Aug. 13, 1957 F. G. BOUCHER ET AL 2,802,640

CABLE TOOL BIT

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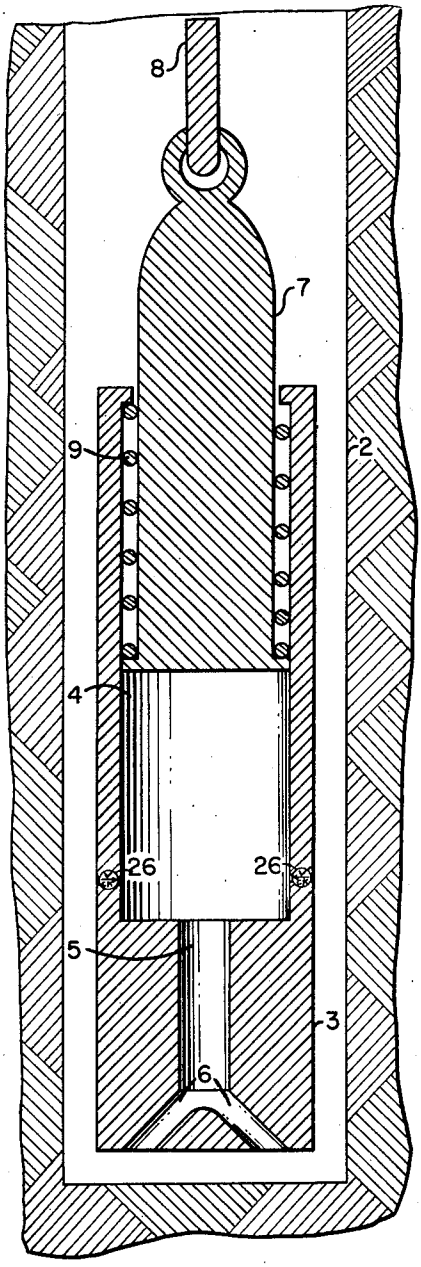


FIG. I

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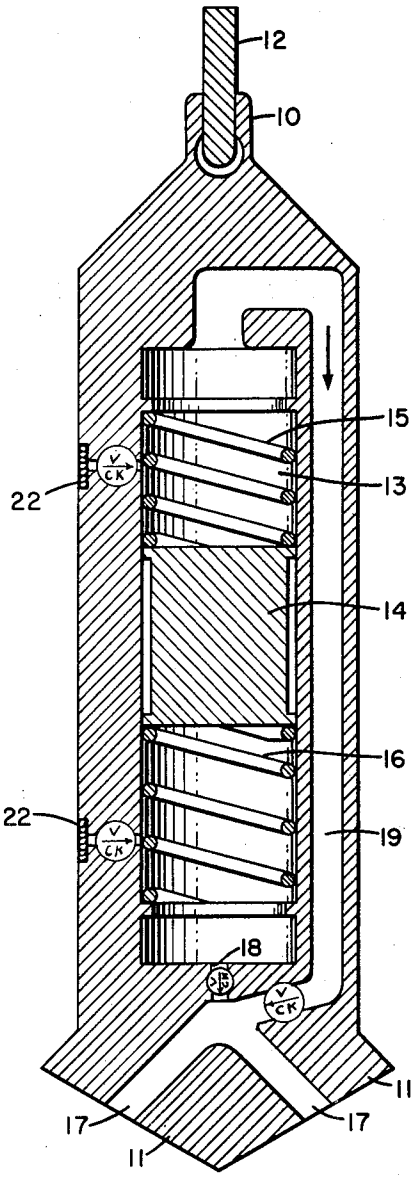


FIG. II

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CABLE TOOL BIT

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5 Claims. (Cl. 255—5)

This invention concerns an improved form of drill bit for use in the so-called percussion tool or cable tool drilling technique. The drill of this invention is provided with a spring-loaded piston arrangement adapted to eject fluid against the formation to be drilled during each impact of the tool, so as to wash debris from the drilling surface. The invention thus concerns an improvement in the cable tool drilling technique achieved by providing positive means to clean the formation to be drilled just prior to and during impact with a cable tool drill bit.

In drilling boreholes in the earth, and particularly in exploration for petroleum, two principal drilling techniques are employed at the present time. The older of these techniques is the so-called percussion tool system of drilling. In this drilling technique, the pounding action of a heavy cutting tool is employed to disintegrate the formation to be drilled. The system consists essentially of means to lift the massive drilling tool a short distance, after which the tool is allowed to fall by its own weight so as to strike the bottom of the borehole with sufficient impact force to shatter the formation. Drill cuttings or debris are removed by placing water in the borehole so that a slurry is formed with the cuttings which is bailed out periodically.

