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(54) CONNECTOR ARRANGEMENT, DRILLING ARRANGEMENT AND METHOD FOR HIGH VOLTAGE ELECTRO PULSE DRILLING

(57) A connector arrangement, drilling arrangement and method for high voltage electro pulse drilling of rock. The connector arrangement (Ca) comprises a high voltage joint (Cj) for connecting high voltage conductors (7, 7a, 7b) and being surrounded by a ground conductor (9). There are flushing channels (11) between the joint and the ground conductor for allowing passage of flushing fluid (F).

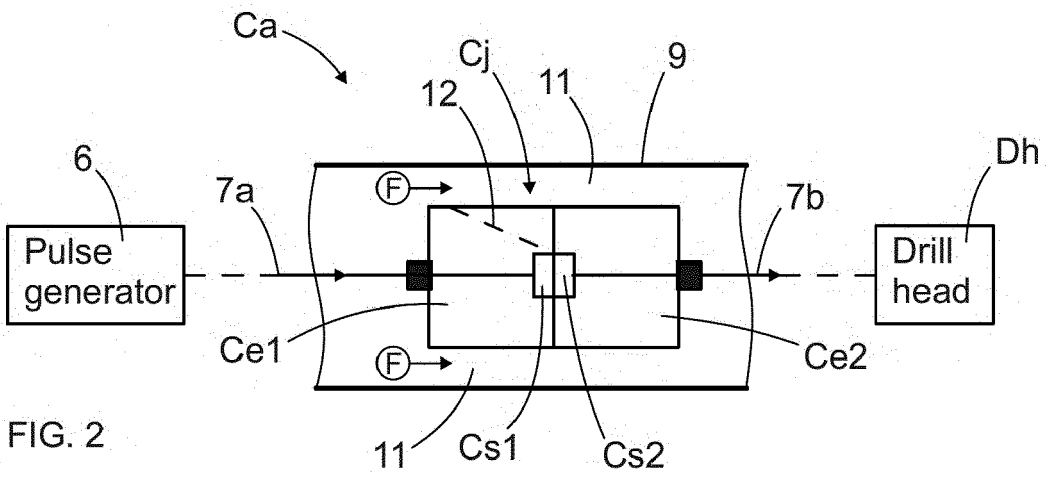

FIG. 2

EP 4 112 868 A1

Description

Background of the invention

[0001] The invention relates to a connector arrangement for an electro pulse rock drilling wherein drill holes are formed by means of high-voltage electro pulses conveyed through rock material.

[0002] The invention further relates to a drilling arrangement and method for a high voltage electro pulse rock drilling.

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

[0004] In mines and at other work sites different type of rock drilling systems are used for drilling drill holes to rock surfaces. Conventionally the drill holes are drilled by means of mechanical drilling systems utilizing rotation of drill bits which mechanically break and remove rock material. The systems may also implement impacts for improving the mechanical rock removal. In addition to the mechanical drilling, different type of electrical drilling methods has been developed. One of them is a high voltage electro pulse rock drilling wherein the drill holes are formed by means of high voltage electro pulses conveyed through the rock material to be drilled. However, the known solutions for the high voltage electro pulse rock drilling have shown some disadvantages especially when they are implemented in practice at work sites.

Brief description of the invention

[0005] An object of the invention is to provide a novel and improved connector arrangement, drilling arrangement and method for a high voltage electro pulse rock drilling.

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

[0007] The drilling arrangement according to the invention is characterized by the characterizing features of the second independent apparatus claim.

[0008] The method according to the invention is characterized by the characterizing features of the independent method claim.

[0009] An idea of the disclosed solution is that a high voltage electro pulse supply line is provided with one or more high voltage conductor joints made of dielectric material and provided with electrical connecting surfaces between successive high voltage conductors which are connected to each other. The high voltage conductor joint is surrounded by a tubular ground conductor made of metallic material. Further, between the high voltage conductor joint and the mentioned tubular ground conductor is at least one flushing fluid channel whereby flushing fluid flow can pass the high voltage joint. In other words, there is a kind of coaxial electro pulse lead system with joints and flushing fluid flow possibility.

[0010] An advantage of the disclosed solution is that the disclosed high voltage conductor joint allows the pulse generator, which initially generates the pulses, to be at a long distance from the drill head because the cable or other conductors can be extended. Efficient rock drilling requires efficient flushing of removed rock material. Since the joint comprises channels or paths for the flushing fluid flow, the joint does not jeopardize the flushing. In other words, the disclosed solution allows long drill holes to be drilled in an effective manner.

[0011] Further, the high voltage electro pulse rock drilling has several general advantages compared to the conventional mechanical drilling. In the electro pulse drilling the rock is destroyed without a need for significant mechanical forces, which drastically reduces wear on the drilling tool and increases service life of all drilling components. Due to achieved high energy efficiency and shorter drilling time overall price of the drilling process can be decreased.

