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(54) **WELLBORE REAMING TOOL**

BOHRWERKZEUG

OUTIL DE FORAGE

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Description

[0001] The object of the invention is a drilling tool for maintaining a borehole and for cutting rock material.

[0002] Obtaining hydrocarbons by means of directional holes consists of a series of complex operations. The first of them is to drill a hole. This phase is followed by geophysical research on geometry condition of the raw borehole. Then, casing pipes are introduced into the borehole, which ensure stability and sealing of the borehole. Because of the forces inside the hole, present under the ground, and diversity of drilled rocks, the borehole begins to change its geometry immediately after the withdrawal of the drill. Therefore, there is a risk of capturing the casing pipes by rock layers tightening around and reducing the diameter of the hole. In addition, a swelling packet clay material is deposited on the surface of the casing pipes and prevents conducting a proper cementing operation. To prevent such a scenario, a number of methods are used:

- forcing a reciprocating movement and/or rotational movement of the cemented casing string,
- selection of optimal parameters of fluid,
- use of leading, buffering and washing fluids,
- use of packers,
- use of mud cake scrapers and centralisers,
- tools such as guide-shoe, reamer-shoe.

[0003] From the point of view of the invention, the latter are important. These tools are placed at the beginning of a casing string and have a drillable, substantially conical nose and abrasive elements which are made of materials highly resistant to abrasion processes, for example sintered carbides. Usually, they have, in their lower part, openings to allow proper execution of cementing and to ensure a steady flow of drilling fluid. The tool is intended to cut or abrade the rock material from the walls of the hole in places where the hole has a diameter smaller than the designed one. After introducing the pipes together with the tool and cementing the space between the hole wall and the casing string, a nose cone of the tool is drilled in order to allow subsequent steps of the hole exploration. These tools are produced by international concerns, such as Weatherford, Downhole Products or Halliburton.

[0004] From British patent specification no. GB 2482703, a tool in a form of a bit for maintaining or expanding a borehole is known. This tool has a form of a hollow pipe which is placed in the borehole in which this tool is moved along this hole. The tool further comprises means constituting blades and openings which are connected to the interior of the tool in the form of a pipe and

are located axially in the front of the blade. The removed material can be directed to the interior of the pipe, and the openings can have a form of slots and have an edge which constitutes a blade.

[0005] US 5 199 511 A discloses a drill bit and method in which polycrystalline diamond cutters mounted on a bit crown cut formation chips akin to the manner in which a grater cuts cheese. Chips in impermeable or plastic formations are extruded by the cutters into cavities internal to the bit via slots adjacent each cutter. Drilling fluid circulates internally of the bit from the drill string and into the annulus above that portion of the bit bearing cutters. In one embodiment, the portion of the bit body upon which the crown is formed is made of an elastomer which is pressurized into sealing engagement with the bottom of the borehole thereby further sealing freshly cut formation from drilling fluid.

[0006] US 6 527 065 B1 discloses cutting elements for use in a rotary drill bit, that are configured to facilitate positioning of the cutting elements at a positive rake angle with respect to the formation to enhance compressive stresses in the cutting element and to reduce cutting loads on the cutting elements. The cutting element generally comprises a three-dimensional superabrasive cutting member having a leading edge and a three-dimensional arcuate scoop-like surface which conveys formation cuttings away from the cutting element. The cutting element may also be formed to a substrate or backing. A drill bit suitable for use of the cutting elements is also disclosed which includes passageways and internal fluid passages for enhancing the conveyance of formation cuttings away from the leading edge of the cutting element.

[0007] US 2002189863 A1 discloses a drill bit for drilling casing in a well bore. The drill bit is constructed from a combination of relatively soft and relatively hard materials. The proportions of the materials are selected such that the drill bit provides suitable cutting and boring of the well bore while being able to be drilled through by a subsequent drill bit. Methods of applying hard materials to a soft material body are provided.

[0008] The stability of the borehole is affected by parameters such as:

- weight of the drilling fluid,
- ECD (Equivalent Circulating Density) during the circulation of the hole,
- salinisation of the drilling fluid, and stabilisers of swelling clays,
- pH of the drilling fluid,
- hydrodynamic and dynamic effect of the nozzles of the drill bit and underreamer,
- presence of swelling clays.

[0009] In the drilling technology, there is a phenomenon of stability changes (swelling of smectite/illite clays) of the hole as a function of time. This translates into the quality of the cemented sections of the piping. The situation requires solving encountered problems by means

of new techniques and technologies. One of the risks, to which too little attention has been paid so far, is the phenomenon of directional expansion of swelling clays.

[0010] In the course of exploration and development activities, openings drill through different types of rock with varying physical and chemical properties. Argillaceous rocks (mudstones, claystones, shales) composed of different kinds of clay minerals are among the most frequent rocks. The percentage of mixed packet minerals and illites increases with depth, usually gradually, and the amount of smectites decreases. The Silurian, Ordovician and Cambrian deposits are dominated by illites. Also mixed packet minerals, often containing smectites. Their main structural unit is a film comprising two inwardly facing tetrahedral plates with a central octahedral plate containing aluminum. The layers may extend in two directions but bonds between the films are weak and have a perfect cleavage allowing water and other molecules to be absorbed between the films, resulting in directional expansion. Based on existing information, the occurrence of swelling clays in the Ordovician, Silurian, Devonian, Carboniferous and Jurassic profiles was found. In many situations, the borehole is relatively stable, i.e. its dimensions remain substantially unchanged for several hours. However, this is largely dependent on geological conditions. The main obstacle during drilling and cementing processes are geological conditions prevailing in the holes. One of the main problems is related to the swelling of clay formations, as indicated above. This leads to narrowing of the hole clearance, and consequently to its occlusion.

[0011] The main problem with devices enlarging the hole diameter used so far in the oil drilling industry, is cutting the excavated rock material. Attempts to completely wash it out prove to be ineffective, and additionally lead to escalating changes in geometry of the hole.

[0012] The rock material, exhibiting a high viscosity, is deposited on the surface of the pipes, thereby preventing correct bonding of cement. Accumulation thereof leads to formation of local blockages, which causes formation of channels in the introduced cement paste.

