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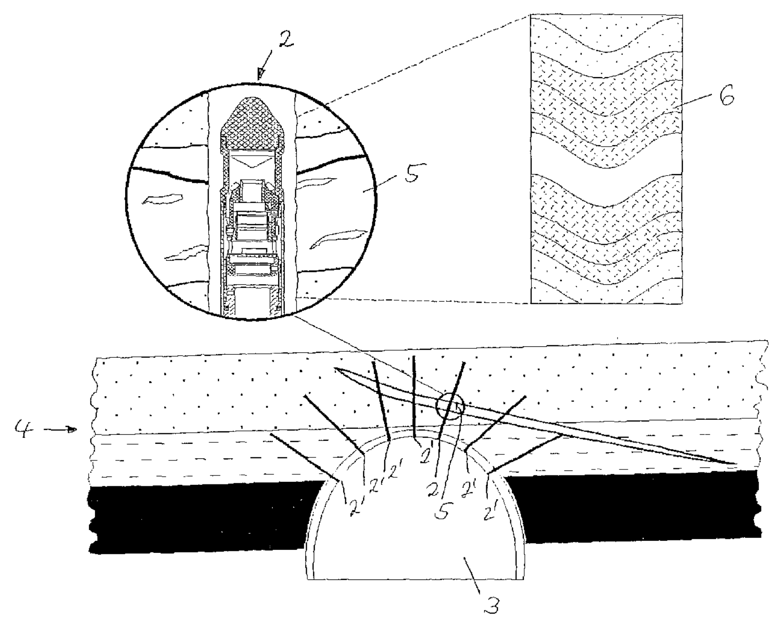
(54) Title: DEVICE FOR EXAMINING ROTOR DRILLED HOLES

(54) Bezeichnung: VORRICHTUNG ZUR UNTERSUCHUNG VON ANKERBOHRLÖCHERN



(57) Abstract: The invention relates to a device for examining rotor drilled holes, which comprises a probe which comprises an optical detection device and which can be displaced in the drilled hole by means of a push rod. The rotor drilled hole probe (1) comprises a video head (10), which comprises a colour CCD-sensor (11) with a lens (12) which is provided with a cone-shaped mirror (13) and an observation window, in addition to light-emitting diodes (15), a path sensor (20), an electronic part (21), a storage module (22) and battery part (23) whereon an infrared interface is arranged.

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Veröffentlicht:
— *mit internationalem Recherchenbericht*

Zur Erklärung der Zweibuchstaben-Codes und der anderen Abkürzungen wird auf die Erklärungen ("Guidance Notes on Codes and Abbreviations") am Anfang jeder regulären Ausgabe der PCT-Gazette verwiesen.

(57) Zusammenfassung: Vorrichtung zur Untersuchung von Ankerbohrlöchern, die aus einer mit einem Schubgestänge in dem Bohrloch verfahrbaren Sonde mit einer optischen Erfassungseinrichtung besteht, wobei die Ankerbohrlochsonde (1) aus einem Videokopf (10), der einen FarbCCD-Sensor (11) mit Objektiv (12) aufweist, das mit einem Kegelspiegel (13) und einem Sichtfenster sowie Leuchtdioden (15) versehen ist, einem Wegsensor (20), einem Elektronikteil (21), einem Speichermodul (22) und einem Batterieteil (23), an dem eine Infrarotschnittstelle angeordnet ist, besteht.

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Device for investigating anchor holes

The invention concerns a device for the investigation of anchor holes, which includes a probe with an optical detection unit, which can be moved in the borehole with a push rod.

US 5,663,559 describes a method and a device for producing an image of an earth formation with petroleum prospecting boreholes.

EP 0 658 253 B1 discloses a borehole observation instrument for investigation of the interior of a borehole or shaft for petroleum prospecting boreholes.

WO 94/07147 A1 concerns a method and a device for simultaneous video-based determination of the ground water direction of flow and speed for bore diameters greater than 2 inches.

