Jan. 30, 1934. H. T. TUPICA 1,945,240

ROTARY DRILL BIT

Filed July 13, 1932

FIG. 1.

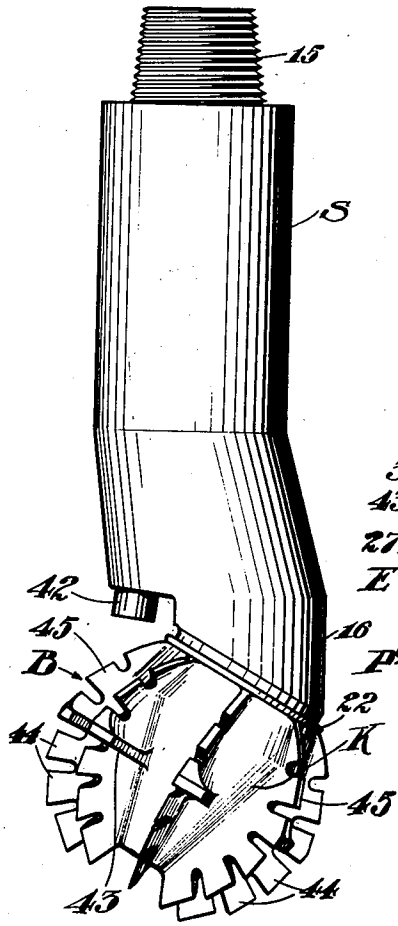


FIG. 2.

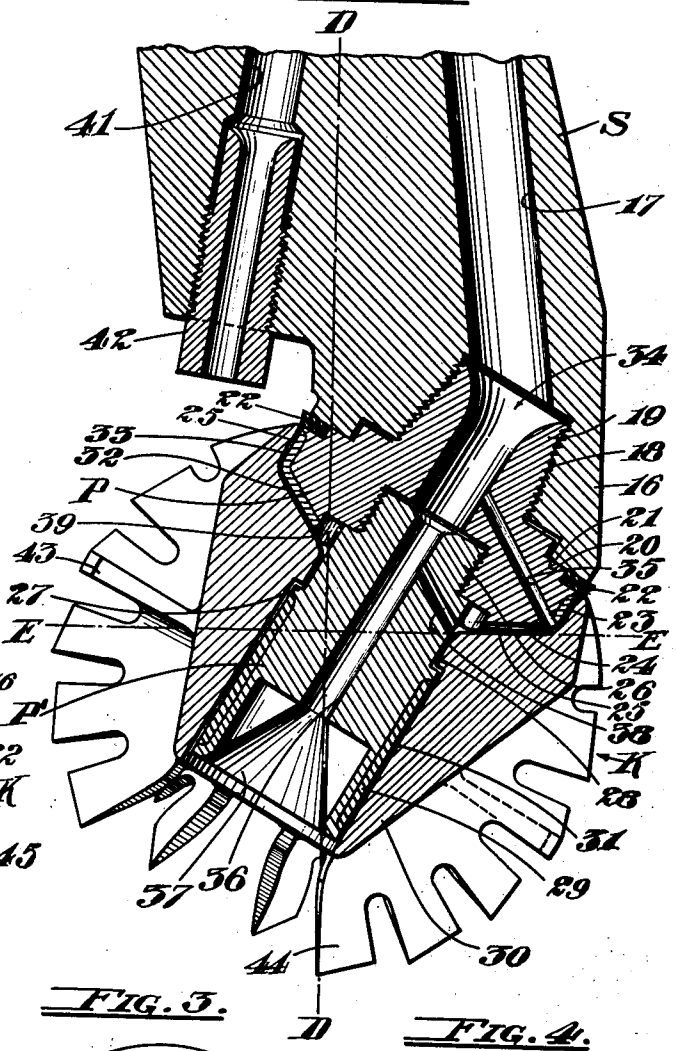


FIG. 3.

