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(54) **An arrangement for orientating a guide device when drilling curved holes in rock.**

(57) When drilling curved drill holes, there is used a drill bit whose axis of rotation forms an angle with the centre axis of a guide tube (1) carrying the drill bit. The orientation of the plane passing through the axis of rotation of the drill bit and the centre axis of the guide tube is determined by means of an arrangement in which a magnet (9) is mounted inside the guide tube (1) and arranged to co-act with a first sensing means (26, 27) which is driven by a motor (20) aroung a housing (11) inserted in the guide tube, and which produces a first position signal each time it passes the magnet. Located in the housing (11) is a chamber (29) having arranged therein an electrically conductive liquid (30) and a second sensing means (28). The second sensing means (28) is driven round by the motor (20), and each time the sensing means is brought into contact with the liquid in the chamber it gives rise to a second position signal. The time difference between the first and second signals determines the inclination of the aforementioned plane relative to the vertical.

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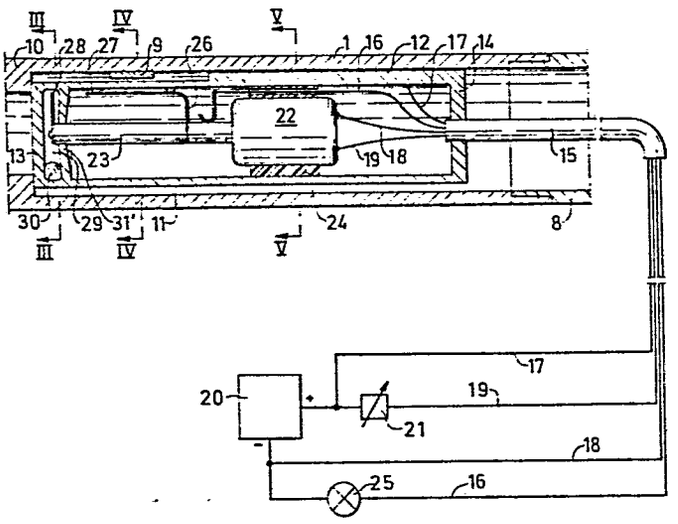
Fig. 2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An arrangement for orientating a guide device when drilling curved holes in rock.

The invention relates to an arrangement for use when drilling curved holes by means of a drill bit which is rotatable relative to a guide tube and the axis of rotation of which forms an angle with the centre axis of the guide tube, said arrangement being intended for determining the position of the plane passing through said axis of rotation and said centre axis.

Various devices for correcting deviations from perfectly straight holes with a high degree of accuracy are known to the art, and reference can be made in this respect, by way of example to the device according to Swedish Patent Specification No 78 02488-2 which device enables corrections to be made with particular accuracy. In order for these corrections to be made, it is necessary to know the orientation of the guide tube and the drill bit in the hole.

The manner in which the guide device must be orientated in a drill hole in order to make the necessary correction to said hole can, in principle, be determined in two ways. In accordance with one very precise method, commonly used today, the drill hole is studied with a drill-hole camera, as proposed in Swedish Patent Specification No 73 04122-0. Alternatively, a series of marked tubes are connected together externally of the drill hole and then used to position the guide device in said hole.

The first method is both time consuming and relatively complicated, but can be applied with drill holes of any depth. The second method is limited to holes of moderate depth, because it is not possible to estimate the torsion in which the assembled tubes are subjected over longer distances, or the different conditions prevailing in different drill holes.

Consequently, a prime object of the present invention is to provide an arrangement with which the orientation of the plane passing through the axis of rotation of the drill bit and through the centre axis of the guide tube can be readily determined in a simple and positive fasion, thereby to enable the guide device,

i.e.the guide tube and the drill bit, to be set to the necessary position for the curved correcting hole to be drilled correctly.