The methods and devices disclosed in these publications are not suited for the investigation of anchor holes, because anchor holes are generally 1 to 2 inches in diameter.

From DE 199 25 733 C2 it is known that boreholes can be examined optically with an endoscope (borehole endoscopy).

In this endoscopy the wall of the borehole is visually inspected on-site; storage of the observation and a true spatial assignment of the mechanical microstructure data for rock is not possible.

According to the invention, there is provided a device for investigating anchor holes, comprising a probe with an optical recording unit which can be moved in a borehole with a push rod, wherein the anchor hole probe is wireless, being built as an independent probe, and comprises a video head which has a colour CCD sensor with a lens equipped with a cone-shaped mirror, a viewing window and LEDs, a travel sensor, an electronics component, a memory module and a battery section on which an infrared interface is arranged, and two position sensors are arranged in the electronics component.

Preferred embodiments of the invention provide a device which enables the borehole wall of anchor holes to be recorded optically and to analyse the information thus obtained in such a way that a safety-relevant evaluation of the geological condition and an objective documentation is maintained during the heading.

Preferably, the travel sensor comprises three wheels with spring bearings staggered by 120 degrees and one wheel has a motion sensor for determining the travel distance.

Preferably, the travel sensor is equipped with a motion sensor which records the probe movement immediately.

Preferably, the anchor hole probe is of explosion-proof construction.

The anchor hole probe according to the preferred embodiments of the invention, which is implemented as a wireless, i.e. independent, probe, is guided in the anchor holes and makes an optical digital recording of the surface of the borehole and saves it. This facilitates documentation of the wall of the borehole with which the true spatial situation of interfaces and layers can be determined by means of an evaluation program. The evaluation program enables convenient administration of the recorded data in a database, image processing and evaluation and interpretation of the borehole images.

For deployments in underground bituminous coal mining the anchor hole probe implemented in an explosion-proof manner.

The position measurement may be accomplished with the help of a contact wheel on which a motion sensor is arranged to determine the path. It is also feasible to record the motion of the probe directly with a motion sensor. This motion sensor may emit radiant energy onto the borehole wall, and reflections during the movement of the probe may be recorded, from which the path is determined.

In accordance with a preferred embodiment of the invention, integrated position sensors record the position of the probe in the borehole and saves it together with the image information. Determination of the true position of the interfaces may be accomplished by the evaluation program taking into account the probe space position data.

The saved digital map of the surface of the borehole wall may be used to reveal the structure and for analysis of lithologic and petrographic characteristics.

As part of this, the true spatial positions of the interfaces and their frequency distribution may be determined for determination of the seam bodies in the slope of a tunnel and/or in the ridge of a tunnel. The more frequent travel of the bore holes can result in an optimized, independent and objective comparative information regarding the loosening distribution and condition of the tunnel ridge.

Using the evaluation program and database, it may be possible to compare the data of older investigations with the newer investigation results so that changes in the opening widths can be determined. This timely recognition of loosening zones enables action to be taken at an early stage. This way, a safety evaluation of the geological condition is possible at any time. Furthermore, clarification of the geological characteristics is of great importance in the planning and optimization of the tunnel extension and particularly for anchor dimensioning. If difficulties occur during heading, a quick documentation of the anchor hole can take place.

Power supply of the anchor hole probe may be able to be handled with conventional Mignon batteries, with the images of the borehole wall being digitally recorded with a colour CCD sensor and saved in the probe. The memory is preferably sufficient for several measurements, so that the probe need not be read out after each measurement. The control and calibration of the anchor hole probe may be handled via a high speed infrared interface integrated in a battery portion together with a mobile PC. The recorded data may also be able to be read out via this infrared interface.

Recordings made with the anchor hole probe may be copied from the probe memory with a USB reader and imported by the software. Here, a wizard may support the entry of specific additional information for the respective measurement. Possibilities include supplementary comments for data on borehole length and diameter and the assignment to locations and boreholes perhaps already defined as part of earlier measurements.

