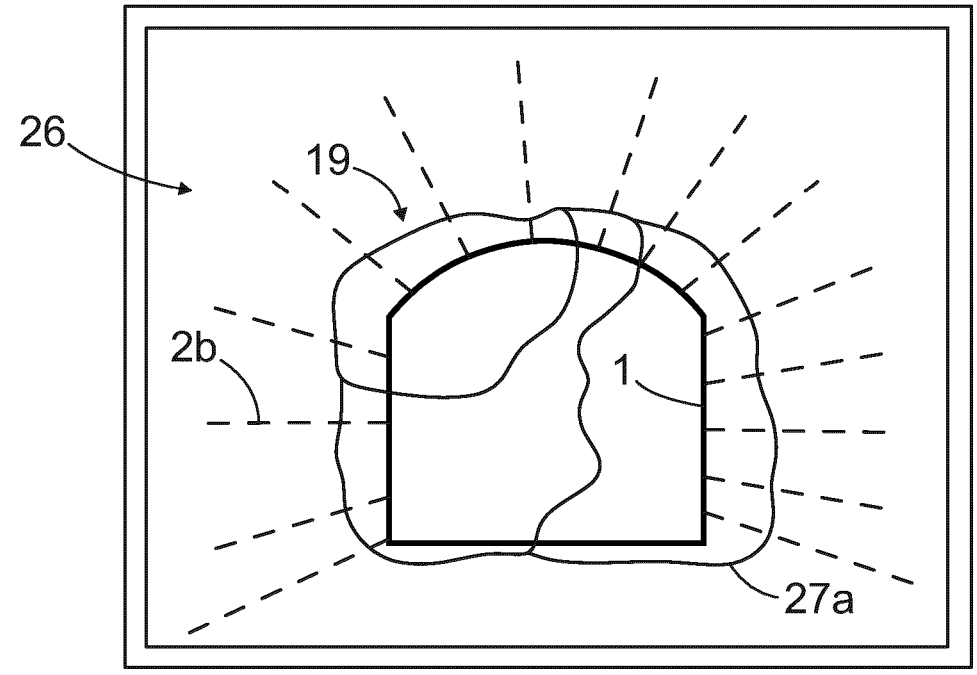

FIG. 8

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 21 19 2508

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 2014/206471 A1 (SANDVIK MINING & CONSTR OY [FI]) 31 December 2014 (2014-12-31) * figures 1-7 * * the whole document *	1-15	INV. E21B7/02 E21B47/00 E21D9/00
X	Sandvik: "iSURE TM software iSURE TM SOFTWARE DRILL AND BLAST INTELLIGENCE", , 31 December 2018 (2018-12-31), pages 1-16, XP055889477, Retrieved from the Internet: URL:https://www.rocktechnology.sandvik/en/news-and-media/news-archive/2019/10/sandvik-launches-updated-isure-8.0-underground-rock-excavation-software/ [retrieved on 2022-02-09] * pages 9,11 * * the whole document *	1-15	
X	Sandvik: "iSURE 8.1 SOFTWARE", , 12 March 2021 (2021-03-12), pages 1-22, XP055889470, Retrieved from the Internet: URL:https://www.rocktechnology.sandvik/en/products/underground-drill-rigs-and-bolters/underground-equipment-support/isure/ [retrieved on 2022-02-09] * the whole document *	1-15	TECHNICAL FIELDS SEARCHED (IPC) E21B E21D

1 The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	15 February 2022	van Berlo, André

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 21 19 2508

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
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

15-02-2022

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2014206471 A1	31-12-2014	AU 2013396723 A1	21-01-2016
		CA 2916148 A1	31-12-2014
		CN 105339579 A	17-02-2016
		EP 3014042 A1	04-05-2016
		US 2017037725 A1	09-02-2017
		WO 2014206471 A1	31-12-2014

EPO FORM P0459

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