[0012] According to an embodiment, the disclosed solution is needed because a pulse generator generating the high voltage electro pulses is located outside the drill hole wherefore there is a long distance between the pulse generator and a drill head. The distance is usually several meters and one or more connector arrangements are needed in the high voltage supply line. When the pulse generator is located outside the drill hole, more powerful pulse generators can be implemented, and their service is easier. The solution allows also more free and versatile design options for the drilling arrangement and the entire system.

[0013] According to an embodiment, the drilling tube may be an extension drill tube or a flexible drill tube, for example.

[0014] According to an embodiment, the disclosed solution is designed and utilized for boreholes with relatively small diameter. The diameter of the borehole may be 4 inches i.e. 101.6 mm.

[0015] According to an embodiment, the high voltage conductor joint comprises at least one centering element supported against inner surfaces of the ground conductor so that the electrical connecting surfaces of the high voltage conductor joint are centered on a central axis of the ground conductor. An advantage of the centering is that connecting the conductor elements is facilitated when the joint is centered on the central axis of the drill tube. This is the case especially when automated drilling tool handling apparatuses are implemented. A further advantage is that when the joint is centered inside a small diameter drilling tool, risks of electric breakdowns may be decreased because distance from the electrical connecting elements of the joint to the inner surface of the drilling tool is as great as possible.

[0016] According to an embodiment, the ground conductor is a drill tube. In other words, the high voltage conductor joint is located inside a drill tube which is part of a drilling tool. The joint may be located at a joint area between two drill tubes or at a distal end of the drill tube or a drill tube arrangement comprising several drill tubes.

[0017] According to an embodiment, components of the high voltage joint may protrude axially from the ends of the drill tubes intended to be connected. The components and their joining principles may be designed so that the connection can be made automatically by means of a manipulator or robotic arm, for example.

[0018] According to an embodiment, the ground conductor may alternatively be an intermediate joint element mountable between opposing ends of two successive drill tubes. In other words, the arrangement may comprise a dedicated tube element mountable to the drill tubes.

[0019] According to an embodiment, there may be a slide connection, friction connection, screw connection, threaded connection, bayonet connection or quick coupling connection between the two connectable components of the high voltage joint.

[0020] According to an embodiment, the high voltage electro pulses can be led to a drill head by means of high voltage cables or other conductors. Thereby, the supply line may comprise bendable cables or may alternatively be formed of rigid bars or other elongated elements, for example. Further, the conductors, cables or bars may be supported to drill tubes and be part of their structure.

[0021] According to an embodiment, the mentioned high voltage pulses has at least 100 kV value of voltage. In tests it has been shown that this 100 kV is the minimum where rock destruction occurs properly and in effective manner.

[0022] According to an embodiment, the mentioned high voltage pulses are generated in a Marx generator which may generate pulses voltage of which may be up to 450 kV.

[0023] According to an embodiment, the flushing fluid is fed inside the one or more drill tubes to the drill head.

[0024] According to an embodiment, the flushing fluid is fed outside the one or more drill tubes to the drill head and is fed in reverse direction inside the drill tube. This is known as a reverse circulation drilling (RC-drilling), and the disclosed solution can also be implemented in the RC-drilling.

[0025] According to an embodiment, the high voltage conductor joint comprises at least one centering element which is an inseparable structural part of the high voltage conductor joint. In other words, the centering element is integrated to the elements or components of the joint.

[0026] According to an embodiment, the joint comprises two compatible sockets both comprising integrated centering elements.

[0027] According to an embodiment, the connector arrangement may comprise two or even more high voltage conductor joints surrounded by at least one tubular ground conductor and comprising the at lest one flushing channel in accordance with the present solution.

[0028] According to an embodiment, the joint comprises alternatively one or more separate centering elements.

[0029] According to an embodiment, the joint arrangement may comprise one or more additional centering elements adjacent the high voltage joint in order to center high voltage cables or other connectors on both sides of the joint and to thereby facilitate the joining.

[0030] According to an embodiment, the joint comprises one or more axial grooves on its outer periphery facing towards an inner periphery of the ground conductor. Then the axial grooves may serve as the flushing fluid channels. When the joint comprises one or more centering elements, then the grooves may be on the centering elements.

[0031] According to an embodiment, the centering element may comprise, alternatively or in addition to the above mentioned grooves, one or more axial through openings serving as the flushing fluid channels.

[0032] According to an embodiment, the high voltage conductor joint comprises at least one fluid channel between its outer surface and the connecting surfaces whereby the connecting surfaces are allowed to be surrounded by the flushing fluid.

[0033] According to an embodiment, the flushing fluid flowing to a space surrounding the connection surfaces has improved electrical insulation properties compared to different gases, wherefore it is advantageous that the flushing fluid flows therein, removes possible gas, and ensures that there is no gas surrounding the connection surfaces.