Furthermore, comprehensive options for graphical processing of the digital image data recorded by the probe may be provided. Image options for the person doing the work include cropping, adjustment of the brightness, contrast, intensity and gamma value, sharpening, softening and smoothing. The images may be rotatable on their axes and aligned. In addition to that, there may be a cleanup function for eliminating measurement artefacts.

With the help of the software, enough data for the bored rock mass can be able to be determined from the borehole images. The determination of interface orientation may be a semi-automatic process by "picking" (clicking) and assignment to the respective types of structures recognizable in the image (such as seam, layer surface). The true spatial situation of the interfaces can also be able to be determined by the evaluation program by additional processing of spatial position data for the probe. A lithologic description of the corresponding depth sections is likewise possible.

Thus, as part of the evaluation, the recognition of rock may take place and the definition of the limits and determination of the extent and degree of loosening zones. All data may be archived in the database for documentation and for repeat measurements.

The structures may be marked both in the image of the borehole wall and visually represented as a surface in various 3-D views. In this process, first 2-D forms may be produced for individual measurement cross-sections of the tunnel based on the borehole endoscopy; furthermore, the software may permit a 3-D representation of the boreholes (location in the tunnel/segment/boring insufficiency with interface microstructure).

With the image data and information for the borehole which are archived and managed in the database (location, spatial position, dimensions, tunnel profile, etc.) a comparison may be possible between current measurement data and data from earlier measurements or data of boreholes nearby. This may enable the determination of the type, extent, and period of occurrence of weak zones in the tunnel.

A preferred embodiment of the anchor hole probe comprises a wireless, independent optical probe with a diameter of 23 mm. This can be suitable for digital recording of the borehole wall of boreholes with a diameter of 25 to 37 mm. Due to its small diameter and low weight, the probe can simply be inserted manually in the borehole using extension rods.

The borehole probe according to a preferred embodiment of the invention comprises a video head, travel sensor, electronics component, memory module and battery section which also contains an infrared interface. Monitoring of the investigations is facilitated by data transmission.

Image recording can be controlled by the travel sensor, which may provide depth measurement in addition to recording control and thus the possibility of exact measurement of structures, such as the interface spacing and RQD index determination, fissure opening width determination, layer thickness, etc.

The true spatial situation of the interface microstructure can be able to be determined by the position sensor values.

The present invention will now be described, by way of non-limiting example only, with reference to the accompanying drawings, in which:

Figure 1 is a schematic representation of the method for determination of the rock mass structure in the surrounding rock of the drift;

Figure 2 is a cross section through the video head;

Figure 3 is an overall representation of the anchor hole probe;

Figure 4 is a schematic representation of the travel sensor; and

Figure 5 is a schematic representation of the video head in a borehole.

An anchor hole was investigated with a probe having the following specifications.

Power supply:	5 x Duracel MN 1500, 1.5 V
Memory:	256 MB
Probe length:	1,300 mm
Probe diameter:	23 mm
Probe weight:	2.2 kg
Sensor:	colour CCD
Measurement rate:	25 images per second
Measurement speed:	Max. 5 cm per second
Illumination:	8 white LEDs
Depth measurement:	wheel-controlled travel sensor

The probe was moved in the borehole using a push rod. The bars built into each coupling ensure good control of the orientation of the probe in the borehole. The anchor hole probe scans an angle of 360 degrees, i.e. it records the entire borehole. In the two-dimensional map of the surface of the borehole wall, which corresponds to a cylinder surface, the borehole wall is shown in an unrolled projection. This causes planar structures, such as layer surfaces, seams, etc.), which are not exactly perpendicular to the axis of the borehole to appear as sinusoidal lines in this view. With the help of the probe study, the true spatial situation and frequency of the was able to be recorded and displayed.