This object is realized fully by means of the invention set forth in the following claims and hereinafter described with reference to the accompanying drawings, in which

Figur 1 illustrates, by way of example a known guide device,
Figure 2 is an axial sectional view of part of the guide tube shown in Figur 1 and illustrates an exemplary embodiment of the invention,
Figure 3 is a radial sectional view taken on the line III-III in Figure 2,
Figure 4 is a radial sectional view taken on the line IV-IV in Figure 2,
Figure 5 is a radial sectional view taken on the line V-V in Figure 2,
Figure 6 illustrates a modified embodiment of a sensor, and
Figure 7 illustrates a further variant of the sensor.

Figure 1 illustrates an embodiment of a guide device according to Swedish Patent Specification No 78 02488-2, although the invention can be applied with any type of guide device, whatsoever, which is intended for drilling crooked holes, for example a device according to US Patent Specification No 2 631 820.

The guide device illustrated in Figure 1 includes a straight guide tube 1 and a drive shaft 2. The shaft is non-rotatably connected at one end thereof, through a spline coupling (not shown), to a spindle 3 which is mounted for rotation on the end of the guide tube 1 and arranged to co-act with an axial bearing 4. Non-rotatably connected to the spindle is a drill bit 5. The axis of rotation 6 of the drill bit 5 forms an angle α with the centre axis 7 of the guide tube 1, and the plane through the axis of rotation 6 and the centre axis 7 must be orientated relative to the plane of the deflection of the drilled, crooked hole, in order to enable said hole to be corrected to the intended drilling line. Thus, when a curved hole is to be drilled in a given plane

of curvature, the plane through the axes 6 and 7 must be orientated so as to coincide with the intended plane of curvature, which applies both to the case when wishing to correct a hole which deviates from a given drilling line and when wishing to drill a totally crooked or curved hole intentionally.

Figure 2 illustrates a much simplified embodiment of the invention for determining the plane passing through the axes 6 and 7 in which the guide tube 1 and the drill bit 5 lie in a drill hole. The drive shaft 2 has been withdrawn from the guide tube. Arranged on the inside of the guide tube 1 is a magnet 9, and the tube 1, is in turn, connected to one or more liner tubes 8, which similar to the guide tube, is or are also held against rotation during a drillingoperation. The magnet 9 may be an electro-magnet or, as with the illustrated embodiment a permanent magnet. As shown in Figures 1 and 2, the magnet 9 lies above an abutment 10. A metal housing 11, which in the illustrated embodiment is of cylindrical configuration is provided with slide bars 12 (Figure 5), for positioning the housing centrally within the cylindrical guide tube 1. The housing 11 has a bottom wall 13 and an upper cover means 14, and is preferably water tight. Extending through the cover means is an electric cable 15, which in the illustrated embodiment contains four electric conductors 16,17,18 and 19. The cable 15 passes out through the end of the upper liner tube. Conductors 18 and 19 are connected to a voltage source 20 having a central means 21, and to an electric motor 22 having an output shaft 23. The motor 22 is held firmly clamped to the inner cylindrical wall of the housing 11 by means of a sleeve 24 made of an insulating material. The conductor 16 is drawn through the wall of the sleeve 24 and connected electrically to the metallic shaft 23 of the motor 22 and to one terminal or pole of an indicator lamp 25, the other pole or terminal of which is connected to conductor 18, and thus to one terminal or pole, of the voltage source 20. The shaft 23 carries an L-shaped, narrow resilient strip of magnetic material, the one leg 26 of which is connected at one end to the shaft 23 and is in electrically conductive contact therewith, while the other leg 27 of said strip extends