[0034] According to an embodiment, length of the mentioned at least one fluid channel may be selected so great that risks of electric breakdown through this flushing fluid path are minimized. The channel can be located between connected elements of the joint wherefore shapes of mating surfaces of the connected elements may be dimensioned to have extra length. In order to shorten overall dimensions but to keep the flushing fluid path long, a maze-like structure may also be implemented.

[0035] According to an embodiment, the flushing fluid is water or water solution.

[0036] According to an embodiment, the high voltage conductor joint comprises an elongated male element made of dielectric material and comprising a first contact surface at a first end part, an elongated female element made of dielectric material and comprising an axial connecting space for receiving the male element at least partly and wherein a bottom of the axial connecting space is provided with a second contact surface compatible to be connected to the mentioned first contact surface. The joint may further comprise centering elements integrated on outer surfaces of both the male element and the female element.

[0037] According to an embodiment, axial lengths of the male element and the female element are multiple in relation to an inner diameter of the tubular ground conductor. When the above mentioned fluid channel is formed between the long-shaped male and female elements, then path length can also be long and electric breakdowns through the flushing fluid can be prevented.

[0038] According to an embodiment, the solution re-

lates to a drilling arrangement for high voltage electro pulse rock drilling. The drilling arrangement comprises: a drilling tool comprising at least one drill tube and a drill head connected to a distal end of the drill tube; a feed device for feeding the drilling tool in a drilling direction and in a return direction; a flushing device for feeding flushing fluid to the drill head; a pulse generator for generating high voltage electrical pulses; first conductors for conducting the generated high voltage electrical pulses to at least one high voltage electrode which is located on a face surface of the drill head, and second conductors for providing a ground potential for at least one ground electrode which is located on the face surface of the drill head; and wherein high voltage electrical pulses are transmitted from the high voltage electrode to the ground electrode via the rock material thereby breaking the rock material. Further, the mentioned second conductor comprises the at least one drill tube which is configured to serve as a ground conductor; and wherein the mentioned first conductor comprises a high voltage supply cable arrangement inside the at least one drill tube and is provided with at least a first high voltage cable or conductor and a second high voltage cable or conductor which are connected to each other by means of a connector arrangement which is in accordance with the features and embodiments disclosed in this document. In other words, the first and second conductors are located between the pulse generator and the drill head. Thus, there is a relatively long distance between the pulse generator and the drill head.

[0039] According to an embodiment, the pulse generator is located outside the drilled hole.

[0040] According to an embodiment, the pulse generator is mounted onboard a carrier or vehicle movable on a surface of the ground.

[0041] According to an embodiment, the disclosed solution relates to a method for electro pulse drilling of rock. The solution comprises: generating high voltage electrical pulses by means of at least one pulse generator; executing the drilling by means of a drilling tool comprising at least one drill tube and a drill head connected to a distal end of the drill tube; feeding the drilling tool in a drilling direction during the drilling; feeding flushing fluid inside the at least one drill tube to the drill head for flushing removed rock material; conducting the generated high voltage electrical pulses to at least one high voltage electrode on the drill head; providing ground potential for at least one ground electrode on the drill head; and breaking the rock by transmitting the high voltage electrical pulses from the high voltage electrode to the ground electrode via the rock material. The method further comprises generating the high voltage electrical pulses outside a drill hole to be drilled; providing the ground potential via at least one metallic drill tube; and conducting the generated high voltage electrical pulses inside the at least one drill tube by means of at least two high voltage supply cables or conductors and a high voltage conductor joint between the cables. Flow of the flushing fluid is allowed to pass the high voltage conductor joint.

[0042] According to an embodiment, the method comprises using liquiform flushing fluid. Further, opposite electrical connecting surfaces of the high voltage conductor joint are flushed by means of the liquiform flushing fluid for removing gas molecules.

[0043] According to an embodiment, the method comprises arranging the high voltage conductor joint at a mechanical joint located between two successive drill tubes. Then the high voltage conductor joint and the mechanical joint are joined simultaneously when adding drill tubes to the drilling tool.

[0044] According to an embodiment, the method comprises allowing distance between the pulse generator and the drill head to be several meters during the drilling.

[0045] According to an embodiment, the disclosed solution is designed for drilling small diameter drill holes being one of the following: blast holes, exploration holes, rock bolt holes, injection holes.

[0046] 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

[0047] Some embodiments are described in more detail in the accompanying drawings, in which

Figure 1 is a schematic side view of a rock drilling arrangement intended for high voltage electro pulse drilling,

Figure 2 is a schematic side view of a conductor arrangement comprising a joint mounted to a high voltage supply line and surrounded by a tubular ground conductor,

Figure 3 is a schematic side view of a conductor arrangement comprising a dedicated tubular piece around a high voltage conductor joint,

Figure 4 is a schematic diagram presenting some alternative ways to implement a high voltage conductor joint,

Figure 5 is a schematic side view of a conductor arrangement comprising a centering element,

Figures 6 is schematic side view of a conductor arrangement at a joint area of two successive drill tubes, and

Figures 7a - 7e are some schematic views of fluid openings of the conductor arrangement seen in axial direction.