To a large extent, percussion tool drilling of this type has been displaced by rotary drilling techniques. However, the percussion tool drilling system has certain unique advantages which make this system of particular value under at least certain conditions. The present invention is intended to further extend the desirability and utility of percussion tool drilling.

Heretofore it has been one of the disadvantages of the percussion tool drilling technique that no positive means has been available to wash drill cuttings from the face of the formation during drilling. To some extent drill cuttings lying on the bottom of the borehole have cushioned the impact of the drilling tool so as to substantially decrease the efficiency of drilling. It is the principal object of this invention to provide simple and effective means in a percussion tool drill bit, resulting in ejection of washing fluid during the impact stroke so as to clean drill cuttings from the formation at the moment of impact.

In accordance with this invention, this objective is achieved by provision of a cylindrical recess in the body of the percussion tool drill bit. A spring-loaded piston is positioned in this recess so as to act as a pump, on reciprocal movement of the piston taking in fluid from the borehole and ejecting this fluid through suitable passages. The necessary ports and means to spring load this piston in accordance with this invention are so arranged that when the percussion tool is dropped, the piston is actuated so as to eject fluid through openings in the face of the drill, washing drill cuttings from beneath the drill as the tool drops for impact against the formation.

The accompanying drawings diagrammatically illustrate in cross-sectional elevational detail two embodiments of this invention. In the drawings:

Figure 1 illustrates the simplest form of the invention in which the piston of the arrangement is fixed to the supporting cable while the drill bit itself is machined as a cylinder and is maintained in sliding relation with the piston, and;

Figure 2 illustrates a preferred embodiment of the invention in which a central piston arranged in a cylinder of the percussion tool acts as a double acting pump during drilling.

Referring first to Figure 1, a percussion tool embodying the principles of this invention is illustrated in operative position in a borehole 2. The body of the drill bit is designated by numeral 3 and constitutes a massive cylindrical element having a suitable configuration at the bottom thereof to fracture earth formations when the drill bit is dropped on the bottom of the borehole. A cylindrical chamber 4 is cut in the central portion of the drill bit body 3 so as to essentially provide a pump cylinder. Cylinder opening 4 connects to a channel 5 and one or more ports or nozzles 6 are positioned in the bottom face of the drill bit so that fluid ejected through these ports can wash cuttings in the vicinity of the drill bit. Check valves are provided in the ports 26 at the lower portion of the pump cylinder permitting flow of fluid inwardly into the pump cylinder but preventing flow in the opposite direction.

A piston 7 is arranged within the pump cylinder 4, extending upwardly through a suitable clearance opening in the bit body 3. The conventional supporting cable 8 is fixed to the upper termination of the piston 7. A spring 9 is provided so as to normally urge piston 7 dornwardly with respect to the drill body 3.

In operation, when the percussion tool is lifted by the conventional means, such as a walking beam, the mass of the drill body 3 serves to compress spring 9 when the cable 8 raises the piston 7 to an upward position with respect to the drill body 3. This serves to cause drilling fluid maintained in the borehole to be pulled through check valves 26 into the pump cylinder. When the percussion tool is then released so as to drop to the bottom of the borehole, spring 9 causes the piston 7 to move downwardly with respect to the body of the drill bit so as to force drilling fluid to jet from orifices 6, cleaning away cuttings from the face of the formation just prior to impact of the percussion tool. In this manner the drill illustrated in Figure 1 serves to wash cuttings from the formation during each impact stroke of the percussion tool.

Referring now to Figure 2, a preferred embodiment of this invention is illustrated. The drill bit of Figure 2 employs the same general principles as the bit of Figure 1 just described, but provides a freely suspended piston arrangement in such a manner as to obtain double acting pump action. In the drawing, the numeral 10 designates the body of the drill bit having the cutting faces 11. The drill 10 is supported in a borehole by means of a cable support 12. A central cylindrical chamber 13 is machined in the body of the drill bit in order to effectively provide a pump cylinder. A piston 14 is provided in the pump cylinder and is freely suspended by means of the springs 15 and 16 above and below the piston. Ports or nozzles 17, opening through the cutting face of the drill bit, are in fluid communication with a channel 18 giving fluid access to the lower portion of the pump cylinder and a channel 19 giving access to the upper portion of the pump cylinder. Ports 18 and 19 are provided with check valves such as the spring-loaded valves illustrated, adapted to permit flow of fluid from the pump cylinder through ports 17 and adapted to prevent flow of fluid in the opposite direction.