parallel with and, when not actuated, at a distance from the inner, cylindrical wall of the housing 11. An arm 28 made from an electrically conductive material is fixedly mounted on the free end of the shaft 23, said free end extending into a preferably liquid-tight chamber 29 in which the arm 28 is arranged to rotate together with the shaft 23. Present in the cylindrical chamber 29 is a small amount of mercury 30, or some other electrically conductive liquid. When the centre axis of the guide tube deviates slightly from the vertical, this small amount of liquid 30 will collect at the lowest point of the chamber 29 and, in doing so, will define a vertical plane through the motor shaft 23, which lies coaxially with the guide tube. It is assumed hereinafter that the centre of the magnet 9 and the centre of the liquid 30 each lie in a plane which intersects the longitudinal geometric axis of the shaft 23, as shown in Figures 3 and 4. When the arrangement is inserted into a curved drill hole together with the guide device illustrated in Figure 1, and the obliquely positioned drill bit is intended to change the direction of the hole in a given plane, the drillingplane of the guide tube and the drill bit through the axes 6 and 7 will be randomly orientated. When the motor is started, the speed of which is regulated through the central means 21, to a given number of revolutions per unit of time, for example one full turn in 72 seconds, corresponding to a rotation of 5^{o} per second, the two sensors 27 and 28 which rotate synchronously with one another will commence this sensing movements. When the sensor 27 is opposite the magnet 9, or enters the magnetic field generated thereby the sensor is drawn against the inner surface of the housing 11 and makes an electric circuit from one pole of the voltage source 20, through the conductor 17 to the housing 11, through the sensor 27 to the shaft 23, and through the conductor 16, through the lamp 25, to the other pole of the voltage source 20. The lamp 25 is thus illuminated, the length of time over which the lamp remains illuminated is determined by the circumferential length of the magnet 9, i.e. by the length of time which the sensor 27 is held attracted to the inner, electrically conductive wall of the housing 11. When the sensor

27 leaves the active region of the magnet 9, the indicating lamp 25 is extinguished, and the second sensor 28, which is angularly displaced relative the first sensor 26,27, will subsequently enter the liquid 30. When contact is made between the sensor 28 and the electrically conductive liquid, which as beforementioned is preferably mercury, a circuit is made from the voltage source 20, through the conductor 17 to the electrically conductive housing 11, the liquid 30, the sensor 28, the shaft 23, the conductor 16, through the lamp 25 and to the other pole or terminal of the voltage source 20. The lamp 25 is thus illuminated and the length of time over which the lamp remains lit-up is determined, in addition to the speed at which the shaft 23 rotates by the length of the arm 28 and the width of the arm at that part of the end thereof which contacts the liquid. The period over which the lamp is illuminated in this case, however, is preferably selected so as to be of shorter duration than the period of illumination caused by the arm 27. When the speed at which the shaft 23 rotates is known, the extent to which the plane through the axes 6 and 7 deviate from the desired plane of curvature can be readily determined by measuring the time between illumination of the lamp caused by arm 27 and that caused by arm 28, using a time-taking clock for example, whereupon a correction can be made by rotating the liner tubes fixedly connected to the guide tube until the measurements show that the plane is orientated in the manner intended. If it is wished to obtain a mean value of the alignment error, two or more magnets can be placed at mutually different angular distances from a vertical plane, and the rotational direction of the motor 22 reversed. Although it is said in the aforegoing that the whole of the housing 11 is electrically conductive, it will be understood that, for example, a metal plate can be arranged adjacent the leg 27 for contact with said leg when it is attracted by the magnet 9. In this case the conductor 17 is connected to the metal plate. The chamber 30 must be provided with a metallic wall in contact with the liquid 30, the conductor 17 also being connected to said wall. The conductor 16 is connected to the shaft 23 through a slide contact or the like.

The aforedescribed arrangement can be modified in various ways, without departing from the concept of the invention. Thus, the sensor 26,27 can be replaced with a reed relay 31, Figure 6, carried on the shaft 23 by means of an arm (not shown). When the relay 31 approaches the magnet 9, the contacts of the relay are closed, if the circuit to the indicator lamp 25 is made. One important advantage afforded by this arrangement is that the risk of the contact surfaces oxidizing can be ignored. The chamber 29 is preferably kept completely isolated from the remainder of the housing, by mounting sealing rings or like elements between the inner wall 31' of the chamber and the shaft 23. Instead of the indicator lamp 25 there can be used a writing instrument which records the time difference between the signals received, or a calculator which gives directly angular deviations between the desired plane of curvature and the plane through the axes 6 and 7.

