Dec. 26, 1944. W. ST. M. E. CRAKE 2,365,941

OIL WELL DRILL BIT

Filed Aug. 31, 1942

Fig. II

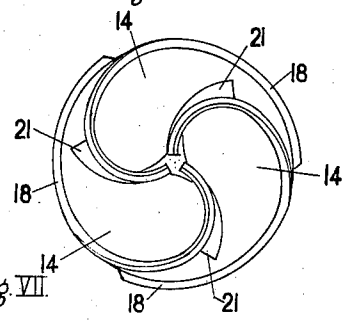


Fig. VII

Fig. III

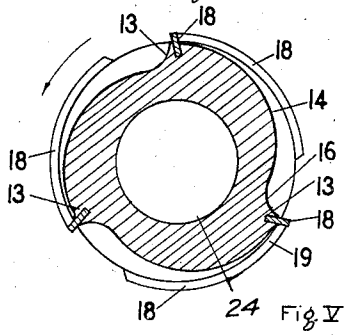


Fig. V

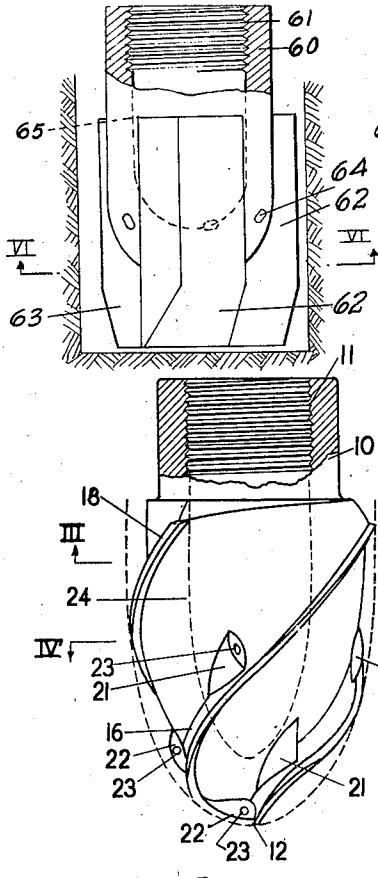
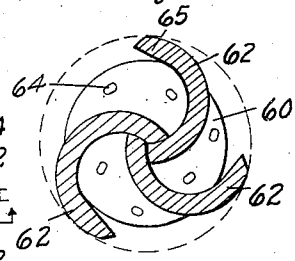
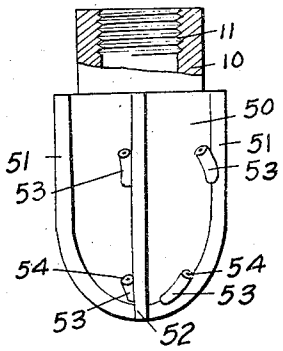


Fig. I

Fig. VI





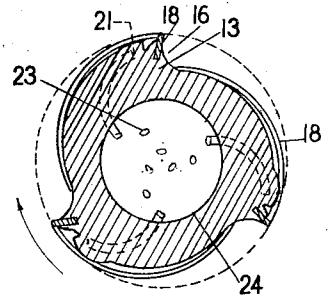


Fig. IV

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By his Attorney

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UNITED STATES PATENT OFFICE

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OIL WELL DRILL BIT

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Application August 31, 1942, Serial No. 456,829

4 Claims. (Cl. 255—61)

The present invention relates to improvements in rotary drilling bits, and pertains more particularly to an oil well bit for drilling in relatively soft formations.

A general object of this invention is to provide a practical, effective and long-wearing drill bit for use in drilling wells.

Another object of this invention is to provide a drill bit having its blades formed along substantially hyperbolic spiral lines. This shape has been found to give the greatest cutting edge length for a given axial length and diameter of bit, and thus keeps the bit shorter for the same effective length of cutting edge.