Figure 1 shows a schematic representation of the method for investigation of anchor holes to determine the rock mass structure in the surrounding rock of the drift. An anchor hole probe 1 is run into an anchor hole 2 using a push rod. In a tunnel 3 there are further anchor holes 2' arranged. This enables the structure of the rock mass 4 to be analysed by means of the anchor hole probe. The anchor hole probe 1 is located in the anchor hole 2 in the area of a fissure 5. Using the video head, a two-dimensional map 6 of the surface of the borehole wall is digital recorded.

In Figure 2 it can be seen that a video head 10 has a colour CCD sensor 11 which is arranged with a lens 12. Using a cone-shaped mirror 13, an optical digital recording of the borehole wall, which is illuminated by the LEDs 15, can be made through the viewing window 14. There is a plug connection 16 arranged at the bottom of the video head 10.

Figure 3 shows the anchor hole probe 1. It is made up of the video head 10, the travel sensor 20, an electronic component 21, a memory module 22 and a battery section 23, which also contains an infrared interface 24. There are two position sensors 25 and 26 arranged in the electronics component. The individual components of the anchor hole probe 1 are connected to each other by plug connections 16.

Figure 4 shows that the travel sensor 20 consists of three wheels 30, 30' and 30" on spring bearings, which are staggered 120 degrees with respect to each other. The wheel 30 has a motion sensor 31 to determine the travel of the anchor hole probe 1.

For reasons of space, the movement of the wheel 30 is transferred to toothed gears 32 and recorded by the motion sensor 31.

Figure 5 shows the video head 10 of the anchor hole probe 1 in the anchor hole 2. The remaining reference indicators have the same meaning as in Figure 2. The LEDs 15 produce a cone of light 35 to illuminate the borehole wall of the anchor hole 2. In the area of the beams 36 an optical digital recording of the borehole wall of the anchor hole 2 is made using the colour CCD sensor 11 dependent on the travel. This map of the borehole wall is saved using the evaluation program and investigated semi-automatically with menus. In this way the structure of the rock mass 4 is determined.

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Many modifications will be apparent to those skilled in the art without departing from the scope of the present invention.

Throughout this specification and the claims which follow, unless the context requires otherwise, the word "comprise", and variations such as "comprises" and "comprising", will be understood to imply the inclusion of a stated integer or step or group of integers or steps but not the exclusion of any other integer or step or group of integers or steps.

The reference in this specification to any prior publication (or information derived from it), or to any matter which is known, is not, and should not be taken as an acknowledgment or admission or any form of suggestion that that prior publication (or information derived from it) or known matter forms part of the common general knowledge in the field of endeavour to which this specification relates.

Drawing reference list

1	Anchor hole probe
2	Anchor hole
2′	Anchor hole
3	Tunnel
4	Rock mass
5	Fissure
6	Two-dimensional map
10	Video head
11	Colour CCD sensor
12	Lens
13	Cone-shaped mirror
14	Viewing window
15	LED
16	Plug connection
20	Travel sensor
21	Electronics component
22	Memory module
23	Battery section
24	Infrared interface
25	Position sensor
26	Position sensor
30	Wheel
30'	Wheel
30"	Wheel
31	Motion sensor
32	Toothed gears
35	Cone of light
36	Beams

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THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. A device for investigating anchor holes, comprising a probe with an optical recording unit which can be moved in a borehole with a push rod, wherein the anchor hole probe is wireless, being built as an independent probe, and comprises a video head which has a colour CCD sensor with a lens equipped with a cone-shaped mirror, a viewing window and LEDs, a travel sensor, an electronics component, a memory module and a battery section on which an infrared interface is arranged, and two position sensors are arranged in the electronics component.

2. A device according to claim 1, wherein the travel sensor comprises three wheels with spring bearings staggered by 120 degrees and the wheel has a motion sensor for determining the travel distance.

3. A device according to claim 1 or claim 2, wherein the travel sensor is equipped with a motion sensor which records the probe movement immediately.

4. A device according to any one of the preceding claims, wherein the anchor hole probe is of explosion-proof construction.

5. A device for investigating anchor holes, substantially as hereinbefore described with reference to the accompanying drawings and/or Examples.

