April 9, 1963 W. TIRASPOLSKY 3,084,752

DRILL BIT TOOL FOR WELL DRILLING

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Fig. 2

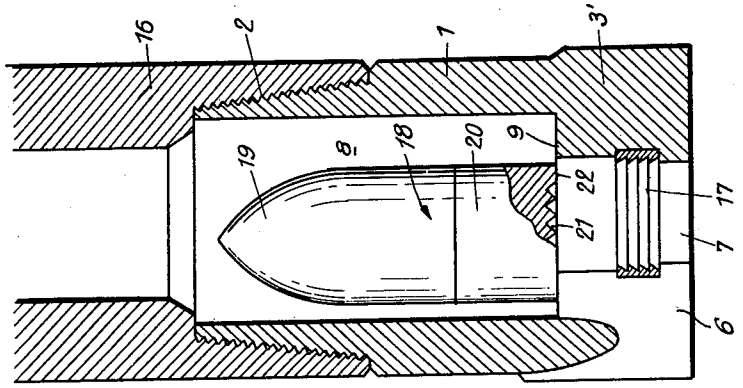

Fig. 1

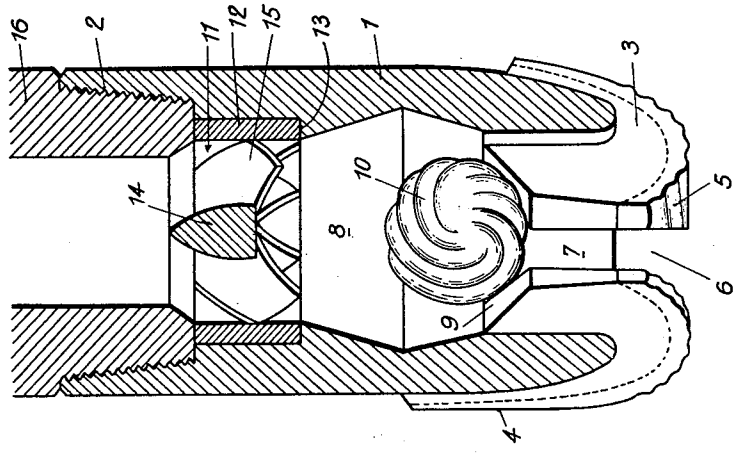

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Fig. 3

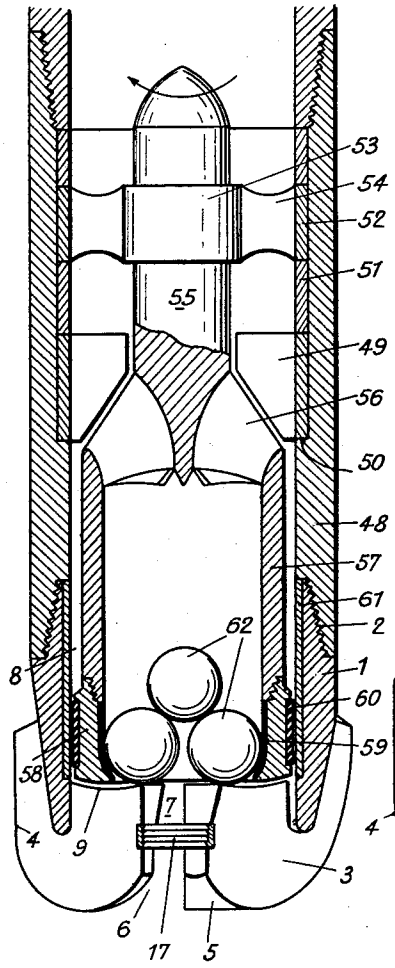

Fig. 4

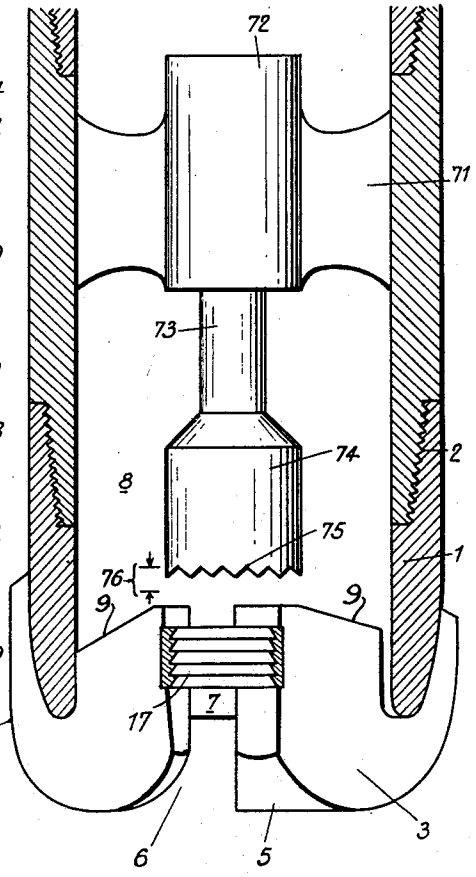

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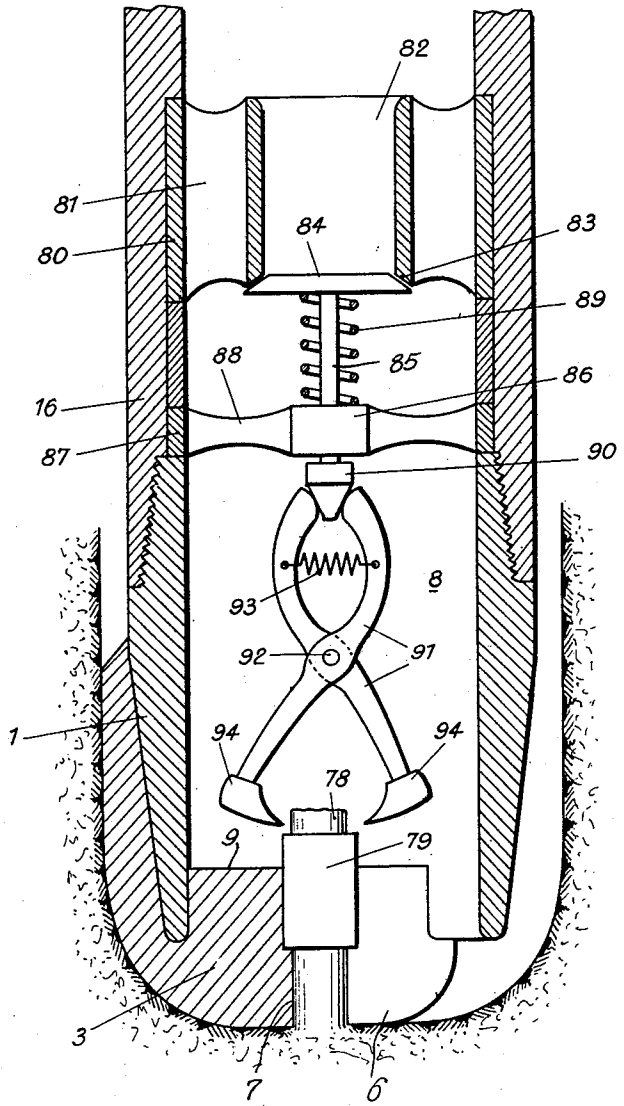
Fig. 5



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DRILL BIT TOOL FOR WELL DRILLING

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5 Claims. (Cl. 175—404)

The present invention relates generally to tools or drill bits as used for drilling the ground particularly for the exploitation of oil wells.

It is known that one of the difficulties encountered when drilling the ground is the destruction of the central part of the hole drilled through the rock, particularly when practising so-called "full diameter drilling" by means of solid tools such as bladed bits, winged bits and especially diamond-bearing or like tools because the efficiency of the drilling action through the rock is a function of the linear speed of each cutting element and also because said speed decreases from the periphery to the centre of the tool down to a substantially zero value along the rotation axis of the tool.

Such a disadvantage is still more conspicuous when the tool is subjected to heavy duty work as is the case when drilling is performed by means of an underground motor, particularly a turbine. It is partially compensated for when using tools having revolvable rollers and it disappears in crown tools adapted to cut through the ground a cylindrical rock portion known as a "core."

Full diameter drilling tools having a crown-shaped body have already been proposed. In such a case, endeavors were made to obviate the aforesaid disadvantage owing to the use of a central pilot bit capable of drilling a front hole for disintegrating the central portion of the hole or by mounting inside the tool a bit element having for its special purpose the function of destroying a core cut out by the main crown portion.

However these technical solutions of the problem are not fully satisfactory because they do not ensure a sufficient protection against a defective operation of the central portion of the tool or against clogging when drilling certain types of rocks. Moreover, an internal destruction element of this type generally becomes ineffective when the core is broken near its base whereby clogging inevitably ensues.

It is an object of the invention to provide a new or improved tool for full diameter drilling or boring work of the crown-shaped type capable of producing a central core and adapted to ensure a reliable and efficient destruction of said core as the drilling work is being performed so as to stave off any risk of the advance of the tool being hampered.