[0013] The aim of the invention is to develop a drilling tool without the disadvantages of known tools.

[0014] The invention is defined by the appended claims.

[0015] According to the invention, a drilling tool for maintaining a borehole and for cutting rock material, comprises a hollow elongated body in the form of a pipe, the body having a longitudinal axis and being provided with a plurality of cutting blades arranged around the body in such a way that they protrude from the external surface of the body, the drilling tool having an upper end, wherein the cutting blades are grouped into sets arranged on the periphery of the body,

- wherein in each set, the cutting blades are shaped as bands, the ends of which are connected to the body, and the central parts of the cutting blades be-

tween the ends protrude from the body, and in each set the cutting blades are placed one upward of the other and are angularly offset relative to each other, wherein in each set, each cutting blade in the set is spaced from the axis of the body of the drilling tool by a dimension larger than the dimension of the distance from the axis of the body of the cutting blade located directly downward of it,

- wherein the body is provided with slots connecting the interior of the body to its external surface and arranged radially under the cutting blades, and not connected to the cutting blades, and, in use, drilling fluid flows through the interior of the body,
- wherein in each set, the bands of the cutting blades form, in their central part, a lateral channel extending in parallel to the longitudinal axis substantially on the external surface of the body and under the bands of the cutting blades, and, in use, the drilling fluid along with cut rock material flows through the lateral channel,
- and wherein, in use, a zone of lower pressure under the cutting blades in lateral channels is obtained, allowing suction of the cut rock material, and then its fragmentation through transverse flow of the drilling fluid.

[0016] Preferably, the cutting blades are grouped into two levels of arranged on the periphery of the body, and arranged one upward of the other and offset from each other by an angle of 0° to 45° .

[0017] Preferably, each set on one level comprises four cutting blades, wherein the sets of cutting blades are arranged on the periphery of the drilling tool every 90° .

[0018] Also preferably, each set on one level comprises six cutting blades, wherein six sets of cutting blades on one level are arranged symmetrically on the periphery of the drilling tool.

[0019] Also preferably, the cutting blades in each set are offset from the cutting blades located directly under it by an angle of 5° to 25° .

[0020] Also preferably, the upper end of the drilling tool is provided with a thread for connecting the drilling tool to casing pipes.

[0021] Also preferably, the drilling tool ends in a base made of a cuttable material.

[0022] Also preferably, directional channels are made in the base for optimal flow of the drilling mud.

[0023] Also preferably, inlet openings are made in the base for the flow of the drilling mud.

[0024] The object of the invention is presented in embodiments in the drawing, in which:

- Fig. 1 shows a drilling tool in a side view,
- Fig. 2 shows a drilling tool in a partial cross-section,
- Fig. 3 shows a drilling tool in its frontal view,

- Fig. 4 shows a drilling tool in a side view of a portion showing the cutting blades,
- Fig. 5 shows the flow of drilling fluid and excavated material during the operation of a drilling tool,
- Fig. 6 shows a schematic diagram of a drilling tool operating as an ejector,
- Fig. 7 shows computer simulations of drilling fluid flowing through a drilling tool.

[0025] As shown in an embodiment of the invention in Fig. 1, Fig. 2 and in Fig. 4 of the drawing, a drilling tool 1 for maintaining a borehole and for cutting rock material comprises an elongated body 2 in a form of a pipe. The external surface of the body 2 of the drilling tool 1 is provided with a series of cutting blades 3 arranged around the body 2 in such a way that the cutting blades 3 protrude from the external surface of the body 2.

[0026] The cutting blades 3 are shaped as bands 4 connected to the body 2 of the drilling tool 1 in such a way that the ends of the bands 4 are connected to the body 2, and in the central part between the ends of the bands 4 they protrude from the body 2 so that they are at a larger distance from the axis of the drilling tool 1 than the external surface of the drilling tool 1.

[0027] The cutting blades 3 are grouped into sets 5 of cutting blades 3 so that in each set 5, the cutting blades 3 are placed one upward of the other, and the sets 5 can be angularly offset relative to each other. This angular offset of the cutting blades 3 can vary within a range of 0° to 45° , wherein the offset value depends on many factors, such as, for example, size of the drilling tool 1 generally meant as its diameter, type of rock material in which the borehole is drilled, depth of the borehole, and many others. In an embodiment of the invention shown in Fig. 1, this offset does not occur, i.e. it equals zero.

[0028] Each cutting blade 3 in the set 5 is spaced from the axis of the body 2 of the drilling tool 1 by a dimension larger than the dimension of the distance from the axis of the body 2 of the cutting blade 3 located directly downward of it. Such a solution causes that the cutting blade 3 located upward, collects a further layer of rock material the cutting blade 3 located downward was unable to collect.

[0029] In the body 2 of the drilling tool 1, elongated slots 6 are made, extending radially relative to the body 2, connecting the interior of the body 2 of the drilling tool 1 to its external surface. The slots are not connected to the cutting blades 3 but, as shown in Fig. 5, they are located under the bands 4 of the cutting blades 3.

[0030] The bands 4 of the cutting blades 3, in their central part extending between the ends connecting the bands 4 to the body 2 of the drilling tool 1, form, in each set 5 of the cutting blades 3, a lateral channel 11 extending in parallel to the axis of the drilling tool 1 substantially on the external surface of the body 2 and under the bands

4 of the cutting blades 3.

[0031] The cutting blades 3 on the body 2 of the drilling tool 1 are configured so that their operation causes fragmentation and discharging the cut rock material towards the heel of the borehole.

[0032] In the preferred embodiment of the invention, shown in Fig. 1, Fig. 2, Fig. 3 and in Fig. 4, the cutting blades 3 are grouped into sets 5 arranged on the periphery of the body 2 of the drilling tool 1 and placed one upward of the other, wherein in each set, there are six cutting blades 3, and on one level around the body 2 of the drilling tool 1, six sets 5 of the cutting blades 3 are arranged. The sets 5 of the cutting blades 3 are therefore arranged every 60° . Of course, in other embodiments, the number of sets 5 of the cutting blades 3 both horizontally and on the periphery of the body 2 of the drilling tool 1, depending on the destination, can vary.

