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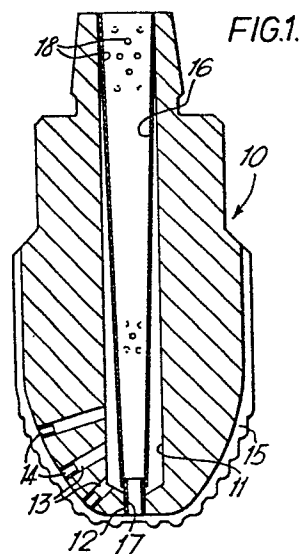
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(54) Rotary drill bits and method of use.

(57) To prevent foreign bodies or lost circulation material in drill mud locking the nozzles of a rotary drill bit, the central passageway incorporates a separating means arranged to separate larger particles from the drill mud and to divert them away from the nozzles and out of the bit. The separating means is arranged to operate in a static or dynamic manner.



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ROTARY DRILL BITS AND METHOD OF USE

The invention relates to rotary drill bits and a method of use and in particular to such bits which are used to drill holes in subsurface formations to extract oil, gas or water or in mining or in the removal of cores. The bit is disposed at the leading end of a drill string.

The drill bits comprise a bit body having a passageway within the body, e.g. for a fluid such as a drilling mud, opening at an external surface of the body, elements being mounted on the external surface of the body and many fluid channels extending over the face of the bit from the passageway opening and past some of the elements to the periphery. The elements may be formed of diamond, synthetic diamonds or the like and they may cut into the formation by a true cutting action or by an abrading action. Such bits are disclosed in, for example, U.S. patents 2 371 489, 2 809 808, 3 709 308, and 3 727 704. In use of such a drill bit, drilling fluid "mud" is pumped through the passage within the bit body and emerges through the openings and flows outwardly and upwardly along the many fluid channels, on the face of the bit body to the annulus. The mud flushes cuttings away from the drill bit and cleans and cools the cutting or abrading elements, and to a certain extent

cools the formation being drilled. The bit may have many cutting elements but far fewer openings so that the mud emerging from any one opening will have to flush cuttings away from several cutting elements. This is because the flow area of each opening must be large enough to pass occasional foreign bodies in the mud and the total flow area must be small enough to ensure adequate exit velocity to keep them clear and to flush the bit face.

Ideally, the mud travelling through the passageway and the openings emerges at the bit "clean", that is to say the only undissolved solids are of microscopic dimensions. In practice, however, occasional foreign bodies are present in the mud, such as pieces of rubber, metal or rock. For example, pieces of rubber or metal may become detached from valves or pistons of the mud pumps associated with the drilling rig. The foreign bodies often range in size from 2 mm to 12 mm and frequently cause blockage of the mud openings in the bit.

Such foreign bodies could also be harmful to the successful functioning of a downhole motor such as a mud turbine near the bottom of the drill string. It is common practice when using such turbine to use a coarse strainer having holes approximately 6 mm diameter interposed just below the kelly and above the uppermost piece of drill pipe. This strainer must be changed each time an additional 10 metres length of drill pipe is connected. It is cleaned before the next connection and then re-used, so that two such strainers are required. Despite this precaution it is found foreign bodies still reach the bit and this may be due to dirty drill pipes, dirty joint compound, or occasional accidental omissions of the strainer.

Another source of contaminated mud is debris left in the

hole from previous drilling operations and entering the drill string through the bit while the bit is travelling to the bottom of the hole.

Another potential cause of blockage of such bits with small openings is the occasional but important use in drilling of so-called "lost circulation material", which is added to the mud to seal an accidental fracture of the formation being drilled. This material may consist of large mica flakes or even walnut shells, and particles of this size can block small openings of 6 mm or less. The need to use such material may occur urgently and unexpectedly.

It has been proposed to overcome the blockage of small openings in the bit by providing a strainer within the bit itself. While this strainer may prevent blockage of the openings in the surface of the bit the strainer can become plugged by accumulated retained material and it also precludes the use of lost circulation material since the large particles in such material would be trapped by the strainer.

The invention sets out to provide a drill bit adapted to prevent blockage of small openings in the bit by foreign bodies and which still permits the use of lost circulation material.