[0048] 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

[0049] Figure 1 discloses a drilling arrangement 1 pro-

vided with a drilling tool D comprising at least one drill tube Dt and a drill head Dh connected to a distal end of the drilling tool D. The drilling tube Dt may comprise one single rigid tubular element, or several rigid extension tubes connected to each other by means of joints Dj. One alternative is that the drill tube is a flexible tube that can be wound on a reel and can be straightened when being fed inside a drill hole 5. Length of the drilling tool D may be several meters. There may or may not be a rotating device 2 for rotating at least the drill head Dh around a rotation axis during drilling. The rotating device 2 may be top mounted and may turn the entire drilling tool D, or alternatively it may be of in the hole (ITH) type device and may be arranged to turn only the drill head Dh. A feed device 3 is arranged to feed the drilling tool D in a drilling direction and in a return direction. A flushing device 4 is for feeding flushing fluid to the drill head Dh so that drilling cuttings can be removed from the drill hole 5. The drilling is based on high voltage electrical pulses which are generated in a pulse generator 6 and transmitted by means of a high voltage supply system to the drill head Dh which is located at a bottom of the drill hole 5. There are high voltage conductors 7, such as cables, for conducting the generated high voltage electrical pulses to at least one high voltage electrode 8 which is located on a face surface of the drill head Dh, and ground conductors 9 for providing a ground potential for at least one ground electrode 10 which is also located on the face surface of the drill head Dh. The generated high voltage electrical pulses are transmitted from the high voltage electrode 8 to the ground electrode 10 via the rock material thereby breaking the rock material. The drill tubes Dt are made of metallic material and they may serve as the ground conductor 9. During the drilling process flows flushing fluid inside the drilling tube Dt. Depending on the implemented drilling method, the flushing fluid flows inside the drill tube Dt either towards the bottom of the drill hole 5 or towards an opening of the drill hole 5.

[0050] The drilling tool D may comprise several connector arrangements Ca for coupling the successive high voltage conductors 7 such as cables to each other. The connector arrangements Ca are in accordance with the features and embodiments disclosed in this document. The connector arrangements Ca may be located at the joint areas Dj between the drill tubes Dj and also at an end of the drilling tool D which is closest to the pulse generator 6. The connector arrangements Ca are needed especially when an extension drilling is implemented and there is a need to connect several extension tubes for drilling long drill holes, and a need to disconnect the drill tubes when the drill hole is finished. As can be noted, the pulse generator 6 is located outside the drill hole 5.

[0051] Figure 2 discloses a conductor arrangement Ca comprising a high voltage conductor joint Cj made of dielectric material and provided with electrical connecting surfaces Cs1, Cs2 between two high voltage conductors 7a, 7b being connected. The joint Cj may comprises two matching connecting elements Ce1, Ce2. The elements may be of a socket and plug type elements, for example. The high voltage conductor joint Cj is surrounded by a tubular ground conductor 9 made of metallic material. The tubular ground conductor 9 may serve as a path for flow of a flushing fluid F. The joint Cj is so arranged, dimensioned, designed or formed that the flow of the flushing fluid F is not hampered. Therefore, there is one or more flushing fluid channels 11 between the joint Cj and the ground conductor 9.

[0052] Figure 2 further discloses that the high voltage conductor joint Cj may comprise one or more fluid channels 12 for leading the flushing fluid F to the connecting surfaces Cs1, Cs2 so that possible air is pushed away from there by means of water serving as the flushing fluid F. Alternatively or in addition to, mating surfaces of the elements Ce1 and Ce2 can be provided with small channels for providing the flushing for the joint Cj.

[0053] Figure 3 discloses a conductor arrangement Ca which differs from the one shown in the previous Figure 2 in that a ground conductor 9 is a separate intermediate joint element 13 mountable between opposing ends of two successive drill tubes Dt.

[0054] Figure 4 discloses some alternative implementations for the disclosed high voltage joint Cj. Features disclosed in Figure 4 are discussed already above in this document.

[0055] Figure 5 discloses a conductor arrangement Ca wherein a high voltage conductor joint Cj is supported inside a drill tube Dt by means of one or more centering element 14. The centering element 14 keeps the joint Cj on a central axis of the drill tube Dt whereby coupling of the joint Cj is facilitated. The centering is also beneficial in that respect that distance 15 from electrical connecting surfaces Cs1, Cs2 to an inner surface of the metallic drill tube Dt is as great as possible. The centering element 14 may comprise openings 16 or grooves 17 for allowing passage of flow of flushing fluid F.