It is also possible to arrange a speed differential between the output shaft 23 of the motor and the sensors, in order to move said sensors at a given speed. In this case it is unnecessary for the sensors to move at precisely the same speed, as presumed in the described and illustrated embodiment. As will be understood, it is only necessary for the two sensors to be moved at known speeds, in order to carry out the final calculations.

In the aforegoing it has been assumed that the sensor 26,27 and the sensor 28 are arranged to make a respective electric circuit when passing the magnet 9 or when coming into contact with the liquid 30. It will be understood, however, that the sensors may also be arranged to break a circuit, such that a broken circuit causes the indicator lamp to be illuminated. An example of a modified sensor 26,27 for breaking a circuit when co-acting with the magnet 9 is illustrated in Figure 7. In this modified embodiment the flexible, magnetisable leg 27 of the sensor co-acts with a contact element (not referenced) which is fixedly mounted on an arm (not shown) on the shaft 23 and which this accompanies the movement of the leg 27. When the leg 27 enters the magnetic field of the magnet 9, it is drawn away from the contact 32 and breaks the connection between the conductors 16 and 17. The signal is noted or registered either by the lamp being extinguished or graphically on a record sheet. So that voltages is also supplied to the liquid 30, the conductor 16 is also connected to the housing 11.

C L A I M S

1. An arrangement for use when drilling curved holes by means of a drill bit (5), which is rotatable relative to a guide tube (1) and the axis of rotation (6) of which forms an angle (α) with the centre axis (7) of the guide tube, said arrangement being intended for determining the plane passing through said axis of rotation (6) and said centre axis (7), characterized by at least one magnet (9) mounted on the inside of the guide tube (1) in a predetermined position relative to said plane; a housing (11) which can be inserted into the guide tube (1) and in which there is arranged an electric motor (20) having an output shaft (23) for driving a first magnetically operable sensor (26,27) in a rotary path within the housing (11) and around said shaft (23), said first sensor being so arranged that when located opposite the magnet (9) it activates a first signal-indicating circuit (16,17,23,25,26,27) and drives a second, electrically conductive sensor (28) which is angularly displaced in the direction of rotation of said axis relative the first sensor, said second sensor being arranged to be moved along a rotary path by said shaft (23) at a predetermined speed relative the first sensor (26,27) and being located in a chamber (29) containing an electrically conductive liquid (30) arranged to collect in the lowest peripheral part of said chamber (29), the arrangement being such that when said second sensor (28) is in contact with said liquid (30) it activates, together with said liquid a second signal indicating circuit (16,17,23,28,29,25).

2. Apparatus as claimed in claim 1, characterized in that the electrically conductive liquid (30) is mercury.

3. Apparatus as claimed in claim 1 or claim 2, characterized by control means (21) for controlling the speed of the motor (20)

4. Apparatus as claimed in claims 1-3, characterized in that the first sensor is fixedly mounted on the output shaft (23) of the motor (20) and comprises an arm (27) made of a flexible magnetic

material and extending parallel with the inner cylindrical surface of the housing wall, said arm being arranged to co-act with an electrically conductive contact element (11) and in that the second sensor (28) comprises an electrically conductive arm projecting from the shaft (23).

5. Apparatus as claimed in any one of claims 1-4, characterized in that said magnet (9) is a permanent magnet.

6. Apparatus as claimed in any one of claims 1-5, characterized in that the housing (11) is cylindrical and provided with outer guide means (12) for centering the housing (11) in the guide tube (1).