According to the invention there is provided a rotary drilling bit for use in subsurface formations comprising a bit body, a passageway within the body for a drill fluid, cutting elements mounted on the external surface of the body for cutting or abrading the formation, the passageway opening at a plurality of nozzles adjacent the cutting elements, filter means being present

in the passageway characterised in that separating means is arranged to separate larger particles from the mud and to divert them away from the nozzles and out of the bit.

The separating means is adapted to prevent foreign bodies in the drilling fluid from passing to and blocking the smaller openings, but allows or directs them to pass with the drilling fluid to the larger opening or openings. There is thus little risk of the smaller openings being internally blocked by foreign bodies in the drilling fluid. If it should become necessary to use lost circulation material, such material can pass through the bit and will be diverted out of the bit by the separating means without passing through the small openings.

The separating means may take a variety of forms arranged to operate in static or dynamic manner. In one simple form the means comprises a plate or disc having perforations to hold back foreign matter and larger perforations joined to tubes leading to the exterior of the bit and arranged to pass the foreign matter out of the bit. Another static form of separating means is preferably a cone or a cylinder, is preferably disposed in the passageway of the bit and communicates with an outlet at the surface of the bit independent of the nozzles. The tube may instead be disposed in a passageway of another part of the drill string, e.g. the stabiliser and be in communication with the outlet of the bit.

The separating means may be shaped and arranged to act as a hydrocyclone or centrifugal separator. As the drill fluid is passed through the separator the particles therein are accelerated at different rates and in this way, foreign particles of a different density than the drill fluid may be separated from the drill fluid proper.

By virtue of the presence of the separating means the nozzles may be made smaller and substantially of the same diameter so improving nozzle density and/or mud exit velocity.

The invention includes a method of drilling involving use of the bit disclosed herein in which any foreign matter in the drill fluid is diverted to the exterior of the bit and away from the nozzles. The invention includes a method as outlined in which the drill fluid contains a lost circulation material.

In order that the invention may be well understood, it will now be described with reference to the accompanying diagrammatic drawings, in which :

Figure 1 is a vertical section through a rotary drill bit including a separating element in the bit,

Figure 2 is a vertical section as Figure 1 in which the separating element is present in the drill string stabiliser, and

Figure 3 is a vertical section through a rotary drill bit including a separating element acting as a hydrocyclone.

In the following description the same reference numerals are used to describe the same parts in the different embodiments where possible.

A drill bit 10 is of known form and has a number of synthetic agglomerate polycrystalline preform cutter elements, not shown. Preferably the bit is according to our co-pending Application 81.300062.7 (UDS 7/10). A central passage 11 extends from the trailing end of the bit towards the leading end. The passage 11 narrows at the leading end of the bit and a shorter

diameter conduit 12 extends from the passage 11 to the exterior of the bit. Bores 13 branch off the passage and end in nozzles 14 which lie in fluid channels 15. The cutters, not shown, lie on the walls of the fluid channels 15. In the drawing only three bores 13 are shown but many such nozzles are present. The nozzles typically will be of circular shape and may be about 2 to 6 mm in diameter whereas the conduit 12 is usually of trefoil shape and may be 12 to 20 mm in diameter.

A separating element 16 is disposed in the passage 11. As shown, the element is conical and extends the length of the passage with a short tube 17 in the conduit 12 being in engagement with the narrower end of the element 16. The walls of the element have perforations 18 dimensioned relative to the nozzles 14; preferably the perforations are smaller than the nozzles - for example the perforations can be 1.5 mm diameter for nozzles about 2 mm diameter. The element may be of sheet metal or mesh. The perforations are preferably circular but may be of another shape.

In operation, drilling fluid is pumped downwardly into the passage 11 and into the upper end of the element 16. Some of the fluid passes through the element 16 and emerges through the conduit 12 from where it passes outwardly and upwardly along the channels 15. A certain proportion of the fluid passes through the perforations 18 and then along the bores 13 to the nozzles 14. The element 16 acts as a static separator because any foreign bodies large enough to block the nozzles 14 will not pass through the perforations 18 and will be carried downwardly through the larger opening 12. The fluid passing to the nozzles 14 will thus be "clean" and there will thus be little likelihood of the nozzles 14 becoming internally blocked.

If it becomes necessary to use lost circulation material,

this will pass down the whole length of the separating element 16 and through the conduit 12 without passing to the small nozzles 14.