Figure 1

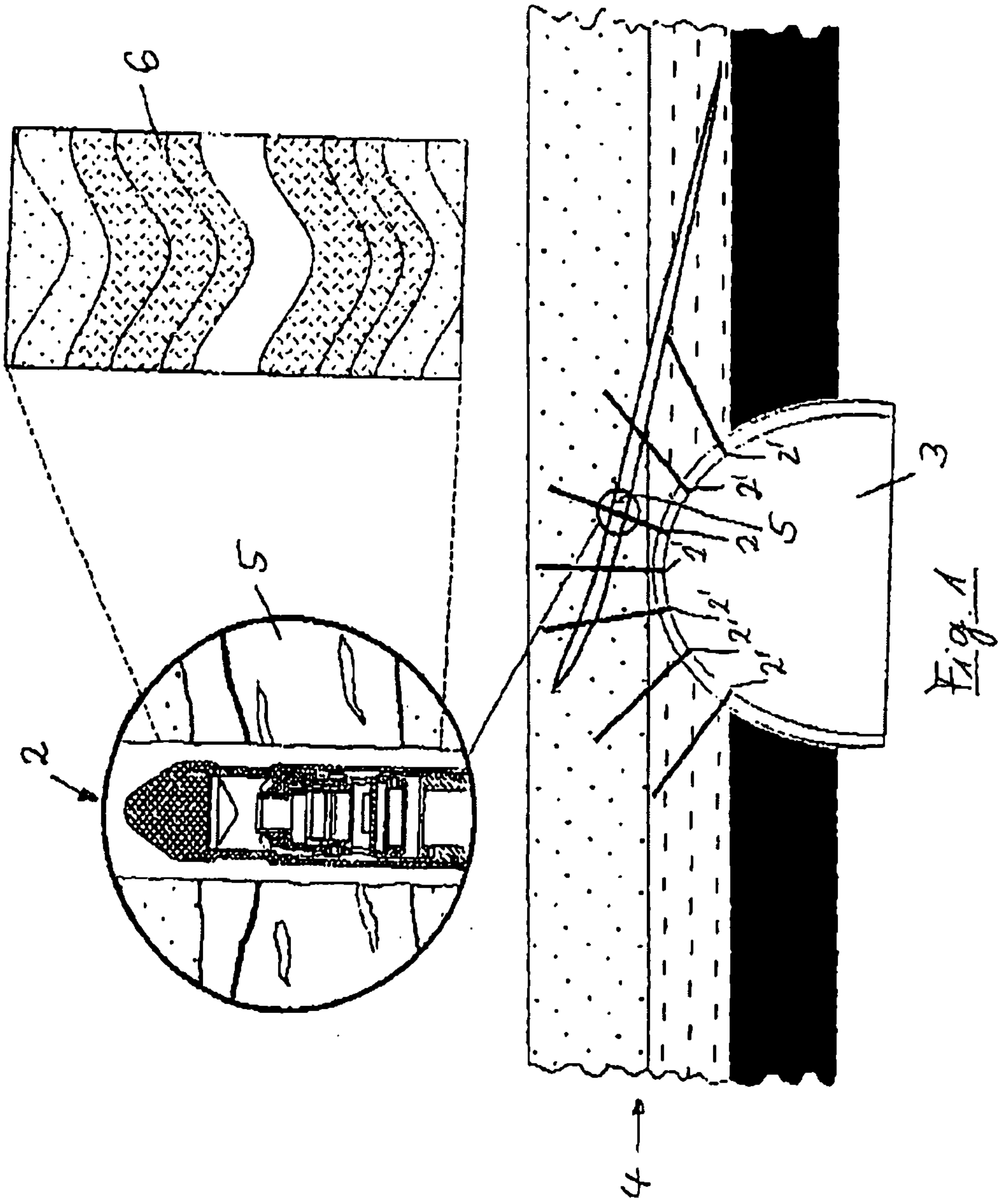

Figure 2