In the drilling of deep wells, the bit is secured to the lower end of a drilling string made up of a large number of pipe sections, and the string is rotated and fed downwardly so that the bit drills away the earth formation. The cutting parts or edges of a conventional rotary drag type or fishtail bit wear away very rapidly, and the bit must be removed from the well for replacement by a new or reconditioned tool after a relatively short period of use. The removal of the worn bit necessitates the withdrawal and disconnection of the long string of drill pipe, which must then be again re-assembled and lowered into the well, whereby large time losses are incurred. The present improved bit with hyperbolic spiral blades has a much longer effective life than conventional bits, since, due to the lines of curvature used, the cutting edges of the bit are caused to wear off evenly per effective projected radial length. The time and labor lost in pulling and running in the drilling string when using the present bit are accordingly substantially reduced.

Another object of this invention is to provide an improved drill bit formed with high grade steel blades of constant cross-section in a lateral or radial direction, whereby a constant pressure on the bit will cause a constant unit loading between the formation and the cutting edge of the blades until the blades are completely worn out.

A further object of this invention is to provide a drill bit having upwardly-directed circulation ports located along the length of the blades, and close thereto whereby the bit is more effectively kept clear of debris. In normal fishtail or other scraping or drag-type bits, the circulation ports are directed downwardly, either parallel to the axis of the drill pipe or nearly so, and therefore the cuttings removed by the blades are forced by the blades into a stream of fluid moving downward and in an opposite direction from the natural direction of the cuttings, as they clear the cutting edge of the blades. This delays the removal of the cuttings from the blades and causes turbulence before the cuttings and circulation fluid start to move clear of the bit as required for disposal to the surface along the outside of the drill pipe. The upwardly-directed circulation ports in the present drill bit most effectively maintain the blades free from cuttings and muck.

A still further object of this invention is to provide an improved drill bit which has even bearing points on the borehole walls, will be smooth running, and will tend to center itself and to drill straight holes.

With the above and other objects in view, the invention has particular relation to certain novel features of construction and arrangement of parts, an example of which is given in this specification and is illustrated by the accompanying drawing, wherein:

Figure I is an elevation view of a preferred embodiment of the drill bit of the present invention.

Figure II is a plan view of an inverted drill bit.

Figure III is a cross-section view taken along the line III—III in Figure I.

Figure IV is a cross-section view taken along the line IV—IV in Figure I.

Figure V is an elevation view of another embodiment of the drill bit.

Figure VI is an elevation view of still another embodiment of the drill bit.

Figure VII is a cross-sectional view taken along the line VII—VII in Figure VI.

Referring to the Figures I to IV of the drawing, a preferred embodiment of the drill bit of the present invention is provided with a shank 10 which is illustrated as a sleeve having internal threads 11 to engage the end of the drill string. It is to be understood that the shank, instead of being an internally threaded sleeve, can be an externally threaded cylinder.

The body portion of the bit is formed, as shown in the drawing, with a plurality, preferably two or more, of blade-carrying raised portions 13 spirally extending upwardly and outwardly from the apex 12 of the bit towards the shank 10 in a clockwise direction. In other words, the raised portions 13 spiral downwardly and inwardly from the shank 10 in the direction of rotation of the bit and meet or nearly meet at the apex 12. The blade-carrying raised portions 13 of the bit are so contoured that the rotation of the bit drills a hole having a shape substantially like the figure of revolution described by a hyperbola when ro-

tated about its focal axis. In other words, the raised portions 13 are contoured in the form of a hyperboloidal or substantially hyperboloidal spiral, that is, spirals on a hyperboloidal base, which figure is obtained by rotating a hyperbola or reasonable modification thereof, about its focal axis. It is preferable that the raised portions 13 converge from the hyperboloidal shape in the lower part of the bit to a cylindrical shape for several inches of vertical length in the upper part of the bit, this upper part thereby constituting a reaming section to maintain full gauge of the drilled hole. As shown most clearly in Figure III, the faces 14 between the raised blade-carrying portions 13 dip sharply as at 16 ahead of the raised portions 13 in the direction of rotation and then smoothly build up to the preceding raised portions 13. Thus, each face 14 comprises a relatively long inwardly receding portion and a relatively short outwardly and sharply inclined portion 16 arranged with the latter portion 16 on the leading or forward side of the raised portions 13, as shown in Figures III and IV.

