Oct. 11, 1932. L. M. BRIGHAM 1,882,545

ROTARY DRILL BIT

Filed Dec. 27, 1929

Fig. 1.

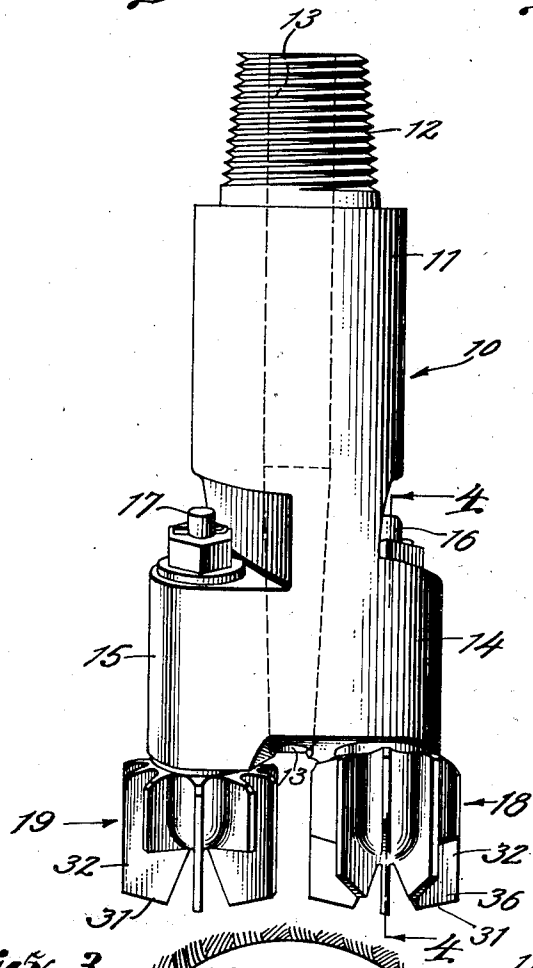


Fig. 2.

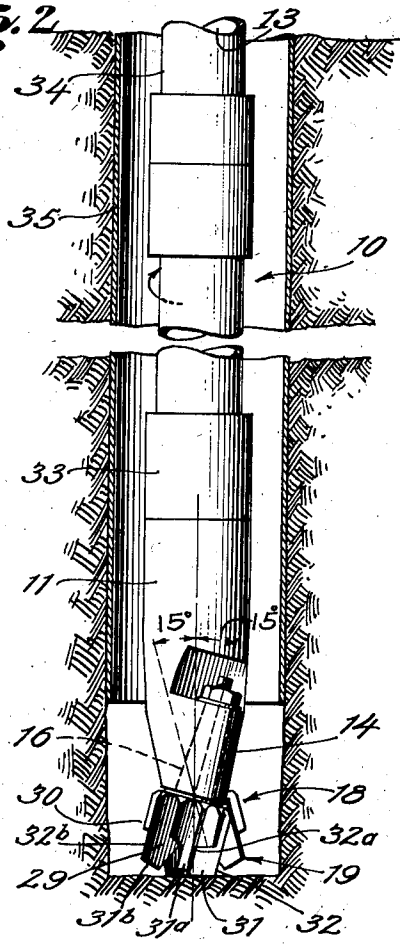


Fig. 3.

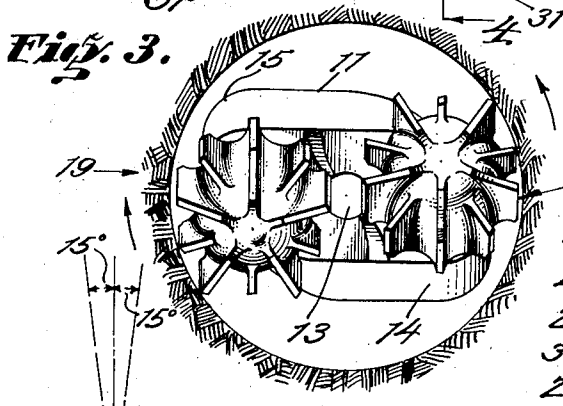


Fig. 4.