A further object of the invention is to provide a full diameter drilling or boring tool especially of the so-called solid type comprising a chimney having a chamber rearwardly of the drilling crown portion in which are arranged one or several elements for destroying and disintegrating the core produced by said chimney, said elements enjoying a spontaneous or hydraulically controlled freedom of motion both with respect to the drilling crown portion and with respect to the core.

Throughout the specification, the expressions "forwardly" and "rearwardly" must be construed relatively to the direction of feed of the tool during the drilling or boring operation.

During the drilling or boring operation, the core which penetrates into the chamber is distintegrated by a positive destroying action exerted by the aforesaid elements so that full diameter drilling action initiated by the crown portion may be continued without any hindrance. As the disintegrating members may move or are constrained to move both with respect to the tool itself and with respect

to the core, the latter is efficiently disintegrated even if it becomes broken near its base or where it is revolved with the tool.

Disintegrating members as used may work by attrition, by impacts, by a grinding action, by a blast effect or in any other desired manner. Their action may be reinforced owing to an adaptation of the tool to the ground being drilled or to additional means such as a violent axial irrigation, by the use of core pullers, by an inward core widening, etc.

The chamber in which the disintegrating members are arranged may be provided in the rearward portion of the tool or in an element such as an extraneous joint or union disposed rearwardly thereof.

The particular arrangement of the tool with which said disintegrating members are combined may have any appropriate shape there is provided a hollow nucleus or chimney for allowing the core to pass therethrough. However use may be advantageously made in such a case of a tool including a tubular body portion whose front end is capped by separate drilling wings defining between them large section passages but interrupted at some distance from the tool axis for providing a central chimney forming the aforesaid hollow nucleus, said passages permitting the ejection of core fragments outside said chamber arising from the disintegration process in the flow direction of the fluid that passes through the tool.

A further object of the invention is to provide a tool as aforesaid wherein the distintegrating members are constituted by ball or like elements freely movable through the disintegrating chamber, the latter being then preferably defined forwardly by a grid or equivalent surface on which said ball elements normally rest, thereby permitting the core fragments to be readily drained away. Said ball elements may have any desired shape, for example, a spherical, cylindrical or like shape; they may or may not be provided with cutting or grinding elements such as teeth, sharp ends, insets, etc. Just like the grid and the walls of the disintegrating chamber they may be preferably so treated as to be wear resistant.

During the drilling or boring operation, it is generally necessary periodically to disengage the tool from the bottom of the hole or well being drilled. Such disengagement is then accompanied by angular accelerations or decelerations which cause a better destroying action of the balls or like free elements. The independent movement of said balls may be further increased by imparting to the stream of fluid a turbulent or vortex motion, for example. Such a result can be obtained owing to a suitable arrangement, for example, owing to a slanting disposition of the passages for the intake of the fluid into the chamber or by mounting therein blades or deflectors.

If the tool is applied to horizontal drilling or boring, for example for drilling a front hole as galleries or shafts are being formed in the ground, there may be provided rearwardly of the tool a grinder drum containing balls capable of destroying the resultant core. This drum may have any desired length. Such a method is also applicable to reverse flow drilling involving the use of a single or double tubular column.

A still further object of the invention is to provide a tool as aforesaid wherein the destroying and disintegrating members may be so guided as to limit their freedom of motion in some directions. Such a limitation must be such as to permit in all cases a relative motion of said members with respect to the tool and to the core even in case of breakage of the latter, near its base.

In a suitable constructional form of the invention, the destroying and disintegrating members may be provided with positively driven elements, for example elements driven by an independent hydraulic prime mover

where the required energy for performing the disintegration is fairly large. Such a prime mover may be of the rotary, reciprocatory or vibratory type.

Yet another object of the invention is to provide a drilling tool wherein the disintegrating members are so mounted as to receive a directed displacement having at least a transverse component with respect to the longitudinal axis of the core so as to impart to the latter cutting, percussing or shearing stresses in the transverse direction, thereby permitting the same to be distributed in short lengths or its cutting to be facilitated in proportion as it penetrates into the tool.

Research work that led to the invention showed that such transverse stresses are particularly suitable for cutting a rock core for forming sufficiently small fragments for being evacuated through the irrigation passages of the tool when stratification or cleavage planes extend approximately at right angles to the drilling axis. This is a frequent occurrence because most sedimentary rocks have preferential breakage or cleavage planes which often extend substantially at right angles to the drilling axis.