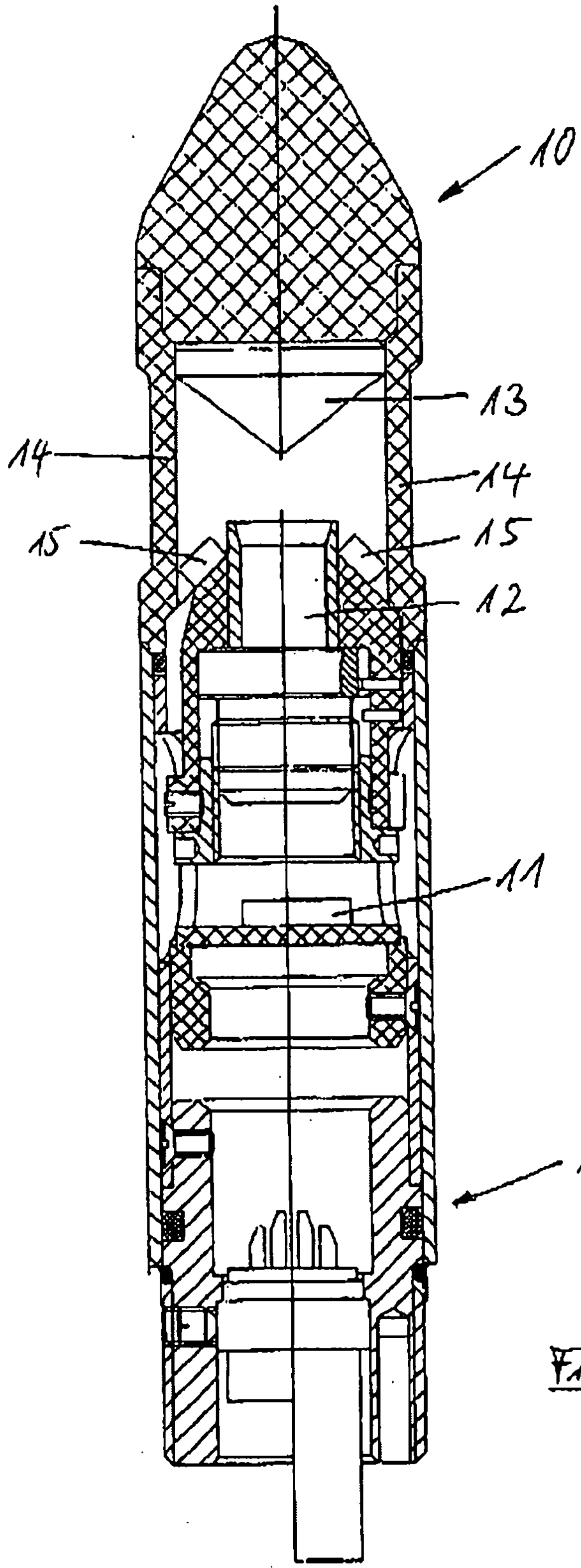

Fig. 2

Figure 3