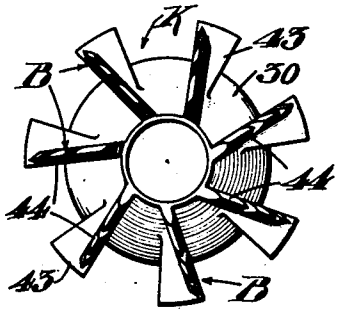
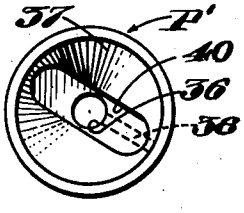
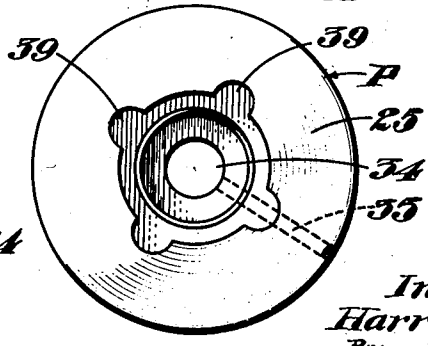


FIG. 4.





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ROTARY DRILL BIT

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14 Claims. (Cl. 255—71)

My invention relates to rotary drill bits as used in rotary apparatus for drilling wells, and it has particular reference to drill bits of the Zublin type or that type having a cutter rotatable on an inclined pin carried eccentrically by a stem which is adapted to be fixed to a rotary drill pipe.

Because of the manner in which the cutter is mounted and secured to the pin, as well as the structure of the pin, drill bits of the Zublin type as heretofore constructed present numerous disadvantages among which are the following:

The cutter in its rotative movement has direct bearing contact with the stem, and the bearing and journal surfaces of the pin and cutter are such as to cause the weight of the drill pipe to impose on the stem additional transverse bearing stresses. The stem, as a natural consequence, is caused to wear relatively rapidly. Repairing a worn stem is not only expensive but in most cases extremely difficult, because in refacing the worn part of the stem the temper of the metal is destroyed, thus rendering the stem useless.

The cutter, in the Zublin type of bit, is so associated with the stem as to leave an open joint into which sand, cuttings, and other solid matter is deposited to bind and in many cases lock the cutter against rotation on the pin. In consequence, the cutter fails to function as intended and in many cases is twisted off and lost in the well.

This latter disadvantage leads to the further handicap in those bits employing balls for locking the cutter to the stem to permit rotation of the cutter on the stem, of solid matter entering the ball races and preventing rotation of the balls to jam and thus lock the cutter against rotation on the stem and pin. Further, the balls when jammed in the races, are impossible of removal when attempting to release the cutter from the stem, and, as a consequence, it is impossible to remove the cutter from the stem or pin under these conditions.

A further and important disadvantage of the heretofore proposed bits is that the circulation fluid is not delivered onto the exterior of the cutter as to prevent accumulation of formation or diggings on the surface of the cutter, and, as a result, the cutter becomes "balled up" and its drilling efficiency greatly reduced as a consequence.

It is a purpose of my invention to provide a rotary drill bit of the type herein described which eliminates the disadvantages above pointed out by so mounting the cutter on the pin that it is out of rotating contact with the stem and, therefore, the stem is not subjected to wear by reason of the rotating cutter.

On the contrary all such wear is imposed directly on the pin so that refacing or renewal of the stem is rendered unnecessary, and reconditioning of the bit as a whole can when necessary, be effected by merely repairing or renewing the pin or the cutter or both. Further, means is provided for detachably securing the cutter to the pin and the pin to the stem, and this means avoids the use of balls or any other elements which present the disadvantages enumerated. Such securing means permits the use of a sealing device which, as applied, functions to exclude the entrance of solid matter between the pin and cutter so that by making provision for and causing high pressure circulation of a lubricating slush fluid between the pin and cutter, permanently free rotation of the cutter is assured.

It is also a purpose of my invention to provide a cutter for use on bits of this character in which the cutter body is shaped to preserve maximum thickness to the end of maintaining maximum torsional strength and to coact with a slush circulation passage for maintaining the cutter body devoid of accumulations and thus preventing "balling up".

A further purpose of my invention is the provision of a cutter having a novel construction and arrangement of blades which results in a new mode of operation of the cutter as a whole.

I will describe only one form of rotary drill bit embodying my invention, and will then point out the novel features thereof in claims.

In the accompanying drawing:

Fig. 1 is a view showing in side elevation one form of rotary drill bit embodying my invention.

Fig. 2 is an enlarged fragmentary central vertical sectional view of the bit shown in Fig. 1.

Fig. 3 is a bottom plan view of the thrust-bearing pin shown in Fig. 2.

Fig. 4 is a bottom plan view of the radial-bearing pin shown in Fig. 2.

Fig. 5 is a bottom plan view of the cutter shown in Fig. 1.

