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ROCK BIT DULLNESS INDICATOR

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Fig. 1.

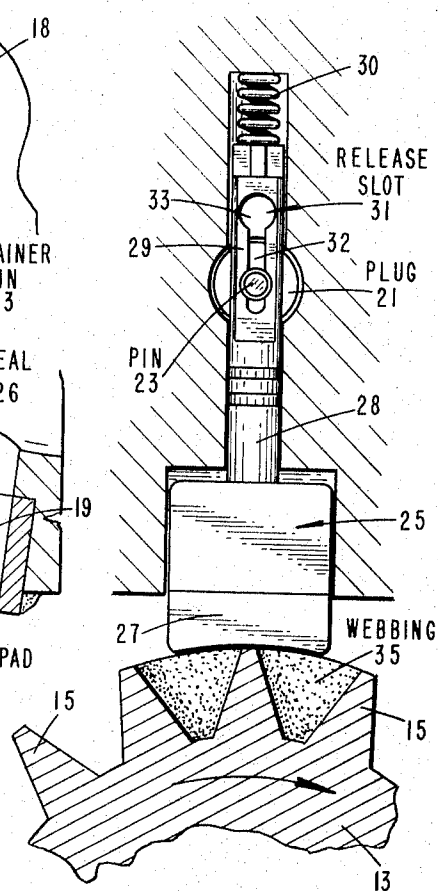
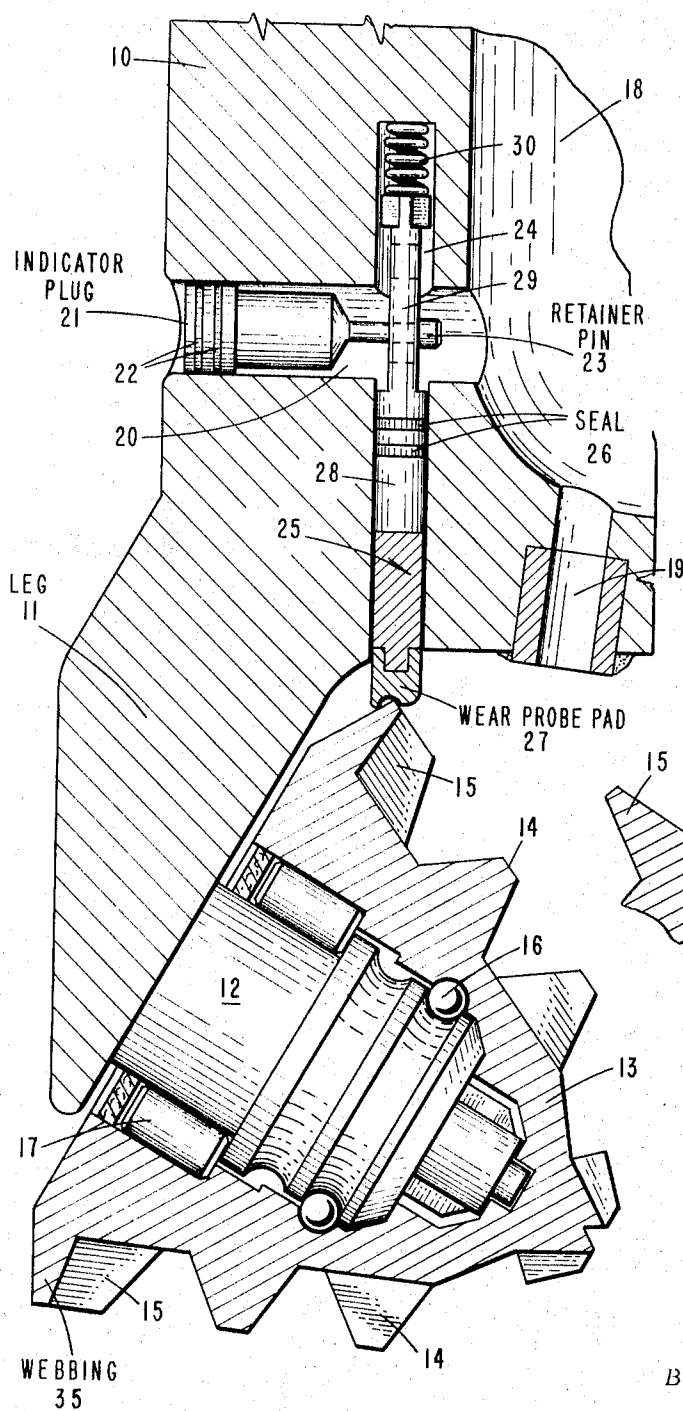


Fig. 2.

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ROCK BIT DULLNESS INDICATOR

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6 Claims. (Cl. 175-39)

The present invention concerns drill bit apparatus for use in drilling boreholes in the earth. More particularly, the invention concerns a roller cone-type drill bit which, when worn to the extent that further use of the bit would result in inefficient drilling operations, will give an indication of such wear at the surface of the earth.