A fluid entry port 20 is also provided at an upper portion of the pump cylinder and a fluid port 21 is provided at the lower portion of the pump cylinder. Ports 20 and 21 permit flow of fluid from the annulus of the borehole about the drill bit into either the upper or lower portion of the pump cylinder. Spring-loaded check valves are again positioned in ports 20 and 21 so as to permit flow of fluid inwardly to the pump cylinder while preventing flow of fluid in the opposite direction. The ports 20 and 21 may be covered with screens 22 in order to prevent drill cuttings or other debris from gaining entrance to the pump cylinder.

In the arrangement described, the supporting cable 12, because of its natural elasticity, can be effectively considered a spring, supporting the main mass of the drill bit. The spring suspended piston 14 can be considered an auxiliary mass having a spring constant determined by the characteristics of springs 15 and 16 and having a damping or dash-pot effect depending on the characteristics of the fluid in the pump cylinder. The spring constant of the supporting cable, considered in conjunction with the main mass of the drill bit, and the spring constant of the auxiliary mass or piston together with its damping effect, can be selected and designed so that during use of the drill bit any desired phase relation can be maintained between the movement of the bit body and the movement of the piston. For example, in operation of the drill, the optimum relationship for effective use is that movement of the piston 14 should be 90° out of phase with movement of the drill bit 10. As a result, therefore, when the drill bit 10 is at its uppermost position, piston 14 may be moving upwardly at about the central position of the pump cylinder causing fluid to be drawn into the pump cylinder below the piston. When the drill bit is then dropped toward the bottom of the formation, at the moment of impact, the piston 14 will have reached its uppermost position for full intake of fluid beneath the piston and will have moved downwardly to about the central portion of the pump cylinder, having discharged about half of the fluid capacity of the pump while the drill bit moved from its uppermost position to the impact position. This 90° phase relation results in the piston having maximum velocity at the moment the drill bit strikes the formation to provide the fastest jet of fluid from the pump cylinder through ports 17 at this time.

On consideration, it will be apparent that the phasing of the movements of the pump cylinder with respect to the movements of the drill bit will be effective in providing a washing jet of fluid at the face of the drill bit for all phase relations other than 180°. Because of the double acting pump effect, any phase relation other than 180° will be effective to provide the desired fluid ejection during impact of the drill bit.

It is apparent that in employing this invention, somewhat greater power is required than in the operation of the conventional cable tool bit. This extra power is required for transmission of energy to the pumping arrangements described. The extent of fluid ejection possible in accordance with this invention is primarily limited by the power which it is desired to put to this use which can be set by the design of the pump components.

What is claimed is:

1. A percussion drilling tool comprising, in combination: a body member adapted to be suspended within a bore hole, cutting faces defining a first end of said body member, said first end also being the lower end of the body member when the body member is suspended within a bore hole, a cylindrical chamber centrally disposed within said body member, the longitudinal axis of the chamber being substantially vertical when the body member is suspended within a bore hole with the lower end of the chamber being disposed toward the lower end of the body member, a piston fitted and movable within said chamber, spring means within said chamber in a manner biasing said piston against travel within said chamber toward the upper end of said chamber, a first fluid port extending from within said chamber and below said piston to the exterior of the lower end of said body member, a second fluid port extending through the wall of said body member from a point near the lower end of said chamber to a point exterior of the body member, first check valve means within said first port to enable fluid to flow from within said chamber through said first port, and second check valve means within said second port to enable fluid to flow into said chamber.

2. An apparatus as defined in claim 1 including means attachable to the upper end of said body member for suspending the apparatus.

3. An apparatus as defined in claim 1 including means attachable to the piston for suspending the apparatus within a bore hole.

4. An apparatus as defined in claim 1 in which the spring means comprises a separate spring positioned on each side of the piston within the cylindrical chamber.

5. A percussion drilling tool comprising, in combination: a cylindrical body member adapted to be suspended within a bore hole, cutting faces defining a first end of said body member, a plurality of nozzles opening through said first end, said first end also being the lower end of the body member when the body member is suspended within a bore hole, means attachable to the opposite end of the body member for suspending the body member, a cylindrical chamber centrally disposed within said body member and arranged such that the longitudinal axis of the chamber is substantially vertical when the body member is suspended within a bore hole, the lower end of the chamber being that end of the chamber which is disposed toward said first end of said body member, a piston movably fitted within said chamber, a separate spring element positioned on each side of said piston and within said chamber, a first fluid port extending from the lower end of said chamber to said plurality of nozzles, a second fluid port extending through the wall of said body member from a point near the lower end of said chamber to a point exterior of the body member, a third fluid port extending through the wall of said body member from a point near the upper end of said chamber to a point exterior of the body member, a fluid channel within the body member connecting the upper end of said chamber to said plurality of nozzles, separate check valve means in each fluid port and in said channel, the check valve means in said second and third ports being adapted to enable fluid to flow into said chamber, the check valve means in said first port and said channel being adapted to enable fluid to flow from within said chamber.

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