The blade-carrying raised portions 13 may be integrally formed with cutting edges or blades or, as shown in Figures III and IV, preferably, may be fitted with short constant cross-section blades 18. The cutting edges, whether formed integrally with or inserted into the raised portions 13, are preferably made of high-grade hardened steel, or hard-surfaced. Tool steels, such as tungsten carbide and alloys, such as the chromium-cobalt alloys known as Stellite, may be used.

By constant cross-section blades it is meant that the blades 18 are formed to give a transverse cross-section in the shape of a parallelogram or rectangle, that is, a transverse cross-section with the lateral sides parallel, whereby the thickness of the blade 18 remains constant as it is worn away. The blades 18 are preferably inserted and fastened, such as by welding, into a groove 19 in the peak of the raised portions 13. In order to give a slightly slicing action to the cutting, the blades 18 are preferably set at a leading angle, such as about 10° to 30°, for example 20°, to a radial line, i. e., a line passing through the axis of the bit and normal or perpendicular to the formation. This arrangement in addition gives greater life to the cutting edge of the blades 18.

At the juncture of the sharply inclined portions 16 and the long receding portions of the faces 14 between the blade-carrying raised portions 13, that is, closely adjacent to and on the upper side of the blades 18, are a series of streamlined bulges 21 having flat faces 22 in more or less perpendicular relation to the blades 18 adjacent thereto. Arcuate bores or ports 23 extending from said faces 22 through the bulges 21 to the axial bore 24 in the bit body serve as fluid circulation channels, or water-courses, through which drilling fluid or mud, or the like, is discharged in an upward direction along the sharply-inclined faces 16 of the raised portions 13 and the upper and leading side of the blades 18, whereby the blades 18 are kept washed clean by a smoothly flowing upwardly-swirling stream of drilling fluid issuing from said ports 23. Preferably, as shown in Figure I, the bulges 21 and their circulation ports 23 are spaced along adjacent each raised portion 13 with one close to the apex or tip 12 of the bit and two, as shown, or more, up further on the bit. The bottom holes 23a point downwardly, but at an angle which causes the fluid therefrom to start flowing along the edge of the blade. On the other hand, the mud ports may be formed of removable nozzles positioned along the leading side of the blades 18. If desired, the axial bore 24 extending through the shank 10 into the drill bit body may be tapered or, as shown by dotted lines in Figure I, may be in the form of a hyperbolic figure of rotation similar to the outer general shape of the bit.

It will be readily seen that in operation the improved drill bit of the present invention provides numerous advantages over prior bits. The hyperboloidal spiral contour of the blades 18 gives a long wearing bit and provides the greatest cutting length per vertical length and per unit diameter of the bit, thus keeping the bit shorter for the same effective length of cutting edge or blade. In addition, the rotating action of the bit causes the spiral blades 18 to act as a screw pump impeller and to assist in forcing or pumping cuttings and circulating mud or drilling fluid upwardly to clear the bit. Further this type of blade will require less horsepower and torque to rotate and thus will give steadier and smoother cutting action. The form and position of the upwardly-directed circulation ports 23 causes the fluid, such as mud, circulation to be directed so that cuttings are forced in the natural direction of flow from the cutting edge of the blades 18 to clear the bit, i. e., towards the formation as it is cut and at an angle tending towards the shank 10 at the top of the bit. Thus, better and more efficient use is made of the available circulation of drilling fluid.

Various modifications and changes may be made within the scope of the appended claims without departing from the spirit of the invention. Thus, although the above-described hyperboloidal spiral-bladed drill bit is the preferred form of the invention, some of the advantages of the present invention are retained with a hyperboloidal drill bit having non-spiral blades, as shown in Figure V, or with a flat bottom drill bit having spiral blades, as shown in Figures VI and VII.