[0033] Also, the angular offset of the cutting blades 3 in the set 5 in relation to the cutting blades 3 located directly downward of them can vary and amount 5° to 25° , wherein in the embodiment shown in Fig. 1, it amounts to 6° .

[0034] In order to connect to a set of pipes used to maintain the borehole, the drilling tool 1 is provided with a thread 7 at its upper end. In an embodiment shown in Fig. 2, the thread 7 is an internal thread but it is obvious that in other embodiments the thread may be formed outside the drilling tool 1.

[0035] The drilling tool 1 ends in a base 8 made of a cuttable material. In the base 8, directional channels 9 are made for optimal flow of the drilling fluid. The base 8 also has inlet openings 10 for the drilling fluid. After completion of its task, the base 8 of the drilling tool 1 may be drilled.

[0036] The principle of operation of the drilling tool 1, according to the invention, is based on a solution innovative on a global scale, which allows cutting the rock material, and then fragmentising it and discharging it onto the surface out of the borehole. The very idea of operation can be compared to the calibrator known from the engineering industry, which, however, uses the principle of operation of the ejector for removing the cut material from the cutting zone. It is this innovation that provides the developed tool with significant advantages over analogous structures.

[0037] Fig. 6 schematically shows the principle of operation of the ejector, relating to the drilling tool, according to the invention. In Fig. 6, it can be seen that in the negative pressure zone, formed in the narrowing of the space into which a fluid, in this case a drilling fluid, is forced, the sucked rock material, cut by the cutting blades 3 of the drilling tool 1, is captured and accelerated.

[0038] This phenomenon is shown in more detail in Fig. 5 in relation to the drilling tool 1 according to this embodiment. The slots 6 connecting the interior of the body 2 of the drilling tool 1 to its external surface correspond to the negative pressure zone of Fig. 6. Directly upward the slots 6 the bands 4 of the cutting blades 3

are arranged, thereby forming, in each set 5 of the cutting blades 3, lateral channels 11 in which the rock material cut by the cutting blades 3 in the resulting borehole is accelerated. This capturing and accelerating of the rock material leads to its further fragmentising at the edges of the cutting blades 3 and preventing formation of deposits on the casing pipes which could disturb the process of their cementing.

[0039] The proposed solution allows the use of high velocity gradients in the vicinity of the cutting blade 3 for precise fragmentation of the cut material and discharging it up the hole along with the drilling fluid. Appropriate fragmentation of the cut material is essential as it prevents formation of so-called mud cakes. This translates into proper cementing of the hole and into environmental safety and return on investment. It is worth noting that the drilling tool 1, according to the invention, does not have any moving parts, which contributes to its reliability.

[0040] In relation to the drilling tool 1, according to the invention, computer simulations with the use of CFD (Ansys Fluent) tool were conducted, which showed that the flow of the drilling mud in appropriately profiled openings and channels inside the cutting blades 3 induces the occurrence of pressure anomalies, as illustrated in Fig. 7. A special form of the so-called hydrodynamic paradox was used herein. Thereby, a zone of lower pressure under the cutting blades 3 in lateral channels 11 was obtained, allowing suction of the cut rock material, and then its fragmentation through transverse flow of the drilling fluid.

Claims

1. A drilling tool (1) for maintaining a borehole and for cutting rock material, comprising a hollow elongated body (2) in the form of a pipe, the body (2) having a longitudinal axis and being provided with a plurality of cutting blades (3) arranged around the body (2) in such a way that they protrude from the external surface of the body (2), the drilling tool (1) having an upper end, wherein the cutting blades (3) are grouped into sets (5) arranged on the periphery of the body,
 - wherein in each set (5), the cutting blades (3) are shaped as bands (4), the ends of which are connected to the body (2), and the central parts of the cutting blades (3) between the ends protrude from the body (2), and in each set (5) the cutting blades (3) are placed one upward of the other and are angularly offset relative to each other,
 - wherein in each set (5), each cutting blade (3) in the set (5) is spaced from the axis of the body (2) of the drilling tool (1) by a dimension larger than the dimension of the distance from the axis of the body (2) of the cutting blade (3) located

directly downward of it,

- wherein the body (2) is provided with slots (6) connecting the interior of the body (2) to its external surface and arranged radially under the cutting blades (3), and not connected to the cutting blades (3), and, in use, drilling fluid flows through the interior of the body (2),

- wherein in each set (5), the bands (4) of the cutting blades (3) form, in their central part, a lateral channel (11) extending in parallel to the longitudinal axis substantially on the external surface of the body (2) and under the bands (4) of the cutting blades (3), and, in use, the drilling fluid along with cut rock material flows through the lateral channel (11),

- and wherein, in use, a zone of lower pressure under the cutting blades (3) in lateral channels (11) is obtained, allowing suction of the cut rock material, and then its fragmentation through transverse flow of the drilling fluid.

2. The drilling tool, according to claim 1, **wherein** the cutting blades (3) are grouped into two levels of sets (5) arranged on the periphery of the body (2), and arranged one upward of the other and offset relative to each other by an angle of 0° to 45°.
3. The drilling tool, according to claim 1, **wherein** each set (5) on one level comprises four cutting blades (3), wherein the sets (5) of the cutting blades (3) are arranged on the periphery of the drilling tool (1) every 90°.
4. The drilling tool, according to claim 1, **wherein** each set (5) on one level comprises six cutting blades (3), wherein six sets (5) of the cutting blades (3) on one level are arranged symmetrically on the periphery of the drilling tool (1).
5. The drilling tool, according to claim 1, **wherein** the cutting blades (3) in the set (5) are offset relative to the cutting blades (3) located directly under them by an angle of 5° to 25°.
6. The drilling tool, according to claim 1, **wherein** the upper end of the drilling tool (1) is provided with a thread (7) for connecting the drilling tool (1) to casing pipes.
7. The drilling tool, according to claim 1, **wherein** the drilling tool ends in a base (8) made of a cuttable material.
8. The drilling tool, according to claim 7, **wherein** directional channels (9) are made in the base (8) for optimal flow of the drilling fluid.
9. The drilling tool, according to claim 7, **wherein** inlet

openings (10) are made in the base (8) for the flow of the drilling fluid.

abgebaute Gestein eingesaugt und anschließend durch den Querstrom der Bohrflüssigkeit zerkleinert wird.