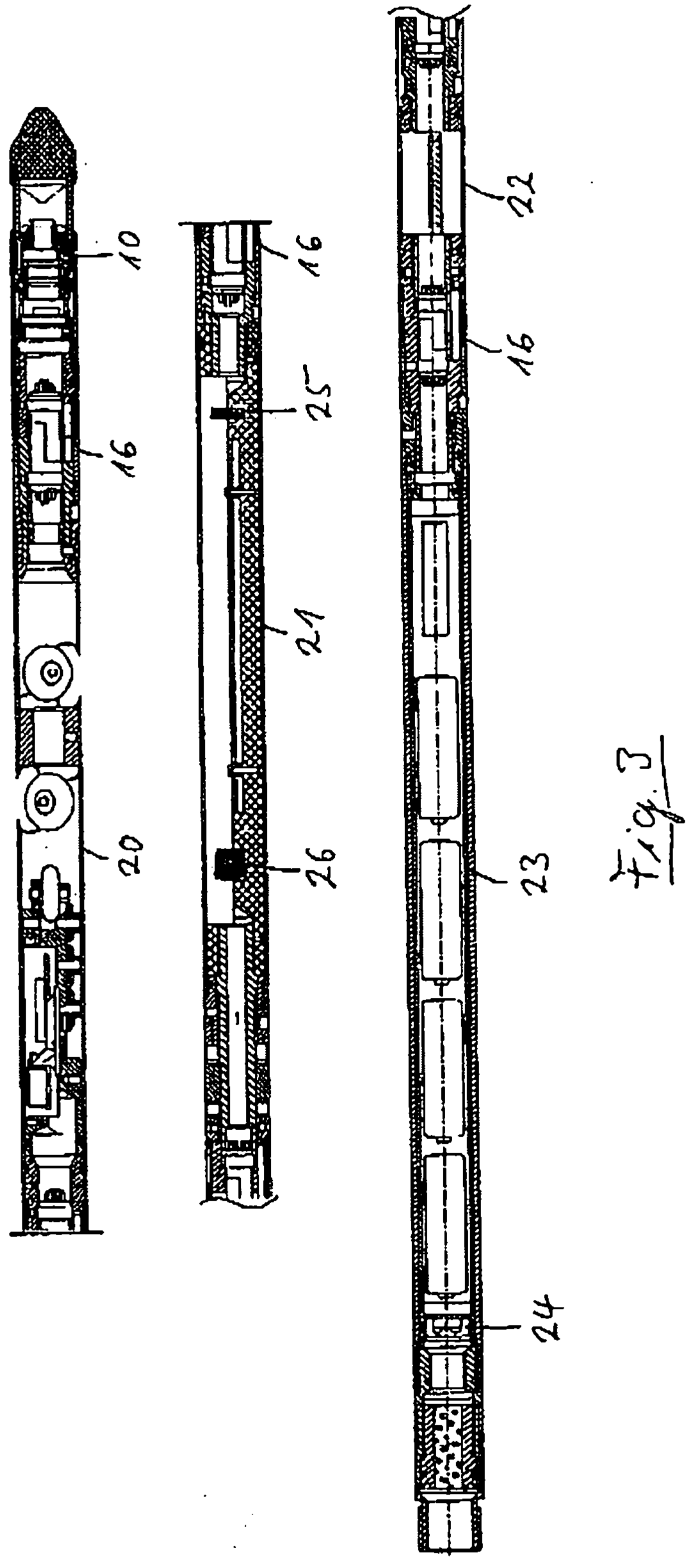

Figure 4

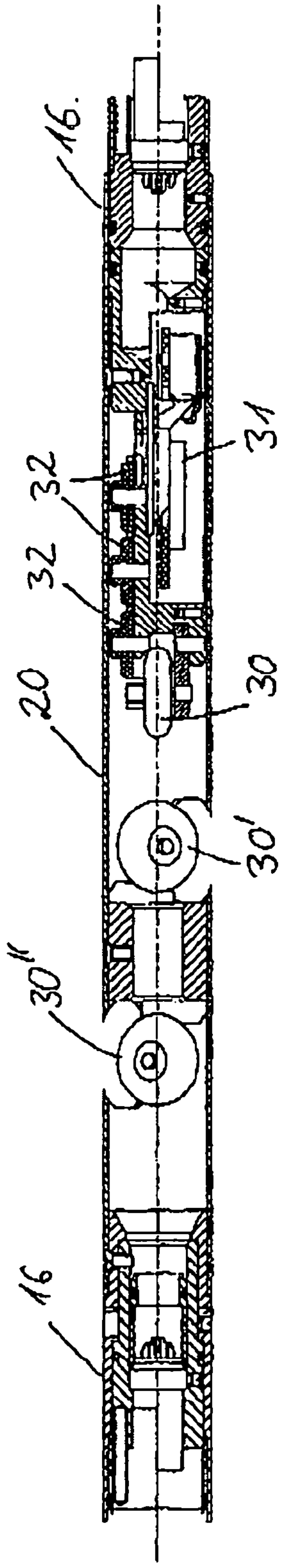