During use of the bit some of the perforations 18 may become blocked but in view of their large number relative to the number of small nozzles 14 this can be tolerated.

In the embodiment of Figure 2, the separator 16 is mounted within a central passage 19 of a stabiliser 20, to which the bit is connected. The tube 17 is of greater length than in Figure 1 and extends the length of the passage 11 in the bit body.

The embodiment of Figure 3, includes a hydrocyclone separator. A disc 30 is present at the trailing end of the bit 10. The disc has inlet holes 31 leading to exit holes 32, which point in a tangential direction. The disc 30 is above a cone 33 (non perforated) and a passageway 34 extends between the underside of the disc 30 and the top of the cone 33. The top of the cone 33 is narrower in diameter than the body cavity and the annular cavity 35 so formed communicates with bores 13 leading to nozzles 14. A tube 36 directs mud to the passageway 34. The parts 30 to 34 and the tube 36 constitute the hydrocyclone.

In operation drilling mud flows down the passage of the bit and through the inlets 31 of the disc 30. As the mud emerges from the outlet holes 32 the velocity is increased and any larger particles are thrown to the outside of the cone 33, the clean mud being forced up the tube 36 and along the passageway 34 to the nozzles 14. The larger particles exit through the conduit 12 at the nose of the bit. In this way the separator separates the clean mud from foreign bodies which are passed out of the bit.

The invention is not limited to the embodiments described.

For example the element 16 may be cylindrical instead of tapered. The separator of Figure 3 may have volute chambers or guide vanes. Turbine-like blades may be present to give the drill mud rotation about the axis of the bit. The bit of Figure 3 may include a second separator to separate from the mud foreign matter which is less dense than the mud.

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CLAIMS:

1. A rotary drill bit for use in subsurface formations comprising a bit body, a passageway within the body for a drill fluid, cutting elements mounted on the external surface of the body for cutting or abrading the formation, the passageway opening at a plurality of nozzles adjacent the cutting elements, filter means being present in the passageway characterised in that separating means is arranged to separate larger particles from the mud and to divert them away from the nozzles and out of the bit.
2. A bit according to Claim 1, characterised in that the separating means is arranged to operate in a static or dynamic manner.
3. A bit according to Claim 1 or 2, characterised in that the separating means is static and comprises a perforate element having tubular means for the passage of foreign matter towards the outside of the bit.
4. A bit according to Claim 1 or 2, characterised in that the separator means is static and comprises a tube disposed in the passageway, the tube including a perforated wall the majority of the perforations of which are smaller than the diameter of the nozzles,

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and communicating at one end with an outlet at the surface of the bit.

5. A bit according to Claim 4, characterised in that a conduit extends from the end of the passageway to the outlet and a cylinder is connected to a tube in the conduit.

6. A bit according to any of Claims 2, 4 or 5, characterised in that a separating cylinder is present in a passageway in a drill string behind the bit and a tube extends from the cylinder through the passageway of the bit to an outlet at the surface of the bit.

7. A bit according to Claim 1, characterised in that the separating means is dynamic and is arranged as a hydrocyclone or centrifugal separator.

8. A bit according to Claim 7, characterised in that a disc extends across the passageway of the bit and through holes are present in the disc, the holes being arranged to propel the drill fluid and a barrier is present to direct the propelled drill fluid to the nozzles and the propelled larger particles to an outlet at the surface of the bit.

9. A bit according to Claim 7 or 8, characterised in that the disc includes a depressed portion and the through holes are present in the side walls of the depressed portion.

10. A bit according to any preceding Claim, characterised in that the nozzles are substantially of the same diameter.

11. A method of drilling comprising urging a bit according to any of Claims 1 to 10 into a subsurface formation with rotation

and pumping a drill fluid through the bit, any foreign matter being diverted to the exterior of the bit and away from the nozzles.

12. A method of drilling according to Claim 11, in which a lost circulation material is pumped into the hole and is passed to the exterior of the bit and away from the nozzles.

13. For use with a bit according to Claim 6, a drill string or stabiliser having a passageway, a separating cylinder being present in the passageway and arranged to be locatable in communication with the outlet of the bit.