[0056] Figure 5 further discloses that the joint Cj comprises an elongated male element Ce1 made of dielectric material and comprising a first contact surface Cs1 at a first end part. The joint Cj further comprises an elongated female element Ce2 also made of dielectric material and comprising an axial connecting space for receiving the male element Ce1 at least partly and wherein a bottom of the axial connecting space is provided with a second contact surface Cs2 compatible to be connected to the mentioned first contact surface Cs1. Between mating surfaces of the elements Ce1 and Ce2 may a relatively long path or channel 12 for providing the surfaces Cs1 and Cs2 with flushing fluid F in order to flush air or gas away. As can be seen, the female and male elements Ce1 and Ce2 may be relatively long in axial direction which allows formation of the long flushing path. The long flushing path is advantageous for preventing electric breakdowns through the channel 12 as has been disclosed above in this document.

[0057] Figure 6 discloses a conductor arrangement Ca wherein a high voltage conductor joint Cj is supported at

an area of a drill tube joint Dj wherein two successive drill tubes Dt are connected to each other mechanically, such as by means of connecting screws. The high voltage joint Cj may comprise matching male and female elements Ce1, Ce2 and may comprise the features disclosed above in connection with Figure 5. Between outer surface of the elements Ce1, Ce2 and inner surfaces of the ground conductor 9, in this case the drill tube Dt, is one or more flushing channels 11. Cross-sectional shapes of the elements Ce1, Ce2 may comprise shapes disclosed in Figures 7a and 7b, for example. Alternatively, or in addition to, there may be openings, grooves or other type of channels for allowing flow of flushing fluid F to pass the joint Cj.

[0058] Figure 7a discloses a substantially triangularly shaped connector element Ce arranged inside a ground conductor 9. Figure 7b discloses a substantially square shaped connector element Ce arranged inside a ground conductor 9. In both cases there remains flushing fluid channels 11 for the passage of flushing fluid.

[0059] Figure 7c discloses bar-like centering elements 14 between which are flushing channels 11. Figure 7d discloses a centering element 14 provided with several openings 16, and Figure 7e discloses a centering element 14 with several grooves 17.

[0060] 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. A connector arrangement (Ca) for electro pulse rock drilling wherein drill holes (5) are formed by means of high-voltage electro pulses conveyed through rock material;
   wherein the arrangement comprises:

   at least one high voltage conductor joint (Cj) made of dielectric material and provided with electrical connecting surfaces (Csl, Cs2) between two high voltage conductors (7, 7a, 7b) being connected;
   characterized in that
   the high voltage conductor joint (Cj) is surrounded by at least one tubular ground conductor (9) made of metallic material;
   and between the high voltage conductor joint (Cj) and the tubular ground conductor (9) is at least one flushing fluid channel (11) allowing thereby flushing fluid (F) passing the high voltage conductor joint (Cj).

2. The connector arrangement as claimed in claim 1, **characterized in that**
   the high voltage conductor joint (Cj) comprises at least one centering element (14) supported against inner surfaces of the ground conductor (9) so that the electrical connecting surfaces (Csl, Cs2) of the high voltage conductor joint (Cj) are centered on a central axis of the ground conductor (9).

3. The connector arrangement as claimed in claim 1 or 2, **characterized in that**
   the ground conductor (9) is a drill tube (Dt).

4. The connector arrangement as claimed in claim 1 or 2, **characterized in that**
   the ground conductor (9) is an intermediate joint element (13) mountable between opposing ends of two successive drill tubes (Dt).

5. The connector arrangement as claimed in any one of the preceding claims 2 - 4, **characterized in that** the at least one centering element (14) is an inseparable structural part of the high voltage conductor joint (Cj).

6. The connector arrangement as claimed in any one of the preceding claims 1 - 5, **characterized in that** the high voltage conductor joint (Cj) comprises at least one axial groove on its outer periphery facing towards an inner periphery of the ground conductor (9), whereby the at least one axial groove is serving as the at least one flushing fluid channel (11).

7. The connector arrangement as claimed in any one of the claims 1 - 6, **characterized in that**
   the high voltage conductor joint (Cj) comprises at least one fluid channel (12) between its outer surface and the connecting surfaces (Csl, Cs2) whereby the connecting surfaces (Csl, Cs2) are allowed to be surrounded by the flushing fluid (F).

8. The connector arrangement as claimed in any one of the preceding claims 1 - 7, **characterized in that** the high voltage conductor joint (Cj) comprises:

   an elongated male element (Ce1) made of dielectric material and comprising a first contact surface (Cs1) at a first end part;
   an elongated female element (Ce2) made of dielectric material and comprising an axial connecting space for receiving the male element (Ce1) at least partly and wherein a bottom of the axial connecting space is provided with a second contact surface (Cs2) compatible to be connected to the mentioned first contact surface (Cs1); and
   the centering elements (14) are integrated on outer surfaces of both the male element (Ce1) and the female element (Ce2).