Patentansprüche

1. Ein Bohrwerkzeug (1) zur Herstellung von Bohrungen und zum Abtragen vom Gestein, das aus einem hohlen, länglichen Körper (2) in Form eines Rohrs besteht, wobei der Körper (2) eine Längsachse aufweist und mit einer Vielzahl von Schneide (3) versehen ist, die so rund um den Körper (2) angeordnet sind, dass sie von der Außenfläche des Körpers (2) abstehen, wobei das Bohrwerkzeug (1) ein oberes Ende aufweist,

wobei die Schneide (3) in Form von Streifen (5) an der Begrenzungsfläche des Körpers angeordnet sind,

- wobei in jedem Streifen (5) die Schneide (3) in Form von Bändern (4) herausgebildet sind, deren Enden mit dem Körper (2) verbunden sind, und die mittleren Bereiche der Schneide (3) zwischen den Enden von dem Körper (2) abstehen und in jedem Streifen (5) die Schneide (3) übereinander angeordnet und um einen Winkel zueinander versetzt sind,

- wobei in jedem Streifen (5) jeder Schneide (3) im Streifen (5) von der Achse des Körpers (2) des Bohrwerkzeugs (1) um ein Maß entfernt ist, das größer ist als das Maß der Entfernung von der Achse des Körpers (2) des Schneides (3), der sich direkt unterhalb davon befindet,

- wobei der Körper (2) mit Schlitz (6) versehen ist, die den Innenraum des Körpers (2) mit dessen Außenfläche verbinden und radial unter den Schneide (3) angeordnet und mit den Schneide (3) nicht verbunden sind, wobei im Betrieb der Vorrichtung die Bohrflüssigkeit durch den Innenraum des Körpers (2) fließt,

- wobei die Bänder (4) der Schneide (3) in jedem Streifen (5) in dem zentralen Bereich

einen seitlichen Kanal (11) herausbilden, der parallel zur Längsachse an der Außenfläche des Körpers (2) und unter den Bändern (4) der Schneide (3) verläuft und im Betrieb die Bohrflüssigkeit zusammen mit dem abgetragenen Gestein durch den seitlichen Kanal (11) befördert werden,

- und wobei im Betrieb eine Zone mit einem geringeren Druck unter den Meißeln (3) in seitlichen Kanälen (11) entsteht, womit das

2. Ein Bohrwerkzeug nach Anspruch 1, **wobei** die Schneide (3) in zwei Ebenen von Streifen (5) an der Begrenzungsfläche des Körpers (2) angeordnet sind und übereinander und um einen Winkel von 0° bis 45° zueinander versetzt angeordnet sind.

3. Ein Bohrwerkzeug nach Anspruch 1, **wobei** jeder Streifen (5) auf einer Ebene vier Schneide (3) umfasst, wobei die Streifen (5) der Schneide (3) an der Begrenzungsfläche des Bohrwerkzeugs (1) je 90° angeordnet sind.

4. Ein Bohrwerkzeug nach Anspruch 1, **wobei** jeder Streifen (5) auf einer Ebene sechs Schneide (3) umfasst, wobei sechs Streifen (5) der Schneide (3) auf einer Ebene symmetrisch an der Begrenzungsfläche des Bohrwerkzeugs (1) angeordnet sind.

5. Ein Bohrwerkzeug nach Anspruch 1, **wobei** die Schneide (3) im Streifen (5) gegenüber den direkt unter ihnen liegenden Schneide (3) um einen Winkel von 5° bis 25° versetzt sind.

6. Ein Bohrwerkzeug nach Anspruch 1, **wobei** das obere Ende des Bohrwerkzeugs (1) mit einem Gewinde (7) zum Anschluss des Bohrwerkzeugs (1) an die Bohrröhre versehen ist.

7. Ein Bohrwerkzeug nach Anspruch 1, **wobei** das Bohrwerkzeug mit einer Sockel (8) endet, die aus einem schneidfähigen Material besteht.

8. Ein Bohrwerkzeug nach Anspruch 7, **wobei** die Fließkanäle (9) an der Sockel (8) für eine optimale Führung der Bohrflüssigkeit vorgesehen sind.

9. Ein Bohrwerkzeug nach Anspruch 7, **wobei** an der Sockel (8) Einlassöffnungen (10) für die Führung der Bohrflüssigkeit vorgesehen sind.

Revendications

1. Outil de forage (1) pour maintenir un trou de forage et pour couper des matériaux rocheux, comprenant un corps allongé creux (2) sous la forme d'un tuyau, le corps (2) ayant un axe longitudinal et étant pourvu d'une pluralité de lames coupantes (3) disposés autour du corps (2) de telle sorte qu'ils dépassent de la surface externe du corps (2), l'outil de forage (1) ayant une extrémité supérieure, dans lequel les lames coupantes (3) sont regroupées en ensembles (5) disposés sur la périphérie du corps,