Fig. 1

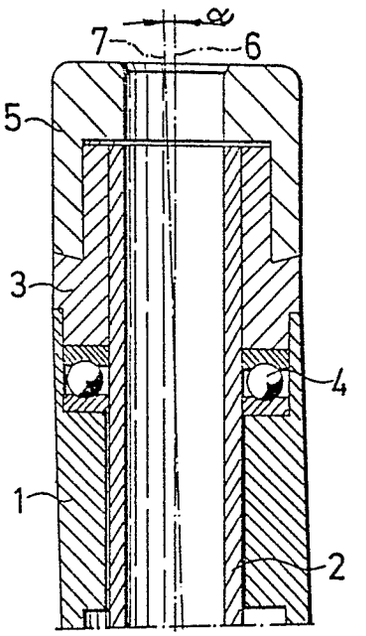
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Fig. 2

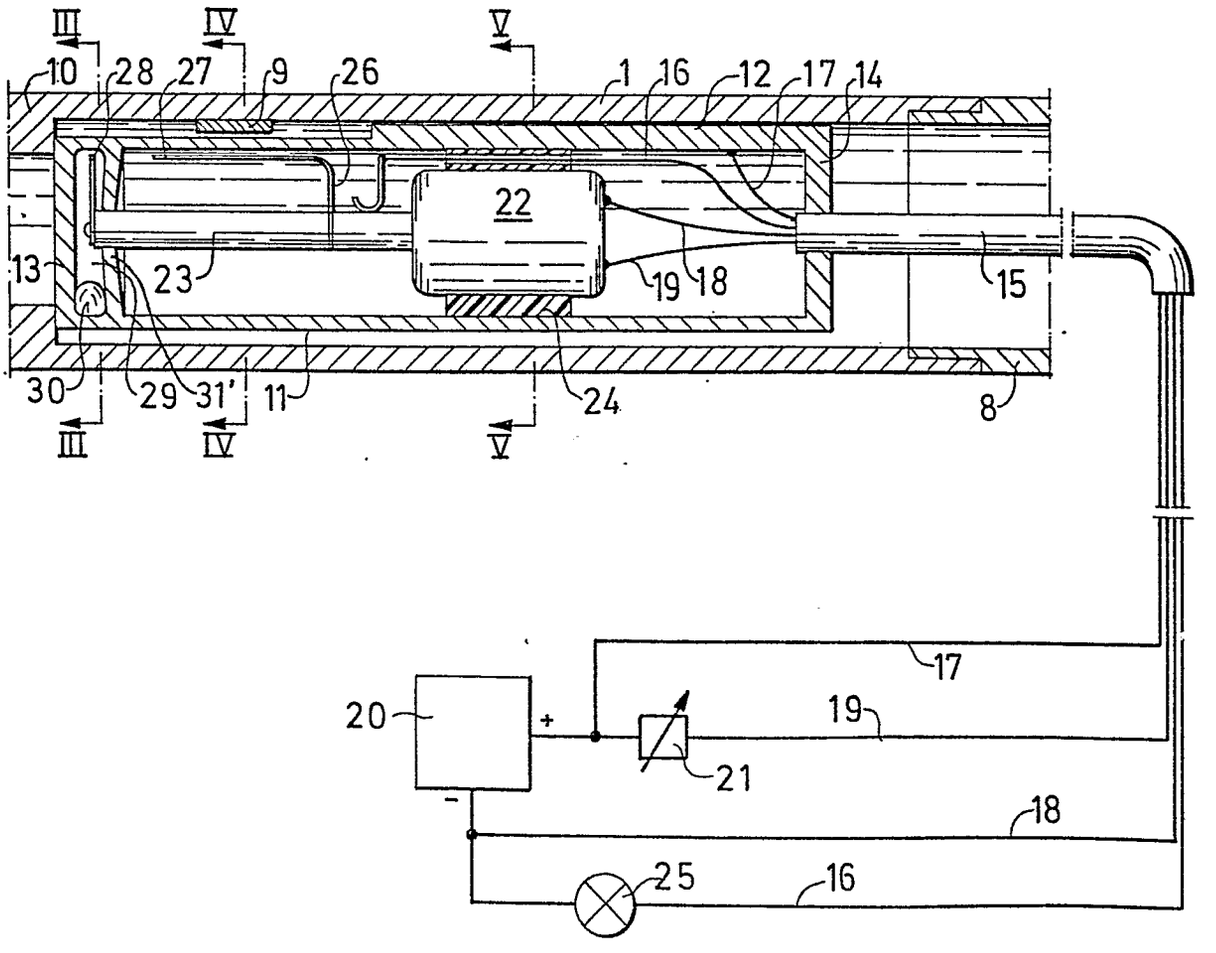
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Fig_3