9. A drilling arrangement for high voltage electro pulse rock drilling,

wherein the arrangement comprises:

a drilling tool (D) comprising at least one drill tube (Dt) and a drill head (Dh) connected to a distal end of the drill tube (Dt);
a feed device (3) for feeding the drilling tool (D) in a drilling direction and in a return direction;
a flushing device (4) for feeding flushing fluid (F) to the drill head (Dh);
a pulse generator (6) for generating high voltage electrical pulses;
first conductors (7) for conducting the generated high voltage electrical pulses to at least one high voltage electrode (8) which is located on a face surface of the drill head (Dh), and second conductors (9) for providing a ground potential for at least one ground electrode (10) which is located on the face surface of the drill head (Dh); and wherein high voltage electrical pulses are transmitted from the high voltage electrode (8) to the ground electrode (10) via the rock material thereby breaking the rock material;
characterized in that
the mentioned second conductor (9) comprises the at least one drill tube (Dt) which is configured to serve as a ground conductor;
the mentioned first conductor (7) comprises a high voltage supply conductor arrangement inside the at least one drill tube (Dt) and is provided with at least a first high voltage conductor (7a) and a second high voltage conductor (7b) which are connected to each other by means of a connector arrangement (Ca);
and wherein the connector arrangement (Ca) is in accordance with any one of the previous claims 1 - 8.

10. The drilling arrangement as claimed in claim 9, **characterized in that**
the pulse generator (6) is located outside the drilled hole (5).

11. A method for electro pulse drilling of rock, wherein the method comprises:

generating high voltage electrical pulses by means of at least one pulse generator (6);
executing the drilling by means of a drilling tool (D) comprising at least one drill tube (Dt) and a drill head (Dh) connected to a distal end of the drill tube (Dt);
feeding the drilling tool (D) in a drilling direction during the drilling;
feeding flushing fluid (F) to the drill head (Dh) for flushing removed rock material;
conducting the generated high voltage electrical pulses to at least one high voltage electrode (8) on the drill head (Dh);
providing ground potential for at least one ground electrode (10) on the drill head (Dh); and
breaking the rock by transmitting the high voltage electrical pulses from the high voltage electrode (8) to the ground electrode (10) via the rock material;
characterized by
generating the high voltage electrical pulses outside a drill hole (5) to be drilled;
providing the ground potential via at least one metallic drill tube (Dt);
conducting the generated high voltage electrical pulses inside the at least one drill tube (Dt) by means of at least two high voltage supply conductors (7, 7a, 7b) and a high voltage conductor joint (Cj) between the conductors; and
allowing flow of the flushing fluid (F) to pass the high voltage conductor joint (Cj).

12. The method as claimed in claim 11, **characterized by**
using liquiform flushing fluid (F); and
flushing opposite electrical connecting surfaces (Csl, Cs2) of the high voltage conductor joint (Cj) by means of the liquiform flushing fluid (F) for removing gas molecules.

13. The method as claimed in claim 11 or 12, **characterized by**
arranging the high voltage conductor joint (Cj) at a mechanical joint (Dj) located between two successive drill tubes (Dt); and
joining the high voltage conductor joint (Cj) and the mechanical joint (Dj) simultaneously when adding drill tubes (Dt) to the drilling tool (D).

14. The method as claimed in any one of the preceding claims 11 - 13, **characterized by**
allowing distance between the pulse generator (6) and the drill head (Dh) to be several meters during the drilling.

15. The method as claimed in any one of the preceding claims 11 - 14, **characterized by**
drilling a small diameter drill hole (5) being one of the following: blast hole, exploration hole, rock bolt hole, injection hole.