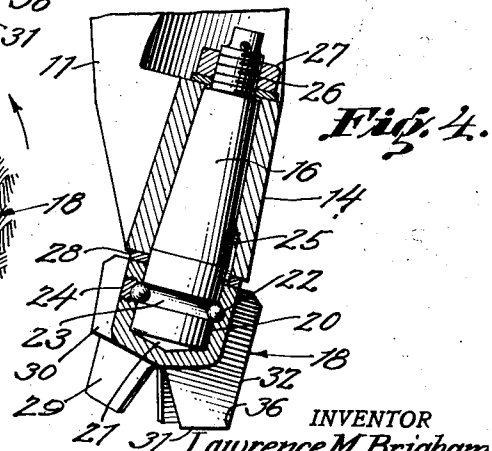
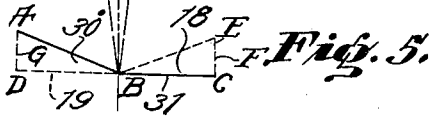


Fig. 5.



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UNITED STATES PATENT OFFICE

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ROTARY DRILL BIT

Application filed December 27, 1929. Serial No. 416,807.

This invention relates to improvements in drilling bits whereby bore holes are drilled in the earth, and has for its particular object the provision of a rotary drill bit body with oppositely placed rotary cutters, the longitudinal axes of which are inclined at a preferred angle to the longitudinal axis of the body.

Another object of the invention is to provide a rotary drill bit having a plurality of rotary cutters adapted to form a bore in the earth by vertical and horizontal cutting.

Referring to the drawing:

Fig. 1 is a side view of an assembled rotary drill bit according to this invention.

Fig. 2 shows the drill bit in place in the earth, as in an oil well.

Fig. 3 is a bottom view of the bit shown in Fig. 1.

Fig. 4 is a sectional detail along the lines 4—4 of Fig. 1.

Fig. 5 is a diagram showing the cutting planes of the cutters.

The drill bit as a whole is indicated at 10 and comprises a body 11 having an upper tapered screw joint 12 and a central orifice 13 through which mud or water may be forced. The lower portion of body 11 has two oppositely disposed bulges or shoulders 14, 15 which form supports for stems 16, 17 respectively on which are rotatably mounted the cutters 18 and 19.

The upper and lower faces of shoulders 14 and 15 are milled off at a preferred angle to a horizontal plane and are drilled through to receive the tapered stems 16 and 17, each stem rotatably supporting similar cutters 18 or 19 in the following manner.

Referring particularly to Fig. 4, cutter 18 is provided with a central cavity 20 into which the stem 16 fits, the bottom of cavity 20 being formed in conical shape, the angle of slope 21 being the same angle at which a plane through the longitudinal axis of stem 16 is set with respect to a plane through the longitudinal axis of body 11. The lower portion of stem 16 is machined in similar fashion to snugly, but rotatably, fit into cavity 20 which has an interior groove 22 adapted to register with a groove 23 on stem 16 when the parts are assembled.

A key 25 is set in stem 16 and adapted to lock in shoulder 14 to prevent turning of stem 16, which is further locked by having a threaded end 26 locked by nut 27, and a thrust washer 28 fits between cutter 18 and the lower face of shoulder 14.

The cutter 14 is detachably held on stem 16 by removing a plug 24 and filling the grooves 22 and 23 with steel balls, or pouring therein a molten metal such as bronze, whereby rotation is permitted but the cutter cannot fall off the stem.

The cutter 14 has long radially extending fins 29 and short radially extending fins 30, the long fins 29 being provided with a bottom cutting edge 31 set at the preferred angle to a plane to which the longitudinal axis of stem 16 is perpendicular and a side cutting edge 32; the short fins 30 having similar cutting edges in proportion.

In the operation of drilling a hole, the body 11 is threaded into a drill collar 33 suitably connected with a string of drill pipe 34 extending to the surface of the earth, the cutters 18 and 19 working below the casing 35.

Water or mud is forced through the drill string, which is rotated by suitable machinery from the surface, thereby forcing cutters 18 and 19 into engagement with the bottom of the hole and causing them to rotate in a direction opposite to the drill string rotation.

As shown in Fig. 2, the bottom cutting edges 31, 31*a* and 31*b* are in planes which set at the preferred angle to a plane to which the longitudinal axis of stem 16 is perpendicular and upon rotation clockwise come successively into a horizontal cutting position on the bottom of the hole, and then go out of cutting position to a maximum angle from

horizontal which is equal to twice the angle at which stem 16 is set with respect to body 11.

In actual practice the preferred angle at which a plane through the longitudinal axis of cutter 18 is inclined with respect to a plane through the longitudinal axis of body 11 may be properly varied between 10° to 20° and I find a maximum efficiency of cut at 15°.