The power required for exerting such transverse stresses is of small value and can be provided hydraulically by any suitable method. The disintegrating members themselves may be constituted by weights, hammers, knives, saws or the like. In a suitable constructional form, weights may be suspended so as to be movable along a path having a component extending transversely of the axis of the core, said weights being connected to hydraulic actuators ensuring their movement. A suitable construction includes a hydraulic ram actuated by the stream of circulating fluid or by a portion of said stream and imparting motion to members connected to said weights, the latter being advantageously associated with return members in inoperative position.

With these and such other objects in view as will incidentally appear hereafter, the invention comprises the novel construction and combination of parts that will now be described with reference to the accompanying diagrammatic drawings exemplifying the same and forming a part of the present disclosure.

In the drawings:

FIGURE 1 is a detail vertical sectional view of a construction of drilling bit utilizing a core-destroying ball having a vortex outflow.

FIGURE 2 is a view similar to FIG. 1 showing a drilling bit having a freely movable disintegrating cylinder.

FIGURE 3 is a similar view of a tool having destroying balls housed in a rotary cage.

FIGURE 4 is another similar view of a drilling bit including a disintegrating rammer to which a reciprocating motion is imparted.

FIGURE 5 is a sectional view of a drilling bit including breaking members to which a motion having a transverse component is imparted.

Throughout the drawings, the invention is assumed to be applied to a drilling bit including a tubular body 1 the rear end of which has a male or female threaded union portion while its front end is capped by rock-engaging wings 3 having a cylindrical outer boring zone 4 and front boring lands 5 defining therebetween large section flow passages 6. The wings 3 terminate at some distance from the tool axis to provide a central chimney 7 through which the core may pass, said chimney 7 ending at its rear end in a chamber 8 of large size provided inside the tool body. The wings 3 are delineated rearwardly inside the tool by lands 9 which, for example in the showing of FIG. 1, provide a grid-like structure.

Throughout the present specification the same reference characters are used to designate equivalent elements of the shown drilling bits. It will be understood, however, that the invention is not limited to this particular type of tool.

In the constructional form shown in FIG. 1, a disintegrating ball 10 is housed inside the tool chamber 8. Normally this ball 10 rests upon the grid made up of the lands 9. In the present construction, the ball 10 has a roughened or irregular surface provided with protuberances such as sharp edges which increase the sought disintegrating action. The chamber 8 is formed in its middle portion with a widening so that under the rotational effect, the ball 10 and the loosened fragments have a tendency to be lifted over the disintegrating area.

In the upper region of the tool body is provided a deflector designated generally by 11 and comprising an outer annular body portion 12 resting on a shoulder 13 provided on the tool body, a central lancet 14 and inclined blades 15. The deflector 11 is held in position on the shoulder 13 by a rear union or joint 16 screwed into the female threaded portion 2 of the tool. The flowing fluid which passes through the rear union 16 in the forward direction is subjected in the deflector 11 to a deviation which imparts thereto a vortex flow in the chamber 8 so as to increase the action of the tool rotation on the ball 10, thereby producing a composite motion of said ball inside the chamber 8.

When the tool is fed forwardly, the core penetrates into the chimney 7 and its head is broken up and progressively crushed by the ball 10. Fragments resulting from the disintegration are afterwards drained through the passages 6.

If core fragments happen to clog the chamber 8 and if the ball 10 is locked against the dome formed by the front end of the deflector 11, the pressure rises. The drilling worker may then disengage the tool and permit the flowing fluid to free the ball 10 and to clean out the chamber 8.

In the alternative constructional form shown in FIG. 2 in which the drilling bit includes rectangular wings 3' and is provided in the chimney 7 with a core breaker 17, a crushing cylinder 18 is mounted inside the chamber 8 in which it can freely move. The rear portion 19 of the cylinder 18 is lancet-shaped so as to exert a minimum resistance to the fluid flow, while its front portion has flutes 20. Its front face has a central land provided with teeth 21 and a circular bearing surface 22. The operation of the cylinder 18 is similar to the operation of the aforesaid ball. In each case, free movement of the disintegrating member in the chamber 8 performs destruction of the core even if the core became broken near its base and is revolubly driven by the tool.

In the showing of FIG. 3 is represented a constructional modification including freely movable members that are urged to effect a positive grinding motion inside the chamber 8. The rear union 48 screwed upon the threaded portion 2 of the tool carries directing vanes 49 which rest upon a shoulder 50 of said union. Said directing blades are surmounted by a ring member 51 on which rests an outer ring member 52 which carries a thrust bearing 53 by means of arms 54 defining fluid flow passages. A shaft 55 is mounted in said bearing 53 and is terminated at its front end in motive blades 56 an extension of which forms a revoluble cage 57. This cage terminates at its front end in a ring member 58 whose inner face carries an anti-abrasive coating 59 while its outer face forms a rubber or like bearing 60 which guides the revoluble cage inside a chimney 61 fitted inside the tool body 1. Balls 62 are mounted for free motion in the revoluble cage 57 and are abutted against the grid made up of the lands 9 on the tool wings.