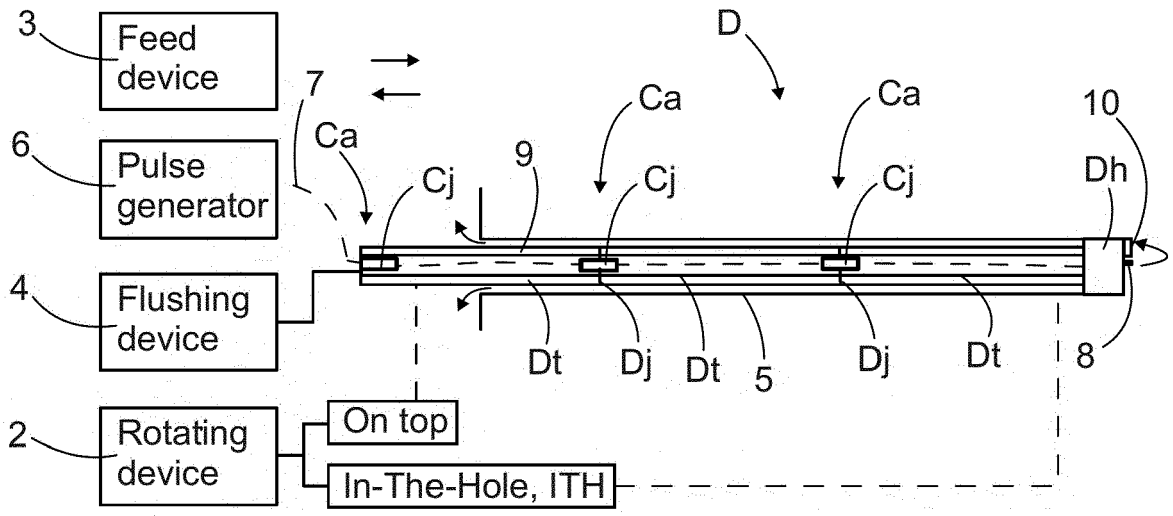

FIG. 1

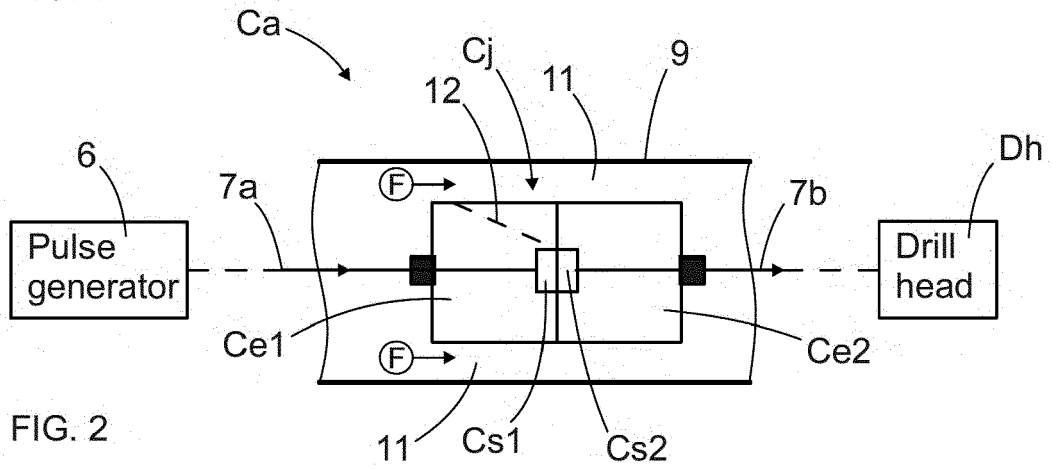

FIG. 2

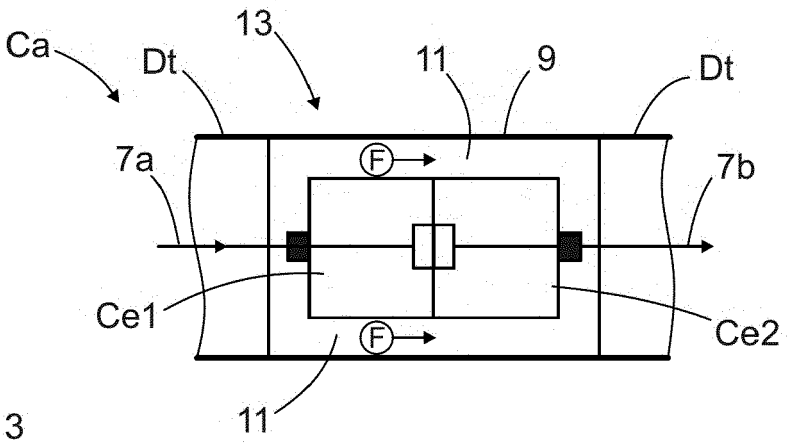

FIG. 3

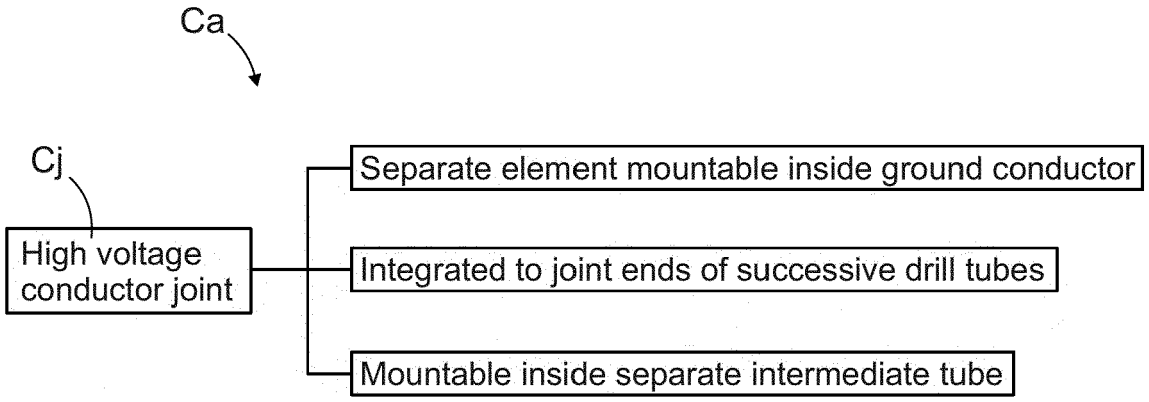

FIG. 4

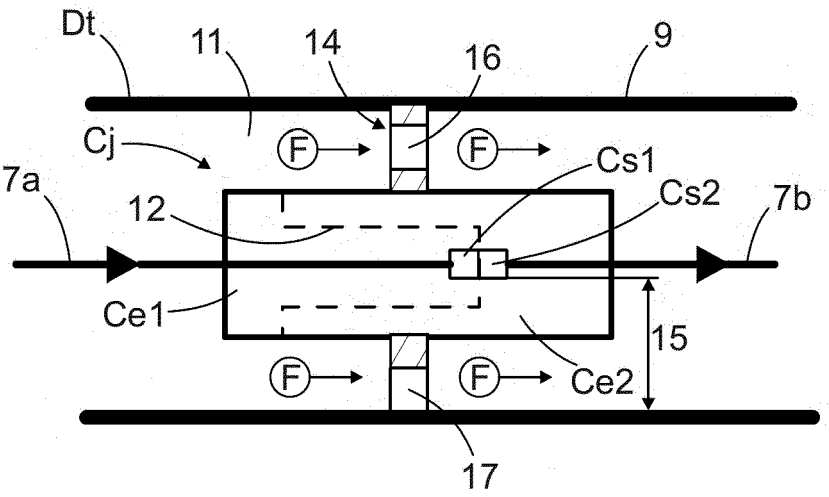

FIG. 5

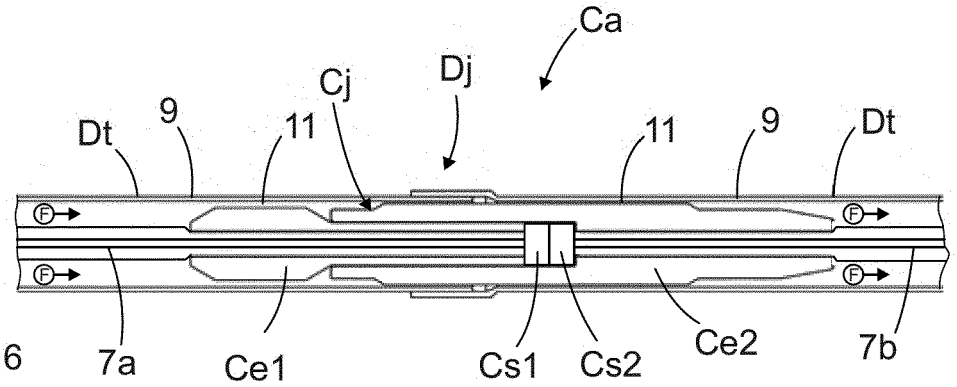

FIG. 6

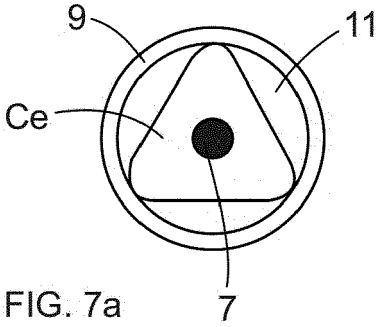