The cutting planes of cutters 18, 19 are illustrated in Fig. 5, in which it will be seen that the bottom cutting edges of cutter 18 will be in the position A, B, C, while the bottom cutting edges of cutter 19 will be in the position D, B, E.

Such positions provide that when a cutting edge 31 reaches a horizontal position on the bottom of the hole, said cutting edge will cut into a face F while the opposing cutter will provide a cutting edge 31 to cut into a face G.

The depth of faces F, G will be determined by the angle at which the plane through the longitudinal axes of cutters 18, 19 is inclined with respect to the plane through the longitudinal axis of body 11. If such angle goes much beyond 20°, the cutters will be inclined too much to rotate and cut, and if such angle be much less than 10°, an insufficient cut will be had. As already stated, maximum cutting efficiency is attained in the use of an angle of 15°.

In like manner the edges 32, 32*a* and 32*b* come into cutting position successively on the sides of the hole to provide a reaming action. In both cases it will be especially noted that the action of both cutting edges 31 and 32 is a shearing action. There is only one position in which edge 31 is horizontal while cutting and in this position it will be parallel with the slope of the conical end of stem 16 as shown at 21.

This provides that the thrust is taken through said conical end on a horizontal line through which the vertical axis of body 11 passes centrally and gives a long life to the bit, the filling of grooves 22 and 23 merely assuring that cutter 18 will not fall off stem 16.

The cutters 18 and 19 form the bottom of the hole as indicated by the lines in Fig. 5, leaving a small central core which is broken away partly by the jet of water issuing from passage 13, which jet also serves to aid in the rotation of cutters 18 and 19 by impinging on the blades thereof and is particularly useful when the cutters stick because then the whole string may be raised a short distance off the bottom to permit the jet to rotate the cutters and free them from dirt, mud, etc.

In setting the planes through the longitudinal axes of cutters 18, 19 and stems 16 and 17 at an angle of about 15° to a plane through the longitudinal axis of body 11, a maximum cutting rate is provided in which cutters 18, 19 are maintained free from soil, etc. and give the desired shearing action; Fig. 2 giving the relative positions of said planes referred to, it being particularly noted that the inclination of stem 16 is towards the direction of rotation of the drill body, which direction is anticlockwise and therefore the rotation of the individual cutters will be clockwise.

Such shearing action provides that at only one position in each rotation of the cutters is the full length of either of the cutting faces 31, 32 in contact with the bottom face to be cut or side of the hole and the efficiency of the cutters is due to this action, the contact edge of fins 29 providing a toe 36 between cutting edges 31 and 32.

It is, of course, obvious that in large size bits more than two cutters may be symmetrically mounted on body 11, but less than two cutters would be undesirable because of unbalanced side thrust.

Also, the number of long fins 29 may be increased and the short fins 30 may be eliminated according to the stratum being drilled, but in providing that the preferred angular inclination of a plane through the longitudinal axis of cutter 18 or stem 16 to a plane through the longitudinal axis of body 11 is equal to the angle of slope 21 and to the "set" of cutting edges 31, maximum cutting efficiency is attained for any particular number of cutting edges.

Where referred to herein, it is assumed that the longitudinal axis of body 11 is in a vertical plane in its normal operating position towards which the planes through the longitudinal axes of the cutters 18, 19 are inclined at a preferred angle and that the lower faces of shoulders 14, 15 are inclined at a preferred angle to a horizontal plane, both of said angles being equal in the best practice.

I claim as my invention:

1. A rotary drill bit comprising: a body, shoulders on the body each having a lower face inclined to the horizontal but in opposed angularity to the other, a stem on each shoulder and having a conical lower end, a rotary cutter detachably held on each conical end to fit the same, and spaced blades on the cutters having bottom and side cutting edges; the said bottom cutting edges being in planes parallel to elements of said conical end, and planes through the longitudinal axes of the cutters being inclined at an angle to a plane through the longitudinal axis of the body.

2. A rotary drill bit comprising: a body, shoulders on the body each having a lower face inclined to the horizontal but in opposed angularity to the other, a stem projecting from each shoulder and having a conical lower end, a rotary cutter on each stem surrounding its conical end and having an upper face parallel to said lower face, and cir-

cumferentially spaced blades on the cutters having straight bottom and side cutting edges; the said bottom cutting edges being in planes parallel to elements of said conical end and planes through the longitudinal axes of the cutters being inclined at an angle to a plane through the longitudinal axis of the body.

In testimony whereof, I have hereunto set my hand at Los Angeles, California, this 18 day of December, 1929.

LAWRENCE M. BRIGHAM.