Referring specifically to the drawing and particularly to Fig. 1, my invention comprises the conventional stem or shank S which is formed at its upper end with the usual threaded pin 15 by which the bit as a whole is connected to a rotary drill pipe (not shown) for rotation thereby in the operation of the bit. The lower end of the stem is formed with a portion 16 eccentric thereon so that when rotated it imparts to a cutter K

the intended three dimensional movement characteristic of the Zublin type of bit.

As shown in Fig. 2, the stem S is formed with a passage 17 for circulation of a slush fluid downward to the end of the eccentric portion 16 and axially of a box 18 in which is screwed the tapered end 19 of a thrust-bearing pin P. Radially of the box 18, the stem is recessed to form an annular shoulder 20 against which abuts a similar shoulder 21 on the pin P, but the shoulder is inset from the periphery of the pin to accommodate a sealing gasket 22. This gasket is at the upper edge of a peripheral and radial-bearing surface 23 of the pin P, the lower side of the pin being of frusto-conical form to provide a correspondingly shaped thrust-bearing surface 24. Both surfaces 23 and 24 are faced with any suitable wear-resisting alloy indicated at 25.

Axially of the bearing surface 24, the pin P is recessed and threaded to receive a threaded and reduced extension 26 of a radial-bearing pin P' and by which the pin P' is detachably secured to the pin P. The cutter K is rotatably mounted on this pin P' and, as best shown in Fig. 2, the cutter is locked thereon against displacement downward by the provision of annular shoulders 27 and 28 on the pin and cutter, respectively. The shoulder 28 is relatively wide for strength, and the shoulder 27 is reinforced by a facing sleeve 29 of wear-resisting alloy which is seated in an annular groove of the pin.

To receive the radial-bearing pin P', the body 30 of the cutter K is bored axially as shown, with the shoulder 28 on the wall of the bore. This wall provides a radial journal face 31 which has rotating contact with the periphery of the pin P', the latter providing a radial bearing surface.

The bore of the cutter K at its upper end communicates with a cupped portion in the cutter which corresponds in shape to that of the thrust-bearing surface 24 and the radial-bearing surface 23, and provides a thrust journal face 32 and a radial journal face 33 which have rotating contact with the surfaces 23 and 24, respectively.

The cutter body 30 at its upper edge, has contact with the gasket 22 so that the gasket serves to span and thus seal the joint between the surfaces 23 and 31 against the admission of sand, cuttings or any other solid matter which, if admitted, would bind the cutter against free rotation on the pin. As will be noted, the outer edge of the gasket is beveled downward so as to present an inclined surface to the edge of the cutter body. This is for the purpose of causing the body edge to press the gasket inward as it creeps upward because of wearing away of the thrust and journal surfaces of the cutter body and pins. As a result of this pressing action, the gasket is expanded and thus caused to maintain the joint sealed against the admission of solid matter.

An important feature of my invention is the positioning of the lowermost portion of the frusto-conical bearing surface 24 of the cutter and the pin P in a plane perpendicular to the stem axis. Lines D—D and E—E, in Fig. 2, designate, respectively, the stem axis and the plane of the lowermost portion of the surface 24. In consequence of such an arrangement, the tremendous load of the drill pipe which is imposed on this bearing, is distributed evenly over the lower half of the bearing and particularly transversely of the bearing, thus insuring free rotation of the cutter as well as uniform wear thereof.

For lubricating the mated surfaces and faces of the cutter body and pins to insure free rotation of the cutter with minimum wear, passages and ducts are provided through which the usual slush can be circulated. As shown in Fig. 2, a passage 34 axially in the pin P communicates with the upper end of the stem passage 17. The upper end of the passage 34 is of funnel form, tapering into a passage of smaller diameter than the passage 17 to increase the pressure with which the slush fluid is circulated. The funnel shaped entrance eliminates abrupt shoulders which tend to form eddy currents that rapidly wear away the walls of the passages. From the passage 34 a duct 35 leads to the junction of the surfaces 23 and 24 to deliver a jet of slush between the pin P and the cutter body.

The pin P' is likewise formed with an axial passage 36 of less diameter than the passage 34, and this passage conducts the slush through the pin discharging it from the pin into the hole directly beneath the cutter. The passage, at its lower end, leads into an outlet 37 which is funnel-shaped for the purpose of insuring free discharge of the slush even when the lower end of the pin and cutter body become badly worn. A duct 38 leads from the passage 36 to the bottom of the cupped portion of the cutter body so that the slush as emitted is discharged downward around the pin P' with the slush from the duct 35 so as to thoroughly lubricate the pin and cutter before its final discharge from the bottom of the cutter.