- dans lequel dans chaque ensemble (5), les lames coupantes (3) sont en forme de bandes (4), dont les extrémités sont reliées au corps (2), et les parties centrales des lames coupantes (3) entre les extrémités font saillie du corps (2), et dans chaque jeu (5) les lames coupantes (3) sont placées l'une vers le haut l'une de l'autre et sont décalées angulairement les unes par rapport aux autres, 5
 - dans lequel dans chaque ensemble (5), chaque lame coupante (3) dans l'ensemble (5) est espacée de l'axe du corps (2) de l'outil de forage (1) d'une dimension plus grande que la dimension de la distance de la l'axe du corps (2) de la lame coupante (3) situé directement en bas de celle-ci, 10
 - dans lequel le corps (2) est pourvu de fentes (6) reliant l'intérieur du corps (2) à sa surface externe et disposées radialement sous les lames coupantes (3), et non reliées aux lames coupantes (3), et, en service, le fluide de forage s'écoule à l'intérieur du corps (2), 15
 - dans lequel dans chaque ensemble (5), les bandes (4) des lames coupantes (3) forment, dans leur partie centrale, un canal latéral (11) s'étendant parallèlement à l'axe longitudinal sensiblement sur la surface externe du corps (2) et sous les bandes (4) des lames coupantes (3), et, en cours d'utilisation, le fluide de forage avec la matière rocheuse coupée s'écoule à travers le canal latéral (11), 20 25
 - et dans lequel, en utilisation, une zone de pression inférieure sous les lames coupantes (3) dans les canaux latéraux (11) est obtenue, permettant l'aspiration de la matière rocheuse coupée, puis sa fragmentation par écoulement transversal du fluide de forage. 30 35
2. Outil de forage selon la revendication 1, **dans lequel** les lames coupantes (3) sont regroupées en deux niveaux d'ensembles (5) disposés sur la périphérie du corps (2), et disposés l'un au dessus de l'autre et décalés l'un par rapport à l'autre par un angle de 0° à 45°. 40 45
 3. Outil de forage selon la revendication 1, **dans lequel** chaque ensemble (5) sur un niveau comprend quatre lames coupantes (3), dans lequel les ensembles (5) des lames coupantes (3) sont disposés sur la périphérie de l'outil de forage (1) tous les 90°. 50
 4. Outil de forage selon la revendication 1, **dans lequel** chaque ensemble (5) sur un niveau comprend six lames coupantes (3), dans lequel six ensembles (5) des lames coupantes (3) sur un niveau sont disposés symétriquement sur la périphérie de la outil de forage (1). 55
 5. Outil de forage selon la revendication 1, **dans lequel** les lames coupantes (3) dans l'ensemble (5) sont décalées par rapport aux lames coupantes (3) situées directement sous elles d'un angle de 5° à 25°.
 6. Outil de forage selon la revendication 1, **dans lequel** l'extrémité supérieure de l'outil de forage (1) est munie d'un filetage (7) pour connecter l'outil de forage (1) aux tubes de tubage.
 7. Outil de forage selon la revendication 1, **dans lequel** l'outil de forage se termine par une base (8) réalisée en un matériau découpable.
 8. Outil de forage selon la revendication 7, **dans lequel** des canaux directionnels (9) sont réalisés dans la base (8) pour un écoulement optimal du fluide de forage.
 9. Outil de forage selon la revendication 7, **dans lequel** des ouvertures d'entrée (10) sont réalisées dans la base (8) pour l'écoulement du fluide de forage.