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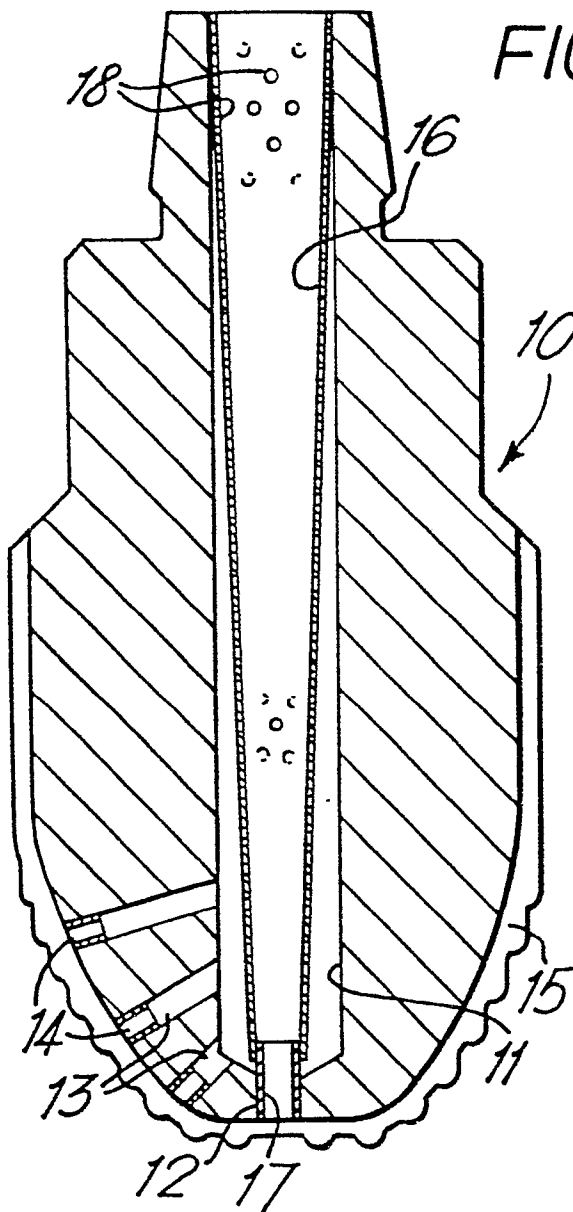
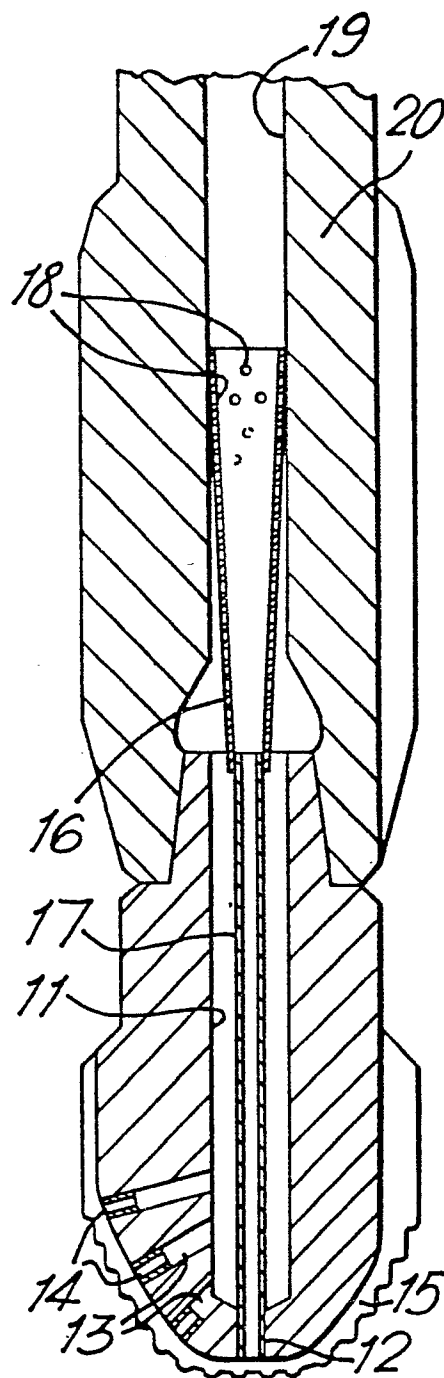


FIG. 2.



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FIG.3.