During the drilling or boring operation, the circulating fluid rotates the cage 57 which positively stirs the balls 62, thereby increasing the disintegrating efficiency of the core. This has the advantage of being simple while only requiring a relatively small torque.

The arrangement represented in FIG. 4 comprises a seat 71 for mounting a motor or engine 72 of the hydraulic type whose shaft 73 carries a rammer 74 terminating

on its lower face in teeth 75 and having a reciprocatory motion imparted thereto corresponding to the distance indicated by 76. The rammer 74 which is moved relative to the tool and core ensures the destruction of the core by impact i.e. by a percussive action.

In the showing of FIG. 5, the core 78 passes, during the drilling operation, through a core guide 79 and penetrates into the chamber 8 defined in the drill bit. In this constructional form, a hydraulic ram sleeve 80 is fitted in the rear union 16 and provides peripheral passages 81 and a central passage 82 for the flow of the circulating fluid. The central passage 82 provides at its lower end a seat 83 for a poppet valve 84 carried by a rod 85 slidable through a guide 86 supported by an annular seat 87 by means of spider arms 88. The valve 84 is normally urged upwardly by a compression spring 89.

The rod 85 carries at its lower end a conical ram head 90 which normally engages the rear ends of a pair of scissor-like levers 91 hinged to each other by a pin 92 set into the drill bit wall and urged together by a return spring 93. The other ends of said levers 91 carry breaking weights 94 which are arranged in front of each other and in offset relation depending upon the nature of the rock being drilled.

The operation of this core-breaking device will be easily understood: As the hydraulic ram raises and lowers the valve 84, the motion of the conical ram head 90 opens and closes the corresponding ends of the scissors-like levers 91 and the weights 94 for breaking the core 78. Such a movement of the weights occurs at a frequency which permits the core to be sufficiently disintegrated to enable its fragments to be evacuated through the drill bit irrigation passages. The percussive force of the weights is amply sufficient to cause breakage due regard being paid to the splitting characteristics of most cores as before indicated.

Constructional details may vary without departing from the scope of the subjoined claims.

What is claimed is:

1. A tool of the drill bit type through which a liquid flows for achieving full diameter boring of the ground comprising a tubular body having a central axis and a front end, means defined on said body for attaching said body to a tubular support, wings capping said front end of the tubular body and radially extending within said body and terminating at a distance spaced from its central axis having radially disposed lands within said body, a passageway defined centrally within said body by said wings receiving a core when the tool is forwardly fed, circulation channels defined between adjacent wings and said tubular body, a chamber defined within said body extending rearwardly of said wings from said lands with respect to the direction of forward feed of the tool, and liquid-actuated percussing means within said chamber for disintegrating the core defined by said passageway into fragments, the circulation fluid draining away the fragments of the broken core through said channels.

2. A tool of the drill bit type through which a liquid stream flows for achieving full diameter boring of the ground comprising a drilling crown, a chimney formed centrally of said crown to define a core as the tool is fed forwardly, a chamber extending rearwardly of said crown with respect to the direction of forward feed of the tool, a grid-like structure limiting said crown on its rear face inside said chamber, and ball means for breaking up and disintegrating said core defined by said chimney, said ball means freely resting on said structure inside the chamber and enjoying a spontaneous freedom of motion both relative to the drilling crown and relative to the core.

3. A tool according to claim 2 wherein the ball means have a shape at least substantially spherical and are provided on their surface with rough protuberances forming core-disintegrating sharp edges.

4. A tool of the drill bit type through which a stream of liquid flows for achieving full diameter boring of the ground comprising a drilling crown, means having vertical surfaces providing a passageway formed centrally of said crown to define a core as the tool is fed forwardly, means defining a chamber extending rearwardly of said crown with respect to the direction of forward feed of the tool, ball means for breaking up and disintegrating the core defined by said passageway, said ball means being freely housed in said chamber and enjoying spontaneous freedom of motion both relative to said drilling crown and relative to said core, and deflector means fitted in said chamber rearwardly of said ball means so as to impart a vortex motion to the liquid stream within said chamber.

5. A tool according to claim 4, wherein a grid limits the drilling crown on its rear face inside said chamber, the core-destroying and disintegrating ball means normally resting on said grid-like structure.

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