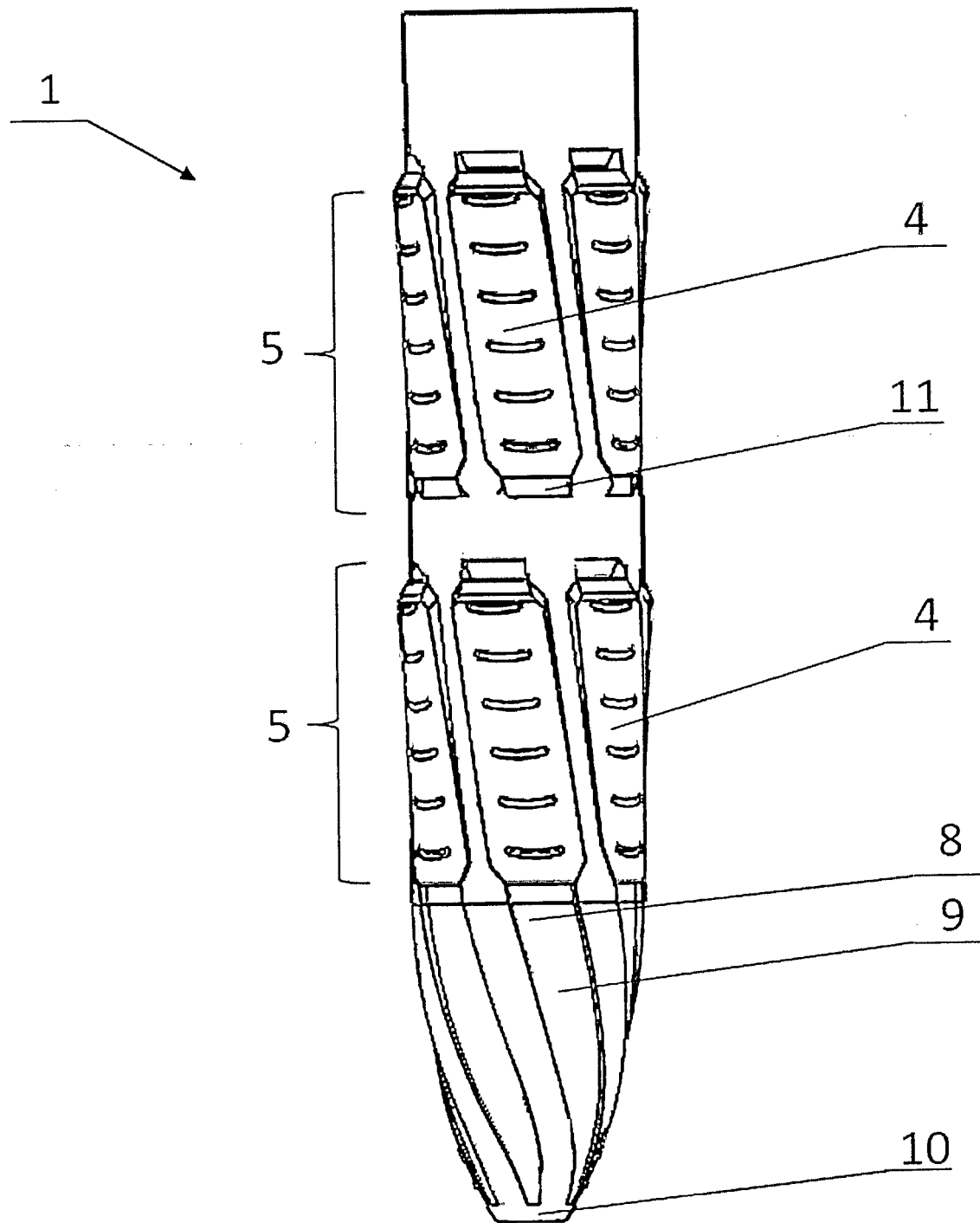


Fig. 1

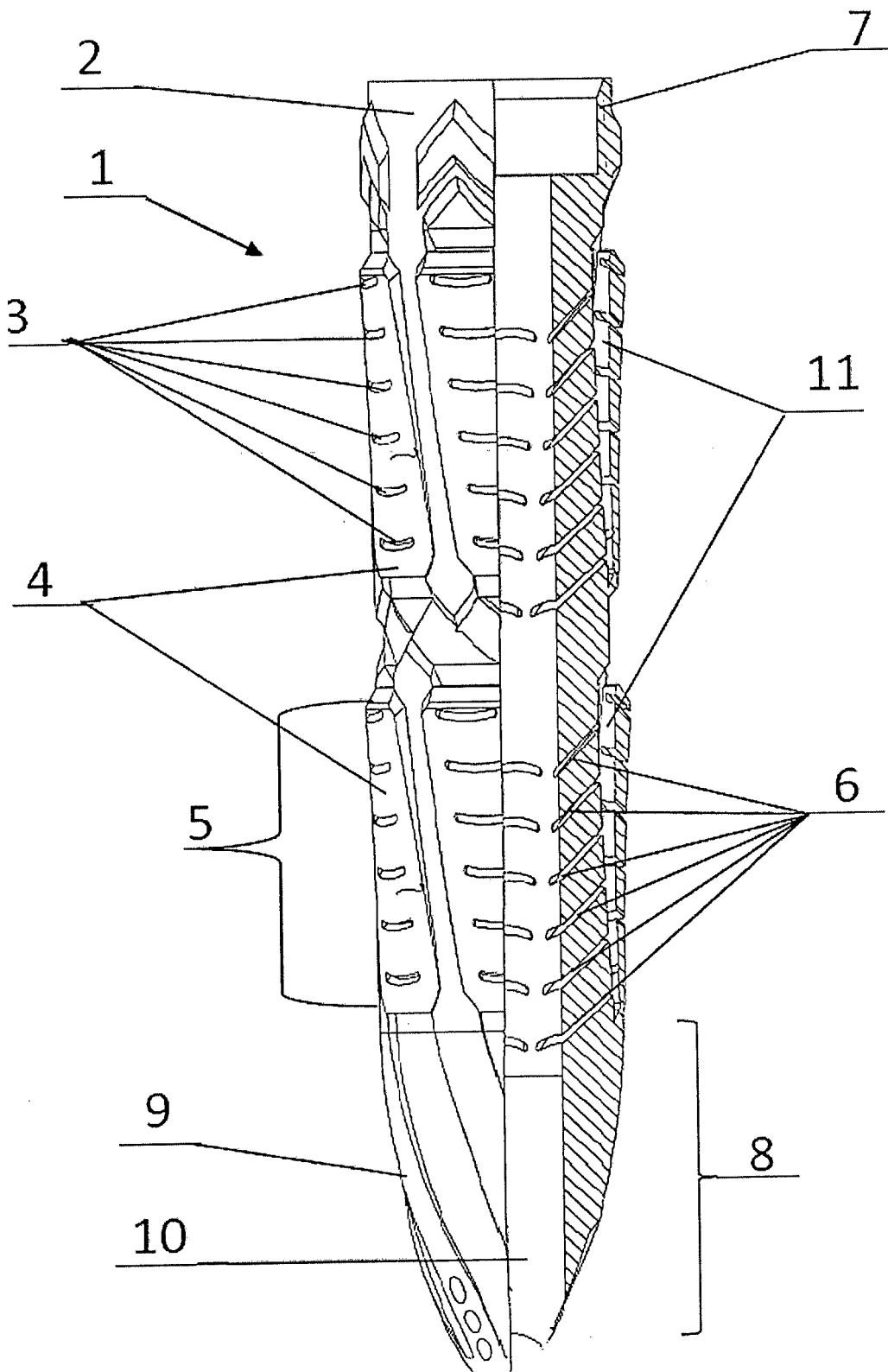


Fig. 2

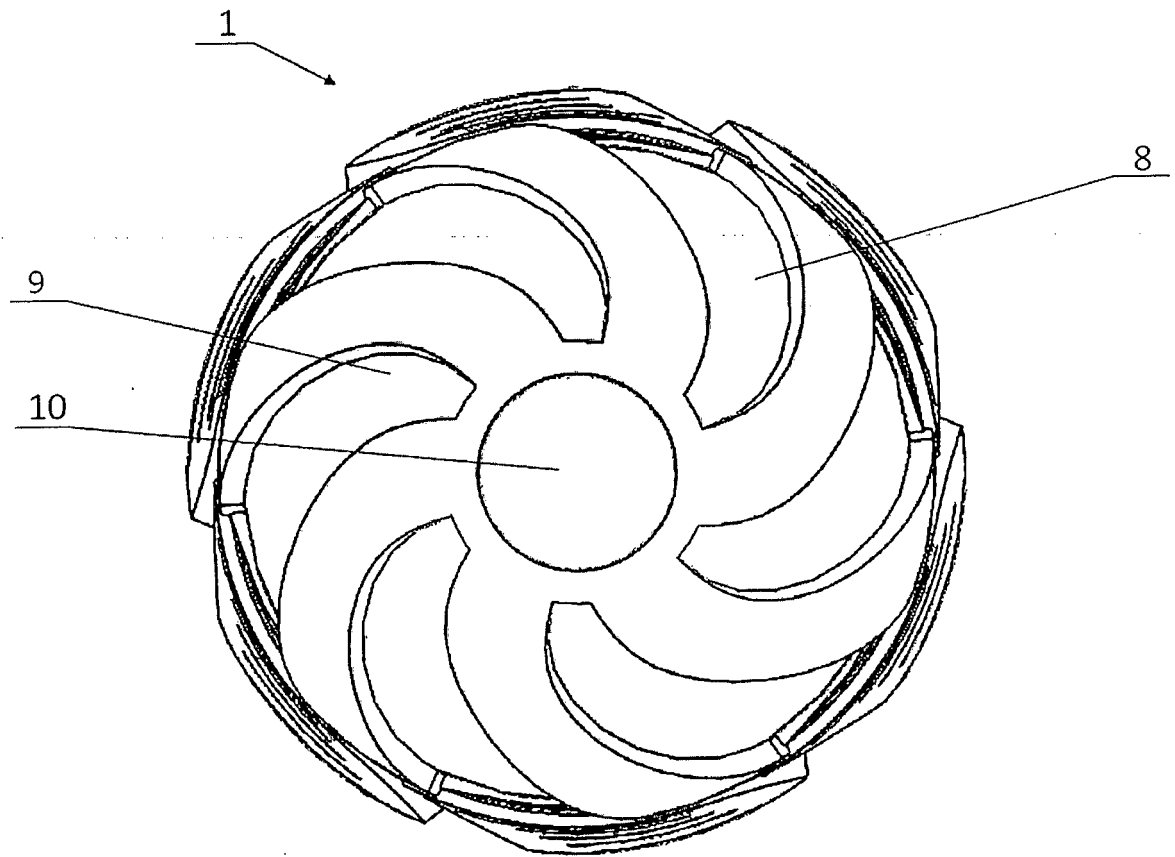