To facilitate removal of the pins P and P' incident to repairing or replacing worn pins or a worn cutter, the lower end of the pin P is formed with a plurality of pockets 39 spaced circumferentially about the axis of the pin as shown in Fig. 3, to receive a special form of wrench (not shown) and by means of which the pin can be readily unscrewed from the stem once the pin P' has been removed. As shown in Fig. 4, the lower end of the pin P' is formed with a diametric slot or pocket 40 in which another special form of wrench (not shown) can be inserted for unscrewing the pin P' from the pin P.

When the two pins P and P' and the cutter K are assembled as shown in Fig. 2, the pin P serves to maintain the pin P' attached to the stem S, while the pin P' not only forms a mounting for the cutter K upon which it rotates, but by virtue of the shoulders 20 and 21, the cutter is retained against displacement from the pin. The cutter body 30 contacts only with the pins P and P' and, hence, all wear occurs on the pins and not on any part of the stem S so that the latter is never impaired and the substitution of the pins or cutter or both are the only replacements necessary.

As shown in Figs. 1 and 2, the cutter body 30 is generally of frusto-conical form, thus providing the advantage of preserving maximum thickness to maintain maximum strength so that it can successfully withstand the tremendous torsional, longitudinal, and transverse stresses to which it is subjected when in use. This shape body provides the further advantage of permitting a slush stream to be used in such manner as to maintain the cutter body surface free of all accumulations to prevent "balling up" of the cutter.

As shown in Fig. 2, the stem S is formed with another slush passage 41 having the usual nozzle 42 at its lower end. This passage and nozzle are so situated with respect to the surface of the

cutter body that the slush stream as discharged therefrom extends substantially parallel thereto but so as to have contact herewith over its entire length and to thereby maintain the surface free of all accumulations.

The cutter body 30 is provided with a series of blades B, with each blade extending from top to bottom of the body and of arcuate form to lend a spherical contour to the cutter as a whole. Each blade B extends substantially spirally of the body and consists of a plurality of teeth each of which decreases in thickness but increases in width from its base or point of connection with the cutter body to its free end. By increasing the width of the tooth as described there is presented the advantage of increasing or at least not diminishing the penetrating ability of the tooth as it wears away, rather than decrease the penetrating ability as would be the case if the tooth decreased in width as it approaches its free end.

By forming each blade with a plurality of teeth and arranging the several blades spirally on the cutter body, retracking in the formation being drilled of the teeth of any one blade with respect to the teeth of an adjacent blade, is prevented and the drilling efficiency of the cutter as a whole increased.

As best shown in Figs. 1 and 2, there are three forms of teeth to each blade, namely, a transverse reaming tooth 43 medially of the blade ends; a plurality of drilling teeth 44 below the tooth 43; and a plurality of reaming teeth 45 above the tooth 43.

Although I have herein shown and described only one form of rotary drill bit, it is to be understood that various changes may be made herein without departing from the spirit of my invention and the spirit and scope of the appended claims.

I claim:

1. A rotary drill bit comprising; a stem; a thrust-bearing pin removably secured to the stem; a radial-bearing pin removably secured to the first pin; a cutter rotatable on the radial bearing pin and bearing against the thrust-bearing pin; and coacting means on the cutter and radial-bearing pin for securing the former against displacement from the latter.

2. A rotary drill bit comprising; a stem; a thrust-bearing pin removably secured to the stem; a radial-bearing pin removably secured to the first pin; a cutter rotatable on the radial bearing pin and bearing against the thrust-bearing pin; coacting means on the cutter and radial-bearing pin for securing the former against displacement from the latter; and means for sealing the joint between the cutter and the thrust-bearing pin against the admission of solid matter.

3. A rotary drill bit comprising; a stem; a thrust-bearing pin removably secured to the stem; a radial-bearing pin removably secured to the first pin; a cutter rotatable on the radial bearing pin and bearing against the thrust-bearing pin; coacting means on the cutter and radial-bearing pin for securing the former against displacement from the latter; and an elastic gasket for sealing the joint between the cutter and the thrust-bearing pin against the admission of solid matter.