In rotary drilling, a commonly used method in drilling boreholes, a drill bit attached to the lower end of a string of drill pipe is suspended from the surface of the earth. During drilling operations, a drilling fluid under high pressure is forced downwardly through the drill string, through the drill bit and back to the surface through the annulus between the drill pipe and the wall of the borehole. The drill bit is rotated by rotation of the drill pipe at the earth's surface.

A rock bit or roller-cone bit, a common type of bit in use, is normally composed of a shank member, which threadedly connects to the lower end of the string of drill pipe, having two or three leg members which extend downwardly from the shank. The lower end of each leg member forms a shaft which extends inwardly and downwardly toward the axis of the bit. Roller-cone cutters are rotatably supported on the shaft of each leg. As the drill pipe is rotated, the bit also rotates and as the bit rotates, each individual cone cutter rotates about the shaft of the leg member on which it is supported. The cone also rotates about the bottom of the hole. The cutting surfaces or teeth of each cone contact the bottom of the hole to dislodge the formation material by twisting, tearing, gouging, chipping and crushing action.

The condition of the cutter teeth on the rotary rock bit is important in the drilling of deep wells and it is especially important to know when the teeth are worn to the extent that inefficient drilling results from further use of the rock bit.

Therefore, a primary object of the present invention is to provide a new and improved rotary rock bit which will give indications at the earth's surface when the teeth of the bit have become so worn that further use thereof would result in inefficient drilling operations.

In accordance with the teachings of the present invention, the well drill bit comprises a shank attachable to the lower end of a drill string; a leg thereon having a shaft integral with and extending inwardly of said leg; a cone containing cutter teeth rotatively mounted on said shaft; a first chamber adjacent said bit capable of fluidly communicating the interior and exterior of said drill string; a plug removably arranged in said first chamber; a second chamber intersecting said first chamber; a wear probe means arranged in said second chamber and extending therefrom to engage teeth of said cone; means releasably coupling said indicator plug and said probe means to permit fluid pressure within said drill string to remove said indicator plug upon movement of said probe means downwardly in response to wear of said teeth in contact with said probe means whereby an indication of removal of said indicator plug is provided at the surface by a drop in drilling fluid circulating pressure. The probe means is preferably arranged so as to engage the heel teeth of the cone containing the most webbed teeth. Although fluid pressure exerted on the probe means from within the drill string should provide adequate downward force to maintain the probe means in contact with the teeth of the cone, where additional downward force is

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desired or necessary, a compression spring located above the probe means may be used to apply such additional force to the probe means.

The above object and other objects and advantages of the invention will be apparent from a more detailed description thereof when taken with the drawings wherein:

FIG. 1 is a front view partly in section illustrating the drill bit apparatus in accordance with the invention prior to excessive wear of the teeth of the bit; and

FIG. 2 is a side view of a portion of the drill bit apparatus shown in FIG. 1.

Referring to the drawings in greater detail, in FIG. 1 is shown a bit shank 10 attachable to the lower end of a string of drill pipe (not shown) from which a leg portion 11 downwardly extends. Two or three such leg portions are usually provided; however, for purposes of illustrating this invention, only one leg portion and associated elements will be described. A spindle or shaft 12 formed integral with leg member 11 extends downwardly and inwardly toward the axis of the bit. A roller cone 13 provided with cutter teeth 14 including heel teeth 15 is rotatably mounted on spindle 12 by means of antifriction bearings 16 and 17. Shank 10 has an interior chamber 18 in fluid communication with the interior of the drill pipe at its upper end (not shown) and a passageway 19 at its lower end to provide a conduit for the drilling fluid through the shank of the drill bit to the cutters thereof. A cylindrical chamber or hole 20 extending laterally from the exterior of shank 10 to the interior chamber 18 is formed in shank 10. An indicator plug 21 provided with seals 22 at one end and a retainer pin 23 at the other end thereof is arranged in chamber 20.

Another chamber 24 formed in shank 10 extends downwardly from above chamber 20 to the interior of leg 11 adjacent the row of heel teeth 15 and intersects chamber 20. As also shown in FIG. 2, a wear probe 25, provided with seals 26 and a wear probe pad 27 and formed of enlarged and narrowed portions 28 and 29, respectively, is arranged in chamber 24. A compression spring 30 is arranged in chamber 24 above the upper end of wear probe 25. A release slot 31 having a narrowed portion 32 and an enlarged portion 33 is formed in wear probe 25 adjacent intersection of chambers 20 and 24. Retainer pin 23 extends through release slot 31, as shown in FIGS. 1 and 2.