FIG. 7a

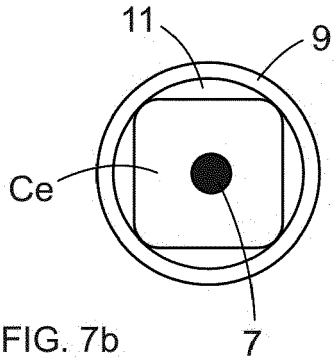

FIG. 7b

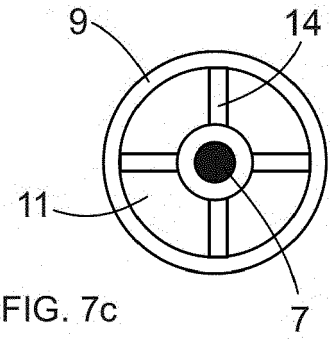

FIG. 7c

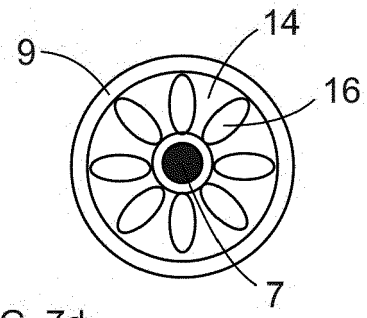

FIG. 7d

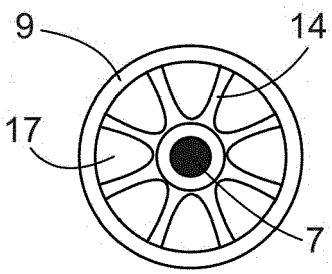

FIG. 7e

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EUROPEAN SEARCH REPORT

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