Fig. 4

Figure 5

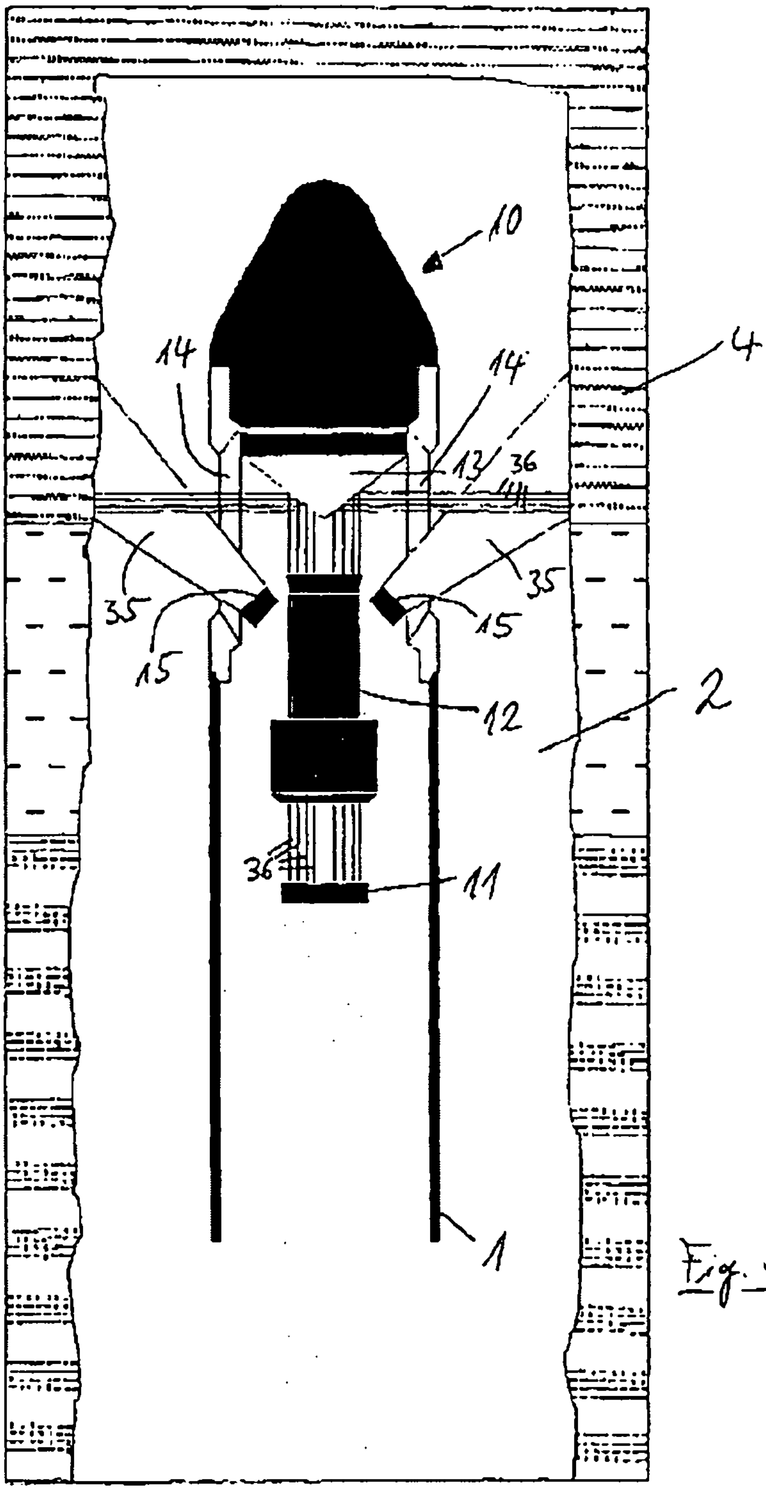

Fig. 5