Wear probe 25 is arranged to engage the heel teeth of one of the cutter cones, preferably of the cutter cone, if any, which contains the most webbed heel teeth. The webbing designated 35 in FIG. 2 inhibits excessive "gauge" wear, breaks up the bottom of the hole adjacent the borehole wall and removes rock teeth at the junction of the borehole wall and the bottom of the borehole. Such webbing may interconnect two teeth, three teeth, or four teeth. It is not necessary for the row of heel teeth to contain webbing, for the wear probe would be made sufficiently wide so that its lower surface would always be in contact with at least two teeth.

Attention is now directed to operation of the drill bit. With the elements of the drill bit in their positions shown in FIGS. 1 and 2, drilling fluid is circulated down the drill string through chamber 18 and passageway 19 and around the cutter cones 13 and upwardly past shank 10 and through the annulus between the drill pipe and the borehole wall to the earth's surface. While drilling fluid is circulated in this manner, the drill pipe and shank 10 are rotated, which causes cone 13 to rotate on spindle 12. Wear probe 25 is urged downwardly by pressure of the circulating drilling fluid acting on the upper surface of the enlarged diameter portion seals 26 of wear probe 25 (and also, if included, by compression spring 30) into engagement with the row of heel teeth 15. Indicator plug

21 is retained in chamber 20 by means of retainer pin 23 which is held in the narrow portion 32 of release slot 31. As the teeth 15 of cutter 13 wear down, wear probe 25, continually urged into engagement with teeth 15, moves downwardly. Fluid pressure from the circulating drilling fluid acts against the indicator plug and when wear probe 25 moves downwardly a sufficient amount to position enlarged portion 33 of release slot 31 adjacent retainer pin 23, indicator plug 21 is released and is removed from chamber 20 by the circulating drilling fluid. A distinct drop in drilling fluid circulating pressure is then indicated at the surface, which shows that the heel teeth on cone 13 are worn to such an extent that inefficient drilling will result from further use of the bit.

The invention is not to be restricted to the specific details set forth as various modifications thereof may be made without departing from the scope of this invention. For example, a short sub member mounted on the bit could be provided with the chamber and indicator plug instead of the shank of the bit as shown and described above. In such modification, the wear probe would extend through a hole bored in the bit.

Having fully described the objects, advantages, apparatus and mode of operation of my invention, I claim:

1. A drill bit comprising:

- a shank member;
- a leg extending therefrom provided with a shaft extending downwardly and inwardly of said leg;
- a cone containing rows of cutter teeth rotatively mounted on said shaft;
- a first chamber in said shank extending from the exterior to the interior thereof in fluid communication with said circulating drilling fluid;
- an indicator plug removably arranged in said first chamber;
- a second chamber in said shank intersecting said first chamber and containing probe means, the lower end of which engages said cone teeth; and
- means releasably coupling said indicator plug and said probe means adapted to release said indicator plug to permit removal of said indicator plug by drilling fluid pressure within said shank upon downward movement of said probe means in response to wear of said cone teeth whereby an indication of removal of said indicator plug is provided at the surface by a drop in drilling fluid circulating pressure.

2. A drill bit as recited in claim 1 including a compression spring arranged in said second chamber above said probe means adapted to urge said probe means downwardly into engagement with said cone teeth.

3. A drill bit as recited in claim 1 in which said means coupling said indicator plug and said probe means in-

cludes a release slot in said probe means having a narrow portion and an enlarged portion and including a retainer pin arranged on said indicator plug, said narrow slot portion retaining said pin and said enlarged slot portion permitting release of said pin to permit drilling fluid pressure to remove said indicator plug from said first chamber.

4. In rotary drilling apparatus employing a drill string through which drilling fluid is circulated during drilling operations, the improvement comprising:

- means attachable to the lower end of said drill string having means containing cutter teeth rotatively mounted thereon;
 - a first chamber formed in said means attachable to the lower end of said drill string capable of fluidly communicating the interior and exterior of said drill string;
 - an indicator plug removably arranged in said first chamber;
 - a second chamber formed in said means attachable to the lower end of said drill string intersecting said first chamber and containing probe means the lower end of which engages said cutter teeth; and
 - means releasably coupling said indicator plug and said probe means adapted to release said indicator plug to permit removal of said indicator plug by drilling fluid circulating pressure upon downward movement of said probe means in response to wear of said cutter teeth whereby an indication of removal of said indicator plug is provided at the surface by a drop in drilling fluid circulating pressure.
5. Apparatus as recited in claim 4 including spring means arranged in said second chamber above said probe means adapted to urge said probe means downwardly into engagement with said cutter teeth.
6. Apparatus as recited in claim 4 in which said means coupling said indicator plug and said probe means includes a release slot in said probe means having a narrow portion and an enlarged portion and including a retainer pin arranged on said indicator plug, said narrow slot portion retaining said pin and said enlarged slot portion permitting release of said pin to permit drilling fluid pressure to remove said indicator plug from said first chamber.

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