Fig. 3

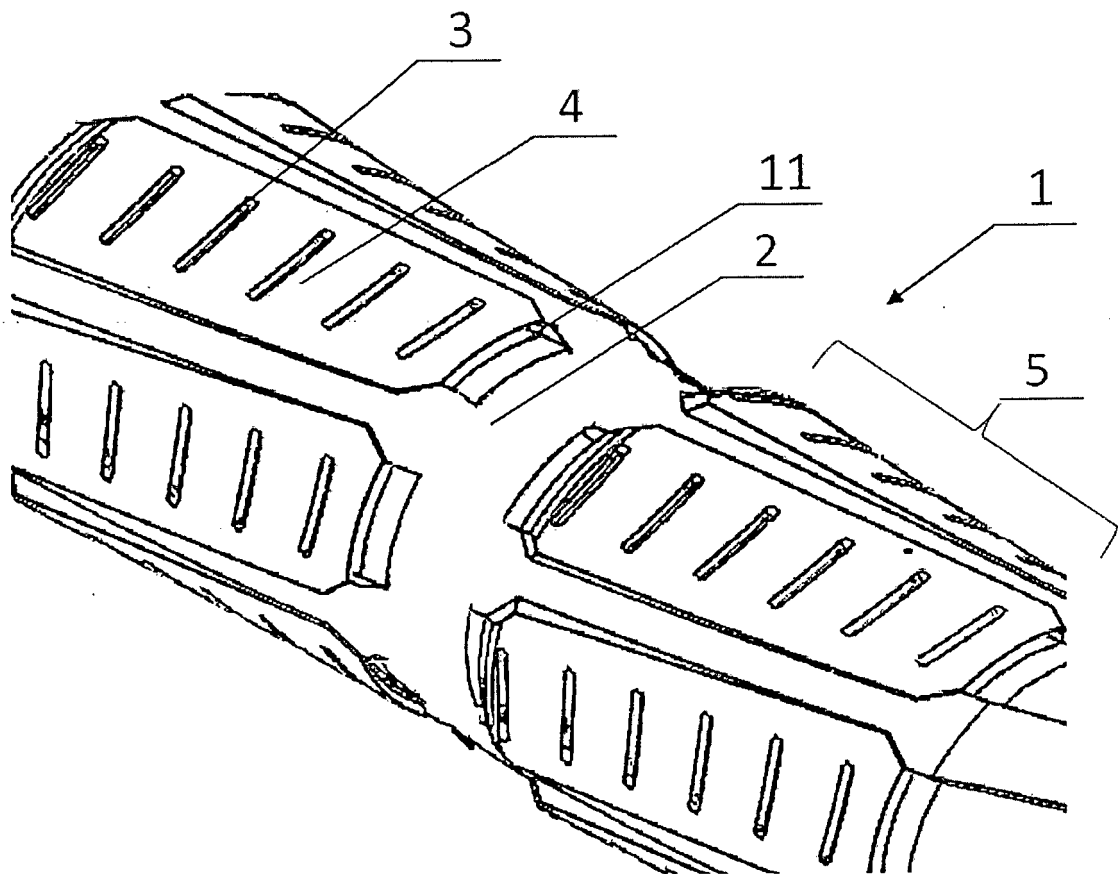


Fig. 4

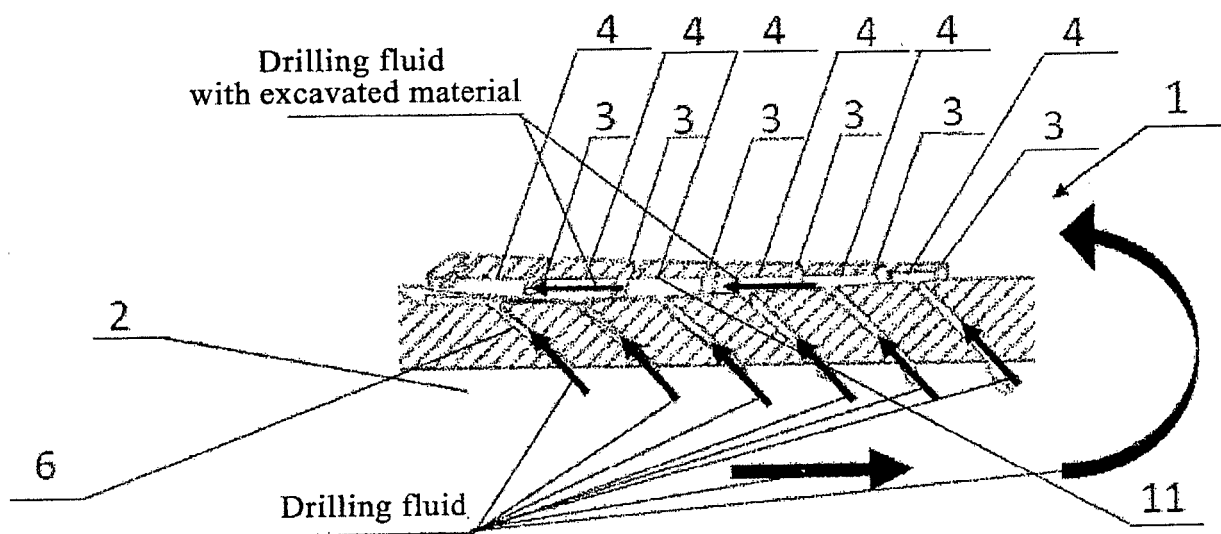


Fig. 5

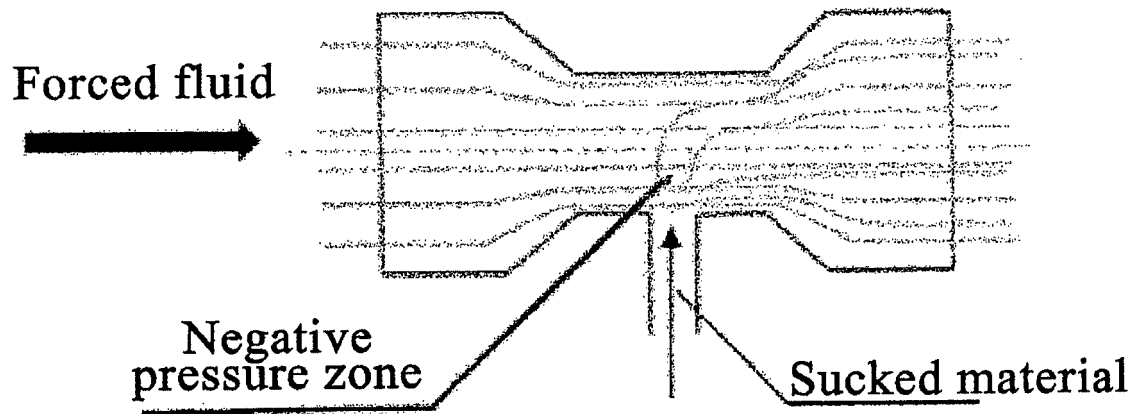