4. A rotary drill bit comprising; a stem having an eccentric portion at its lower end; a pin inclined and secured to the eccentric portion; and a cutter rotatably concentric on the pin; said pin and said cutter having conical thrust-bearing and journal surfaces, respectively, the lowermost portion of which lies in a plane perpendicular to the major axis of the stem.

5. A rotary drill bit comprising; a stem having an eccentric portion at its lower end; a thrust-bearing pin removably secured to the eccentric portion and inclined thereto; a radial-bearing pin removably secured to the first pin and alined therewith; a cutter rotatable on the radial-bearing pin; said thrust-bearing pin and said cutter having contacting surfaces a portion of which lie in a plane at right angles to the major axis of the stem; and coacting means on the cutter and radial-bearing pin for securing the former against displacement from the latter.

6. A rotary drill bit comprising: a stem having an eccentric portion at its lower end; a thrust-bearing pin removably secured to the eccentric portion and inclined thereto; a radial-bearing pin removably secured to the first pin and alined therewith; a cutter rotatable on the radial-bearing pin, said thrust-bearing pin and said cutter having contacting surfaces a portion of which lie in a plane at right angles to the major axis of the stem; coacting means on the cutter and radial-bearing pin for securing the former against displacement from the latter; and means for sealing the joint between the said contacting surfaces against the admission of solid matter.

7. A rotary drill bit comprising: a stem; a thrust-bearing pin removably secured to the stem; a radial-bearing pin removably secured to the first pin; a cutter rotatable on the radial-bearing pin; and annular shoulders on the cutter and radial-bearing pin for securing the former against displacement from the latter.

8. A rotary drill bit comprising: a stem; a pin secured to the stem and having a thrust-bearing surface; a cutter rotatable on the stem and having a journal-bearing surface contacting with said thrust-bearing surface; an elastic gasket on the pin for sealing the joint between said surfaces; and means on the cutter engaging the gasket to expand the latter as either surface wears to maintain a sealed joint between said surfaces.

9. A rotary drill bit comprising: a stem; a pin secured to the stem and having a thrust-bearing surface; a cutter rotatable on the stem and having a journal-bearing surface contacting with said thrust-bearing surface; and an elastic gasket on the pin for sealing the joint at the outer edges of said surfaces, said gasket having a portion projecting across the joint and engageable by the cutter to be expanded thereby as either surface wears and thus maintain the joint sealed.

10. A rotary drill bit comprising: a stem having a passage downward therethrough and an eccentric portion with which said passage connects; a thrust-bearing pin secured in the eccentric portion and provided with an axial passage communicating with the stem passage, said pin having a frusto-conical bearing surface at its bottom and a peripheral-bearing surface at its side; a duct in the pin leading from the axial passage to the frusto-conical bearing surface; a radial-bearing pin secured to the lower end of the first pin and having an axial passage of funnel form at its lower end, a duct leading from said passage to the periphery of the pin; a cutter rotatable on the radial-bearing pin and having a cupped upper part conforming in contour to the side and lower end of the thrust-bearing pin; annular shoulders on the cutter and the radial-bearing pin for confining the former against displacement from the latter and in such manner as to permit limited

movement of the cutter upward to abut the said frustro-conical bearing surface.

11. A rotary drill bit as embodied in claim 10 wherein a gasket is secured between the stem and thrust-bearing pin so as to span and thus seal the joint between the upper edge of the cutter and the thrust-bearing pin.

12. A rotary drill bit comprising; a stem; a thrust-bearing pin threaded in the stem; a radial-bearing pin threaded in the thrust-bearing pin; a cutter rotatable on the radial-bearing pin and bearing against the thrust-bearing pin; said thrust-bearing pin having pockets spaced circumferentially about the axis of the pin adapted to receive parts of a wrench for unscrewing the pin from the stem; said radial-bearing pin having a transverse recess in its end adapted to receive a wrench for unscrewing the pin from the thrust-bearing pin.

13. A rotary drill bit comprising; a stem; a thrust-bearing pin removably secured to the stem; a radial-bearing pin secured to the first pin; a cutter rotatable on the radial bearing pin; and means for securing the cutter against displacement from the radial-bearing pin.

14. A rotary drill bit comprising; a stem; a thrust-bearing pin removably secured to the stem; a radial-bearing pin secured to the first pin; a cutter rotatable on the radial bearing pin; means for securing the cutter against displacement from the radial bearing pin; and means for sealing the joint between the cutter and the radial-bearing pin against the admission of solid matter.

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