Referring to Figure V, the second embodiment of the drill bit comprises a shank 10 having internal threads 11, a hollow body 50 of substantially hyperboloidal shape, axial blades 51 projecting from said body 50 and preferably meeting at the apex 52 at the bottom of the bit, and preferably streamline bulges 53 on the leading side of said blades 51 and having upwardly-directed mud ports 54 therein.

Referring to Figures VI and VII, the third embodiment comprises a cylindrical bit body 60 having internal threads 61 at its upper end, the lower end of the body 60 being rounded off, and blades 62 projecting from said body 60. The blades 62 in transverse cross-section, as shown in Figure VI, have a form spiralling outwardly in the direction of the rotation of the bit, with the outer end of the inner face modified slightly to a substantially straight portion 65. Vertically the blades 62 are parallel to the axis except for the lower portions 63, which are slightly tapered, as shown in Figure VII. Ports 64 provide passage of drilling fluid from within the axial bore 65 of the drill.

I claim as my invention:

1. An improved drill bit for rotary drilling of wells comprising a hollow body having a plurality of laterally-extending cutting edges curved spirally downwardly in the direction of rotation of the drill bit and substantially meeting at an apex at the lower end of the bit said cutting edges together with said hollow body being formed to describe upon rotation of the bit a substantially hyperboloidal figure of revolution, said body hav-

ing fluid circulation ports extending therethrough and directed upwardly adjacent said spiral cutting edges on the leading side of said cutting edges, and means in the upper end of said hollow body for connecting the bit to a drill string.

2. An improved drill bit for rotary drilling of wells comprising a hollow body formed with a plurality of laterally raised portions curved spirally downwardly in the direction of rotation of the bit and substantially meeting at an apex at the lower end of the bit, each of said raised portions having a groove along its peak, cutting edges comprising blades partially inserted and fastened in said grooves at a leading angle of 10° to 30° to a radial line from the axis of the bit, said blades having a transverse cross-section substantially in the form of a parallelogram, passage means through said hollow body for conducting and directing circulation fluid against the forward side of said cutting edges, and means in the upper end of said hollow body for connecting the bit to a drill string.

3. An improved drill bit for rotary drilling of wells comprising a hollow body formed with a plurality of raised portions curved spirally downwardly in the direction of rotation of the bit and substantially meeting at an apex at the lower end of the bit, each face between pairs of raised portions on said body being formed with a relatively long inwardly-receding portion and a relatively short outwardly and sharply inclined portion arranged with said sharply inclined portion adjacent the leading side of said raised portions, said raised portions having formation cutting edges, said raised portions and said cutting edges together with said hollow body being formed to describe upon rotation of the bit a substantially hyperboloidal figure of revolution, passage means through said hollow body for conducting and directing circulation fluid against the forward side of the cutting edges, and means in the upper end of said hollow body for connecting the bit to a drill string.

4. An improved drill bit for rotary drilling of wells comprising a hollow body formed with a plurality of raised portions curved spirally downwardly in the direction of rotation of the bit and substantially meeting at an apex at the lower end of the bit, each face between pairs of raised portions on said body being formed with a relatively long inwardly-receding portion and a relatively short outwardly and sharply inclined portion arranged with said sharply inclined portion adjacent the leading sides of said raised portions, streamlined bulges spaced along the junctures of said receding and sharply inclined portions of the faces between the raised portions, each of said raised portions having a groove along its peak, cutting edges comprising blades of hardened steel partially inserted and fastened in said grooves at an angle of 10° to 30° to a radial line of the bit, said blades having a transverse cross-section substantially in the form of a parallelogram, said raised portions and cutting edges together with said hollow body being formed to describe upon rotation of the bit a substantially hyperboloidal figure of revolution, passage means extending through the walls of said hollow body and said bulges, the outlet opening of said passages in said bulges being directed upwardly along the leading side of the cutting edges, and means in the upper end of said hollow body for connecting the bit to a drill string.

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