Fig. 6

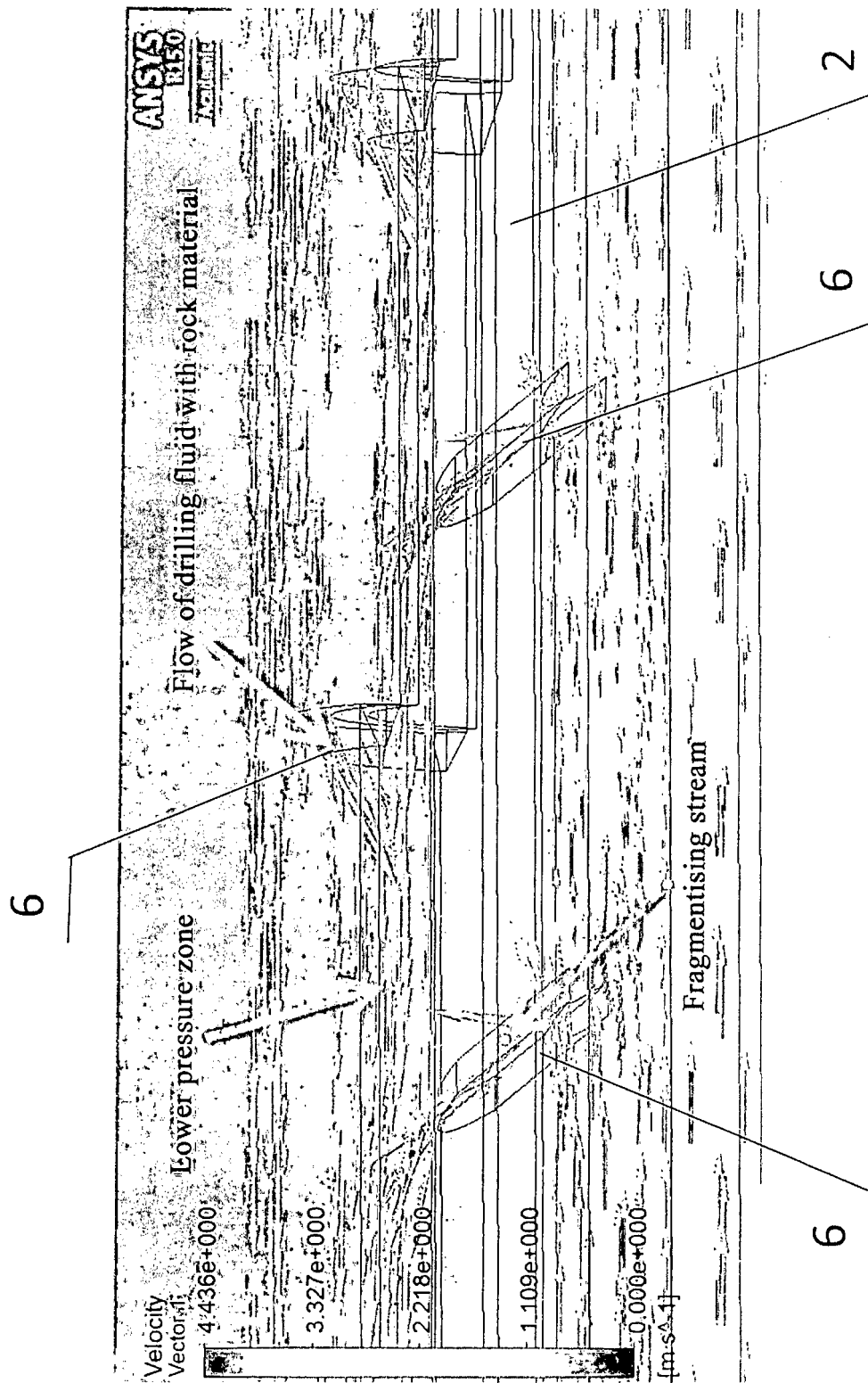


Fig. 7

REFERENCES CITED IN THE DESCRIPTION

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