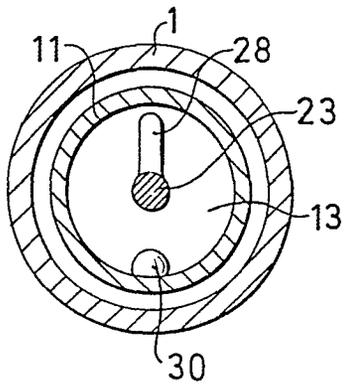


Fig_4

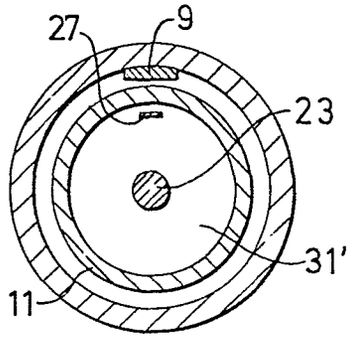


Fig_5

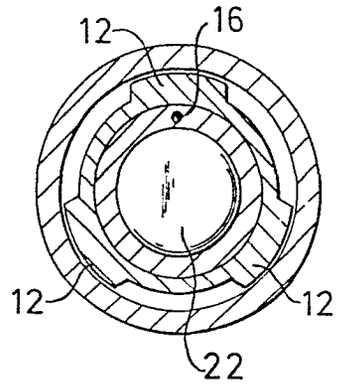


Fig_6

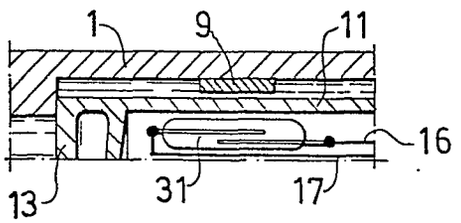
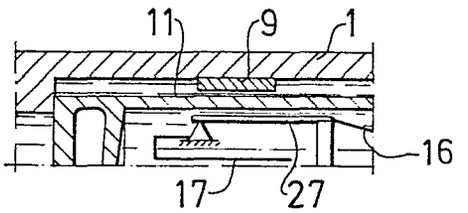


Fig_7



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EUROPEAN SEARCH REPORT

0086926
Application number

EP 82 85 0034

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. ³)
A	DE-C- 871 733 (O. MARTIENSSEN) * the whole document *	1	E 21 B 47/024 E 21 B 7/04
A	US-A-2 303 360 (E.M. IRWIN et al.) * page 3, column 1, line 50 to page 5, column 1, line 25; figures 4-7 *	1	
A	US-A-2 255 721 (H.W. MATTINGLY et al.) * page 2, column 2, line 22 to page 3, column 2, line 24; figures 4-6 *	1	
A	FR-A-1 593 371 (FORAMINES)		
A	US-A-4 040 189 (L.J.B. LACOSTE)		TECHNICAL FIELDS SEARCHED (Int. Cl. ³) E 21 B
A	US-A-3 997 008 (J.M. KELLNER)		
A	US-A-2 425 319 (D. HERING)		

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	28-06-1982	JAUNEZ X.

CATEGORY OF CITED DOCUMENTS

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